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The contribution of agroforestry systems to climate change mitigation - Assessment of C storage in soils in a Mediterreanean context

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To cite this version:

Claire Chenu, Rémi Cardinael, Tiphaine Chevallier, - Germon A, Christophe Jourdan, et al.. The contribution of agroforestry systems to climate change mitigation - Assessment of C storage in soils in a Mediterreanean context. International scientific and professional conference, Our common future under climate change, Jul 2015, Paris, France. 858 p., 2015. hal-02739812

HAL Id: hal-02739812

https://hal.inrae.fr/hal-02739812

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International Scientific Conference

ABSTRACT BOOK

7-10 July 2015 • Paris, France

This Abstract book is based on a compilation of all abstracts selected for oral and poster presentations, as of 15 May 2015.

Due to the inability of some authors to attend, some of those works will therefore not be presented during the conference.

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Welcome to the Conference

Welcome to Paris, welcome to 'Our Common Future under Climate Change'!

On behalf of the High Level Board, the Organizing Committee and the Scientific Committee, it is our pleasure to welcome you to Paris to the largest forum for the scientific community to come together ahead of COP21, hosted by France in December 2015 ("Paris Climat 2015").

Building on the results of the IPCC 5th Assessment Report (AR5), this four-day conference will address key issues concerning climate change in the broader context of global change. It will offer an opportunity to discuss solutions for both mitigation and adaptation issues. The Conference also aims to contribute to a science-society dialogue, notably thanks to specific sessions with stakeholders during the event and through nearly 80 accredited side events taking place all around the world from June 1st to July 15th.

When putting together this event over the past months, we were greatly encouraged by the huge interest from the global scientific community, with more than 400 parallel sessions and 2200 abstracts submitted, eventually leading to the organization of 140 parallel sessions.

Strong support was also received from many public French, European and international institutions and organizations, allowing us to invite many keynote speakers and fund the participation of more than 120 young researchers from developing countries. Let us warmly thank all those who made this possible.

The International Scientific Committee deserves warm thanks for designing plenary and large parallel sessions as well as supervising the call for contributions and the call for sessions, as well as the merging process of more than 400 parallel sessions into 140 parallel sessions. The Organizing Committee did its best to ensure that the overall organization for the conference was relevant to the objectives and scope. The High Level Board raised the funds, engaged the scientific community to contribute and accredited side events. The Conference Secretariat worked hard to make this event happening. The Communication Advisory Board was instrumental in launching and framing our communication activities on different media. We are very grateful to all.

We very much hope that you will enjoy your stay in Paris and benefit from exciting scientific interactions, contributing to the future scientific agenda. We also hope that the conference will facilitate, encourage and develop connections between scientists and stakeholders, allowing to draw new avenues in the research agenda engaging the scientific community to elaborate, asses and monitor solutions to tackle climate change together with other major global challenges, including sustainable development goals.

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L1.1 - Climate variability and change over the last millennia: Paleoclimate information and climate simulations

K-L1.1-01

Model-data comparison over the last millennium: progress, uncertainties and challenges

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Present day climate variability and change, including recent anthropogenic warming, poses questions that cannot be answered based solely upon instrumental records. The last two millennia (L2k), and specifically the last millennium (LM), are immediate temporal intervals that involve climate processes similar to nowadays. The last 2k and LM have the potential to expand our understanding of climate variability from inter-annual and decadal to multi-centennial timescales, place a wider context for current warming and explore internally induced and externally forced responses of the climate system. Knowledge about proxy-based climate reconstructions, paleoclimate model simulations and estimations of external radiative forcing emerge then as key elements to gain insights about the relative roles of internal versus forced variability.

Comparisons of last millennium simulations and reconstructions constitute opportunities for learning about pre-instrumental climate variability beyond the lessons that climate simulations or reconstruction efforts can offer by themselves. Model-data comparisons provide insight about the relative roles of internal variability and external natural or anthropogenic induced changes and the processes involved. The relatively short ranges of external forcing variability within the last 2k/LM nevertheless make these comparisons challenging and further complicated by the large uncertainties that affect both reconstructions and model simulations (Masson-Delmotte et al. 2013).

This work reports on the progress of about a decade of efforts in L2k/LM model-data comparison and discusses how model-data comparison exercises focused on the last millennium can improve our understanding of decadal to multi-centennial climate variability as well as contribute to our knowledge of present and future climate and/or associated projection uncertainties. For this purpose, the available continental, hemispherical and global L2k/LM temperature reconstructions, an ensemble of simulations including both Paleoclimate Modelling Intercomparison Project Phase III / Coupled Model Intercomparison Project Phase 5 (PMIP3/CMIP5; Taylor et al 2012) and non-PMIP3 model experiments, as well as the external forcing configurations applied (Schmidt et al 2012) are analysed. In addition, for each simulation considered, a total external forcing (TEF), including all individual forcing factors, is estimated as a simple approach to compare the total radiative forcing applied to each experiment (Fernández-Donado et al., 2013).

At hemispherical and global scales, simulations and reconstructions broadly agree on the major temperature changes and suggest, despite the important influence of the internal variability, an overall linear response to external forcing above multidecadal timescales. The rate of temperature response to LM changes in TEF is quantified as a metric of the transient climate response during the LM (LMTCR) and its distribution from the model and reconstructed ensembles are compared to other estimates of climate sensitivity and transient climate response. LMTCR also allows to frame a simple quantitative comparison between simulations and reconstructions where discrepant behaviors can be singled out. The uncertainties in reconstructions and model experiments that impact our understanding of simulated and reconstruction responses at these spatial scales are also discussed.

At regional/continental scales we focus on the assessment of PMIP3/CMIP5 experiments and temperature reconstructions developed within the PAGES 2k project (PAGES 2k consortium 2013) and their responses to forcing and report on their consistency across regions and timescales. Inter-regional behavior is more homogeneous in the simulated than in the reconstructed climates. Agreement between simulations and reconstructions is higher for Northern Hemisphere regions whilst models disagree more with the reconstructions in the Southern Hemisphere.

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K-L1.1-02

Variability of the North Atlantic Oscillation during the past millennium

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The North Atlantic Oscillation (NAO) is the dominant mode of winter atmospheric circulation variability in the Northern Hemisphere. This atmospheric mode is characterized by a changing dipole of sea-level pressure between the Azores and Iceland, and has widespread impacts on temperature, precipitation, storm tracks and therefore on strategic sectors such as insurance, renewable energy production, crop yields and water management.

Recent developments of dynamical methods offer promising advances for seasonal NAO predictions. However, assessing potential predictability at multi-annual time scales requires a documentation of past NAO low-frequency variability. A recent bi-proxy NAO reconstruction spanning the last millennium suggests that long-lasting positive NAO conditions were established during medieval times, explaining the particularly warm conditions over Europe; however, this result is still debated. Here, we present a new annually-resolved NAO reconstruction for the last millennium based on an initial selection of 48 proxy records distributed around the Atlantic Ocean and surrounding continents and built through an ensemble of multivariate regressions. This approach has been validated in perfect model analyses, using climate simulations as physically consistent surrogates of the real world. The analysis makes evident that the multi-proxy reconstruction outperforms the bi-proxy index.

The final reconstruction shows no persistent positive NAO during the medieval period, but suggests that positive phases were dominant during the thirteenth and fourteenth

centuries. It also reveals that a positive NAO emerges two years after strong volcanic eruptions, consistent with results obtained from models and satellite observations for the Mt Pinatubo eruption in the Philippines.

K-L1.1-03

European summer hydroclimate variability during the last millennium

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Associated with global warming, changes in extreme weather and climate events have been observed in Europe, including increased frequencies of heat waves as well as the frequency or intensity of heavy precipitation events. In a future warmer world, it is likely that the risk of hydroclimatological extremes will increase. Extreme hydroclimate events, such as droughts and floods, can have significant impacts on society, e.g. by affecting food availability, water quality, health, energy, infrastructure etc., but also on ecosystems. It is apparent that climate variability and change already pose a challenge to Europe's economic sectors, production systems, and ecosystems. Increased drought frequency will significantly affect natural and human systems, and compared to other hazards, hey can persist for long periods and affect large areas. Floods, associated with heavy precipitation events, can pose threats to human life and property, and also affect water quality, e.g. by spreading pollutants and fertilizers.

Clearly, society must prepare for an intensification of hydroclimate extremes in the future. However, major uncertainties and knowledge gaps still exist in understanding and modeling hydroclimate, making it difficult to quantify future changes and their impacts on systems and sectors. A prerequisite to mitigate extreme hydroclimatological events is good understanding of their spatiotemporal characteristics as well as the mechanisms generating such events. However, the lack of instrumental observations limits the period of spatial analysis to the recent century, making it difficult to fully understand natural hydroclimate variability.

Tree rings can provide annually resolved environmental and climate information and are widely used as proxies of past climatic events, such as drought or floods. The wide geographical distribution of tree-ring chronologies, compared to most other high-resolution climate proxies, provides a potential to infer past climate change on large spatial scales. Recently, past hydroclimate variability has been reconstructed from networks of moisture-sensitive tree-ring chronologies in North America and Monsoon. These reconstructions have not only provided valuable information of past hydroclimatic characteristics, but they have also contributed essential background data for increasing the understanding of the underlying mechanisms of past drought variability.

This presentation will focus on a new reconstruction of summer hydroclimate variability in Fennoscandia during the last millennium. Using tree-ring data from a dense network, a point-by-point multiple nested regression approach was used to reconstruct June through August average Standardized Precipitation Evapotranspiration Index (SPEI) with a spatial resolution of 0.5°x 0.5°. We will show that the data provides highly useful information of regional natural hydroclimate variability in time and space in a long-term context, making it possible to assess the impact of global warming on hydroclimate in Fennoscandia. It also allows for identification of historical extreme hydrological events, including severity, duration and magnitude. Moreover, we will discuss potential drivers of hydroclimate regional drought variability on different time scales. Finally, we will take a broader, European, look on summer hydroclimate variability during the last 1000 years.

K-L1.1-04

Atmospheric carbon dioxide tracks climate and land carbon changes during the past millennium

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The land carbon reservoir is predicted to turn into a net source of carbon to the atmosphere if global warming continues unabated. Multi-decadal, global-scale observations needed to test this predication are difficult adding uncertainties to projections of atmospheric CO2 and climate. Ice core records of the last millennium document atmospheric CO2 variations on multi-decadal to centennial timescales but attempts to constrain the underlying drivers of atmospheric CO2 using the stable isotopic composition of atmospheric carbon dioxide (δ13C-CO2) have been limited by the precision and temporal resolution of existing data. This spurred discussion on the magnitude of climate-carbon feedbacks and emissions from past anthropogenic land use change .

We developed a new high-resolution, high-precision ice core record of δ13C-CO2 and use it to show that terrestrial organic carbon likely controlled multi-decadal scale atmospheric CO2 variability from 760-1850 C.E. Our results put strong limits on the net source of land carbon to the atmosphere prior to the Industrial period. If significant long-term carbon emissions came from pre-industrial anthropogenic land-use changes, they must have been offset by some natural 13C depleted land sink, plausibly peatlands. On multi-decadal timescales, carbon cycle changes appear to covary with reconstructed regional climate changes, consistent with climate as an important driver of land carbon storage on these time scales.

Our new observations present a challenging benchmark for models attempting to simulate the climate and carbon cycle of the past in order to understand the projections for the future. However, reducing the uncertainties in past temperature reconstructions and developing stronger constraints on pre-Industrial anthropogenic emissions are likely needed to provide further insight into climate-carbon cycle interactions.

L1.2 - Climate Change and Land Systems: Impacts and Feedbacks

K-L1.2-01

Climate change and land systems: Impacts and feedbacks related to drought

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Land systems have numerous two-way interactions with the climate system. While they are often strongly affected by climate variability and changes, in particular in relation to droughts and hot extremes, they also impact climate through direct forcing and feedbacks. In particular, the modulation of soil water dynamics by ecosystems is an important factor affecting itself the evolution of droughts and heatwaves in several regions. In addition, human management, e.g. through changes in surface properties associated with agriculture practice, also affects these interactions. This presentation will provide a brief overview of the underlying mechanisms, including insights from new research, and will introduce the main topics addressed in this session.

K-L1.2-02

Climate and the water-energy-food nexus

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Water, energy and food are essential for human well-being, and socio-economic development. Global projections indicate that demand for these resources will increase significantly over the next decades, under the pressure of population growth, economic development, urbanisation, diversifying diets, cultural and technological changes, and climate change (Hoff 2011). Annual and seasonal climate variability, as well as climate change, strongly affect all components of the water-energy-food nexus, adding to the challenge of using resources sustainably across sectors. While uncertainties remain high, climate models project decreases in annual precipitation in many developing countries, e.g. by as much as 20% in southern Africa by 2080. These changes would propagate into reduced water availability and crop yields, which, combined with projected population growth, reinforces the need for planners to collaborate across sectors and account for climate variability and change. Recognition of spatial and sectoral interdependencies in the nexus should inform policies, institutions, and investments for enhancing water, energy, and food security, and thus support sustainable development in climate-sensitive environments. This presentation will highlight the importance of recognising these linkages, and identify spatial and topical hotspots in current nexus research.

K-L1.2-03

Revising the planetary boundary for freshwater use

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Nine intertwined 'planetary boundaries' demarcate the multidimensional 'safe' space for key earth system processes. Leaving this safe space due to the environmental imprint of collective human activities, Earth may be moved out of its Holocene status which up to now enabled the development of a human society of several billion people. While the concept and quantitative basis of planetary boundaries has recently undergone a comprehensive update (Steffen et al., Science, 2015), some boundaries still require a more robust quantification, especially in terms of upscaling regional patterns to the planetary scale and in terms of boundary interactions. Moreover, comprehensive assessments of development pathways for civil society under the constraint of planetary boundaries are still lacking.

This talk shows ways to improve the definition and assessment of the planetary boundary for human freshwater use, which is challenging as the regional pattern of water availabilities and limitations and the tight interactions with land cover and use are to be considered. The core approach is to account, spatially explicitly, for the environmental flow requirements of riverine ecosystems, which define local limitations to human water use and serve as a basis for a geographically explicit 'bottom-up' estimation of the planetary boundary. A pilot assessment - based on high-resolution simulations with a dynamic global vegetation and water balance model - indicates that the value of the planetary boundary may be lower than suggested earlier. Different estimation methods to assess environmental flows suggest a value between 1,100 and 4,500 km3 consumptive water use per year (original estimate from Rockström et al., Nature 2009: 4,000 km3 per year). Thus, humanity's current consumptive water use (at least ~1,600 km3 per year), let alone water withdrawal (~3,600 km3/year), already exceeds the lower end of this range that reflects stringent environmental policies. Moreover, local tolerance limits of water use are already exceeded in many places, such as in parts of southern Europe, southern Asia, the Near and Middle East, and in the western US. Building on these results, the presentation elaborates on how the definition and quantification of the freshwater boundary can be further improved, for example by including "green" water, by specifying linkages with other planetary boundaries (such as the one for land-system change), and by water ethical considerations. Initial estimates of the potential of improved on-farm water management to increase crop production while staying within the planetary boundaries for freshwater use and land-system change are also presented.

K-L1.2-04

Land use changes and their impacts on climate

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About three quarters of the ice-free land surface have undergone some form of land use change: about one quarter has undergone a change in land cover, in particular deforestation for agricultural expansion; on another one half the vegetation cover has been kept but is managed, as happens e.g. in forestry. This land cover change and land management affects climate through multiple pathways. The political focus mostly lies on land use change as contributor to the human-induced rise in atmospheric CO2 and thus global warming. The local-scale climate, more relevant for adaptation, can show strong effects due to biogeophysical effects such as changes in water and heat fluxes.

Land use change (mostly restricted to land cover change) has therefore entered into most Earth system models (ESMs) used to project climate change. With the Coupled Model Intercomparison Project 5 (CMIP5) land use change has for the first time been considered in the climate simulations underlying the IPCC assessment report. However, the spread across model results for both carbon cycle and biogeophysical aspects has been found to be substantial. This initiated a range of studies that aim at understanding the reasons why estimates differ so much. These findings can be arranged along a chain of uncertainties from uncertain land use datasets, differences in their implementation in ESMs, to various definitions of land-use-induced carbon fluxes in models. This talk will discuss these sources of model spread and ways forward to reduce the uncertainties.

Understanding the sources of uncertainty is particularly important now: Recent observational studies suggest that land management can have effects on climate that are of similar strength as those of land cover change, yet occur on much larger area. The ESM community is therefore moving beyond land cover change towards land management for a more complete representation of the human impact on climate.

K-L1.2-05

Terrestrial carbon cycle feedbacks in the climate system

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Terrestrial ecosystems take up around a quarter of the human CO2 emissions from fossil fuel burning, land use and land cover changes each year (Le Quéré et al., 2015), mitigating climate change for the present day. Can we rely on this carbon sink in the future?

Terrestrial ecosystems store a vast quantity of carbon in biomass and soils and their storage capacity depends on environmental conditions. Elevated CO2 is known to act as a fertilizer, stimulating plant production, and a changing climate (e.g. temperature and precipitation) will alter the lifetime of carbon in plants and soils. For example, the seminal work by Cox et al., (2000) suggested that future climate warming will lead to a release of carbon from terrestrial ecosystems, through temperature-enhanced soil decomposition, and highlighted the vulnerability of tropical forests to climate change. This represents a positive climate carbon cycle feedback, whereby an initial warming leads to a terrestrial release of CO2, which in turn leads to further warming.

Subsequently much research has focused on the role of terrestrial ecosystems and their feedbacks in the Earth system. Here we review the current state-of-the-knowledge drawing from the latest synthesis in the IPCC AR5 WG1 report, and our research at the University of Exeter, Met Office Hadley Centre and Centre of Ecology and Hydrology, UK. In particular, we present the effect of aerosols, implications of plant acclimation to temperature,

and the resilience of tropical forests on the future development of the land carbon sink (Mercado et al., 2009, Booth et al., 2012, Huntingford et al., 2013). I will highlight the key uncertainties in our understanding of climate- terrestrial carbon cycle feedbacks, and present recent work on emerging constraints on climate carbon cycle feedbacks (Cox et al., 2013, Wenzel et al 2014).

K-L1.2-06

Global impacts of climate change on terrestrial biodiversity and ecosystem service supply

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Impacts of recent climate change have been observed and attributed worldwide. Many of these affect land ecosystems, their function and the diversity of organisms in them. Scenarios of future warming, changes in rainfall patterns, and sea-level rise all indicate significant impacts on biodiversity in natural and managed landscapes, despite uncertainties regarding spatial patterns and confounding drivers such as land use and land management change, and urbanisation. While biodiversity loss may be considered a major impact of climate change in its own right, concerns are growing that the supply of essential services to humanity, where these depend on intact ecosystems, is also at risk. For certain key ecosystem services, such as climate regulation, food and timber production, water purification and others, the global nature of possible losses has been considered widely (also by the IPCC), but other ecosystem services are less easily quantified. I will summarise the state of knowledge for more comprehensive assessments of future global biodiversity loss and changes in ecosystem service provisioning, and thereby indicate the need for interaction between assessments of risks made by the IPCC and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

L1.3 – Climate Change and Ocean Systems: Introduction and Background

K-L1.3-01

Climate Change and Ocean Systems: Introduction and Background

JP. Gattuso (1)
(1) CNRS and Université Pierre et Marie Curie, Laboratoire d'Océanographie de Villefranche, Villefranche-sur-mer, France

The ocean moderates climate change at the cost of profound alterations of its physics, chemistry, ecology, and services. However, despite the ocean's critical role in global ecosystem processes and services, international climate negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will facilitate the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.

K-L1.3-02

Challenges to ocean life and associated human interests: IPCC assessments and beyond

HO. Pörtner (1)
(1) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Oceans cover more than 70% of the planet and their biota create half the oxygen humankind uses to breathe and burn fossil fuels. Oceans cover about 11 % of the global population's demand for animal protein. Climate change causes oceans to warm and stratify, and sea level to rise, as well as Arctic summer sea ice to shrink. Ocean warming accounts for more than 90% of the energy accumulated in the climate system. Warming causes oceans to lose oxygen overall and during an expansion of hypoxic water layers. Concomitantly, the accumulation of anthropogenic CO2 in ocean surface waters disturbs water chemistry and causes acidification. These climate drivers alter ocean ecosystems and the services they provide. They frequently relocate and reduce marine biological resources on which human societies depend, affecting economic benefits, livelihoods, food availability and public health particularly for coastal communities. The recent IPCC assessment report (AR5) as well as the Structured Expert Dialogue have comprehensively considered impacts, vulnerability, adaptation options and projected climate risks for the oceans and their services to humankind. Ocean warming has caused geographical shifts in the distribution of marine species, associated with changes in the species composition and function of ecosystems. Recent meta-analyses indicate that ambient temperature and hypoxia extremes in some regions are already close to permanent tolerance limits of marine animals and plants indicating a risk of expanding water bodies void of higher marine life. Empirical observations together with mechanism-based knowledge of organism and ecosystem vulnerabilities support the detection of climate impacts in the field and their attribution to climate change. They also support more accurate, higher confidence projections of climate change impacts in the oceans, as well as of associated risk such as of ocean acidification effects on key animal phyla and their economic value. Such assessments of risks were recently developed further by the Oceans 2015 initiative. Warming-induced shifts in ocean productivity and species distribution, including of exploited fish and invertebrates, and declines in their body size are projected to result in reductions of fisheries productivity, especially at lower latitudes. In contrast, fisheries at high latitudes may benefit from increased abundance and diversity of commercially valuable species. Evidence is increasing that anthropogenic ocean acidification is affecting organisms, ecosystems and associated human interests (particularly bivalve fisheries and aquaculture) in areas with and without a natural background of elevated CO2 concentrations. Hypoxic areas that exclude active pelagic fishes such as tuna and their fisheries are expanding. Impacts thus go beyond those of simply warming and include effects of acidification and deoxygenation. These combined effects of the three climate drivers will lead organisms to reach long-term tolerance limits even earlier than with temperature changing alone, enhancing sensitivity through dynamic shifts of thermal limits. For example, recent modeling emphasizes that combined warming and oxygen loss constrain metabolic scope of key species and thereby habitat and biogeographical distribution across wider ocean areas than previously thought. Through effects on performance at the levels of reproduction, behaviour and growth, marine life forms including those that are economically relevant, are thus threatened by climate drivers changing individually and even more so by their additive or synergistic effects. Together with shifts in ocean circulation and productivity the resulting dynamic changes in thermal bioenvelopes have major implications for the ranges of geographical distribution of marine species, their competitive and trophic interactions, population dynamics and community compositions. Such integrative view is also being developed for paleo-observations of climate change effects. It should also be included in modeled projections of ecosystem change, which will inform social-ecological models projecting effects on fisheries and aquaculture. Assessments of risks of ocean warming, deoxygenation, and acidification to ecosystem services have generally concluded that human communities and artisanal fishermen at low latitudes often have the lowest capacity to adapt to losses in natural resources, for example by replacement with alternative foods. Substantial challenges remain to anticipate the ecosystem-wide impacts of the combined drivers of warming, deoxygenation, and acidification, and the ensuing alterations of ecosystem services for human communities. Finally, the projections of climate change impacts in the oceans and along coasts, including sea level rise, and the associated risks and scopes for adaptation,

need to be considered when setting the long-term global goals (LTGG) of climate change mitigation. As an example, the long-term risks of sea-level rise, Arctic sea ice loss and combined impacts of ocean warming and acidification on key groups of corals, bivalves and other calcifiers, that have high economic value in tourism, coastal protection and fisheries, strongly support setting the LTGG to but not above 1.5°C global warming above preindustrial values.

K-L1.3-03

Oceans of Concern

E. Poloczanska (1)
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Climate change and ocean acidification will reorganize food webs and alter ecosystem function, with attendant impacts on human communities and activities. The impacts of climate change have been detected across all oceans; changes to ocean have altered the timing of plankton blooms and migratory patterns and spawning in fish and invertebrates, over recent decades. Shifts in species distributions to higher latitudes are a commonly reported response of marine fishes and invertebrates to warming oceans. Differences in rates of change with climate change amongst species and populations imply that marine ecosystems may be substantially reorganized at regional scales. Indeed, at a global scale a strong warming signal is already evident in fish catches, with an increasing dominance of warm-water species found in catches coastal and shelf areas. Modelling approaches project a global redistribution of marine biodiversity this century with regional differences driven by species invasions and local extinctions. The emergence of novel assemblages of species with no past or contemporary analogues will consequently require new strategies for managing coastal areas and fisheries. Large changes in species composition are projected in both polar and tropical oceans with increases in species richness at high latitudes. High local extinctions are projected in equatorial oceans, particularly in the central Indo-Pacific, as species are eliminated with warming. The different futures emerge for tropical biodiversity by 2050s under high and low emission scenarios with widespread species losses and declines in species richness around the equator, particularly in the central Indo-Pacific, if global temperatures exceed the 2°C limit. Further, under the medium to high emission scenarios, ocean acidification poses substantial risks to marine ecosystems, particularly coral reefs and polar ecosystems. Climate change is a risk food resources, coastal livelihoods, and industries dependent on the Ocean, adding to the threats of over-fishing and other non-climate stressors, and the likelihood of exceeding adaptation limits increases with greater rates and magnitude of climate change.

L1.4 - Climate change and health - Risks and Responses

K-L1.4-01

A holistic approach to assessing the risks of climate change

D. King (1)
(1) Foreign and Commonwealth Office, London, United Kingdom

Sir David King will present a new approach to assessing the risks of climate change, designed to inform governments' decision-making on how to prioritise the objective of reducing the risks of climate change relative to other national objectives. At the core of this is a different way of interrogating the science: instead of projecting 'most likely' climatic changes and then describing the impacts of those, this approach asks first what it is that we might wish to avoid, and then considers its likelihood as a function of time under different scenarios. This assessment of the science is complemented by assessments of the relative difficulty of achieving different global emissions pathways, and of the systemic risks of climate change to the global economy and international security. When combined with a recognition of the essentially subjective nature of any valuation of future events, this approach can give governments a clearer and more holistic assessment of the risk that climate change poses to their national interests.

K-L1.4-02

2015 Lancet Commission on Health and Climate Change: Emergency actions to protect human health

W. Nick (1)
(1) Lancet Commission On Health And Climate Change, London, United Kingdom

In 2009, the UCL-Lancet Commission on Managing the Health Effects of Climate Change called climate change "the biggest global health threat of the 21st century". Five years on, a new multidisciplinary, international Commission has formed to map out a comprehensive response to climate change, in order to ensure the highest attainable standards of health for populations worldwide. The Commission represents a collaboration between over 80 European and Chinese climate scientists and geographers, social and environmental scientists, biodiversity experts, engineers and energy policy experts, economists, political scientists and public policy experts, and health professionals - all seeking a response to climate change which is designed to protect and promote human health.

Nick Watts will present the key messages and recommendations from the Commission's work.

K-L1.4-03

Climate change, co-benefits and the global public health agenda

N. Maria (1)
(1) World Health Organization, Geneva, Switzerland

Dr Neira will address the implications of the evidence presented for the wider public health agenda, and in making a positive contribution to the preparations for the UNFCCC CoP21 in Paris in December. This will include outlining how evidence is now being translated into a support programme to build health system resilience to climate change, focussing on the most vulnerable countries. It will also focus particularly on the opportunities for large, local health cobenefits of climate change mitigation policies, particularly in reducing the over seven million annual deaths that WHO estimates are attributable to air pollution.

L1.5 – Climate variability, change and vulnerability in the Pacific, Indian and Southern Oceans

K-L1.5-01

ENSO and the Tropical Pacific in a Changing Climate

M. Mcphaden (1)
(1) NOAA/PMEL, Seattle, United States of America

The El Niño/Southern Oscillation (ENSO) cycle represents the strongest year to year fluctuation of the climate system on the planet. El Niño, the warm phase of ENSO, and La Niña, the cold phase of ENSO, arise through coupled ocean-atmosphere interactions in the tropical Pacific mediated by positive feedbacks between surface wind and sea surface temperature variations. Warm and cold ENSO episodes lead to global shifts in patterns of weather variability that cause droughts, floods, heat waves and other extreme events around the world. ENSO-related natural disasters have significant consequences for society in terms of lives lost, property damage and economic vitality. Understanding how ENSO may change in the future as a result of anthropogenic greenhouse gas forcing is therefore a compelling question that has challenged the scientific community. This presentation will review our current understanding of ENSO dynamics, predictability, and societal impacts. It will also assess current efforts to understand how ENSO may change in the future based on analyses of the instrumental record, CMIP models, and paleo data.

K-L1.5-02

Indian Ocean interannual to decadal variability in the context of climate change

J. Vialard (1) ; W. Han (2) ; M. Lengaigne (3) ; A. Nidheesh, (4) ; V. Parvathi, (4) ; I. Suresh, (4)
(1) IRD, LOCEAN, Paris, France; (2) University of Colorado, Boulder, United States of America; (3) UPMC, Paris, France; (4) National Institute of Oceanography, Goa, India

In the sixties, the Indian Ocean was the focus of the oceanographer's international community due to its dynamic response to monsoons. In the eighties, this focus shifted entirely to the neighbouring Pacific, berth of the El Niño Southern Oscillation (ENSO), most powerful interannual climate mode on earth. It is only at the turn of the century that the Indian Ocean came back into fashion with the discovery of its own intrinsic interannual climate variability (the Indian Ocean Dipole) and the development of a basin-wide observing network. After reviewing interannual variability of the Indian Ocean, I will turn to the natural decadal climate variability, which has comparatively been much less described in this basin than in the Pacific and Atlantic Oceans. I will in particular question if this decadal variability purely arises from the neighbouring Pacific or if an intrinsic variability also exists in the Indian Ocean. The climate change signal will finally be discussed in the Indian Ocean. We will show, on the particular example of anoxic events along the west coast of India, how long-term trends and shorter-term variability can cause extreme events with important societal consequences.

K-L1.5-03

21st century projections for the Pacific region

S. Power (1) ; M. Collins (2) ; K. Hennessy (3) ; E. Guilyardi (4)
(1) Bureau of Meteorology, Cawcr, Melbourne, Australia; (2) Exeter University, Exeter, United Kingdom; (3) SCIRO, Dickson, Australia; (4) LOCEAN/IPSL, UPMC case 100, Paris, France

Here we will examine the latest scientific information available on projections for climate in the Pacific, and what this means for developing island states in the region. Particular attention will be paid to changes in surface temperature, winds, rainfall, El Nino, tropical cyclones, and ocean acidification, for different scenarios of future greenhouse gas emissions. The continuing importance of decadal climate variability for the region will also be highlighted. This presentation will draw upon the latest IPCC report and more recent research, including research conducted in the Pacific Australia Climate Change Science and Adaptation Planning Project.

K-L1.5-04

Southern Ocean in a changing climate

A. Thompson (1)
(1) Caltech , Los Angeles, United States of America

Recent Southern Ocean studies have suggested a slowdown of ocean carbon sequestration, an acidification of the water-masses, an overall warming and freshening in the vicinity of Antarctica, and drastic changes in sea-ice and ice-shelf distributions. Observed changes are profound: the warming rate is faster than the global average, and occurs in the deepest layers of the ocean, therefore isolating the climate signal for decades to millennia ; ice-shelves are melting, which accelerates the discharge of the ice sheet via the ice streams, and has a direct and major impact on the global sea level rise. These important changes are directly related to the large-scale circulation of the Southern Ocean and the associated biogeochemistry. This talk aims at summarizing our current understanding of how the large-scale circulation of the Southern Ocean works, how it impacts the carbon cycle, and how interactions with the Antarctic cryosphere influence it.

O-L1.5-01

Future changes in the South Pacific convergence zone and its tropical cyclones using regional dynamical downscaling

M. Lengaigne (1) ; M. Bador (2) ; C. Menkes (3) ; J. Lefèvre (4) ; N. Jourdain (5) ; S. Jullien (6) ; P. Marchesiello (7) ; S. Thibaut (8) ; L. Terray (9)
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The South Pacific Convergence Zone (SPCZ) is the largest convective area of the Southern Hemisphere and has been recognized as a hot spot for climate variability (CLIVAR, 2012) as its functioning is poorly understood. Regionally, the SPCZ is the main source of rainfall in a vast majority of the Southern Pacific Island nations and the strong precipitation gradients related to the SPCZ make local hydrological conditions very sensitive to small displacement of this rain belt. The interannual variability of the SPCZ location is related to the El Niño/Southern Oscillation. El Niño events tend to occur accordingly with a northeastward displacement of the SPCZ, and La Niña events tend to occur with a southwestward displacement of the SPCZ. During strong El Niño events, the SPCZ undergoes an extreme swing by up to ten degrees of latitude toward the equator and collapses to a more zonally oriented structure. The SPCZ location not only strongly constrains the hydrological cycle but is also the breeding ground of tropical cyclones (TCs) in the South Pacific, as it combines all the large-scale atmospheric conditions that favor the genesis of TCs. Current climate models poorly reproduce the key characteristics of the SPCZ, leading to large uncertainties in the potential evolution of the South Pacific TC activity. Hence, assessing the SPCZ and its tropical cyclones in the future climate remains a challenge.

Here, we use a dynamical downscaling approach. Using results from an ensemble of 14 CMIP3 climate models under the SRES-A2 greenhouse gas scenario, we force a regional configuration of the WRF atmospheric model. The configuration uses a two-way nesting approach to increase the spatial resolution from 1° to 1/3° in the SPCZ region. We first perform a control simulation forced by the NCEP2 reanalysis over the past 30 years, and a future

simulation based on an anomaly method (e.g. Zhao et al. 2009), where we add the mean 21st century regional SST warming pattern and atmospheric change along lateral boundaries to the NCEP2 fields.

Results show an accurate representation of the SPCZ location, its north-south displacements in response to El Niño/Southern Oscillation, as well as a correct TC distribution in the region. The future simulation indicates an increase of the precipitation within the SPCZ and the equatorial region, and a decrease northeast of the SPCZ mean location, in good agreement with climate models. The mean SPCZ location under future conditions presents a southward shift in its eastern part, and generally an increased variability of its interannual geographical position. We also find more frequent strong El Niño events in the future, with zonally oriented SPCZ. We explore the respective role of increased greenhouse gases in the domain versus the role of lateral boundaries. Large-scale conditions from lateral boundaries induce a significant (-20%) decrease of cyclones frequencies in the region. However, greenhouse gases locally counter this decrease. Overall, we do not find any significant change of cyclone frequencies in the Southwest Pacific in a warmer climate, in contrast with most recent studies, which find a decrease of cyclogenesis (-6% to -34% according to references gathered in Knutson et al. 2010).

L2.1 - Drivers of Change and Visions of Development: Are Climate Policy and Development Compatible Goals?

K-L2.1-01

Energy Transition towards Two-Degree Target: The Case of China

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Abstract not communicated

K-L2.1-02

The Climate-Development 'Conflict': Asking the right questions

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There is both confusion and concern regarding the impact of poverty eradication on climate change. Some equate poverty eradication with coal use, particularly in India and China; others assume consumption from people rising out of poverty would be highly material-intensive. What if all the world's poor had refrigerators? What implications does economic development have for stabilizing climate change at 2 degrees C? Conjectures abound, but scientific research so far offers few real answers to these questions. This is in part because we haven't been asking the right questions. What stands between poverty eradication and greenhouse gas emissions is the nature of developing countries' development pathways, income distribution, patterns of energy use, technological development, and different scenarios of global cooperation on climate change mitigation. There is much yet to be learned about the interaction of these drivers. New approaches to quantifying human development and energy use shows that there have been many low-carbon development pathways in the past, and that meeting basic needs may be less carbon intensive than growth in affluence. Current trends in India reveal an exponential growth in low-carbon resources, even among the poor. While basic development aspirations cannot be thwarted, their impact on climate change is by no means outside the realm of influence by both national and international policy.

L2.2 - New pledges (INDCs) for 2025/2030: Are they reinforcing development and consistent with a 2 oC pathway?

K-L2.2-01

INDCs and development objectives

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Abstract not communicated

K-L2.2-02

What science tells us about the emission levels for a 2oC pathway

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Limiting global warming to below 2°C above pre-industrial levels will require sustained and important efforts to reduce anthropogenic emissions of greenhouse gas emissions and to enhance and maintain sinks of carbon dioxide in the land-use sector. Fossil fuel CO2 emissions have continued to grow at an average rate of 2.5% per year over the past decade. Even at today's annual emission levels, the cumulative CO2 emission quota in line with staying below 2°C would be exhausted in less than 30 years. We will examine how pledges of largest emitting countries to reduce emissions, or maintain sinks in the land-use sector are consistent with a trajectory enabling not to breach the international agreed 2°C temperature limit. In particular, we examine how forest carbon sinks in the US, Canada, Russia, China and the EU, as well as reduced deforestation in tropical countries, can help efforts to attenuate near-term climate change. A specific attention will also be given to the contribution of nations to historical radiative forcing and climate change, including long-lived greenhouse gases and short-lived forcers such as CH4 and aerosols, of which the latter can have a climate cooling or warming effect.

K-L2.2-03

Assessment of intended nationally determined contributions to a 2015 international climate agreement

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One of the most fundamental questions in the preparation of a new international climate agreement is whether countries' proposals to reduce greenhouse gas emissions after 2020 are equally ambitious compared to their peers. Methodologies to rate countries' climate action often rate different things and therefore come to different conclusions (Surminski and Williamson, 2014).

From the variety of methods that have been applied in the past to rate the ambition of countries climate action proposals, we distinguish two main strands, which are described here as black and white for illustration, acknowledging that they overlap in practice. Both relate to the principle of common but differentiated responsibilities and respective capabilities:

- Moral obligation: From this viewpoint, countries have a moral obligation to reduce their emissions. This moral obligation can be measured in a simple way, e.g. for developed countries as the sustained emission reduction

effort since 1990 (a commonly used base year) or more sophisticated using a variety of equity principles, so called "effort sharing" calculations (including the IPCC AR5 equity database (Clarke et al., 2014; Höhne et al., 2014)). This strand relates to the "differentiated" element of the agreed principle.

- Technical necessity: The starting point of this viewpoint is whether the proposal is in line with what is technically necessary from now on, irrespective of the moral obligation. This could be judged by whether the countries' proposal is in line with its contribution in globally cost effective model pathways (according to scenarios such as those included in the IPCC AR5 scenario database (Clarke et al., 2014) and model comparison studies, like LIMITS (Tavoni et al., 2015)), leverages all mitigation potential, or covers all policies that the country's peers undertake. This strand relates more the "common" element of the agreed principle.

The two strands may lead to fundamentally different outcomes. A developing country for example may have limited moral obligation, but significantly more mitigation potential, as developing countries are characterized by higher energy and carbon intensities, have rapidly rising baseline emissions and a high share of new infrastructure (Clarke et al., 2014). For a developed country it may be the other way around, it may have a very high moral obligation, but may have technical difficulty to reduce domestic emissions in the same order of magnitude without retiring old infrastructure before the end of its life ("carbon lock in" or "stranded assets").

The methods are applied illustratively to the recent post-2020 climate proposals by the USA, China and the EU. The results differ substantially per method, which confirms that a comprehensive ambition assessment is necessary to provide the full picture.

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K-L2.2-04

Integrating development and climate policy in South Africa

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South Africa's approach to its INDC will very likely be framed by development and climate. The formal process of consultation by government has yet to take place, but we know that the National Development Plan (NDP) is as important as South Africa's climate policy. Some research we have undertaken at the Energy Research Centre (ERC) illustrates the challenges of seeking a substantial reduction in poverty, inequality and emissions.

The key question facing the mitigation community in South Africa is the pace with which the country can decarbonize the energy sector, which currently accounts for majority of total emissions, without undermining development imperatives – the NDP places reduction of poverty and inequality at the top of a list of multiple priorities.

The current structure of the South African economy has resulted in sub-optimal environmental (high carbon intensity) and social (high Gini-coefficient and low HDI) outcomes. High levels of poverty and inequality are likely to be exacerbated substantially by climate change impacts in the future, while a reliance on energy- and capital-intensive, and low-labour-absorbing sectors means that even with a sophisticated tax and redistribution system, there are simply too few employed and skilled citizens in the economy to drive improvements in living standards and key socio-economic indicators for majority of the population. Inclusive growth is a necessary condition for attaining better socio-economic outcomes in the future, but the type of growth that South Africa has experienced in the past few decades has not been sufficient.

A key question then is the extent to which a structural change in the economy can meet both mitigation and development objectives. Growth in sectors that are labour-intensive, absorb low- and un-skilled workers and are low carbon need to be incentivized if South Africa is going to move forward with climate compatible growth and development.

The domestic policy system is characterized, however, by lock-in and path dependency. While consultations on the INDC are ongoing, ERC research suggests that what is crucial is an understanding of how a just transition over the next decades from an inequitable and carbon intensive economy to a more equitable and low carbon economy can be achieved. South Africa's national climate policy, as indicated in 2009, is that its emissions will follow a 'peak, plateau and decline' trajectory to 2050. The NDP includes an environmental chapter that talks to "an equitable transition to a low-carbon economy", yet this remains to be fully integrated with chapters on economy, employment and infrastructure. ERC research has provided initial analysis on what would be required, either with a more skilled work force or possibly a different structure of the economy, to move toward a successful integration of development and climate policy.

K-L2.2-05

The economic and competitiveness dimensions of the Draft Chilean INDC

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Chile's national contribution to mitigation is based on a commitment to reducing greenhouse gases for the post-2020 period. It is based on the sectorial analyses and the mitigation scenarios developed in 2013-2014 with MAPS Chile (Phase 2), the results of the National Greenhouse Gas Inventory, and additional information provided by the Ministries of Environment, Energy, Agriculture and the Treasury.

Chile aims to reduce its greenhouse gas emissions while decreasing poverty and inequality as well as continue advancing toward sustainable, competitive, inclusive and low-carbon development. To confront these challenges successfully, the country should direct all its efforts to decoupling economic growth from greenhouse gas emissions.

Draft Intended Nationally Determined Contribution on Mitigation

Chile analyzed a subset of three forms of contribution for the whole economy, namely: i) carbon intensity target, ii) a deviation below business as usual scenario specified ex ante, and iii) trajectories. From a review of existing literature and considering the national experience with the Copenhagen pledge, Chile has chosen to report its contribution for the post-2020 period in the form of emissions intensity. Chile's contribution will allow the country to reach high levels of economy-wide mitigation. Methodologically, it takes two components into account: a) a carbon intensity target, expressed in greenhouse gas emissions per unit of economic development (GDP) which includes all sectors where mitigation is possible in Chile except for forestry; and b) a separate target for forestry. t

The draft INDC was submitted to a national consultation process, were two options of carbon intensity target were consulted.

Option A: Chile is committed to reducing its CO2eq emissions per GDP unit by 30-35% below their 2007 levels by 2025. Chile is also committed to reducing its CO2eq

emissions per GDP unit by 40-45% below their 2007 levels by 2030.

Option B: Chile is committed to reducing its CO2eq emissions per GDP unit by 25-30% below their 2007 levels by 2025. Chile is also committed to reducing its CO2eq emissions per GDP unit by 35-40% below their 2007 levels by 2030.

Figure 1:Upper value of Option A expressed in emissions (excluding LULUCF) per unit of GDP

Source: Draft INDC. Government of Chile. 2015.

In addition, for the forestry sector Chile has proposed restoring about 100,000 hectares of degraded land (forestation) with its own resources investing an estimated US$250 million, reaching an area of at least 100,000 hectares of managed native forest by 2035.

National perspective

Chile already has concrete and ambitious goals and policies, and has consistent energy policies to move towards a clean, safe, sustainable matrix (Law on renewable energy, energy efficiency targets, carbon tax). Emission mitigation is seen as an opportunity to low-carbon development with multiple benefits such as job creation, improved population health, competitiveness and others.

The mitigation scenarios considered for the draft INDC were modeled through a dynamic stochastic general equilibrium model (in Phase 2 of MAPS-Chile) for two macroeconomic variables: increase in the value of GDP and increased employment. The values presented in the table below correspond to percentage deviations from the baseline from 2013 to 2030. The three scenarios represent the mitigation range included in Option A and Option B of the draft INDC.

Table 1: Macro economic effects of mitigation options

Scenario	GDP	Employ ment	C O 2 e q Emissions
	2030	2030	2030
80/20 (Lower value of Option B)	1,2%	0,0%	-18,8%
Medio (Upper value of Option B and lower value of Option A)	6,7%	5,5%	-23,4%
Alto (Upper value of Option A)	7,4%	6,3%	-26,2%

Source: MAPS Chile results (Phase 2).

According to the GDP growth rate, the population projections, and the mitigation measures and policy choices considered in the three mitigation scenarios, the macroeconomic modeling results indicate that high mitigation scenario is not only the most ambitious in terms of emission reduction, but also verifies the largest increases in GDP and employment levels to 2030.

L2.3 - Climatic Variability and the Social and Human Dimensions of Vulnerability

K-L2.3-01

Extremes of climate variability and impacts on society: The drought and water crisis of 2014-15 in Southeastern Brazil

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Deficient rainy season during the austral summers of 2013-14 and 2014-15 over most of southeastern Brazil affected the São Paulo Metropolitan Area (SPMA)-South America's largest metropolis, home to 20 million people and where 10% of Brazilians live and a third of GDP is produced. Together with high temperatures throughout 2014 and up to January 2015 and a subsequent increase in water demand, the persistent lack of rainfall determined a drought situation, impacting on the use of water for human consumption, hydropower, as well as water for agriculture, creating an acute "water crisis" situation. In the last 60 years, some extreme dry events have impacted Southeastern Brazil, including the 1953-54 episode and the 2000-2001 as the most intense. Here we intend to assess how extraordinary the recent extreme drought that started in summer of 2013, persisted throughout 2014 and continued up to January 2015 was, and to analyze some of the main factors contributing to it.

The hydropower reservoirs—which account for around 70% of the country's entire hydroelectric power generation-and the rivers feeding the Cantareira reservoir system, which provides almost half of the city of São Paulo's water, were almost dry by the end of 2014.The severe drought of the summer 2014-2015 was associated with a wide, intense and very persistent high-pressure area placed from surface to the upper troposphere. The anticyclonic system that dominates the atmospheric circulation over eastern South America extended from the sea level to the upper troposphere inhibiting the distinctive seasonal convective activity. This anticyclone lasted 45 days, extremely rare in terms of duration and never previously recorded for that region.

The region of Cantareira region experienced the most severe drought during the summer of 2014, and this year corresponds to the warmest year in the region since 1962. Other drought years, as in 1971 and 2001 were also among the six warmest years during that period. Therefore, the worse water crisis in Sao Paulo during the warmest year during the last 52 years is a relevant example of climate change risk due to rising temperatures due to anthropogenic influences.

However, origins of the current water crisis go beyond the rainfall deficiency, to include an array of interconnected factors: the city's surging population growth in the 20th century; a chronically leaky system that spills vast amounts of water before it can reach homes; and the destruction of surrounding forests and wetlands that have historically soaked up rain and released it slowly into reservoirs. Rainfall over the Cantareira system has been decreasing during the last decades and the levels in 2014 were the lowest since 1940. Longer-term planning by regional governments has fallen short, and many residents are already enduring sporadic water cutoffs, some going days without it. SABESP, the state utility company has reduced its extraction from the reservoir by a third, cut its pump pressure at night, and offered discounts to customers who reduce their consumption. Some parts of the city are relying on water trucks to maintain their supply.

K-L2.3-02

Managing multifunctionnality for Climate Smart Landscapes

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This presentation addresses the importance of managing trade-offs for sustainability in the face of climate change and how in particular the integrated landscape approach could be the one way to achieve many climate change related objectives. The presentation suggests a analytics for harnessing the climate smart landscape approach to the emerging climate challenges using some examples of practices that are suited to different contexts. From the historical footprints of the co-evolution between policy and science in the aim of achieving integrated solutions to climate/environmental crisis, we suggest some avenues on how to use landscape management principles in the design and the implementation of multiple goals; and what are the key barriers.

K-L2.3-03

Exploring the human dimension of urban resilience: perspectives from the Pacific region

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Cities in the Pacific region, which in many instances are already vulnerable to a range of natural hazard and weather-related events, will be faced by a multitude of resilience challenges in the future as a consequence of the interactions between a changing climate and rapid urbanization processes. These challenges are further complicated in the Pacific by land tenure arrangements, with tensions between municipal and customary land ownership often commonplace. Drawing from ongoing research activity as part of UN-Habitat's Cities and Climate Change Initiative, the presentation will explore the human dimension of climate vulnerability in the capital cities of Honiara (Solomon Islands) and Port Vila (Vanuatu). Both these case studies have been affected by recent weather-related disasters as evidenced by the Honiara floods in 2014 and the impact of Cyclone Pam on Port Vila in 2015. Discussion of the human dimension of urban resilience will not only address the current and future hazard component but also how changing levels of exposure, sensitivity and adaptive capacity will affect the resilience of the urban system (and its component parts). Lessons learnt from this analysis have the potential to positively influence the development of adaptation pathways and the enhancement of local resilience strengthening activity.

L2.4 - Early Warning for Thresholds and Tipping Points in the Earth System

K-L2.4-01

Early warning of climate tipping points

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A 'tipping point' occurs when a small change in forcing triggers a strongly non-linear response in the internal dynamics of a system, qualitatively changing its future state. Large-scale 'tipping elements' have been identified in the Earth's climate system that may pass a tipping point under human-induced global change this century. At the smaller scale of ecosystems, some tipping points have already been observed, and more are anticipated in future. Our capacity to forecast such abrupt, non-linear changes has historically been poor. However, much excitement has recently been generated by the theory that some approaching tipping points carry generic early warning signals. I will critically examine the prospects for gaining early warning of approaching tipping points. Promising methods are based on detecting 'critical slowing down' in the rate a system recovers from small perturbations, and on accompanying changes in the statistical distribution of its behaviour. I will show examples of early warning signals in paleo-data approaching past abrupt climate changes, and in models being gradually forced past physical climate tipping points. I will also discuss the conditions under which the methods fail. Finally, I will show an example of pronounced slowing down in observational climate data, for North Pacific sea surface temperatures, and explore the implications for well-known marine ecosystem 'regime shifts'.

K-L2.4-02

Are there tipping points in terrestrial ecosystems?

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Terrestrial ecosystems have been undergoing unprecedented climate and human-induced disturbances, which are likely to push these systems towards changes in their physiognomies, structure, and functioning. It has been hypothesized that these new configurations may be alternative regimes of systems comprising vegetation-climate-disturbance interactions. Thus, one way of explaining the dynamics of ecosystems in transition may be the theory of multi-stability and concepts such as resilience, hysteresis and tipping points. However, whether such multiple regimes indeed exist in climate-vegetation-disturbance systems and whether we can identify and quantify tipping points of such systems still remain largely unclear due to various reasons such as the role of heterogeneity and multi-scale processes in amplifying or dampening hysteresis and environmental change. This highlights the need to inter- multidisciplinary teams, which investigate such questions and help addressing management practices and preserving ecosystem services for future adaptation policies.

Acknowledgements:

This work is a contribution from the Brazilian National Institute of Science and Technology (INCT) for Climate Change funded by CNPq Grant Number 573797/2008-0 and FAPESP Grant Number 2008/57719-9, and from a proposal funded by Microsoft-FAPESP grant number 13/50169-1.

K-L2.4-03

Approaching Tipping Points: context, anticipation and community-based monitoring

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From the Arctic to the topics, Prairie and steppeland environments to high mountain areas, deltaic regions and low-lying ecosystems, people are observing and experiencing significant environmental shifts. However, it does not necessarily follow that they think about climate change as the most pressing issue affecting their lives. In this presentation, I discuss some aspects of how to understand the consequences of climate change, as well as identifying tipping points and thresholds, in a broader context. Rapid social, economic and demographic change, resource management and resource development, quota systems, trade barriers and conservation policies, among many things, have significant implications for human security and livelihoods. In many cases, climate change merely magnifies existing societal, political, economic, legal, institutional and other challenges that people experience in their everyday lives. In the far north of Greenland, for example, while the thinning sea ice and melting glaciers are perceived as troubling and worrying, local people see economic opportunities for their communities in the form of emerging halibut fisheries. Yet, although dramatic changes in climate require people to respond in particular ways, transformations in global markets that affect small-scale fisheries often have greater consequences. And while the disappearance of sea ice and glacial retreat may indicate approaching tipping points, irreversible social, cultural and economic change was precipitated in the 1980s by environmentalist opposition to seal hunting, while the prospect of oil development and mining mean different kinds of tipping points in the near future. As they reflect on a changing climate, local people do so from the position of living through considerable social and economic transformation that may have nothing to do with environmental change.

In this presentation, I consider the above and then focus on two things. First, building on earlier work on tipping points and anticipatory knowledge, I consider anticipation; how people think about the world around them, how they orient themselves and live toward the future, and how they create and enact change within a world that is also undergoing a constant process of becoming and being remade. I discuss how a focus on anticipation in local settings would give us a greater understanding of a diversity of approaches to precaution, pre-emption and preparedness. Given the

challenges (as well as opportunities) that climate change brings to environment and society, understanding how anticipation is inherent in everyday life and implicit in social relations and cultural practices, and how aspects of those relations and practices can emerge from anticipation, is a way to understand successful local strategies of adaptation, the nature of resilience and how people prepare themselves for uncertain futures. Second, I discuss some anthropological methods and prospects for identifying and gaining early warning of tipping points through reflection on collaborative and participatory-based community research. By way of example, I draw on an interdisciplinary project in the High Arctic environment of northern Greenland (the EU-funded ICE-ARC project) which is working with communities to help them prepare for and negotiate change in the future. Central to this project is community-based monitoring, a process that not only seeks to identify early warnings of tipping points, but something that builds local research capacity and puts in place a local observing system. This will help improve climate predictions for understanding the impacts of climate change on marine ecosystems and Arctic societies and enable communities to build capacity towards ensuring sustainable livelihoods.

K-L2.4-04

Can we avoid the next tipping in Antarctica?

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Sea-level rise is a given consequence of anthropogenic climate change. How much and how fast it is going to rise will depend critically on the future evolution of the Antarctic Ice Sheet which stores water equivalent to more than 50 meters of global sea-level rise. Most of West Antarctica's marine ice sheet lies on an inland-sloping bed and is thereby prone to an instability mechanism, the so-called marine ice sheet instability. Recent observations suggest that the grounding line has probably already transgressed into the unstable regime in part of the West Antarctic Ice Sheet due to warm water intrusion into the shelf cavities. Similar topographic configurations are found in large parts of the East Antarctic Ice Sheet which holds marine ice equivalent to 19 meters of global sea-level rise, more than five times as much as West Antarctica. For Wilkes basin in East Antarctica, it has been shown that removing a specific coastal ice volume, a so-called ice plug, can destabilize the entire basin, leading to self-sustained ice discharge and long-term sea-level rise of several meters. Here, we will explore the regions which might be subject to the marine ice-sheet instability, the processes potentially triggering it, and the consequences and implications for future sea-level rise.

K-L2.4-05

Effects of climate change and other driver of global changes on biodiversity

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Current threats have greatly accelerated the rate at which extinctions occur. Climate change is expected to become one of the most important threat in the future (Bellard et al. 2012). In general, multiple threats, such as habitat destruction, invasive species, overexploitation, and climate change lead to an increase in species extinction risk. The combined impacts of multiple threats are also diminishing the capacity of natural systems to cope with the effects of these changes. Yet, over the past decade most studies have assessed the future spatial distribution of these threats individually. This approach can be ineffective and ecologically misleading, because cumulative effect of different threats are not considered. Most of the conservation measures that are based on such studies consider a subset of threats, which may be of little benefit if other threats remain unaddressed. In addition, the combined impacts of different threats might be larger than the cumulative effect of each threat on biodiversity. Because little is known about the possible existence of interacting effects, quantifying the magnitude of potential synergies should become a priority.

Here, we propose to use two case studies at a global scale: biodiversity hotspot (Bellard et al. 2014), and USA to illustrate the need to consider multiple interactions between climate change and other threats. For instance, we will examine the effect of climate change including sea level rise and land use changes on biodiversity hotspot. We will discuss congruence between threats, species vulnerability and protected areas through the biodiversity hotspot. We will also discuss the potential impact of future interaction of climate change, land use changes, and invasive species for 196 endemic species across USA (Bellard et al., submitted). To this aim, we took into account the spatial distribution of biodiversity vulnerable to these threats. In particular, we found high cumulative threat values (>2 threats) aggregated over the eastern part of the USA, with lower values in the central and western parts. Cumulative impact analyses also suggested that the return on investments for conservation purposes may be low when high cumulative threat areas with low species diversity require protection from many threats (e.g., Minnesota, Wisconsin, Michigan, Iowa states). These analyses provide a useful means of identifying where conservation measures and monitoring programs that should consider multiple threats should be implemented in the future. Ultimately, we will further discuss why manager should consider multiple threats to mitigate the future effect of climate change.

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L2.5 - Food and water security under climate change

K-L2.5-01

Future landscapes of food supply and demand and implications for emissions

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Climate change and the rise in atmospheric CO2 will reorganize food systems and alter agricultural productivity, with impacts on food security, land use and greenhouse gas emissions. Food security is still an issue for about 795 million undernourished people, mostly located in the least developed countries of the planet. The agriculture sector is already affected by climate change, with significant global negative impacts on wheat and maize yields being observed over the last decades. The global food systems would be severely threatened under high end global warming scenarios. The agriculture, forestry and land use sector contributes to 24% of global anthropogenic greenhouse gas (GHG) emissions, with livestock alone estimated to contribute about 14.5% of total human induced emissions when a supply chain approach is considered. Globally, GHG emissions from agriculture could be reduced by 20-30% if less efficient producers would adopt the best practices of their peers, in the same production system and region. Technologies and practices that help reduce emissions exist but are not yet widely used. Those that improve efficiency and plant and animal health also have productivity co-benefits. In addition, the agriculture sector could benefit from carbon offset programs that represent potential additional income. Climate change matters to the agriculture sector. Direct impacts on production range from extreme climatic events, droughts and floods, to thermal stress and reduced yields. A large proportion of low income farmers are highly exposed to climate change. Forward-looking scenarios of plausible agricultural sector developments were developed

based on the new IPCC scenario framework. The results in terms of agricultural market developments, land and water use, and GHG emissions going until 2050 highlight the role that demand driven and supply driven changes in the sector could play both for greenhouse gas mitigation and for adaptation to climate change.

K-L2.5-02

Past and future weather-induced risk in crop production

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The global food system has seen increased volatility in recent years, with spiking food prices blamed for civil unrest on several continents. Rising prices for global commodity products like soy, meat and palm are increasingly driving deforestation around the globe, and with agriculture increasingly interconnected to global food and energy markets, weather-related risk and supply-side shocks have become a key issue or concern for governments and businesses alike.

Using archives from the Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intersectoral Impact Model Intercomparison (ISI-MIP), we look first at the impacts of 65 years of continental and global extreme events using observation-driven models and data. We identify the most severe historical events in caloric terms at national to global scales and evaluate the ability of models and model ensembles to identify weather-induced extreme years, correctly assess the magnitude of large-scale extreme events, reproduce historical country-level variability, and reproduce spatial patterns of losses under extreme drought.

We next consider global crop models driven with large ensembles of climate model output (both under historical forcing and with future scenarios) to characterize present day risk and the extent of non-stationary risk in global crop production. We find increasing, and in many cases accelerating risk, of extreme global loss events even in scenarios with little to no climate-induced long-term mean changes. In some cases, one-year global-scale production loss events that would have recently been called 1-in-100 year events are estimated to occur every 30 years by mid-century, and every 10-20 years by end-of-century. We discuss some regional and global protective measures that might be introduced, including increased trade, stock-hoarding, crop breeding, and improved forecasts, monitoring, and modeling.

K-L2.5-03

Future landscapes of crop water supply and demand

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The real hydrological cycles on the Earth are not natural anymore. Humans are now driving changes in atmospheric processes through emission of green-house gases and land cover changes directly and indirectly. Global mean temperature is projected to rise approximately proportional to the cumulative total anthropogenic CO2 emissions from 1870 (AR5, IPCC WGI). Temperature rise itself will have direct impacts on the availability of water resources through changing flow regimes in snow-dominant or glacier-effluent river basins, and it will also be associated with sea level rise because thermal expansion is one of the major causes of observed and projected sea level rises. Further, climate change is projected to alter hydrological cycles: changing temporal and geographical patterns of hydrological components, such as precipitation, evapotranspiration, runoff, and ground water recharge, and particularly in their extremes. Consequently, the frequency of floods and/or droughts is projected to increase some parts of the world.

However, as articulated in the AR5 of IPCC WGII, "Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems", increasing frequency of natural hazards, such as torrential rainfall or long-lasting heat wave, alone will not cause damages on human and natural systems, and both climate and social changes are relevant for planning sustainable development in the future.

AR5 (WGII) also says "Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions". Mitigation and/or adaptation actions should not be planned in an isolated manner, but should be integrated into wider frameworks, such as integrated water resources management and sustainable development. It would preferably be integrated into a risk management framework assessing and managing possible global risks, and ultimately pursue increasing human well-beings.

These issues will be discussed with reviews of the latest estimates of water demand and supply in the future.

K-L2.5-04

Planetary opportunities in crop water management: Potential to outweigh cropland expansion

J. Jägermeyr (1)

(1) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

A major humanitarian challenge for the 21st century is to feed the growing world population in face of climate change and sustainability boundaries. However, as the planetary boundaries for freshwater and land use are being approached rapidly, there is little potential for additional cropland appropriation or irrigation water diversion. In addition, competition between food production, bioenergy plantations and biodiversity conservation increases pressure, while considerable yield gaps remain in many world regions and various water conservancy methods proved instrumental to boost yields in a sustainable way. In the here presented modeling study we investigate, at global scale, to what degree smart on-farm crop water management might contribute to a sustainable global yield increase. We do this under current and projected future climate conditions and under the constraint of environmental flow requirements to represent the planetary boundary for human freshwater use and its regional pattern. We recalculate from this potential how much cropland expansion could be avoided and also quantify associated financial investment needs. The portfolio of management options studied here consists of methods aiming for elevated crop water productivity (irrigation improvements and expansion with thus saved water) and an optimal use of on-field precipitation water (reducing soil evaporation and collecting surface runoff for supplemental irrigation).Global yield simulations based on hypothetical scenarios of these management opportunities are performed with the process-based agro-biosphere model LPJmL, driven by reanalysis data and GCM ensemble simulations. We consider a range of 20 climate change projections to cover respective uncertainties, and we analyze the effects of increasing CO2 concentration on the crops and their water demand. Crops are represented in a process-based and dynamic way by 12 crop functional types, each for rainfed and irrigated areas, per 0.5° x 0.5° grid cell. Irrigation is represented through a newly implemented dynamic irrigation module that accounts for beneficial and non-beneficial irrigation water consumption. Our results show that irrigation shifts to more efficient systems can save substantial amounts of water (54-76% of non-beneficial water consumption) at the basin level, and if used to transform rainfed into irrigated systems, can increase crop yields significantly in many major river basins (14-18% global production increase). Large-scale irrigation transitions are however very expensive. Moreover, affordable low-tech solutions for small-scale farmers on water-limited croplands can increase yields to a similar extent. A simulated global ~15% yield increase from a low-intensity water management scenario could outweigh, i.e. possibly avoid, an estimated 120 Mha of cropland expansion under current climatic conditions. A maximum-intensity water management scenario shows the potential to increase global yields by more than 35% without expansion or withdrawing additional irrigation water. Climate change will have adverse effects on crop yields in many regions, but as we show such adaptation opportunities have the potential to mitigate or compensate these impacts in many countries. Overall, proper water management (sustainably maximizing on-farm water use efficiency) can substantially increase global crop yields and at the same time relax rates of land cover conversion.

K-L2.5-05

Agricultural Adaptation to Climate Change in Rich and Poor Countries

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This talk will review the evidence on the effectiveness of adaptation in reducing climate change impacts in different countries. Much of the model-based evidence is relatively weak, not only in that it relies on models, but that it depends on strong assumptions about what farmers would do in the absence of climate change. A few observational studies have been published in recent years, which will also be reviewed. Overall, the challenge of adapting to climate change is formidable, and rapid learning will be essential for achieving as much reduction in impacts as possible.

K-L2.5-06

Adaptation to Extreme Weather Events by Farmers in China

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Growing evidence indicates that climate change has aggravated the intensity and frequency of extreme weather events in the past and will future aggravated in the future. Overcoming the challenge of increasing extreme weather events, particularly drought and flood, has captured much attention in many developing countries. In China, the annual average crop area suffering from serious drought and flood has also increased in recent decades. Key issues to be discussed in this presentation include: how farmers have responded or adapted to the extreme weather events? What are major measures that have been taken by farmers when they face serious drought and flood? How effectiveness of these measures in mitigating the risk resulted from the extreme weather events? How policy can facilitate farmers to better adapt to the rising intensity and frequency of extreme weather events in the future? Based on primary data from a large-scale field survey in China, the results show that when faced with severe drought or flood, farmers do take various measures to mitigate the climate risk. Most measures taken by farmers are related to investment in and management of water used in agricultural production. The local irrigation infrastructure, policy supports and early warning information services as well as farmers' social capita have facilitated farmers to take the adaptive responses. In addition, existing village, household and plot characteristics also significantly Further analysis shows that the adaptation through farmers' responses significantly reduce crop yield loss and risk of crop yield. The presentation concludes with several policy implications.

L3.1 - Socio-economics and Instruments for Transforming the Energy Sector: Economic Policy Tools for Mitigation of Energy-related GHG Emissions

K-L3.1-01

The economic and policy structure of energy transitions

M. Grubb (1)
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This presentation will summarise key structural lessons from quarter of a century's debate and experience in seeking to foster low carbon energy transitions, offering a new framework to explain how climate and energy challenges can be tackled more effectively whilst containing energy bills. It will explain three domains of socioeconomic processes each of which involves different actors and decisionmaking characteristics. These three domains operate at different scales of time and social entities and rest on different theoretical foundations. The unique characteristic of energy and climate change is that the issues raised span all three domains in approximately equal measure. The policy implication is the need for three distinct pillars of action, each being approximately equally important.

Drawing on the book Planetary Economics, co-authored with Professors Hourcade and Neuhoff, the presentation will explain from these foundations how the different pillars are complementary and why only packages spanning all three are credible, economically efficient and environmentally effective - and hence, politically stable.

K-L3.1-02

Carbon Markets: Past, Present and Future

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Carbon markets are substantial and expanding. There are many lessons from experience over the past 10 years: fewer free allowances, careful moderation of low and high prices, and a recognition that trading systems require adjustments that have consequences for market participants and market confidence. Moreover, the emerging international architecture features separate emissions trading systems serving distinct jurisdictions. These programs are complemented by a variety of other types of policies alongside the carbon markets. This architecture sits in sharp contrast to the integrated global trading architecture envisioned 15 years ago by the designers of the Kyoto Protocol and raises a suite of new questions. In this new architecture, jurisdictions with emissions trading have to decide how, whether, and when to link with one another, and policy makers overseeing carbon markets must confront how to measure the comparability of efforts among markets and the comparability of markets to a variety of other policy approaches.

An important recent development is the 2014 U.S. Environmental Protection Agency (EPA) proposed rules to regulate fossil fuel power plants under existing U.S. law. Final rules are expected this summer. The rules' key features include state-by-state emissions rate targets and considerable flexibility for the states to achieve them. This flexibility includes the states' choice to implement the targets through traditional regulation or the use of carbon markets. If implemented through carbon markets, states face additional questions about carbon market design. Different strategies for emissions reductions and regulation design will have important near-term consequences, in terms of the cost of electricity generation and market prices, and important long-term consequences, in terms of retirements and new investments. These consequences can vary significantly from region to region and from stakeholder to stakeholder.

The long-term consequences are particularly important in terms of the legacy for future policies. If current regulations turn out to be inadequate to address future mitigation goals, debate could begin again over federal legislative options, namely, a tightening of the existing program, an explicit national trading program, emissions taxes, or other alternatives to reduce emissions such as renewable or clean electricity goal. In this event, it will be important to understand how responses to the current proposed regulation may both affect the ability of the electricity industry to respond cost effectively to any new policies in the future as well as the distribution of future costs across stakeholders.

K-L3.1-03

Carbon Pricing Future in China

J. Kejun (1)
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A global 2 Degree temperature increase was identified as a political target for climate change. The newly published IPCC AR5 presents a lot of research on scenarios, policies for the 2 degree target. Carbon pricing is one of the key policy options for CO2 emission mitigation. In China, CO2 emissions trading was adopted as a policy for China's low carbon development. The emission trading was launched in 2011 in 7 pilot cities and provinces. An implementation of carbon tax in China was widely discussed, and now is under decision making process in government. This presentation summarizes the analysis of a carbon tax based on IPAC model simulation, and discusses the choice between carbon tax or emission trading in China. In the modeling analysis, in order to support the global 2 degree target, CO2 emissions in China have to reach peak before 2025 and then start deep cut on CO2 emissions. In IPAC modeling analysis, feasibility analysis for this emission scenario was developed. By using this detailed analysis modeling tool, it is feasible for China to peak CO2 emissions before 2025, and start deep cut after that, reaching more than 70% cut by 2050 compared with that in 2020. In the analysis, various policies were considered, including energy efficiency improvement, fuel switching in end use sectors, low carbon power generation, land use mitigation, carbon pricing etc. Based on China's policy making regime, these policies could be implemented in different government agencies according to their functions. There has been a significant progress on energy efficiency improvement since 2005 when China started the energy conservation program as a national fundamental strategy. And in recent years, renewable energy development in China is also playing the main role in the world, accounting for nearly one third of the global production capacity for renewable energy added per year.

However, we do need to consider an economic method for GHG mitigation in China. We have started analysis on carbon tax and emission trading from 2005, by now ETS is undergoing, and a carbon tax was proposed to government. In the modeling analysis, it is found that carbon pricing has significant effects on CO2 emissions mitigation to reach the global 2 degree target, and could be implemented in China. By reviewing the progress of ETS in China, we have discussed the advantages and disadvantages of both carbon tax and ETS, and suggested the future pattern for carbon pricing in China. Carbon tax is strongly recommended as a national policy for GHG mitigation. A system to combine carbon tax and ETS in China is also proposed.

K-L3.1-04

India's Energy and Climate Debate: Uncertainties in Future Emissions and the Scope for Co-benefits

N. Dubash (1)
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India occupies a dual position in global climate debates. As a large and rapidly growing economy, India's future energy and emissions trajectory holds considerable importance for global efforts to address climate change. On the other hand, India starts from a very low base of energy use and emissions on a per capita basis, illustrating the considerable future energy needs required if India is to meet the development needs of Indian citizens.

This duality frames Indian climate and energy policy. Given the low levels of current energy usage, poor quality of infrastructure and the need to provide jobs for large numbers of people entering the workforce, the only acceptable starting point from a domestic point of view is India's energy needs, rather than carbon limitations. However, Indian policy formulation is able to consider climate impacts through explicit consideration of 'co-benefits' of alternative development policies. Hence, understanding and operationalising co-benefits is an important theme in Indian energy and climate policy.

This study reviews recent national energy and climate modelling studies to assess the projected range of future emissions, energy demand patterns and energy supply futures. What emerges is a wide variation in projected business as usual futures. Policy scenarios included are a carbon tax, and bottom up demand and supply mix scenarios, leading to a relatively modest deviation from reference cases until 2030.

Key results include: a projected doubling or tripling of carbon dioxide emissions, and an increase in coal use by 2.5-3 times, despite considerable increase in renewable energy use. However, these projections assume continued high GDP growth rates until 2030, which partially drive these results.

Despite the importance of co-benefits, the studies do not systematically assess the co-benefits arising from various climate policies. However, a review of global integrated assessment models applied to South Asia do suggest that air pollution and energy security co-benefits in particular can be considerable.

Looking to the future, the co-benefits framing of India's climate policy is likely to result in sector by sector policy formulation, driven primarily by sustainable development and energy security concerns, with some attention to climate benefits. The co-benefits analysis suggests that the climate gains in terms of 'bending the curve' could be substantial. In order to assess the magnitude of potential reductions in CO2 will require more careful attention to sectoral scenario construction in future model runs.

K-L3.1-05

Mitigation of Energy-related GHG Emissions in Brazil

E. La Rovere (1)
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Brazil is one of the largest developing economies in the world. Its long-run developmental pathway needs to face huge challenges, such as: poverty eradication, reduction of inequalities, food security, access to energy and water, public security, technological innovation and competitiveness. Climate change will have to be added to this list, due both to the country high vulnerability to climate change and to its important contribution to global GHG emissions. In this context, this presentation summarizes an analysis of the social and economic implications of different GHG emission mitigation scenarios for Brazil.

Brazilian voluntary commitment to reduce emissions until 2020 shall be reached thanks to the sharp cut on Amazon deforestation achieved since 2004. As the economy grows, emissions related to the combustion of fossil fuels for energy production and consumption have been increasing significantly and are expected to become the dominant source of GHG emissions over the next decade. Mitigation policies and measures, beyond those included in governmental plans, have been identified and grouped in scenarios up to 2030, according to expert judgement on assumptions about its economic and political feasibility, resulting in different penetration rates of technological and management innovations.

Comparative analysis of the scenario results has allowed for highlighting economic (GDP, inflation, trade balance, industrial competitiveness) and social (employment, income distribution, low income household consumption patterns) implications of lower carbon pathways in Brazil. These results provide new insights as an input to the national debate on the strategy to curb down country's GHG emissions up to 2030.

In the past, different policy tools have been used in Brazil to foster the development of renewable energy in Brazil, including: a mandatory blending of ethanol to gasoline; soft loans to increase ethanol production; fiscal exemptions for planted forests of fast growing species such as eucalyptus and pinus, used for charcoal manufacturing; tendering of hydropower plants to be built through public/private partnerships; feed-in tariffs for power generation from wind farms, solar PV and biomass; among others. These instruments have enabled Brazil to reach a level of 45% of renewable energy in total energy supply in 2010, against a world average of 13%.

Now, different command/control and economic instruments may be used to promote a transition to a even lower carbon energy system: the creation of domestic

carbon allowance market is under study by governmental bodies; and the possibility of increasing fossil fuel prices by a variety of taxation schemes is also considered.

The study findings highlight that if command and control measures coupled to microeconomic policies are able to overcome the barriers to mitigation options, decoupling of economic growth and GHG emissions would be possible: additional mitigation scenarios, on the top of existing governmental plans, might increase GDP, employment and household income of the poorer income classes, providing a "win-win" outcome. The gain of income is higher than inflation for low and middle income classes, helping to reach a better income distribution pattern. However, under a global carbon tax scheme, applied on burning of fossil fuels in Brazil as well, GDP is slightly lower. Even though, the use of the carbon tax revenues to decrease labour charges and foster job creation might keep employment levels and preserve social development gains.

The Brazilian case illustrates the relevance of choosing the appropriate instruments to overcome the economic/financial and non-economic barriers to the mitigation options, according to the national circumstances, in order to achieve a transition towards a lower carbon society.

K-L3.1-06

Macroeconomic and Financial Policies for Transforming the Energy Sector

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Abstract not communicated

L3.2 - Transformational Energy Technologies

K-L3.2-01

Game Changing Energy Technologies

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Successful transformation of our energy system will require game-changing technological innovations. Some of these innovations are here today - for example photovoltaics and wind turbines. Some are likely to be coming soon, but require additional time and effort to decrease costs and scale them up to the enormous size of our energy system. Looking to the future, additional game changing technologies are needed and on the horizon: carbon capture and storage, renewal fuels made without plants, radiative cooling, just to name a few. Now is an incredibly exciting time be involved in this important research endeavor. Indeed it is the challenge and opportunity of the century. In this presentation I will highlight the tremendous progress that has been made in renewable energy and present emerging innovations needed for a more sustainable energy future.

K-L3.2-02

Prospects for Carbon Capture and Storage

G. Hill (1)
(1) BP Alternative Energy, Global carbon sequestration technology group, London, United Kingdom

Carbon Capture and Storage (CCS) is likely to be a key technology in a world that has a plentiful resource of fossil fuels and cares about limiting CO2 concentrations in the atmosphere. With almost 20 years of development experience, CCS has still to break through the demonstration phase. However internationally a number of large scale projects are about to come on line which might change this perception. This talk will examine what our experience has taught us to date and what challenges remain for CCS.

K-L3.2-03

Energy Systems Integration

M. J. O'malley (1)
(1) Energy Institute and Electricity Research Centre, University college dublin, Dublin, Ireland

Energy systems have evolved from individual energy devices into complex integrated systems that have strong coupling between energy vectors across spatial and temporal scales. Energy Systems Integration (ESI) is the optimization of energy systems across these energy vectors and scales. ESI is most valuable at the interfaces where the coupling and interactions are strong and represent a challenge and/or an opportunity. ESI control variables are technical, economic, regulatory with a strong human dimension. ESI benefits include increase reliability and performance, minimisation of cost and environmental impacts and in particular, increased penetration of renewable energy sources.

L3.3 - Managing Transitions in Cities: Towards resilient, low-carbon cities

K-L3.3-01

Transition and transformation towards low carbon, resilient cities

X. Bai (1)
(1) Australian National University, Canberra, Australia

The facts that link cities and climate change are simple - cities contribute majority of CO2 emissions, and due to the high and growing concentration of population in cities and the geographic locations of world major cities, cities are also increasingly exposed of, and would suffer from, the impacts of climate change. It is increasingly recognized that transition and transformation towards low carbon and resilient cities are critical, and what we do in our cities, and how we do it, may largely determine our collective futures under climate change.

The importance of looking at cities in climate change is paramount, and the need for the role of cities to be better recognized and for cities to be better integrated in international climate change negotiations is essential. However, the real challenge lies in how can we initiate, manage, and achieve transitions and transformations that enable cities to become low carbon and more resilient. Drawing on recent studies and several examples, this paper explores such challenges and potential leverage points, from the following four aspects:

a) The complex and multifaceted linkages between cities and climate change: The linkages between cities and climate change are complex and multifaceted. Cities are the largest contributor of CO2, but they might also be more efficient in terms of delivering the same level of services. Recent research shows that cities impacts on climate change have multiple pathways that go beyond contribution to CO2 emission. Such complexities are not fully recognized, nor they are reflected to inform policy and practice.

b) Contextualizing low carbon concept in rapidly urbanizing regions: The concept of low carbon and

resilient cities often becomes a relative term and context specific. In regions undergoing rapid urbanization and economic growth, the goal of achieving low carbon and resilient cities can have drastically different meaning, which is often contradicted by other objectives that are more pressing and thus given higher priority. For example, how to reconcile the tremendous need to provide urban housing and other infrastructure vs the task of reducing total carbon emission? Competing priorities exist within the cities, but can also be dictated by the national policy and thus beyond the city's administrative capacity.

c)The need to focus from transition to transformation: Transition can be defined as the shifting of system state, in terms of carbon emission quantity, level of resilience. Transformation on the other hand, means fundamental changes in the society, that involves different actors perspective, awareness, behaviour, culture norm, and business governance practices. Much of the efforts in low carbon cities are focused on transition. Research shows majority of consumption based carbon are from upstream indirect emission, which can only be addressed via transformational changes.

d) The need for a better understanding of urban systems processes and interaction: Cities are rapidly changing system with interlinked actors and processes. There are synergies, trade-offs and feedbacks between actions within different sectors, with direct and flow on effects. Such interactions, and in particular the feedbacks, are not well understood. As far as cities are concerned, it probably is not true that all the science needed to take action is out there. Further, the sector or actor that initiates a climate mitigation or adaptation action might be responsible for and own the action, but not the flow on effects, positive or negative. A better understanding of urban system processes and interactions can help identify leverage points and target the most important interactions and actors, which in turn will enable cities to harness synergies while limiting trade-offs.

O-L3.3-01

Urban Climate Change Adaptation and Resilience

C. Rosenzweig (1)

(1) NASA Goddard Institute for Space Studies, New York city, United States of America

Cities are acting as world leaders in climate action. This is a crucial stage where significant opportunities are emerging for the co-production of knowledge between researchers and stakeholders. This discussion will draw on the Urban Climate Change Research Network's (UCCRN) Assessment Report on Climate Change and Cities (ARC3) as an example of the co-production of climate knowledge for cities. The discussion will also highlight the work being done by the New York City Panel on Climate Change (NPCC) to aid in developing science-based policy solutions for resiliency in the metropolitan region of New York City.

The objective of the UCCRN is to bring together experts working on global-scale, climate change and cities assessments in order to simultaneously present state-of-the-art knowledge on how cities are responding to climate change and to define emerging opportunities and challenges to the effective placement of this knowledge in the hands of local stakeholders and decision-makers.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, represents a four-year effort by 100+ scholars from over 50 cities in both developing and developed countries, and is the first-ever global, interdisciplinary, cross-regional, science-based assessment to address climate risks, adaptation, mitigation, and policy mechanisms relevant to cities.

The UCCRN is now working towards launching the next installment in this ongoing series, the Second UCCRN Assessment Report on Climate Change and Cities (ARC3-2, which has been submitted to Cambridge University Press for publication. The ARC3-2 Report is scheduled to be launched at COP21 in Paris in December 2015. The UCCRN is also launching its Case Study Docking Station later this year, providing examples of urban mitigation and adaptation initiatives from 100 cities across the globe.

New York City, one of the cities included in UCCRN's Case Study Docking Station, is a leading example for urban climate change adaptation and resilience. The New York City Panel on Climate Change (NPCC) is an independent body that advises the City on climate risks and resiliency. Utilizing the best available data, NPCC science informs New York City's comprehensive climate policies, positioning residents and planners to confront expected future changes in the most effective way possible. The NPCC was established in 2008 by then Mayor Michael Bloomberg as an ongoing collaboration between scientists and key stakeholders in the City of New York to integrate resilience against the future impacts of climate change into long term sustainable planning.

The NPCC released its first report in 2010 outlining the key impacts that climate change is projected to have on the city through 2080. In February of this year, the NPCC released its second report, Building the Knowledge Base for Climate Resiliency (NPCC 2015). This provided climate projections for temperature, precipitation, and sea level rise through 2100 for the first time, representing advancement in the science for resilience. New topics covered in the NPCC 2015 report also include public health, with a focus on extreme heat events, coastal storms, and enhanced dynamic coastal flood modeling, which incorporate the effects of sea level rise. The work of the NPCC has been used by New York City planners to guide key adaptation initiatives. This science information was included in rebuilding efforts after Hurricane Sandy in 2012 through the Special Initiative on Rebuilding and Resiliency, in the City's $20 billion adaptation plan for climate change, and most recently in Mayor de Blasio's One NYC initiative for approaching sustainability, resiliency, and equality simultaneously in the 21st century.

O-L3.3-02

Shaping low carbon infrastructures – major requirements and illustrative examples

M. Fischedick (1)

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Reduction of GHG emissions caused by cities plays a decisive role in the battle against climate change. Due to rapid urbanization in many parts of the world, particularly in the developing world, appropriate solutions have to be found for growing cities and even new agglomeration areas. In cities with mature infrastructures, their exemplary roles are especially important in demonstrating the cornerstones of a low-carbon transition, such as in their building and equipment operation including deep retrofits, general procurement and mobility system transformation.

Systematic and coordinated strategic urban planning with effective stakeholder participation is of high importance for developing low-carbon urban infrastructures. Specification of mitigation priorities has to start at the very beginning with carefully identifying and addressing the needs and the challenges in each of the key sectors (including basic needs of inhabitants). The planning shall be based on robust scientific analysis, shall start with a solid analysis of the given urban infrastructures, the GHG emission sources (GHG inventory) and their endogenous and exogenous driver. In addition the whole bunch of mitigation options (from smart energy efficiency services to decentralized renewable energy supply structures) has to be considered and properly assessed.

As consequence of high fixed costs of urban infrastructure measures and the long life span of those investments, within the planning process lock-in risks and path dependencies have to be considered carefully. In the long term with the growing implementation of energy efficiency measures to minimize embodied energy becomes more and more important. A better understanding of the value chain and of about how to change the existing relationships is therefore key.

For shaping suitable low-carbon infrastructures no blueprint is available and specific conditions of every city are crucial. However, exchange of experience can play an important role in finding the right solutions. With this regard international city networks and bi- or multilateral partnerships (e.g. in the context of existing twinning towns) can help to exchange experience of how to steer

urban transition processes successfully and how to set a solid fundament to achieve an appropriate implementation culture.

Cities often are the crucial driver and forerunner for significant changes on the national level (or even the international level). They are often focal point for political and cultural changes and provide the right framework for development and testing of (niche) innovations, innovations that have the potential for the necessary changes of socio-economic regimes (including institutional settings and consumer behavior respectively routines). With this regard cities can also be seen as perfect real laboratories. In cities socio-technical texture of modern societies can be found (comprising energy and transport system, provision of food and education etc.), but in comparison to states with a lower grade of complexity. Learning formats can be better placed under those conditions.

Against that background the presentation will provide major requirements for shaping carbon infrastructures and will give illustrative examples for successful practical steps.

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O-L3.3-03

Experiences from the ground: Case study from a City

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Abstract not communicated

L3.4 - Ecosystem-based Adaptation and Biodiversity Conservation: How we can help organisms to adapt by themselves, what the limits are, and how we can use ecosystem processes to help people adapt

K-L3.4-01

Strategic approaches for enhancing climate change adaptation of species and ecosystems

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Even under best case mitigation scenarios, most species and ecosystems must undergo adaptation if they are to avoid extinction and maintain their functions under climate change. Published observations of such adaptation now number in the thousands and include shifts in species' distributions and the timings of seasonal activities such as animal migrations and plant phenology. A large literature is also emerging, however, on the negative impacts of climate change on less adaptive species and ecosystems. The broad spectrum of impacts includes physiological stress and mortality, population and distribution declines, food web disruptions, and increased competition with dispersive 'climate change immigrants'. Climate change challenges conservation strategies to make a strong shift from traditional preservationist approaches towards promoting adaptive changes while minimising negative impacts. Here I discuss emerging approaches for enhancing climate change adaptation of species and ecosystems and outline some of the key gaps and challenges in this field.

Projecting climate change impacts on species and ecosystems is an important early step in effective adaptation planning. This has driven rapid development of a suite of approaches and methods for assessing the vulnerability of species and ecosystems to climate change, generally by co-opting methods used for other purposes. Each differs in its strengths, weaknesses, resource requirements and suitability to different contexts, and no single one has emerged as clearly superior, nor seems likely to do so in the near future. This introduces a considerable challenge for conservation practitioners, who must select between and learn to apply sometimes complex methods for their focal areas, ecosystems or species. Although filled in part by the forthcoming IUCN SSC guidelines for assessing species' vulnerability to climate change, the gap between academic developments and their accessibility to practitioners remains a concerning challenge. Equally, assessing how human responses to climate change will impact on natural systems (e.g., changes in agriculture

and new infrastructure such as dams and sea walls) is an important gap for species-focused climate change vulnerability assessment in particular.

A range of approaches have emerged for enhancing climate change adaptation of species and ecosystems. These include those focused on landscapes (e.g., increasing protected area connectivity and permeability), sites or site networks (e.g., creating habitat refuges and decreasing non-climatic stressors), and species (e.g., enhancing evolutionary potential through translocation or ex situ conservation). Most are extensions or modifications of existing conservation approaches and, to date, there has been little investigation of their effectiveness for minimising climate change impacts, nor of their potential unforeseen maladaptive effects. Since conservation under climate change is unprecedented, we can expect errors and failures along with successes. Development of an evidence base from which we can learn will facilitate the rapid advancements needed in this important emerging field, and will help to avoid both potentially negative actions and wasted resources. Even while climate change adaptation strategies and our skill at implementing them improve, their potential to minimise losses of ecosystem function and extinction is finite. Reducing greenhouse gas emissions and thereby limiting the rate and magnitude of climate change are vital for the success of climate change adaptation initiatives.

K-L3.4-02

Operational interventions to assist the adaptation of terrestrial biodiversity to climate change

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The rate and extent of projected anthropogenic climate change over the next century may be unprecedented in several million to tens of millions of years. This perturbation to the climate system is occurring during an inter-glacial phase, which is a naturally warm phase in the context of the Pleistocene epoch, which prior to the Holocene Epoch of the past 12000 years, has predominantly (more than 80% of the time) seen global temperatures of roughly 5°C cooler than the Holocene, and atmospheric CO2 levels of 180 to 200 ppm vs the 280 ppm CO2 of the Holocene prior to the onset of the Anthropocene. Scenarios of 500+ ppm CO2 and possible warming in excess of 3°C represent a fundamental ecological shock to terrestrial ecosystems globally, especially in the light of the much cooler planetary history of the Pleistocene. Nonetheless, ecosystems and their component biodiversity have been exposed to repeated warming and cooling cycles and have clearly coped with these, indicating the potential for substantial natural adaptive capacity, and inherent resilience.

One clear adaptive response has involved geographic range shifts, especially at higher latitudes in the northern Hemisphere where temperature exerts a dominant control on growing season, biome distributions, and the geographic distribution of species. This observation, together with observations of incipient range shift responses has led to the application of a paradigm largely of "passive" adaptive planning. That is, using projected geographic shifts of species in response to future change, the spatial planning of areas that anticipate the direction and preferred routes for range shifts to facilitate receptive landscapes. Under extreme scenarios involving high rates of climate change on flat landscapes with a high "climate velocity" more active approaches have also been explored, including assisted migration. A final safety-net approach of gene or seed-banking has also been proposed. Such approaches seem relevant for low temperature ecosystems that are rapidly experiencing warming, and may reach levels that could exceed existential tolerance limits established during Pleistocene times.

However, in the subtropics and tropics, where water availability and disturbance regimes exert control over ecosystem structure and function, it is far less clear how important range shifts have been for natural adaptation. In these ecosystems, for example, the past changes in atmospheric CO2 levels have had critical direct impacts on ecosystem distribution, with tropical forests losing significant areal coverage due to the limiting effect of low atmospheric CO2 on tree production. This may have interacted with the fire regime to allow flammable grasslands to expand and dominate tropical regions, possibly enhanced by an ascendant grazing vs diminishing browsing fauna.

Under these conditions, ecosystems respond according to changing disturbance rules, and not climate rules, and thus individual range shifts may be less important, but community effects may be more important as entire ecosystems may change their structure and function over large areas, thus changing habitat conditions for consumers, and indeed interacting with consumer responses. With future atmospheric CO2 projected to approach levels not seen for more than 20 million years, direct CO2 impacts may strongly influence ecosystem and habitat shifts due to changing fire regime and water use efficiency in water-limited ecosystems, potentially encouraging the re-establishment of more woody biomes. This opens the potential for active management response versus the passive landscape planning approach. Active management would involve strategic decisions about desired future states, achievable through the use of fire and graze/browse management responses.

Conservation practitioners would benefit by considering both active and passive adaptive strategies for biodiversity conservation, as both may have relevance, albeit with different emphases, in low and high latitude situations. Much can be learned from experience in active interventions long practiced in tropical and sub-tropical situations involving fire management, browse-graze manipulation, and translocation/reintroduction of animal species. An urgent effort is also required to understand the strength of the CO2 fertilization effect on water-limited ecosystems, and the potential of this process to transform the structure and function of fire and grazing-controlled ecosystems.

K-L3.4-03

Title not communicated

B. Vira

Abstract not communicated

L3.5 - Benefits of mitigation of climate change for coastal areas

K-L3.5-01

Benefits of mitigation of climate change for coastal areas

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This presentation will review the possible benefits of mitigation of climate change for coastal areas with a strong emphasis on sea-level rise. This is one of the most certain consequences of human-induced global warming and has significant impacts. Importantly, there is a long-term 'commitment to sea-level rise' due to the long thermal lags of the ocean system and hence the response of sea-level rise to mitigation is slower than for other climate factors. Therefore, while climate stabilisation reduces coastal impacts during the 21st century, compared to unmitigated emissions, the largest benefits may occur in the 22nd century (and beyond). While we cannot avoid some global rise in sea level, we can still avoid significant losses of the Greenland and Antarctic ice sheets, with significant long-term benefits to coastal inhabitants. The available results suggest that a mixture of adaptation and mitigation policies need to be considered for coastal areas, as this will provide a more robust response to human-induced climate change than either policy in isolation. This point has been clearly articulated in coastal impact chapters of the Fourth and Fifth IPCC Assessments. This approach requires the joint evaluation

of mitigation and adaptation in coastal areas which has not been systematically considered to date. Because of the long time constants involved such assessments need to continue beyond 2100 to provide the full implications of the different policy choices. While the basic science of the commitment was available and presented in the First IPCC Assessment, the policy implications are less appreciated and need wider discussion.

K-L3.5-02

Indigenous knowledge on ecosystem cycles in Northwestern Amazon: a collaborative research towards climate change assessment in a regional scale

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Tropical rainforests are of utter importance for ecological balance and climate stability on global scale. However, as widely reported, there is a growing threat to them and their traditional peoples, deforestation performing between 15 to 20% of the global GHG emissions. The Amazon forest is the largest rainforest in the planet. Indigenous peoples have a key role in the future governance of the Amazon biome, considering that 27,5% of the whole extension of the Amazon basin consists of indigenous territories – in Brazil the percentage is about 22% and in Colombia, it is higher than 50% (http://raisg.socioambiental.org/temas/territorio-indigena). This shows significant interrelations between tropical forests, indigenous peoples and the climate change.

The collaborative research initiative here described aims at joining the efforts of IPCC WG II, as stated in its Summary for Policymakers, to more accurately address adaptation and mitigation solutions, as well as knowledge networks on the regional scale, to face climate change effects. Rather than supporting local population to adapt to climate change, this long term applied research project aims to understand how indigenous peoples are engaged with the environment through their current management practices. The notion of life cycle, integrating both sociocultural and natural aspects, is privileged as an assessment methodology. Indigenous peoples have developed detailed and sophisticated knowledge on the ecological processes, which could improve a more rich and territorialized comprehension of ecosystem transformations and climate change.

Since 2005 a collaborative research has been developed on the ecological and socio-economic cycles in the Northwestern Amazon, a region of about 250000 square kilometers of officially recognized and demarcated indigenous territory at the border Brazil-Colombia. This cross-cultural and interdisciplinary research involves a team of indigenous and non-indigenous researchers, and methodologies aimed at an effective communication and collaboration between the indigenous knowledge and Western science. This initiative aims to: (1) describe the economic-ecological and socio-cultural calendar of indigenous peoples of the Amazon northwest, from observations and recordings done by the indigenous researchers over the years; (2) monitor the annual cycles, identifying and analyzing their patterns and variations, noting possible regional effects of more extensive climate change; (3) as a future perspective, guiding environmental governance policies of indigenous territories considering climate change scenarios; (4) propose ways and methodologies to monitor climate change from the collaboration between indigenous and scientific knowledge within the Amazon basin.

Information and policies related to climate change commonly reach the local communities through biased and inappropriate ways, typically from top to bottom. This collaborative research, which emerged in the context of long-term partnership relations between regional indigenous local organizations, FOIRN (Regional Federation of indigenous organizations) and ISA (Socioenvironmental Institute), who jointly develop several projects in the areas of sustainable community development, capacity building etc.), seeks an exchange of knowledge on annual cycles. It departs from a simple methodology based on daily written logbooks kept by indigenous dwellers (trained as researchers) from various communities along the same river (about 400 km long) and some of its tributaries, usually young adults who search for additional information and interpretations with elder knowledge holders, about the phenomena they are observing. In addition, workshops are made to organize and discuss this material with researchers and advisers of ISA. The main assumption is the recognition that indigenous peoples inhabiting the same region for generations, even centuries, and relying directly on ecological and climatic processes and cycles for their own subsistence activities, are the ones who better know and understand the life cycles.

This research process has accumulated extensive material that is being organized, edited and analyzed. This poster describes the annual calendar of the Eastern Tukanoan peoples, and indicates its relevance in assessing ecosystem and climate change on a regional scale and unfolding possibilities in terms of relevant public policies.

K-L3.5-03

Effective adaptation strategies and risk reduction to global changes in small farmers in Mesoamerica

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Mesoamerica is a region highly vulnerable to climate change because of its geographic location and topography. Moreover, high levels of poverty and social exclusion increase its population vulnerability. In recent years, the region has been severely affected by extreme weather events with high cost in casualties and economic impacts. A single event such as Hurricane Stan in 2005 produced an economic loss similar to the GDP increment for Guatemala for that year. Drought events are occurring more frequently and threaten food security for thousands of impoverished families who depend on subsistence agriculture.

Coffee is an export crop that has been most affected in recent years not only by extreme weather events, but also by the economic crisis as a result of price volatility in the international market and more recently by the strong incidence of coffee rust infestation. Across Mesoamerica, over 4 million people depend directly on coffee production for their livelihoods. Most producers are farmers with limited areas of land and few economic resources but their system of production results in a robust agroforestry system, which provides various environmental services.

Our Global Changes and Coffee research program has been working with small farmers in the region for the last ten years to study the adaptation strategies of families whose livelihoods are threatened by multiple pressures from global changes such as climate change, increase incidence of pests and diseases, and highly volatile international markets for their products. Our research has focused in four countries in Mesoamerica: Mexico, Guatemala, Honduras, and Costa Rica through the work of a multidisciplinary research network formed by scientists from the social and natural sciences.

In this paper, we will discuss results derived from three objectives of our research program: 1. Studying the perceptions of farmers to identify situations that affect them, 2. Identifying the barriers that limit their efforts to adapt to a multi-stressor environment, and 3. Making recommendations for stakeholders at the local and national level working to support these farmers.

Results show that most farmers who participated in this study perceive that there is a change in climate conditions, resulting in warmer days and changes in the seasonality of rainfall (change in the start and end of the rainy season). The incidence of pests and diseases has also changed: pests are observed more aggressive and more abundant. Still, farmers are mostly concerned about the high volatility of coffee prices in international markets, which of course determine the prices paid to them locally. One important strategy adopted by farmers is diversification both of economic activities and cultivated crops.

Our research shows that there are significant barriers to adaptation among farmers: limited financial resources,

insufficient technical support, low availability of key information such as weather forecasts and market variations, and difficulty in keeping local organizations active.

Adaptation should be approached as a two-way process: top-down, with national-level decision-makers developing policies and programs to increase access to financial instruments, and to improve the dissemination of strategic information on global markets and climate variability. This should be complemented with a bottom-up approach that strengthens existing social capital in the form of local organizations and cooperatives, and increases the flow of knowledge from local communities involved in processes of autonomous adaptation to national government officials and decision makers.

K-L3.5-04

Impact of country-level policies on smallholder farmer adaptation to climate change in Sub-Saharan Africa

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The overarching challenge of sub-Saharan Africa (SSA) governments is to design appropriate policies that will increase smallholder farmer uptake of climate-smart land and water management (CSLWM) practices. This study was done to determine impact of policies on farmer adaptation to climate change. The study used a transboundary approach in which communities with comparable biophysical and socio-economic characteristics but residing in two neighboring countries with different policies were used. The study shows that investment in agricultural research and development, strong land & tree tenure, decentralization and investment in smallholder irrigation are the key policies that enhance CSLWM uptake and adaptation to climate change. Additionally policies that provide incentives for tree planting and protection and that give mandate to local communities to manage natural resources are key strategies for enhancing uptake of CSLWM.

The study also found that government policies that provide incentives for long-term land investments are more important than large top-down public investments that ignore the role of farmers in planning and management of such investments.

K-L3.5-05

Achieving the Potential Contribution of Planted Forests to Adaptation to and Mitigation of Climate Change

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Globally, production and provision of ecosystem goods and services from planted forests are being altered by climate change. This poses new challenges to forest policy makers, local communities, forest managers and the forest-based industries which depend increasingly on wood and biomass resources from planted forests. Planted forests can also be managed to make a major contribution to removal of cardon from the atmosphere and hence the mitigation of climate change. Climate change adaptation strategies and recommendations for sustainable forest management have been developed at global or regional scales for planted forests in various environmental and socio-economic contexts, but these need to be complemented and further elaborated for implementation at local scales in close interaction with regional, national and local stakeholders. We will present territorial foresight approaches, landscape simulation tools, carbon budgeting and best practice case studies from planted forests in various temperate regions around the world. These can provide useful models and demonstrators on which to base management options to achieve effective future adaptation to and mitigation of climate change.

K-L3.5-06

Using seasonal forecasts to improve small farmers' resilience and adaptation to climate change and food security in Yatenga northern Burkina Faso

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Agriculture in the Sahel is strongly dependent on rainfall, hence the urgent need to disseminate appropriate seasonal climate forecasts. Since 1998, researchers in several international and regional forecast centers help of experts from national meteorological services strive to provide answers. In June 2014, these predictions were compared with indigenous knowledge based on observations of certain signs, made by people in 11 villages of the CCAFS research site in Yatenga, Burkina Faso. These two types of prediction converged and gave a season rainfall deficit trend compared to the average observed over the last thirty years. Ten farm managers in each of these villages, which produce cowpeas and / or sesame each received a radio to monitor weather information broadcast daily in local language and in French by a community radio station covering the area well. Yield squares were placed in their fields to an assessment of production. Meanwhile, ten farmers in six villages considered as control were also selected and their fields, followed in the same conditions as above. The controls did not receive information on seasonal climate forecasts through the project and have not been endowed with radios. The results show excess rainfall totals to normal in the region, but badly distributed in time and space, causing dry spells in some localities. Preliminary agronomic results do not show significant differences between the two types of monitoring operations.

Key words: Productivity, sesame cowpea, climate forecasting, Yatenga, Burkina Faso

K-L3.5-07

Joint public and private finance for ecosystem-based adaptation - an example from nature-based coastal protection in Indonesia

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Measures to adapt to climate change can have negative environmental impacts. For example, coastal flood protection walls prevent the influx of sediment and the natural build-up of coastal areas, while increased fresh water storage in reservoirs can lead to fragmentation of river ecosystems. However, adaptation can also be done with less impact on the environment, for example by restoring mangrove forests to protect against floods. Such adaptation strategies that make use of the natural functioning of ecosystem processes are referred to as ecosystem-based adaptation. Ecosystem-based adaptation can therefore be assumed not to have negative environmental impacts but rather to strengthen or expand ecosystems and protect biodiversity.

Developing countries may require financial support to adapt to the impacts of climate change. The international community has committed to providing 100 billion USD/year from 2020 to support climate change mitigation and adaptation in developing countries. With roughly half the amount to be spent on adaptation, large financial flows can be expected in the coming decades to support the implementation of adaptation projects in developing countries. Funds should come from both public and private sources; public funds should be used to 'leverage' private sector funds. Through the provision of finance, investors and donors may steer how adaptation is implemented. The question this paper addresses is whether ecosystem-based adaptation is, or can be made, as attractive to

investors and donors as conventional adaptation.

This paper starts with a discussion of the revenue-generating potential of ecosystem-based and conventional adaptation alternatives for different types of climate impacts. Subsequently, we analyze the case of nature-based flood protection in Indonesia, which is currently being implemented as an alternative for concrete breakwaters that have been used so far. We discuss economic benefits and (financial) incentives related to both options. We pay specific attention to the financial aspects of the nature-based flood defense, which is financed through a combination of international and national public, and international private funds. Based on the analysis of the case we provide suggestions for international public funds to further promote ecosystem-based adaptation solutions and to leverage private sector finance for this purpose, and provide a first check regarding to what extent such solutions are actively or passively promoted by a selection of current funds.

K-L3.5-08

Global change adaptation in the Llobregat basin: methodology and tool for medium and long term water resources planning

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In recent years, water resources management has been facing new challenges due to increasing changes and their associated uncertainties, such as climate, water demand or land use. In this context, the Water Change project developed a methodology and a tool which can provide support to decision makers in assessing potential future impact of global change on water resources and give guidance as to the effectiveness of possible strategies of adaptation.

The methodology focuses on the creation of global change scenarios, the analysis of impacts and the definition of adaptation strategies based on a cost-benefit analysis. The tool developed (Water Change Modelling System or WCMS) is a software-based system with a modular approach, linking different models (hydrological, water management and water quality models). The tool enables users to quantify the impacts of global change scenarios and test adaptation measures.

The methodology and tool were applied to the Llobregat river basin, a highly populated catchment under increasing water stress in the North-East of Spain. Impacts of global change scenarios on water supply were assessed for different time horizons and optimum adaptation strategies in terms of cost-benefit were proposed.

The user is free to choose the models to be run in the tool, and different scenarios of global change can be used as inputs, to assess the impacts on water resources (in terms of quality and quantity). Finally adaptation measures can be implemented to test their effectiveness. Including adaptation to global change in water resources management planning is quite challenging given the uncertainty of future predictions in terms of demand, climate and land use. The adaptation strategies chosen must minimise the risk at an affordable cost, taking into account all the scenarios which could occur at a given time horizon.

As mentioned in the Water Framework Directive, water management plans will have to include adaptation strategies taking into account the impacts of climate change on the water sector. In this context, the methodology and tool developed aim to provide support to decision makers in water management: The tool can be used in any basin and the methodology can be applied in order to evaluate different adaptation strategies, in terms of deficit reduction and costs involved. Thus water and basin agencies are likely to be interested in the final product, and they could be identified through associations such as the INBO (International Network of Basin Organisation).

For the tested case study, a total of 65 scenarios of global change were developed and run using the WCMS. The possible future impacts on water resources and on the water supply of the basin were obtained and the results show the range of impacts increases with time. According to the projections, in 2030 the deficit may reach 10% of the demand while in 2100 the deficit could reach 30% of the demand.

As a response to the impact foreseen different adaptation strategies which could be implemented in the Llobregat River Basin were proposed and assessed. Specific adaptation measures were selected to be applied to the Llobregat river basin. Each adaptation strategy was studied in detail and the amount of water gained from its application and the price of implementation were identified, with the aim to avoid water deficit at the lowest costs.

Each of these strategies was tested for several future scenarios with the aim to know which part of the drought damage has been effectively avoided and which cost (investment and operation of the measures) should be assumed. The inclusion of these alternatives into the tool and the calculation of their costs and benefits provided insight for decision-makers about how much adaptation is needed with respect to the uncertainty of future global change scenarios.

In the case of the Llobregat River Basin, the results showed benefits are significantly higher than costs and thus adaptation to Global Change is desirable. Regarding which strategy should be chosen, the decision-maker can apply different selection criteria, combining the economic values with other indicators of impact.

K-L3.5-09

Observations and guidance for land-based mitigation

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Progress in observations, and the development of community consensus guidelines and training materials provide underpinnings for planning, implementation and evaluation of mitigations in the forest and agricultural sector. We review the observation needs from multiple stakeholders involved in mitigation and assess how the evolution of dedicated Sourcebook for REDD+ monitoring development Global Observations of Forest Cover and Land Dynamics (GOFC-GOLD) has supported developing countries. Important developments in the context of the Global Climate Observation Systems (GCOS) are increasingly improving the usefulness of monitoring Essential Climate Variables for climate change mitigation purposes.

L4.1 - The climate, finance and trade nexus: turning a political challenge into a sustainable development opportunity

K-L4.1-01

Upgrading finance and price signals in an adverse economic context

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The current context of the world economy in the aftermath of the 2008 financial crisis makes difficult to implement a quickly rising carbon price to trigger ambitious low carbon transition (competitiveness issues, unemployment, political reluctance to transfers compensating the segments of population the most affected by higher energy prices).

This presentation will demonstrate that the emerging calls for upgrading climate finance will also confront this adverse context because of the tightness of public budgets. It will then propose to turn the question upside-down through

making climate finance a lever to upgrade the efficiency of the current financial intermediation in directing saving towards long term infrastructure investments.

It will then display the basic principles of financial devices apt to a) lower the investment risks on low carbon projects based on an agreed upon notional value of carbon which can be increased at a pace higher than this of a carbon price b) redirect to these investments private savings which go currently in speculative investments and liquid financial products c) foster a sustainable growth recovery out of the current fragile economic context.

It will conclude in showing how such a framework will a) reduce tensions due to the asymmetry of trade- impacts of carbon prices amongst sectors and countries b) fulfill the CBDR principle and c) increase the incentive efficiency of carbon pricing, hence its political acceptability.

K-L4.1-02

Using trade policy to ensure the viability of massive use of low carbon technologies

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The recent IPCC-report clearly demonstrates the need to shift to a cleaner energy mix if we are to stay within the agreed 2-degree target of global temperature rise. In order to do so, costs of renewable energy must go down and markets need to be strengthened so as to allow for a scale-up of innovation, production and deployment of sustainable energy technologies.

Trade policy has an important role to play in this respect. Reducing tariffs and barriers to trade in services related to clean energy will make it easier for private actors to optimize their supply-chains, thereby pushing down costs. In order to further enhance trade opportunities it will also be necessary to address less tangible but nevertheless significant non-tariff barriers such as standards.

In the past few years, there has been a surge in the use of trade remedies in the area of clean energy. Whereas this to a great extent reflects a natural consolidation of the market with steeply falling prices, the pressure is strong on governments to put in place trade restrictions to protect its domestic industry.

Similarly, whereas decision-makers across the world recognise the need to scale up clean energy at home, it can be challenging to put in place policies that may be perceived as costly unless there is an encouragement specifically for the domestic industry. This has led to the proliferation of trade restrictive policies like local content requirements, which demand that a certain amount of inputs in different clean energy projects be produced domestically.

Ironically, many of these trade restrictive policies maintain costs of climate-friendly technologies artificially high.

There are several options for addressing these trade obstacles. First, there are regional trade agreements- many of the world's leading trade nations are currently involved in the negotiations of "mega-regionals" such as the T-TIP and the TPP. Second, there is a negotiation underway under a sectoral initiative aiming towards an Environmental Goods Agreement, EGA. Last, there is the option of unilateral trade reform.

The engagement and support of the climate constituency in these efforts would ensure a better alignment of trade policies with pressing climate change goals.

K-L4.1-03

Connecting emerging initiatives; the lessons for the UNEP finance inquiry

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The UNEP Inquiry was launched in January 2014 to identify and advance policy options that can better align the US$300trn global financial system with long-term sustainable development. The Inquiry has worked through partnerships at the country level - including Bangladesh, Brazil, Colombia, France, India, Indonesia, Kenya, South Africa, Switzerland, the UK and the USA - as well as with international institutions. Its findings show that a growing number of governments, regulators, standard-setters and market actors are incorporating sustainability into the rules that govern the financial system. Across the Inquiry's work, climate change has emerged as a key cross-cutting issue, and the Inquiry has recently published an emerging framework for linking financial reform and climate security. This framework identified four priority areas: risk management and prudential regulation; capital mobilisation; system transparency; and strengthening financial culture. Cutting across these priority areas, the strategic role of central banks has emerged as a critical theme. In this session, the Inquiry will present its findings, suggesting ways in which international cooperation could be strengthened.

L4.2 - Resilience and Transformative Solutions - Refining Old Strategies and Developing New Ones for Adaptation in Island Environments

K-L4.2-01

Climate change governance and Caribbean SIDS

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The analysis of governance of climate change is extremely important, more so for small island developing states: adaptation, mitigation, climate finance, governance architectures, environmental justice, equity etc. Albeit a small proportion of the world, the peoples of these nations and their governance challenges are part of the global climate policy discourse. That said, the recent scholarly literature has focused on the science of climate change for SIDS, but there is less on the governance of climate change for SIDS in general and the Caribbean in particular. The science is clear: adaptation is needed and urgently, yet the formula to make this happen is hard to come by. What would be a useful model for the climate governance architecture in the Caribbean SIDS region? The paper puts the results of the present science and future projections into the context of existing governance arrangements and looks at the weaknesses of the present system and how those may be eliminated to improve governance effectiveness. These issues are important for climate policy practitioners in SIDS and should also be at the forefront of the minds of academics, policy makers and practitioners in donor countries as they seek to engage in the analysis of the best models for effectiveness in climate governance, especially for SIDS.

While there are studies on the global dynamics of environmental governance, governance at the local level in SIDS, and in particular Caribbean SIDS has been neglected in the literature. Transnational climate governance is becoming more complex (Andonova, Betsill, and Bulkeley 2009), with a multiplicity of new actors, roles, structures and architectures of the earth's governance (Bulkeley and Moser 2007). This fragmentation of global and local levels of authority are often a hindrance for climate change governance (Palmujoki 2013). The effectiveness, legitimacy and transparency of voluntary non-binding parallel streams of governance is under debate but reflects global engagement for governing climate change (Suiseeya and Caplow 2013) and (Kalfagianni 2014)). The challenge is to develop a global climate governance model

that balances legitimacy and effectiveness while allowing participation from stakeholders (Dryzek and Stevenson 2011). This is particularly true as vulnerable small island developing states try to find a place in the global governance debate and to govern climate change in their countries.

As in every other area of governance, climate governance works where good governance is institutionally entrenched in political systems and climate governance is difficult where weak and under-resourced institutional arrangements are present. Environmental impacts of climate change increase the social, economic and environmental governance challenges and responses of governments. At the heart of effective climate change governance is the successful political coordination of adaptation and mitigation efforts from global to local scales by state and non-state actors (Fröhlich and Knieling 2013). States and international organisations are responsible for at least a third of the initiatives (Hale and Roger 2014). The private sector has been heavily involved through private carbon certification schemes, emission trading markets and the Clean Development Mechanism (CDM) projects in partnerships with nation states (Lund 2013).

This research reviewed the 15 SIDS that form part of the Caribbean Community (CARICOM) and share mechanisms for climate change governance. Information on climate change and development impacts for this paper was obtained from semi-structured interviews with national and regional officials in climate change related posts. Secondary sources included reports and publications of multilateral development agencies, regional agencies and from the IPCC. The commonality of perspectives from the interviews was remarkable but not unexpected, key themes included: the institutions that provide the greatest support at global, regional and national levels for climate change governance and their most important impacts/contributions; the main sources of financing for climate change governance in the Caribbean and whether they were sufficient; challenges in application of funds; adequacy and effectiveness of regional mechanisms; whether time-bound project financing allowed for sustainable adaptation policies at the national level; alternative approaches for Caribbean states and what more is needed regarding global, regional and local climate change adaptation.

This paper questions whether and to what extent global governance dynamics for climate change resonate in small states. It argues that the Caribbean climate change problem is both a resource problem and a governance problem. States have limited resources due to pre-existing development challenges and insufficient external support given the unsustainability of the traditional project based financing model of climate governance. These small states face huge environmental changes that they cannot influence and weak governance architectures to respond to this new threat to development.

K-L4.2-02

Creating the conditions for transformative action – mobilising the private sector in SIDS

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Acclimatise has worked in over 50 countries assessing the risks arising from a changing climate advising international, national and sub-national governments, NGOs, development partners and business and financial services sectors. Drawing on our experience and observations from published sources this presentation will explore a theme which we believe is a significant driver and enabler in delivering transformative solutions.

The role of the 'private sector' in resilience building and adapting to climate change remains an area which has received little attention. Most SIDS operate on a market based economy in which the private sector directly and indirectly is the largest contributor to a country's GDP. However the scope of national adaptation planning, the vulnerability and risk assessments providing the evidence base; and the recognition of the sector's role in providing and delivering solutions is rarely explored.

This is not helped by using a technical 'adaptation language' during engagement which has little relevance to those in the sector and treating the 'private sector' as a homogenous group. Within many governments the climate change portfolio is 'owned' by Ministries with environmental or natural resource based departments. These Ministries are usually under-funded and have limited political influence within governments. This in turn, constrains their ability to influence cross-sectoral decision making, national budget setting and prioritisation, and ultimately in delivering transformative change working with the private sector. If we are to respond to the climate change challenge then we need to see (in both developing and developed countries) the resilience and adaptation portfolio passing to where the power is: finance, national planning and the offices of Prime Ministers or Presidents.

K-L4.2-03

Transformative solutions in two Caribbean Insular Territories Under Climate Change Pressure : How can we reach Resilience targets ? Climate Governance in two non-independent Caribbean Insular Territories: two different paths?

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This contribution shows how two non-independent islands of the Caribbean reflect the dynamics of climate governance in their respective Metropolis. For Puerto-Rico, the approach and solutions adopted are best understood against the background of USA climate governance, while in the case of Guadeloupe governance arrangements are more aligned with climate change policy in France and Europe. This theme is explored with reference to case studies on the first wind energy projects implemented in both Guadeloupe and Puerto Rico, and other renewable energy initiatives introduced since 2009.

We explore the differences in approach to climate change issues in the two islands by analyzing the perceptions and attitudes of residents living near the wind farms, as well as the local press. While reflecting internationally accepted approaches to adaptation and mitigation and those of the Metropole, Guadeloupe and Puerto Rico may be considered potential "experimental laboratories" for developing transformative solutions, whose experience may be transferred to other island territories, and even to the Metropolis. A brief analysis of the overall contribution of appropriate renewable energy development to the building of resilience to climate change in these islands, is also presented.

K-L4.2-04

Innovative climate financing in Small Islands Developing States (SIDS)

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Acclimatise has worked in over 50 countries assessing the risks arising from a changing climate advising international, national and sub-national governments, NGOs, development partners and business and financial services sectors. Drawing on our experience and observations from published sources this presentation will explore a theme which we believe is a significant driver and enabler in delivering transformative solutions.

As part of a joint effort to mobilize US$100 billion per year by 2020 from both public and private sources to address both the adaptation and mitigation needs of developing countries, a new global financing mechanism was established: the United Nations Green Climate Fund (GCF). Great expectations are being placed on the recently capitalised GCF: The GCF shall meet ambitious goals in terms of promoting a "paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change" with a special emphasis on adaptation in SIDS, Least Developed Countries and Africa, as well as mobilize funds at scale in particular through private corporations, recognising that in the context of strained government budgets the private sector accounts for 70 to 85% of total global investments.

Against this backdrop, the GCF's Private Sector Facility

aims to play a key role in promoting participation of private sector actors in developing countries, with a special emphasis on domestic private sector actors and adaptation (recipients of funding). However, the specific modalities to achieve this still need to be defined. If the GCF is to scale up private investments in building climate resilience in SIDS, it is essential that it reflects up on the experience in a SIDS context gained by existing multilateral and bilateral climate initiatives, such as the World Bank's led Pilot Programme for Climate Resilience (PPCR) in the Caribbean and Pacific, that deploy concessional resources using a programmatic approach.

L4.3 - Regional Perspectives on Low Carbon Pathways: exploring the conditionalities for climate resilient and equitable development

K-L4.3-01

Regional Perspectives on Low Carbon Pathways: Exploring the conditionalities for climate resilient and equitable development with examples from India

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It is beyond debate now that future 'global' stabilization target is fundamental to manage climate change, impacts and associated risks. Mainstream debate is around the need to coordinate the national goals with global agenda. National autonomy argument in fragmented world is dominating. Also national priorities vary depending on relative speed and level on growth trajectories.

Low Carbon Pathways : Even though India has much lower per capita emissions, growth pattern of economic activities including energy supply sector are going to experience very high growth rates in coming decades. With a National Action Plan on Climate Change (NAPCC) in place since 2008 a number of actions are in place. Top down global model estimated with India specific sectoral parameter show what additional widespread actions are needed. This clearly shows need for much larger actions: policies, technology deployment, institutions and capacity building are needed. Cross sectoral implications show need for transformative change in energy supply system. Bottom up study at national, state and city level help in identification of sector specific low carbon growth potential of multiple options compared to base year emissions. Potential is high in energy supply sector, buildings sector and agriculture sector with relatively low potential in industry sector which has made much progress in the past and transport sector has huge challenges. Looked into the issue from investment need perspective the sectoral distribution gets reversed. Industry sector where low hanging fruits are already harvested, high cost options are awaiting deployment. Genuine concerns exist on the technical cost/ investment /system change. The cost effective solution list might not be the easiest to implement based on public acceptability, market entry barriers, existing policy vacuum, technical and institutional capacity available.

Resilience : Impact and Adaptation to develop a climate change proof development trajectory is much in discussion in India also evident from National Action Plan. Many adaptation needs in India e.g. flood management systems, heat and cold related health safety systems, water system security, food security systems will enhance manifold the demand for energy supply with implications for synergistic mitigation efforts. Example of extreme event led health impact study shows that there is close link between adaptation and mitigation. To enhance resilience labour productivity needs to be protected. This needs huge investment on space conditioning. Energy intensive appliances demand is on steep rise for residential, agriculture and mobility sectors not only due to climatic parameters but also due to rising income. There is scope for energy efficient technology diffusion for new technologies but activity level growth is going to take away clearly the benefits in the short to medium term. Bending of curve cannot be seen in at least in next one and half decade.

Equity : Climate justice calls for faster, larger access to modern energy. It is not about providing lighting and space cooling demand but about productive energy input supply. However, case studies on behavioural response also highlight the scope of take back effect due to behavioural response parameter of rebound effect. Experiments (solar micro grids in village electrification) are happening but scale up needs multiple interventions. Technical feasibility is not in question but strategic implementation and multi level governance issues need equal attention. So it is not only technology but behaviour and social practice matter no lesser for making transition to low carbon growth trajectory. Case studies at megacity level show how commitment to larger goal of low carbon growth through conscious decision making can only make a difference in final outcome. Analysis based on case studies of building operational energy demand lead us to conclude that when a technology becomes efficient and if end user is not consciously guided by larger goal of carbon footprint reduction but are looking at financial balance alone may not take a decision in the best interest of low carbon growth. Full economic, social and environmental benefit of appliance efficiency can be realized through better strategic management of operational behaviour of the end users. It cannot be managed by correcting market price policy alone so there is need to strategically balance between social and market norms. Context of implementation in a fast growing developing country are important to understand. Implementation of newer techno-economic solutions does affect host of actors who will be losers and gainers. Technology deployment policy needs to be strategically designed through new fiscal instrument design market correction, land policy, social goal orientation which most of the time rests either with the federal government or with other non government actors. So besides numbers and evidences, coordination among various layer of governance and choice of new policy instruments are also at the core of speed of implementation.

L4.4 - Multilevel Governance of Climate Change - New Strategies for Coordinating Policies on Mitigation and Adaptation

K-L4.4-01

The Emergence of new structures for global governance: will 'bottom up' actually work ?

D. Victor (1)
(1) University of California, San Diego, United States of America

With the failure of integrated, top-down bargaining strategies, analysts and diplomats have now turned to bottom-up methods such as "building blocks" and "climate clubs" to coordinate national climate change policies and to avoid persistent diplomatic deadlock. Decomposition of the grand problem of climate change into smaller units is

a crucial first step towards effective cooperation. But given the great uncertainty of the feasibility and costs of potential solutions, this bottom-up approach will only work if it is supported by institutions that promote joint exploration of possibilities by public and private actors along with the scaling up of successes. As politics precludes creating many of these institutions under the consensus-oriented decision rules of the UN system, engaged outsiders—including especially clubs or building blocks that can learn in the face of uncertainty—working in parallel with the UN diplomatic process will have to provide them.

K-L4.4-02

Delivering ambitious climate action and the role of multilevel governance

J. Corfee-Morlot (1)
(1) OECD, Paris, France

This presentation presents a framework for multilevel governance, showing that advancing governance of climate change across all levels of government and relevant stakeholders is crucial to avoid policy gaps between local action plans and national policy frameworks (vertical integration) and to encourage cross-scale learning between relevant departments or institutions in local and regional governments (horizontal dimension). Vertical and horizontal integration allows two-way benefits: locally-led or bottom-up where local initiatives influence national action and nationally-led or top-down where enabling frameworks empower local players. The most promising frameworks combine the two into hybrid models of policy dialogue where the lessons learnt are used to modify and fine-tune enabling frameworks and disseminated horizontally, achieving more efficient local implementation of climate strategies. Such integration generates benefits at all stages of the policy process. This includes agenda setting and strategic planning, to encourage political leadership and stakeholders' support; policy formulation and approval to promote long-term vision and near term action; local implementation to overcome obstacles, build necessary capacity, and establish reliable financing for action; feedback and evaluation; and dissemination to promote information sharing and cross-scale learning.

A review of current practices suggests the need for national governments to create a sound institutional foundation and knowledge base to support decision making and action at local levels. National governments are also essential to help deliver financial resources to support local action. Key tools include harmonized GHG inventory methods for local government use and climate risk screening and mapping tools. Institutions designed to support learning and iterative policy making include establishment of regional science-policy centres or "boundary" organisations, often located in academic institutions, to provide locally-relevant scientific and other expert information, and a means for providers and users of such information to engage in a two-way conversation that leads to usable information. Strong urban climate policy networks - working horizontally across local actors to exchange information and experience - is another key institution innovation that enhances learning and that is helping to scale up action from the bottom-up. Designing tools and institutions to strengthen multi-level governance of climate change will help governments to scale up climate action and to find cost-effective climate policy solutions to drive low-carbon, climate resilient development. It will also help national governments to deliver on ambitious climate policy goals in the coming decades.

K-L4.4-03

Climate governance in Latin America: Case studies of Brazil, Chile, Colombia and Peru

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Since 2007, there has been an increase in government institutionalization of climate mitigation actions, and many of these efforts are relatively recent and in design or early implementation stage. There is insufficient literature from developing countries that evaluates this institutionalization. It is important to monitor this trend closely to evaluate if policies and institutions created are sufficiently strong and effective to lead to the reductions required (Working group III, chapter 15, AR5 IPCC).

The institutional arrangements case studies aim at describing and documenting the governance related to climate change within MAPS Latin American countries (Brazil, Chile, Colombia and Peru). A case study per each country (Brazil, Chile, Colombia and Peru) will be conducted to describe and document, from a practitioner´s perspective, the state of the play of the institutional approaches in each country. The results can be useful for other developing countries when examining and enhancing their institutional structures.

The research questions that the country case studies aim to answer are:

• What institutional arrangements exist in MAPS LAC countries (Brazil, Chile, Colombia and Peru), at a public and national level, to address climate change?• What institutions related to climate change mitigation (and adaptation if information is available) exist? • How are decisions taken at a national and subnational level?• Are the decisions and actions legally binding? How climate change decisions are institutionalised or implemented?• If there is information available about how climate change is institutionalised in the private sector, local government and NGOs? • How have MAPS processes benefitted from certain institutional arrangements? Has there been any changes or additions in the institutional arrangements as a result of MAPS processes or during MAPS processes? Has there been collaboration among MAPS LAC countries to share and learn from certain institutional arrangements?

Note: Mitigation Action Plans and Scenarios (MAPS) is a collaboration amongst developing countries to establish the evidence base for long-term transition to robust economies that are both carbon efficient and climate resilient. These processes involve high-level stakeholders in the research process of determining mitigation scenarios for their countries. For more information on the Mitigation Action Plans & Scenarios Programme see www.mapsprogramme.org

K-L4.4-04

Coordinating adaptation between the municipal and local level: building adaptive capacity of resource poor communities in South Africa

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It has been acknowledged that much adaptation to climate change occurs at the city, municipal and community scale. At this local level, both government and local communities need to take action. Both groups needs to strengthen their adaptive capacity and their ability to interact with each other particularly in the face of shocks and stress, as experienced through climate change, resource depletion, economic volatility and increasing inequality. This paper draws on the experience of the FLOW Programme (Fostering Local Well-being). This is a transdisciplinary research project based in the Bergrivier Municipality, in the Western Cape that seeks to build adaptive capacity of resource poor community members and strengthen their interaction with the municipality. We suggest that individual's adaptive capacity is dependent on three interdependent dimensions, namely, 1) the development of social cohesion, 2) self-determination, and 3) connection to life-support systems. The paper will explore how the three dimensions that engender adaptive capacity have been built in the case study site. Specifically, the project has worked with youth ambassadors, local entrepreneurs and the local municipality using a range of interventions including participatory community mapping, resource flow mapping, personal and collective reflective practices, storytelling skills through video journalism and introducing community currencies. The paper will interrogate the extent to which these interventions have built adaptive capacity and the importance of including this type of work in future climate change adaptation and transformation responses.

Other authors: Anna Cowen and John Ziniades

L4.5 - Equity: A Condition to Triggering Action ?

K-L4.5-01

The necessary role of ethics and justice in climate policy'

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The talk will cover three points:

(1) Justice and the target of climate policy. First, it is often argued that climate policies should avoid «dangerous anthropogenic interference» (UNFCCC Article 2). Specifying what constitutes a 'dangerous' climatic changes necessarily requires the use of normative criteria, and cannot be settled solely by scientific analyses of the effects of climate changes. Determining what the goal of climate policy should be requires policymakers to decide what changes, if any, are acceptable, and which are not and call for action; and this requires ethical criteria and an appeal to ideas of justice. I argue that on any plausible ethical criteria even a 2C goal permits dangerous climatic changes,and that recent calls to move away from the 2C target are misconceived.

(2) Just burden sharing. A second criterion of a just climate policy is that the burdens of combating climate change (including the costs of mitigation, adaptation and compensation) are shared equitably. Many appeal to the doctrine of 'common but differentiated responsibility'. I argue that this requires the endorsement of both a polluter pays principle and an ability to pay principle, and suggest how they should be combined.

(3) My first two points emphasise the need for principles of justice (in both specifying what should be the target of climate policy and how burdens should be shared). My third point draws on this to emphasise the importance of transcending a pure Cost Benefit Approach for evaluating targets and policies.

K-L4.5-02

Analysis of equity (including as related to ambition) in submission of INDCs

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The preparation of Intended Nationally Determined Contributions (INDC) is an important opportunity for countries to provide information about how their contributions are equitable. The COP decision agreed at Lima invites each country to describe in its INDC its contribution is "fair and ambitious, in light of national circumstances, and how it contributes towards achieving the objective of the Convention as set out in its Article 2." A description of equity should include the use of a holistic set of quantitative and qualitative indicators that provide the international community and domestic stakeholders with essential information that includes emissions responsibility, capabilities (including economic and development capabilities), vulnerability and capacity to adapt, potential to act, and co-benefits of action. The information provided can be applicable to both mitigation and adaptation components of INDC. The INDC should also address how the INDC contributes to the global level of ambition for emissions reduction and collective effort for adaptation. Providing robust information and a narrative concerning equitability can provide enhanced transparency; enable comparison of contributions among countries; increase international understanding of what is equitable in the context of specific national circumstances; and enable linkages of the contribution with national sustainable development objectives. Doing so can generate constructive discussions both within and among countries about equity and motivate increased and more equitable collective action, and it can help provide direction in establishing common benchmarks and frameworks concerning equity in the UNFCCC. The presentation will provide a proposed framework for describing equitability in INDCs, as well as a review of how countries have thus far provided information on equity in their INDCs.

K-L4.5-03

Equity in the 2015 Agreement

X. Ngwadla (1)
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The inclusiveness, durability and effectiveness of the 2015 Agreement largely hinges on how questions relating to equity, and/or perception of fairness by Parties to the UNFCCC are achieved by the agreement. The diversity of the basis for making a judgement of what is fair has translated into a false dichotomy of qualitative vs quantitative treatment of equity in the agreement. The second dichotomy has been created in terms of options for national vs international discipline in the application of a common framework for addressing equity.

In Ngwadla & Rajamani, (2014) proposals and options for addressing the divergences on the technical and legal options for operationalising and Equity Reference Framework (ERF) in the 2015 Agreement. The ERF is framed on the determination of the required global effort and a determination of relative fair contributions by Parties, covering both mitigation and adaptation in its definition of the required effort. Its application and reflection in the agreements presents flexibility in both 'top-down' and 'bottom-up' or hybrid approaches in a global agreement.

Several other tools and approaches have proposed for apportioning mitigation responsibility based on a variety of metrics. The ERF is however premised on an envelope of metrics for historical contribution to emissions, capability of countries to respond, and development needs, as such outcomes are presented in a range and median of relative fair efforts by Parties. The envelope of metrics could be informed by the various proposals and metrics, including those various parties have presented as part of equity information in their INDCs.

The strength of the ERF further lies in its ability to be applied in different architectural and legal options, as it can be reflected as an integral part of the agreement, however couched in a language that reflect concerns pertaining to prescriptiveness and sovereignty of states. At the other end of the spectrum of options, it could be expressed as an external process through a declaration and run representative external organisations, with a view of providing a moral pull for fairness in the agreement.

In pursuit of a durable agreement, and that present day political realities do not confine the agreement coming into effect in 2020, several options still remain to have enabling provisions for an ERF kind of approach, taking into account options for aggregate application of such a framework, as well as self-application of such a multilaterally agreed framework.

1101 - From the Holocene to the Anthropocene: the history of human-environmental interactions

ORAL PRESENTATIONS

K-1101-01

Man versus Climate: what we learn from paleodata on the vulnerability of tropical ecosystems

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The timing and amplitude of the end of the Holocene humid period and the transition toward of the present day arid/semi-arid conditions in the northern tropics has been the subject of multiple debates involving many scientists from both model and data communities. Several scenarios have been developed to discuss the abrupt or gradual character of this period and to identify the forcings at work. These debates have mostly focused on regions under the Atlantic monsoon influence with a specific emphasis on the iconic "Green Sahara". This region is well known to have hosted flourishing prehistoric cultures evidenced by widespread archaeological remains, rock paintings and carvings and abundant tropical faunas during the Holocene. Based on paleohydrological and archaeological evidence, it has been shown that the end of the "Green Sahara" period in northern tropical Africa and the initiation of present day arid conditions in the Sahara Desert were latitudinally time transgressive with the lake phase ending from 6.5 ka (between 26 and 28°N) to 3.5 ka between 20° and 16° N.

This late Holocene climate crisis was widely recorded across the tropics. Here we present a synthesis of paleohydrological and paleoenvironmental data in two specific areas: (1) the dry northern tropics from West Africa to East India (10-30°N) to compare the behavior of the Atlantic and Indian monsoon systems at the northern edge of the present day rain belt and the mechanisms responsible for the dramatic regime shift (humid/arid) (2) West and Central Africa to discuss the impact of this crisis on the natural ecosystems (i.e., the equatorial forest) and the adaptation of human populations.

K-1101-02

Abrupt African Quaternary Climate and Vegetation Change

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Pronounced changes in African climate, specifically during the transitions between glacials and interglacials, have been found in palaeo climatic archives. Some geological records suggest abrupt climate shifts others, more gradual transitions. Here, we discuss data and simulations aiming at understanding these changes. African climate and vegetation shifts were likely induced by large changes in ice masses, ocean circulation and monsoon dynamics which, in turn, were triggered by variations in the Earth orbit around the sun and subsequent alteration of meridional insolation gradients. It is shown that abrupt change, or 'tipping, could result from a strong feedback between vegetation and climate at different times at different locations. Moreover, strong feedback in one region can lead to 'induced tipping' in other, seemingly stable regions. However, the diversity of plants can affect the strength of biogeophysical feedback. Regions rich in plant diversity may stabilize the system leading to more gradual transitions. As alternative hypothesis, abrupt changes may also emerge from intrinsic threshold behaviour of hydrological systems and ecosystems. Finally, an assessment is made to which extent abrupt climate and vegetation changes in this region are likely to happen in the future.

K-1101-03

High-resolution paleolimnology opens new management perspectives for lakes adaptation to climate warming

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Varved lake sediments provide opportunities for high-resolution paleolimnological investigations that may extend monitoring surveys in order to target priority management actions under climate warming. This paper provides the synthesis of an international research program relying on >150 years-long, varved records for three managed perialpine lakes in Europe (Lakes Geneva, Annecy and Bourget). The dynamics of the dominant, local human pressures, as well as the ecological responses in the pelagic, benthic and littoral habitats were reconstructed using classical and newly developed paleo-proxies. Statistical modelling achieved the hierarchization of the drivers of their ecological trajectories.

All three lakes underwent different levels of eutrophication in the first half of the XXth century, followed by re-oligotrophication. Climate warming came along with a 2°C increase in air temperature over the last century, to which lakes were unequally thermally vulnerable. Unsurprisingly, phosphorous concentration has been the dominant ecological driver over the last century. Yet, other human-influenced, local environmental drivers (fisheries management practices, river regulations) have also significantly inflected ecological trajectories. Climate change has been impacting all habitats at rates that, in some cases, exceeded those of local factors. The amplitude and ecological responses to similar climate change varied between lakes, but, at least for pelagic habitats, rather depended on the intensity of local human pressures than on the thermal effect of climate change. Deep habitats yet showed higher sensitivity to climate change but substantial influence of river flows. As a consequence, adapted local management strategies, fully integrating nutrient inputs, fisheries management and hydrological regulations, may enable mitigating the deleterious consequences of ongoing climate change on these ecosystems.

O-1101-01

The Mediterranean Basin in a warmer and drier world: what can we learn from the past?

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Since the late-nineteenth century, surface temperatures have non-uniformly increased worldwide. The repercussion of the global warming in drylands, such as in the Mediterranean, may become a main source of concern

in a near future, as it is often accompanied by increased droughts, that will severely degrade water supply and quality. History shows that access to water resources has always presented a challenge for societies around the Mediterranean throughout the Holocene (roughly the last 10,000 years). Repeatedly, adverse climate shifts seem to have interacted with social, economic and political variables, exacerbating vulnerabilities in drier regions. We present a reconstruction of the Holocene climate in the Mediterranean Basin using an innovative method based on pollen data and vegetation modeling. The method consists in calculating the inputs of the vegetation model so that the outputs fit the pollen data, using a Bayesian framework. This model inversion is particularly suited to deal with increasing dissimilarities between past millennia and the last century, especially due to a direct effect of CO2 on vegetation. The comparison of far past and last century shows that the intensity of century-scale precipitation fall, amplified by higher temperatures and then evapotranspiration, is unmatched over the last 10,000 years. The recent climatic change is then unprecedented during the last 10,000 years in the Mediterranean Basin. We show also that adverse climate shifts are often correlated with the decline or collapse of Mediterranean civilizations, particularly in the eastern Basin. The main consequence is that, over the next few decades, Mediterranean societies are likely to be much more critically vulnerable to climate change, than at any dry period of the past.

O-1101-02

Long-term ecological dynamics of an alpine lacustrine ecosystem during the Holocene in the French Alps (Lake Petit, 2200 m a.s.l): regime shift and resilience of algal communities

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Multidisciplinary investigations on lake sediments in the Mediterranean Alps enable tracking back the dynamics of lacustrine ecosystems as well as their response to human activities and climate change. Such external forcing may lead to a variety of lake responses, ranging from gradual changes to sudden regime shifts. Sediments from Lake Petit (2200 m a.s.l., Southern French Alps) were particularly relevant for a coupled palaeoecology of landscape and palaeolimnology study providing (1) exceptional richness in preserved bio-indicators and (2) a well-studied context with archaeological, palynological and geochemical data (Brisset et al., 2013).

The lacustrine ecosystem has been reconstructed for the last 5000 years using microfossil analysis (diatoms and Pediastrum) and organic matter composition of sediments (TOC, TN) (Cartier et al., in press):

- From 4800 to 4300 cal. BP, Lake Petit was a stable diatom productive water body dominated by alkaliphilous diatoms. Nutrients were supplied by the chemical weathering of podzols that developed under conifer woodlands. This overall stability was suddenly interrupted at 4200 cal. BP by a major detrital pulse that triggered a drop in diatom productivity and diversity probably climate-linked with the “4.2 ka event”;
- From 4100 to 2400 cal. BP, diatom productivity decreased whereas the algae Pediastrum developed. Diatom assemblages subjected to terrigenous inputs from continuous erosion of pasture soils, were more diversified;
- Finally, from 2400 cal. BP to the present day, diatom assemblages reveal a slight acidification and nutrient enrichment of waters concomitant with increasing human pressure in the catchment.

Results obtained at Lake Petit provide a good example of abrupt regime shift in mountain systems in response to rapid climatic event, and further by incremental change triggered by human activities beyond critical threshold.

O-1101-03

How humans feed flood: lessons from the past

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Future projections on alpine climate changes suggest that more hydrological extreme can be expected to increase the river flood risk in this region. During mountain-river floods, the amount of sediment rushing down slopes constitutes a threat for society, burring floodplains and devastating people and infrastructures. This hydro-geological phenomenon poses hazards in mountainous areas of the world because they occur on steep slopes having abundant sediment available. By promoting land degradation, human are susceptible to modify the sensitivity of landscapes to natural hazard. As a result, it is crucial to investigate how humans have transformed geomorphic response to river flood on historic timescale, and what this means for our present and future. Here we explore since when mountain-river flood are linked to human agencies and to what extent man influence nature.

To address these issues, we examined the geomorphic response during flood events to vegetation cover and land-use changes over the last 7400 years for a large mountain lake of the European Alps, the Lake Allos (44°14’N, 6°42’35’’E, 2230 m a.s.l.). Indeed, the sediments of the Lake Allos are a reliable geological archive to reconstruct flood deposits calendar over long time scale as their suspension load produce a distinct detrital layer contrasting to background sedimentation allowing their identification, counting and dating.

Our results show that the progressive increase in human activities (domestic livestock grazing) was not followed by a progressive increase in erosion at Allos. At 2000 cal. BP, the flood record shows an abrupt transition in sediment load and in event frequency which have been multiplied by a factor of four. Since this date, precipitations of higher intensity were able to mobilise and transport larger amount of sediment and precipitations of lesser intensity were more frequently able to trigger sediment inputs.

These results indicate that a threshold in the sensitivity to erosion in the source area were attaint due to several millennia of human pressure. These results also argue that humans, by changing sensitivity of landscapes for their activities, have considerably amplified geomorphic responses to natural hazards.

O-1101-04

Interdisciplinary and transboundary work to rebuilt extreme hydrological events in the Rhine Graben (France – Germany - Switzerland) during the last six centuries (TRANSRISK and TRANSRISK² Programs)

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The franco – german projects TRANSRISK (2008 – 2011) and TRANSRISK² (2014 – 2017) have made it possible to elaborate a comparative chronology of the floods in the area of the Upper Rhine over a long period (1480 – 2015), paying attention to the description of the events (characteristics, climatic and human causes, consequences) as well as to the management by those in charge at the local scenes of the risk. The objective was to understand the evolutions and to make comparisons at all scales, particularly between France and Germany. This interdisciplinary work (historians, geographers, anthropologists, sociologists, linguists) has been done by researchers from Germany and France on both side of the Rhine between Basel and Strasbourg. The interest of that

research is twofold:

- It is carried out on a territory which is limited and relatively homogeneous, but divided by borders between three nations, Switzerland, France and Germany, and these two last countries have been three times at war between 1870 and 1945.

- It is really concerning a major stake of territorial management: the prevention of floods, a hazard not well known in its spatio-temporal characteristics on account of the wars and of the many political and administrative changes that this territory has gone through.

The researches in the archives have thus made it possible to establish a database including over 3.000 events related to the floods between 1480 and nowadays, involving the Rhine, and 13 tributaries on both side on the border. The most important of those floods have been mapped, classed and compared, revealing at the end a real underestimation of flood risk and the necessity of building new flood scenarios for the future. That's why these research programs are involved into many actions of flood risk management, concerning, for example, memory and risk culture, as well as modelling of extreme events in a historic - progressive approach.

About scenarios, if no pattern of coherent and synchronized evolution appears for all the rivers, the reconstruction of the underlying climatic conditions permits to determine 4 broad types of situations favourable to flooding in that area. And, facing an extreme situation that has already occurred yet in a past not so far away, neither the actors of prevention, nor the people are really prepared. That's also the reason why we have developed a website (linked to social networks) to share information on historical floods (www.orrion.fr), even if floods need a real contextualization to try to make them comparable over time and space. But the chronologies demonstrate, on the one hand, the importance of conditions on a local scale, and, on the other hand, all the aggravating or lessening role of human factors. They generate variations in time and space of the vulnerability to floods, which are manifest on different scales, revealing in particular a real "borderline effect" between France and Germany.

What those studies also point out, however, is that the fight against floods has been at all times the manifestation of political will, mostly a reaction to disaster, and thus has been constantly re-defined in any context of important changes in the political structures. This is of course a lesson for the future.

1101-POSTER PRESENTATIONS

P-1101-01

Learning from the Past to understand the Presente and predict the Future: The Mexican Quatermary Mammal Database

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The Pleistocene and modern mammal faunas of southern North America partially differ in taxonomic composition, distribution, and physiognomy. The former faunal complexes are part of the ancient landscape in which early people may have interacted. Differences between the Pleistocene and modern faunas have been attributed either to climate change, to human-impact driven extinctions, or even to catastrophic phenomena, like a meteorite impact. México's Pleistocene mammal record is analyzed in time and space, emphasizing the study of the Rancholabrean Chronofauna; furthermore, available isotopic data is reported for supporting paleoenvironmental inferences. Palynological and paleosol records are reviewed as an independent check of the interpretation e from mammals. The integration of the information provides the basis for a proposal regarding Late Pleistocene climate change trends across the country, and whether people were involved in the mammalian community response to climate change in terms of extinction or biogeographic shifting within and outside the country. This approach supports an explanation for the differences between southern North America's Pleistocene and modern mammal faunas. This difference is the combined results of individual species extinctions and range modifications that affected and changed the vertebrate biota physiognomy and taxonomic composition. The available fossil record, however, does not portray this major biogeographic shifting of species in detail due to the lack of associated chronometric data. The analysis of disjunct (i.e., separated from the main range) and of demonstrably relict species may be an alternative to provide greater detail and understanding about the response of individual species to climate change during the Late Pleistocene. The Late Pleistocene mammal record was analyzed by morphotectonic provinces that were grouped into four larger geographic units to examine zoogeographic distribution, any variance in distribution (extinctions, extirpations), and environmental conditions inferred from that distribution and variance. Time and space biases exist, with records favoring the Late Pleistocene (Rancholabrean) and the Trans-Mexican Volcanic Belt (TMVB), particularly the Basin of México. Nevertheless, biological communities throughout the country experience profound changes in species composition and structure. Such a pattern was due not to direct human impact but to the consequences of environmental changes throughout and particularly at the end of the Pleistocene. The shifting of ecological and climatic zones was not a simple matter of displacement and range adjustments. Such conditions, among other things, allowed stenotopic species (restricted tolerance to a narrow range of environmental conditions) to extend their range beyond narrow parameters, and eurytopic ones (broad tolerance to a wide range of environmental conditions) to thrive extensively across the country. The coexistence of a highly diverse group of mammals indicates a community structure organized differently than that of today in order to facilitate the complex relationships that coexistence would have required. The disruption of these biotic interactions would have created a coevolutionary disequilibrium situation. The available information on México's Pleistocene mammal, palynological, and paleosol records allows only broad trends to be discerned in the complex environmental-biota interplay and what role, if any, early people played in extinction. A critical need exists to fill in the time and space gaps in these records. Solid radiocarbon chronologies need to be developed that can anchor the various records and provide the framework for more in-depth analyses of environmental changes and individual species response. In a focused radiocarbon dating program, TMVB province and mammoth would be a reasonable target. The most concentrated research has been in this province and mammoth is the most ubiquitous Late Pleistocene mammal. Research needs to continue and expand in the other provinces in order to have a representative sample across the country. While research in the Northern provinces has been most fruitful in terms of mammal-human interactions during the latest Pleistocene, the Gulf Coastal Plains (Eastern province) has great potential in illuminating that interaction as well. México's record is critical in understanding the continent-wide affects of Pleistocene climatic changes on plants, animals, and humans. This initial synthesis forms a first-order interpretation and basis for future research directions.

P-1101-02

Vulnerability of North Eastern region of India - a global biodiversity hotspot - due to anthropogenic threats and climate change process

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Climate change poses major threats to all levels of biodiversity from genes to landscapes while local level changes within landscape affects its composition and abundance. The North Eastern region (here after referred as 'NER') India refers to the easternmost region of India consisting of the contiguous eight sister states. The region is biogeographically and culturally distinct from rest of India and has strong ethnic and cultural ties with East Asia

and Southeast Asia. The NER of India is expected to be greatly affected by climate change as well as increasing anthropogenic threats on biodiversity because of their geo-ecological fragility, strategic location vis-à-vis the Eastern Himalayan landscape,trans-boundary river basins and the inherent socio-economic instabilities.

Analysis of forest cover statistics of NER of India for last twenty years that is from 1991 to 2011, reveals that there was an overall growth of forest cover of 1274 KM2 .in the region. But individual state level data reflects loss of forest cover in majority of the states during the first decade (1991-2001) , the state of Nagaland being the highest (-976 KM2) followed by Mizoram(-908 KM2), Manipur (-732KM2)and Arunachal (-709KM2) and Meghalaya (-273KM2). Seismically NER is one of the six most active regions of the world, the other five being Mexico, Taiwan, California, Japan and Turkey. The region has experienced 18 large earthquakes (M=7) during the last hundred years including the great earthquakes of Shillong (1897, M=8.7) and Assam-Tibet border (1950, M=8.7) .

The state of Assam in NE India represents highly flood-prone region characterized by severe hazards of floods. With more than 40 percent of its land surface susceptible to flood damage, the total flood prone area in the Brahmaputra valley is about 3.2 Mha. The Brahmaputra valley had experienced major floods in 1954, 1962, 1966, 1972, 1974, 1978, 1983, 1986, 1988, 1996, 1998, 2000 and 2004. According to census statistics 1991-2011 the population in all the states grew by approximately 30 percent between first decade and continued with 20 percent in the next decade. This rapid increase in population density in the region is responsible for large scale destruction and alteration of forest areas, overexploitation of biodiversity resources. While reviewing the agricultural statistics for 17 years period that is 1989-2006 ,it has been observed that there is decrease of gross cropped area in many states particularly the Assam being the highest with about 60% followed by Tripura with about 45% , Arunachal Pradesh 25% and Manipur 10% This is reflected in the general trend of decrease in par capita availability of agricultural land . The trend of mean rain fall activities observed in the region for four decades from the year 1968 to 2008 which shows distinct local variations. During Pre monsoon season from 1990 to 2008 there is a decreasing trend of rainfall with 1996 and 2008 is lowest. This indicates local dry conditions or draught. Similarly 1977 and 2001 shows the very high rain fall indicating more storms, floods and associated disasters. In monsoon season there is a general trend of high rainfall activities with 1988, 2005 being highest indicating major floods in the region and crop and property damage. The trend of atmospheric temperature of the region for the pre monsoon season is found to be going high during from the year 1990 to 2008 indicating prolonged warmer period coupled with decreasing rain fall observed during the season. Again in the monsoon it continues with the rising trend over the past decades clearing indicating increasing warming process may be with response to global warming process. Looking at the data of the buildup areas for the years 1989 and 2006 ,there is enormous rise in build up area due to urbanization in all the NER states. The exploration of fossil fuels viz oil, gas and coal industries in the region is increasing the air, water and land pollution and thereby increasing the vulnerabilities of the biodiversity and ecosystems from these anthropogenic activities coupled with the climate change process.

P-1101-03

Impact of global SST gradients on the Mediterranean runoff changes across the Plio-Pleistocene transition

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This work explores the impact of the development of global meridional and zonal SST gradients on the Mediterranean runoff variability during the Plio-Pleistocene transition, about 3 Ma. By means of a stand-alone atmospheric general circulation model, we simulate the separate impact of extra-tropical and equatorial SST cooling on the Mediterranean runoff. Results show that total annual mean Pliocene Mediterranean runoff is about 40\% larger than during the pre-industrial period due to more increased extra-tropical specific humidity. As a consequence of a weakened and extended Hadley cell, Pliocene northwest Africa hydrological network produces a discharge 30 times larger than today. Our results support the conclusion that during the Pliocene, the Mediterranean water deficit was more reduced than today due to a larger river discharge. While the cooling of equatorial SST does not imply significant changes on the Pliocene Mediterranean hydrological budget, the extra-tropical SST cooling increases the water deficit due to a decrease in precipitation and runoff and river discharge from this area reduces to pre-industrial level. From our simulations there are evidence that the modern atmospheric circulation over the Mediterranean started to develop at least 3 Ma. The main teleconnections acting upon the Mediterranean area, i.e. the North Atlantic Oscillation during winter and the ``monsoon-desert'' mechanism during summer are already at work in our Pliocene simulations. Finally, our results also suggest that in a climate state significantly warmer than today, changes of the Hadley circulation could potentially lead to increased in water resources in northwest Africa.

P-1101-04

Mid-Holocene drought impact on the active Lazaun rock glacier in the Italian Alps

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The study of a 40 m-long ice and debris core from the rock glacier Lazaun in the southern Ötztal Alps (South Tyrol, Italy) revealed a mid-Holocene drought impact around 4000 cal. BP. Plant macrofossils embedded in the ice indicated the overall formation of the rock glacier around 10'300 cal. BP with two superimposed rock glacier lobes persisting active since then. The inferred age-depth model implied very stable sedimentation conditions for snow, ice and rock debris throughout the Holocene, with the exception of a mid-Holocene drought event. This multi-centennial drought period around 4000 cal. BP was probably related to reduced snow accumulation, prevailing warm climate, and a general Mediterranean/Central European climatic reorganization. The palaeoecological study of the ice/debris samples and the quantification of pollen, cryptogam spores, non-pollen palynomorphs, charcoal particles as well as plant and animal macrofossils allowed tracing the former climatically and anthropogenically induced vegetation changes at alpine altitudes (above 2600 m a.s.l.).

P-1101-05

Orbital, solar, volcanic and anthropogenic forcings in the Holocene glacier fluctuations

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Glacier fluctuations integrate both temperature and precipitation, and these signals are often a challenge to separate. However, in the end of 20th-early 21th centuries

the glaciers demonstrate a coherent pattern of uniform retreat, despite the great difference in their morphology, sizes, location and other characteristics. For our global overview of Holocene glacier fluctuations we used 189 time series of glacier fluctuations based on 14C, TCN, OSL, tree rings, sediments from proglacial lakes, and speleothems. We compared the glacier variations with orbital, solar and volcanic forcings and considered the scale and the rate of modern glacier retreat in the context of Holocene natural variability. The general trends of Holocene glacier fluctuations in the extra-tropical areas of the Northern Hemisphere are broadly coherent and agree with the dynamics of the Northern and mountain tree lines. Overall summer temperature, forced by orbitally-controlled insolation, is the most probable driver of increasingly more expansive advances through the Holocene in these regions. In the Southern Hemisphere, glaciers in New Zealand appear to follow the orbital trend, which is opposite to the Northern Hemisphere (less expansive advances through the Holocene). Glacier fluctuations in monsoonal Asia and in Southern South America generally do not correlate with the orbital trends and instead responding to more high resolution forcings in these regions. Glacier advances during Neoglacial clustered at 4.4-4.2, 3.8-3.4, 3.3-2.8, 2.6, 2.3-2.1, 1.5-1.4, 1.2-1.0, 0.7-0.5 ka BP correspond to general coolings in the North Atlantic. Some of these episodes coincide with multidecadal periods of low solar activity, but it is unclear what mechanism might link small changes in irradiance to widespread glacier fluctuations. One cluster of glacier advances at 1.7-1.6 ka does not fit this pattern and probably corresponds to a very strong volcanic eruption (232 CE). Thus, no single driving mechanism explains all ice expansions. The rate and the global character of glacier retreat in the 20th-early 21st centuries appears to be unusual in the context of Holocene glacier changes, however retreating glaciers in most regions are still more extensive today than they were in the Early and/or Mid-Holocene. Since contemporary retreat is occurring during an interval of orbital forcing that is favorable for glacier growth, a combination of factors other than orbital forcing, primarily strong anthropogenic is likely in effect. Due to the delayed reaction of glaciers to climatic changes, retreat will continue into future decades. In some cases the large changes inferred from glacier records are more pronounced than reconstructions based on higher resolution records and models driven by solar forcing. This observation may indicate that other proxies and model results tend to underestimate the amplitude of Holocene climate change.

P-1101-06

Monsoonal changes recorded by Lake Chad sedimentary archives during the Neolithic

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During the last 20,000 years, Northern Africa experienced dramatic climatic and subsequent environmental changes, characterized by a succession of contrasted period. It is now well established that the Last Glacial Maximum (LGM) was dryer followed by a wetter middle Holocene, punctuated by dry events. The numerous Holocene paleolake records document a fairly consistent pattern of a moister early-Holocene resulting in a "Green Sahara" followed by a general aridification ca. 5000 years ago, which still persist today.

However, despite the number of detailed reconstructions increasing during the last decades, a coherent history of the climatic changes has not been yet elucidating. Pronounced differences in the apparent timing and amplitude of these hydrological changes inferred from truncated outcrops point to regional climatic variability fluctuations as well as site-specific influences which could biased the evolution of water balance. Increasing the numbers of observations and reconstruction contribute to arise regional patterns, and rend complex the identification of the climatic signal.

In this paleoclimatic history, one of the main attractive phase, still debated, is the end of the mid-holocene humid period. The increasingly arid conditions after 5,000 years forced Neolithic societies to improve their organization in order to optimize natural resources, in particular freshwater supplies, and help to explain the rise of civilizations that flourished along main rivers such as Nile, Euphrate or Indus. This climatic change corresponds in time with the gradual modulation of the insolation, whereas data from marine records evidenced that environmental changes could be more rapid and abrupt than expected by the sinusoidal insolation curve. But on the continent, the data tell us another history. Lake Yoa record collected in the northern Chad in Sahara desert show that vegetation and dust flux changed gradually, in concert with the slowly weakening monsoon.

In this context, we present new records with original data depicting past tropical hydroclimate history since the LGM from the key, but yet poorly investigated, Lake Chad. In Northern Africa, Lake Chad appeared as one of the main emblematic site during this period of time. Reaching 10 times its surface area, e.g. 340,000 km2 compared to today, e.g. 14,000 km2, it was one of the main water tower during this period. Almost exclusively fed by the Chari-Logone river system that originates from the wet tropics, where precipitation is directly controlled by the West African Monsoon and the seasonal migration of the ITCZ, this particular configuration makes this terminal lake a very sensitive indicator of climate and the environment evolution of north-central Africa at various time-scales. Then, here we present continuous records from past environmental and climatic changes during the last 20,000 years. We highlight coherent monsoonal changes, compared with those from the closest oceanic basins, e.g. tropical Atlantic and Indian oceans, as well as at the scale of the continental tropical belt. Moreover, drastic hydrological changes are recorded, occurring in few centuries, matching with North Atlantic cold spells indicating that Northern African climate could switch from a state to another, quickly, which drive in consequence, ecosystem and human adaptations.

1102 - From past to future Climate Changes

ORAL PRESENTATIONS

K-1102-01

Past climate event suggests severe and long-lasting consequences of fossil fuel burning

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Carbon release rates from anthropogenic sources have reached a record high of ~10 Pg C/y in 2014. Due to uncertainties in climate system feedbacks, the impact of the rapid carbon release on the Earth system is difficult to predict. Hence geologic analogues from past transient climate changes are urgently sought after to guide future climate assessments. Throughout the past 66 Myr, the currently known climate aberration with the highest carbon release rate is the Paleocene-Eocene Thermal Maximum (PETM) - an event characterized by future-relevant total carbon release/peak warming and a surprisingly long duration of at least 50,000 years. Based on time-series analysis of stable carbon/oxygen isotope records and carbon cycle/climate modeling, we determine the initial carbon release during the PETM onset. This constrains the maximum sustained PETM carbon release rate to less than ~1 Pg C/y. Given currently available records, it follows that the present anthropogenic carbon release rate is unprecedented during the past 66 Myr by at least an order of magnitude. Future ecosystem disruptions will hence likely exceed the relatively limited extinctions observed at the PETM. Moreover, unforeseeable future responses of the climate system are possible as the Earth system has effectively entered an era of no-analogue state.

K-1102-02

Understanding a warming world by studying the Pliocene

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The investigation of warm intervals of the Pliocene epoch has intensified dramatically over the last 10 years. The reasons for this are varied but undoubtedly the availability of progressively higher temporal and spatial resolution environmental records is a key driver. These reconstructions are providing new insights into environmental change during the Pliocene, which enable us to investigate local and regional climate response to an atmospheric CO2 concentration akin to the modern. Furthermore, the use of Climate and Earth System Models in a Pliocene context has been encouraged as a means to test the predictive ability of models, and to understand climate processes generating regional patterns of environmental change.

This presentation will summarise the current state of knowledge of the Pliocene Earth System derived from proxy data and model outputs. In particular it will focus on key aspects of the climate system such as the reconstruction of atmospheric CO2, ice sheet and sea-level change, surface temperature change and polar amplification, the hydrological cycle, ocean circulation and the monsoons.

Challenges in environmental reconstruction and modelling will be highlighted with a summary of emerging initiatives, which are designed to enhance our ability to use warm intervals of the Pliocene as a mechanism to understand the dynamics and drivers of a warming world.

K-1102-03

Climate change and variability : lessons from the past

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Past climate states provide a unique opportunity to evaluate model performance outside the range ofrecent observed climate variability. They provide test cases of our understanding of climate feedbacksand thresholds that are not observed in modern variability and that could lead to major changes in thefuture. Because of this, past climate simulations of the Last Glacial Maximum (21 000 years BP), themid-Holocene (6000 years BP) and the last 1000 years have been considered as part of the lastmulti-model CMIP5/PMIP3 experiments (Taylor et al. 2012, Braconnot et al. 2012), so as to put intoperspective future climate changes and provide complementary model evaluation. Using the resultsof these simulations and of mode-data comparisons, this presentation will provide an overview ofrecent analyses of climate sensitivity and feedbacks, hydrological cycle in the tropical regions, andinterannual climate variability. It will highlight the new possibilities offered by the modeling of thebiochemical cycles and tracers or by the high resolution records that provide information oninterannual to multi-decadal variability. Finally, it will discuss the constraints these analyses bring onthe credibility of climate model as well as the new questions that will be addressed in the next phaseof the Paleoclimate Modeling Intercomparison Project (PMIP).

O-1102-01

Linking past, present and future climate change to adaptation in the African Sahel

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The semi-arid African Sahel has received unique attention in the climate science community and beyond since inception of persistent drought at the end of the 1960s. This attention is reflected in the efforts of Working Groups 1 and 2, summarized in the Assessments Reports of the Intergovernmental Panel on Climate Change going back to the first, published in 1990. Initially, drought in the Sahel was attributed to rapid population growth leading to mismanagement of land resources. The hypothesis of a positive bio-geophysical feedback tied human-induced baring of the soils to a reduction of precipitation, which further exacerbated the loss in vegetation cover [Charney 1975, in Q J Roy Meteor Soc]. In the more recent ~10 years the climate of the Sahel has again emerged as the focus of active research, this time as a possible «canary in the coal mine» for anthropogenic climate change. Advances in climate science have first conclusively tied persistent drought to subtle shifts in the surface temperature of the global oceans [Giannini et al. 2003], «freeing farmers of blame» in the drought, then partially attributed these shifts to the influence of greenhouse gases and aerosols [Held et al. 2005, in Proc Nat Acad Sci; Booth et al. 2012, in Nature]. However, in the meantime the region has partially recovered from drought, and is experiencing an increased frequency of flooding [Tall 2010, in Proc Env Sci], underlined, to the extent that it has been documented, by a subtle increase in the intensity of precipitation [Lodoun et al. 2013, in Env Develop; Alhassane et al. 2013, in Secheresse].

Here I present a novel interpretation for the role of the oceans in effecting precipitation change in this region: Sahel rainfall responds to the relative temperature of the North Atlantic, source of the moisture that converges in the region, with respect to the global tropical oceans. The temperature of the global tropical oceans, which is communicated first vertically through deep convection, then laterally by atmospheric waves [Chou and Neelin 2004, in J Climate; Held and Soden 2006, in J Climate; Sobel et al. 2001, in J Atmos Sci], broadly determines the threshold for convection. The temperature of the North Atlantic relative to that of the global tropical oceans measures the potential for the moist, but cool air that is converged onto the African continent from the adjacent ocean to lead to deep convection and precipitation.

This interpretation consistently explains past drought, partial recovery, and the current alternation of wet and dry states on time scales from daily to interannual. It also sheds light on the uncertainty in future projections, relating them to the uncertainty in patterns of sea surface temperature change [Giannini et al. 2013, in Env Res Lett]. This contribution aims to frame the physical context in which to discuss societal response to drought, and its applicability to adaptation to current variability and future change.

O-1102-02

Long-term evolution of feedbacks in a GCM run to equilibrium

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Equilibrium climate sensitivity (ECS) is a common measure of Earth's global temperature response to radiative forcing. To first order, Earth's radiative imbalance decreases linearly with global temperature anomaly when a step forcing is applied. ECS is thereby assumed to be constant and inversely related to the linear feedback coefficient (λ). The validity of this linear approximation has been increasingly questioned recently, with several studies consistently showing that feedback are state- and time-dependent. But can these deviations from linearity significantly shift the final equilibrium state actually reached by a GCM as compared to the linear extrapolation based on the first few centuries given by ECS, or even imply a bifurcation leading to a vastly different equilibrium? What are the dominant physical processes that explain them? Here we analyze the evolution of feedbacks over a six thousand years-long integration to equilibrium of the coupled climate model ECHAM5/MPIOM under atmospheric CO2 quadrupling - the only simulation to equilibrium of a state-of-the-art GCM available to our knowledge. Consistent with previous studies, the global feedback λchanges significantly over the entire integration, but more surprisingly its evolution is markedly non-monotonous. Indeed, while λ progressively decreases (1.5 down to 0.4 Wm-2K-1) during the first thousand years of the run - which is the period partly analyzed by most previous studies and hence yields consistent findings, we observe a steep increase in λ(0.4 up to 1.8 Wm-2K-1) throughout the remaining five thousand years, until the equilibrium is reached. This evolution is predominantly driven by: (i) a steeper

and steeper increase in cloud feedback over the entire simulation which is mainly associated to decreasing low level cloud fractions over high latitude oceanic areas; combined with (ii) a non-monotonous evolution of water feedback characterized by a moderate increase during the first thousand years followed by a steeper and steeper decrease until equilibrium, both being mainly associated to changes in relative humidity over tropical land areas and near the surface. We discuss implications of these results for the above two questions: while the assumption of a linear global feedback may be a useful approximation in energy balance models for the century time scale temperature response, we argue that its validity has not been demonstrated to represent the final equilibrium. In particular, our results suggest that a change in the sign of λ on the very long term, thereby implying a bifurcation potentially leading to a vastly different equilibrium, can not be discarded, given that the relevant processes are poorly understood.

O-1102-03

Past and future aerosol emission reductions and their impact on Arctic climate

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INTRODUCTION

Large changes in the magnitude and spatial patterns of global aerosol emissions have occurred during the 20th century and are projected to continue over the coming century. It is not clear how the Arctic climate has been affected by changes in global and European aerosol emissions. As more and more countries adapt different strategies to reduce air pollution, it is important to examine how this will affect not only the top-of-the-atmosphere radiative forcing, but rather the climate and other parameters important for society. Of particular relevance for the Arctic are the reductions in sulfate emissions from industrial activities, domestic heating, and power production that have taken place in Europe during the latest decades. These changes provide an opportunity to in detail by available observations study how regional emissions over Europe have affected the global and specifically the Arctic climate. This to bring more confidence in projections of how future air pollution emissions will affect especially the Arctic climate.

METHODS

Transient climate simulations over the industrial period (1850 to present) from the Norwegian Earth system model NorESM (Kirkevåg et al., 2013) with different emission levels have be conducted and analysed. The simulated aerosol number size distribution and mass composition have been evaluated versus in-situ observations from different European measurement networks. The analysis is focused on Europe and the Arctic and how surface radiative flux and temperature changes relate to different emission scenarios. We present results from a comparison between the actual estimated emissions 1850 to 2005 NorESM simulations with simulations using constant 1980 SOx emissions for Europe while all other are the actual emissions. We will also present climate projections, 2015 - 2080 with global emission of sulfur, organic and black carbon according to Current Legislation (CLE) or Maximum Feasible Reduction (MFR), assuming CO2 emission according to RCP4.5.

CONCLUSIONS

The simulations show a significant change in the Arctic temperature as a result of the past air quality regulation in Europe giving strongly decreased SOx emissions especially during the 1990-ties. However the effect in Europe is quite smaller. Comparing with the actual temperature change in the Arctic implies that the sulphate aerosol contribute with about 20% of the temperature increase in the Arctic. In the projections with CO2 emissions according to RCP4.5 the future temperature will increase in the Arctic will be about 3 K but with in an air pollution emission reductions according to MFR it will be about 4 K.

These is only results from simulations with one model and have to be corroborate by other models but also by detailed studies to identify the key processes and evaluation of the models towards observations. However our results strongly imply that a continued strong temperature increase will prevail for many years forward.

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O-1102-04

Deep past carbon cycle and climate crises

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Deep past carbon cycle and climate crises

Relationships between carbon cycle and climate are intensively studied for ongoing global warming. There are also in the geological past of the Earth, key periods when huge changes of atmospheric carbon led to drastic cooling: Snowball episods at Neoproterozoïc [800-600 Ma]. Another period of interest is the so-called «terrestrialization» of the continents which also led to a large decrease of atmospheric carbon but without producing an important cooling during Late Devonian [379-359 Ma]. For the first time period, we will show how tectonics-climate perturbation altered sufficiently the carbon cycle and the climate to produce a long lasting global glaciation. It is also the same carbon cycle that allow to escape from a frozen planet. For the second time period :Late Devonian also corresponds to a drastic decrease of atmospheric CO2 associated with vegetation development on continents but paradoxically this decrease doesn't produce a cooling of the Earth because mainly of albedo feedback.

We shall discuss how these deregulations developed and which processess associated with atmospheric carbon-tectonics - biosphere and water cycle may explain the onset and the decay of such crises.

O-1102-05

Causes and consequences of mid-Holocene aridity in mid-continental Eurasia in the CMIP5 simulations

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The extent of mid-continental drying in Eurasia during the mid-Holocene is an example of a persistent regional mismatch between models and observations. The CMIP5 mid-Holocene simulations show drier conditions in Eurasia, particularly between 45°-60° N, whereas several types of palaeoenvironmental data systematically show that the region was wetter than today. At the same time, the models show significantly higher summer temperature, whereas observations indicate that summers were cooler. The simulated temperature bias can be up to 4-6 °C. Temperature biases in the CMIP5 historical (20th century) simulations are linked to systematic biases in evapotranspiration. Diagnosis of the surface energy balance in the mid-Holocene CMIP5 experiments shows that the simulated increase in summer temperatures results from the simulation of too-low evaporative cooling because of water limitation. Surface water- and energy-balance interactions play a similar role in mediating the temperature response in CMIP5 future simulations.

O-1102-06

Climate Change in the Past 2000 Years and its impact on society on the Tibetan Plateau

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Temperature variation on the Tibetan Plateau (TP) in the past 2000 years is reconstructed using stable oxygen isotope in five ice core records on the TP, including Dunde ice core in northeast TP, Guliya ice core in northwest TP, Dasuopu ice core in south TP and the Puruogangri and Tanggula ice cores in central TP. The integration of those ice core records reveals the synchronicity of large-scale climate changes in Tibet, such as the warming in the 7th century, 12-13th centuries and the present, and the cooling in the 3th century, 16th century, and 19th century. We referred to human historical documentary record since A.D. 620 for possible responses of social, economic and military activities to climate changes. By focusing especially on human activities and social development directly determined or indirectly influenced by climate from historical documentary record, we quantified those events into five aspects, i.e., basic resources, economic development, military strength, national coherence, and cultural and religious development, to study social development on the TP by A.D. 1900. Our results show a close Tibetan societal response to climate changes in the past 2000 years, particularly before the modern ages.

O-1102-07

AMOC Evolution in the Last Deglaciation:Forcing Mechanism, Thermo-haline Instability and Implications

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The forcing mechanism and instability of the Atlantic Meridional Overtuning Circulation (AMOC) over the last 21,000 years is studied using transient simulations under realistic forcings in the NCAR-CCSM3. First, in addition to the strong millennial AMOC variability forced by melting water fluxes, the background AMOC is determined by two opposing effects: the intensification by the rising atmospheric CO2 and the reduction by the retreating ice sheet, both through the sea ice feedbacks in the North Atlantic. As a result, the AMOC strength does not change significantly after the deglaciation. Second, the model AMOC exhibits a monostable behavior. This monostable AMOC, which has been observed in almost all state-of-art coupled general climate models (CGCMs), is likely to be caused by a systematic model bias that is associated with the tropical bias, the resulted freshwater flux and AMOC freshwater export. This AMOC over-stabilization bias needs to be improved in these CGCMs to allow for a credible projection of AMOC evolution in the future.

O-1102-08

Different vegetation responses to climatic droughts in the Mediterranean basin

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A number of recent studies have identified a significant increase in the frequency of drought events in the Mediterranean basin. Climatic droughts are relatively frequent in the Mediterranean region as a consequence of the large interannual variability of precipitation, and long periods with low precipitation. Several studies characterized climatic droughts in the Mediterranean region, emphasizing the spatial and temporal complexity of this phenomenon.

The use of remote sensing data holds a great potential since it allows analyzing large regions with a consistent dataset with high spatial and temporal resolution. Several studies analyzed the impact of droughts on the natural vegetation and crops using remote sensing data. The majority of the studies about drought impacts on the vegetation cover considered droughts as a precipitation shortage regarding the normal climatology. Nevertheless, recent drought episodes in the frame of a warming scenario have shown that large evapotranspiration rates associated to high temperatures are equally relevant and may trigger severe droughts. Therefore, in the present scenario of temperature rise it is necessary to acknowledge the impacts of both reduction in precipitation and increase in evapotranspiration rates.

The aim of the present work is to analyze in detail the impacts of drought episodes on vegetation in the Mediterranean basin behavior using NDVI data from (from GIMMS) for entire Mediterranean basin (1982-2006) and the multi-scale drought index (the Standardised Precipitation-Evapotranspiration Index (SPEI).

Correlation maps between fields of monthly NDVI and SPEI for at different time scales (1-24 months) were computed in order to identify the regions and seasons most affected by droughts. Affected vegetation presents high spatial and seasonal variability, with a maximum in summer and a minimum in winter. During February 50% of the affected pixels corresponded to a time scale of 6 months, while in November the most frequent time scale corresponded to 3 months, representing more than 40% of the affected region. Around 20% of grid points corresponded to the longer time scales (18 and 24 months), persisting fairly constant along the year. The strongest control of droughts on vegetation dynamics is obtained during February and May for drier clusters in areas with low water balance values. Accordingly the wet and cold seasons present low water balance values that implies shorter time scales over dry cluster, whereas high water balance values implies longer time scales over Central and Atlantic clusters.

The occurrence of most affected areas over regions presenting low water balance values highlights the strong dependence of vegetation with climate variability. Furthermore, this conclusion is reinforced by the strong control of drought on vegetation activity observed for Arid and Steppe clusters located over areas with higher absolute values of water balance. The projected increase in frequency of drought episodes emphasize the need for an early warning drought system covering the entire Mediterranean basin. However, our results highlight that this requirement is dependent of vegetation types, season of the year and relative location of the regional sector considered. We are confident that our results will provide a useful tool for drought management plans and will play a relevant role in mitigating the impact of such episodes within the context of climate change.

O-1102-09

Observed large leads of Atlantic circulation slowdowns with respect to tropical precipitation events: A challenge for current climate models

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Marine cores MD09-3257 and GeoB3910 were retrieved off northern Brazil at ~4°S, 36°W and 2340 m water depth; their chronology is derived from a corrected and calibrated radiocarbon-based age-depth model. As in other marine cores from this area, XRF measurements show marked Ti/Ca and Fe/Ca peaks over the last glacial that have been interpreted to reflect increased terrigenous input due to increased precipitation and runoff from the adjacent continent. These terrigenous peaks can be shown to be coeval with precipitation events recorded in speleothem d18O records from South America in the 0-30°S latitudinal band, which are considered to reflect southward shifts of the intertropical convergence zone during Greenland stadials.

New sedimentary 231Pa/230Th measurements from core MD09-3257 show that large changes took place in the overlying water mass flow rate over the last glacial in conjunction with millennial precipitation events. Furthermore, our C. wuellerstorfi δ13C data indicate that water ventilation was reduced at ~2340 m in the tropical Atlantic during Greenland stadials, in phase with the reduction in water mass flow revealed by Pa/Th data. Our results thus demonstrate that major slowdowns of the Atlantic Meridional Overturning Circulation (AMOC) upper circulation cell took place during Greenland stadials.

Because both rainfall events and changes in ocean circulation are recorded in the same sediment core, we were able to reliably determine that the AMOC started to slowdown 1420 ± 250 and 690 ± 180 (1σ) y before the onset of two large South American precipitation events associated with Heinrich stadials.

Our data open new prospects concerning causal mechanisms of rapid climate changes. More specifically, current climate models simulate a rapid response of the tropical climate to AMOC changes, whereas our results indicate that there is a large lead of AMOC changes with respect to tropical climate changes. Therefore, more work, both data- and model-wise, is necessary in order to achieve a better understanding of the highly nonlinear behavior of the climate system observed in climate archives and ensure that comprehensive climate models used for climate projections capture the full extent of ocean-ice sheets-atmosphere interactions.

1102-POSTER PRESENTATIONS

P-1102-01

Impact of Climate Change on Onset, Amount and Length of Rainy Season over West Africa as Simulated by COORDEX Models

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The onset of rainfall signals the commencement of viable rainfed agricultural activities and it is therefore very essential for planning farm operations in West Africa. Impact of climate change on the rainfall onset dates (RODs), rainfall cessation dates (RCDs) and hence the length of rainy seasons (LRS) as well as the rainfall amount during the season over West Africa is therefore a welcome idea. The data used was from the Coordinated Regional Downscaling Exercise (CORDEX-Africa) and comprises of daily rainfall for four of the participating regional climate models of scenario A1b of the Intergovernmental Panel on Climate Change (IPCC). The simulated data was divided into two with 1981-2000 serving as present and 2031-2050 representing the near future. RODs was found to be delayed by two weeks (14 days) over most part of West Africa and a delay of three weeks (21 days) over most part of Sierra Leone, Liberia, Guinea, western flank of Cote d`Ivoire and some parts of Mali. RCDs were seen to be earlier in the near future than present in most part of West Africa. LRS which is the difference between the RODs and RCDs show that there is a reduction of between 15 and 25 days over the areas mentioned earlier. There was an extension of about 15days over other areas between the coastline of West Africa and 15oN. The annual rainfall amount shows an increase over all high grounds of West Africa and the immediate environment as well as the coastline of West Africa. Apart from these, most West African sub-region experiences reduction in the annual rainfall amount ranging from 120mm to about 300mm. On a closer look of rainfall amount from June to September (JJAS) rainfall amount, it follows the same trend as that of the annual amount but with more significant reduction in the near future. From coast to about 6oN, there is an average reduction of between 0.2 to 0.6mm/day (24 to 73mm). From about 6oN to 14oN there is an increase in rainfall amount of about 0.7mm/day. There is a significant reduction of JJAS rainfall amount on the leeward side of Cameroonian's Mountain of 1.4mm/day.

P-1102-02

Climate Variability in Nepal: A Time Series Approach

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Climate variability in Nepal has become a big environmental issue. This paper investigates empirically and analytically whether climate variability exists or not in different altitude, whether its direction moves and what will be its future direction. We use time series model based on the secondary data of hydrology and metrology collected from Department of Hydrology and Metrology, the Government of Nepal.

The time series analysis finds climate variability in the different parts of Nepal in which all months have variability of temperature and rainfall precipitation. From 1975 to 2010, temperature raises annually by 20 C. However, rainfall is found declining. It is forecasted change of temperature by 60c over next 40 years. In case of rainfall, it is forecasted constant and results drought in high altitude and flood in low altitude. Climate variability may be a big threat in the different parts of Nepal.

P-1102-03

How will climate change affect the vegetation cycle over France? A generic modelling approach

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The expected response of climate to the increase in greenhouse gas concentration during the 21st century is a 2-3°C warming in Europe (IPCC 2007). However, the sign of the response differs from a climate model to another. Two climate models predicting the same sign in the response of temperature and precipitation, but presenting different magnitudes of change, can lead to very different impacts. This is particularly true if we examine how climate conditions would affect the vegetation cycle. In particular, the implementation of adaptation strategies of agriculture to climate change is conditioned by the knowledge of impacts and of the associated uncertainties. The new generation of generic Land Surface Models (LSMs) that include the carbon cycle of the biosphere and represent vegetation growth provides a wealth of information on this issue.

In the framework of the ORACLE ANR project, CNRM has produced 150-yr (1950-2100) simulations over France of the biomass of various vegetation types (straw cereals, grasslands, broadleaf and coniferous forests) and of the soil water content associated to each of these vegetation types. The ISBA-A-gs generic LSM, able to work at various spatial scales (local to global), was used. Thirteen climatic simulations from the 4th IPCC assessment report, disaggregated at a spatial resolution of 8 km by 8 km, were used to drive the ISBA-A-gs model, over 191 grid-cells representing the main French agricultural and forest regions. Statistical methods were used to quantify the impact of climate change and the agreement between climate models between near future (NF) (2020-2049), far future (FF) (2070-2099) and a reference past period (1970-1999). Everywhere in France, the duration of dry (wet) periods within one year increases (decreases), up (down) to + (-) 30d in NF conditions. For all the vegetation types, leaf onset and the annual maximum LAI occur earlier. On the other hand, large regional discrepancies are simulated for the senescence period (e.g. earlier in western and southern France for broadleaf forests, later in eastern France) for both NF and FF. The length of the growing period is often more uncertain in FF than in NF in relation to differences in climate models. These simulations will be extended to the Euro-Mediterranean area and coupled with a hydrologic model. The new IPCC simulations will be used to complete this work.

ACRONYMS:

- ORACLE : Opportunités et Risques pour les Agro-ecosystèmes et les forêts en réponse aux changements CLimatiquE, socio-économiques et politiques en France
- ISBA-A-gs : Interactions Soil-Biosphere-Atmosphere model, including photosynthesis and vegetation growth
- LAI : Leaf Area Index

P-1102-04

Identifying future climate change hotspots over Southeast Asia

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Southeast Asia is one of the regions most vulnerable to the impacts of a changing climate in a globally warmer future. In this study, climate variables from multiple CMIP5 global climate model output have been analyzed to describe the spatial extent and magnitude of future changes over the region. Potential climate change hotspots, i.e. areas indicating strong response to changes in climate, can therefore be identified. This is important for adaptation planning in the different sectors, including agriculture, on which the developing economies in this region are highly dependent. Initial results show that in the 2030s under the Representative Concentration Pathway (RCP) 4.5 scenario, high changes in the mean climate are likely to occur over Indochina, a region described by high seasonality in rainfall. On the other hand, significant changes in the extremes are noted over the Maritime Continent. However, changes in the location and intensity of these hotspots may still occur depending on the time period and emissions scenario.

P-1102-05

Recent sea-surface pH and SST changes in the eastern equatorial Pacific (Clipperton Reef) inferred from coral geochemistry

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Increased atmospheric CO2 concentrations from 280 (pre-industrial value) to 390 ppmv (present value) have decreased global surface ocean pH by approximately 0.1 unit. Estimates of future atmospheric pCO2 suggest a further decrease of 0.3 pH units by the end of the century. Geochemical records preserved in the carbonate skeleton of shallow water coral presentations provide one of the few means to reconstruct changes in seawater carbonate chemistry. However, since the early 1990´s, when the potential of δ11B in biogenic carbonate as proxy for paleo-pH was realised, only few studies report on the recent decadal to centennial pH record, which is the appropriate timescale for studying the effects of ocean acidification driven by anthropogenic emissions of CO2.

The French island of Clipperton is the easternmost coral atoll in the Pacific Ocean located approximately 1200 km off the coast of Mexico. Due to the small number of ecological niches suitable for coral reefs development, almost no coral-based climatic records exists from the eastern Pacific. The possibility to work on Coral presentations from Clipperton's therefore represents a unique opportunity to obtain information on surface seawater properties (e.g. T°C, carbonate chemistry) of this key area of the central eastern Pacific Ocean. As part of this study we have undertaken, boron and oxygen isotope compositions and elemental ratios (Sr/Ca, Mg/Ca, B/Ca, Li/Mg) have been analysed over the last 80 years of a coral core retrieved in a colony of Porites australiensis (located 10°17.506N/109°13.508W, Clipperton island, 10m depth). Boron isotopes were measured by MC-ICPMS, while elemental concentrations were determined using ICP-QMS. Isotopic compositions and elemental concentrations were used to quantify changes in seawater environmental parameters - and their significance on the global or more regional Pacific oceanic circulation will be discussed.

P-1102-06

The Past is an Essential Element of the Future

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In the natural world, changes happen almost constantly, sometimes rapidly, often very gradually. Those gradual changes demonstrate two important aspects of our living world and its climate: (1) how systems are evolving by natural processes and internal stimuli, and (2) how modulations arebeing forced on them through external stimuli such as alterations to conditions, food patterns and their supplies, or imposed anthropogenic interference. Evolutionary changes have their own characteristic time-scales and are controlled, but forced changes can be accelerated beyond tolerance. Measuring that second type is the subject of this paper.

To understand the nature and rate of changes that are imposed by external stimuli, research MUST access observations and records throughout all the time-spans that are modelled. Modern modelling needs data in electronic formats, but since electronic ("born digital") recording and archiving only commenced about 30 years ago, the output from those models can only be reliable over that time-span. Unfortunately, the anthropogenic interference that may have caused the changes we nowseek to measure was already happening 30 years ago, so to obtain a more reliable base-line we must dig out much earlier data. Therein lies the challenge, because pre-digital data were recorded on paper, film, photographic plates or books, or (a bit more recently) on magnetic tapes that used primitive formatting without meta-data. Transforming any of those historical observations into modern electronic formats is an extra procedure that may require expert assistance and equipment as well as extra funding, with the result that a great many pre-digital data are still in theirvirgin analogue states and are thus inaccessible to modern research. They are constantly at risk of physical degradation and damage, and - worse still - of being dismissed as "unwanted" and thrown away.

The CODATA Task Group "Data At Risk" (DAR-TG) is investigating the plight of historical scientific data, and is actively raising awareness of them in order to help secure for science the information that they alone provide. The matter is growing increasingly urgent; although that information is totally unique to the relevant scientific domains on account of the long time-spans which are represented, fashion and convenience still overlook or ignore them. However, when historical data have been recovered and researched (and there have been some very notable and ingenious efforts, as this paper will describe), the results can be fascinating, even startling.

This conference is an ideal opportunity to reflect on the dangers of NOT including sufficiently historical data when trying to model climate change. Without them, hopes of modelling and predicting conditions in the future will without doubt be seriously compromised

P-1102-07

Geochemical evidence of past atmospheric circulation along a 40-50°N longitudinal transect across Europe during the last climatic cycle

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Highlighting the impact on regional scale of global climate changes is a major issue in climatology and paleoclimatology. While large large (global or continental) scale studies help evaluating the direct physical forcing of climate on ecosystems, constraining the effect of this forcing at local to regional scales is essential to evaluate ecosystem feedbacks on climate.

In paleoclimatology, isotopic organic geochemistry (d13Corg) of typical loess is now widely used to investigate past precipitation (average annual values and monthly distribution) and thus to tackle the impact of past climate changes on a regional scale. This type of study has been applied to several loess-paleosol sequences along a 40-50°N transect from Western France to central Ukraine.

The d13Corg analyses were performed in parallel with those of other climate and environmental proxies like grain size, pedology, paleomagnetism and malacology. The investigated records cover the last climate cycle with sedimentation rates as high as 0.15 and 1 mm/yr during periods of loess deposition.

All these records show alternating periods of more or less pronounced climatic pejoration (glacial stadial) and improvement (glacial interstadial). The combined analysis of all sequences for each climatic episode allows us to propose a schema of intensity of past climate change effects on the European continent. Here we highlight two precipitation gradients that prevailed during most of the last glacial period: a West-to-East decreasing gradient in mean annual precipitation and a North-to-South reinforcement of the seasonality.

P-1102-08

On increasing global temperatures: 77 years after Callendar

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In 1938, Guy Stewart Callendar was the first person to demonstrate that the Earth's land surface was warming. Callendar also suggested that the production of carbon dioxide by the combustion of fossil fuels was responsible for much of this modern change in climate. It is now 77 years since Callendar's landmark study and we demonstrate that his global land temperature estimates agree remarkably well with more recent analyses.

P-1102-09

Climate change signals in Kenyan Rift valley lakes

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Climate over Kenya is largely Arid and Semi-Arid, making drought the most common hazard. Floods and many other local hazards occur with most of them being location specific. These climate extremes often have far-reaching impacts on various life-supporting and economic sectors including agriculture, tourism, food security, health, livestock, water resources, settlement, infrastructure, and environmental resources, among others. Climate change leads to increased frequency of droughts and other climate extremes with devastating impacts on livelihoods in many developing countries including Kenya. Thus, no country can have sustainable livelihoods and development without an effective disaster risk reduction and climate change adaptation policies. Such policies require good knowledge of the past, present and future climate at specific locations that are often missing in many developing countries.

This paper presents the space-time patterns of climate extremes in the Rift Valley parts of Kenya in order to delineate the evidence of changing climate. This is evident in the changes in the Kenyan Rift Valley lake levels. These lakes include Lakes Naivasha, Magadi, Elementaita, Nakuru, Baringo and Bogoria. Rainfall data from nearby stations were used to present past and present patterns of climate trends and the associated extremes. The lake level changes were used with an assumption that lake water inflow, outflow, evaporation, water uses, among other relevant factors remain constant. The results show fluctuating lake levels for specific periods corresponding to changes in precipitation trends. From September 2013 to date, there has been a significant lake level rise that has expanded the lakes' extents for several kilometres and even submerging nearby hotels and schools. Finally, this study simulates future climate change scenarios in the Rift Valley in 2030, 2050, 2070 and 2100 that are critical for all future planning over the region.

P-1102-10

Variations of the Antarctic Circumpolar Current (ACC) and of the Austral ocean in the Kerguelen sector during the Deglaciation and the last Climatic Cycles: implications for global climate mechanisms

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Sedimentary cores were collected with the Casq and Calypso coring systems of the RV Marion-Dufresne during the IndienSud-1 and 2 expeditions in 2011 and 2012 in the Kerguelen sector of the South Indan Ocean. These cores allow producing high-resolution, well-dated records, which document past climate and ocean circulation changes during the last climatic cycles, with a focus on the last deglaciation.

Past Changes in the intensity of the Antarctic Circumpolar Current (ACC) are investigated using environmental magnetism methods, which trace amount and size of sedimentary magnetic grains transported by this current. Oxygen isotopes and foraminifera faunal assemblages trace hydrological and temperature changes, while vertical mixing is documented by δ13C. A precise age scale will be derived from 14C ages determinations, augmented by regional correlations (magnetic susceptibility) to well-dated cores in the same area, thanks to a tephrochronological study of the marine cores and peat cores from the Kerguelen archipelago.

Results document a stronger ACC current during glacial intervals than during interglacials over at least the last 600 kyrs. This pattern is opposite to observations of flow of the NADW branch (WBUC) south of Greenland in the North Atlantic Ocean. It suggests an inter-hemispheric antiphasing between ACC and NADW at Milankovitch timescales, with a strong circulation in the deep North Atlantic when the ACC is weak, and vice versa (thus with an ACC correlated with the GNAIW intensity). During the last deglaciation, temperature and vertical mixing increased prior to changes in the ACC current intensity. A decrease (or northward migration) of the ACC occurred later during the deglacial process. It could be associated to the rate changes of the AMOC and to deep ocean ventilation. Observed changes appear to be closely connected to atmospheric CO2 changes during the last deglaciation.

P-1102-11

Assessing the potential impacts of climate change and reforestation on rainfall onset and cessation over West Africa

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This study investigates the potential impacts of climate change and reforestation on the rainfall onset and cessation over West Africa. It uses two observations (GPCP and TRMM) and two RCMs RegCM and WRF forced respectively with HadGEM and ECHAM for the present-day climate (1971-2004) and projected future climate (2031-2064) under rcp45 conditions. Four definitions (DEF1, DEF2, DEF3 and DEF4) of rainfall onset dates (ROD) and one of rainfall cessation dates (RCD) based on rainfall threshold are used in this study. The results show that both observations (GPCP and TRMM) produce similar results of ROD/RCD in each climatic zones of West Africa (respectively Guinea, Savanna and Sahel). HadGEM and ECHAM fail to simulate the spatial distribution of ROD/RCD and produce later/early ROD/RCD in all definitions as observed. However, RegCM and WRF perform better than their driven GCMs (HadGEM and ECHAM) in simulating the ROD/RCD over the region. The potential impacts of

climate change due to elevated greenhouse gas (GHGs) show that the temperature would likely increase over West Africa in both RCMs and also in the GCMs (HadGEM and ECHAM) more consistently over the Sahel. On the other hand, elevated GHGs would lead to a decrease in rainfall as indicated by the RCMs and GCMs although the decrease is much more consistent again over the Sahel. As for the future ROD, increase in GHGs indicates that regardless of the definitions used, northern Nigeria would have delayed RODs. The vertical structure of the monsoon dynamics in the areas where the highest impacts of climate change (i.e. latest ROD) are observed for each definition shows that the elevated GHGs in the future under rcp45 condition would induce shallower monsoon flow essentially over the Sahel. However, there was no agreement between the RCMs (RegCM and WRF) on the potential impact of climate change on the RCDs due to elevated GHGs, for while RegCM indicates delayed RCDs over the Sahel and early RCDs over the Savanna, WRF produces early RCDs in all the areas. From both models, the projected impact of reforestation under the rcp45 condition indicates that West African climate would be cooler in most areas with more rainfall during the rainy season especially over the reforested zone. The cooling effect is more consistent and higher over Savanna but reforestation would induce a warming over some surrounding areas. Regardless of the definitions used, reforestation over Savanna area would induce early ROD over most areas in West Africa as obtained from both models, except over north of Nigeria. The potential impact of reforestation on the RCDs (under rcp45 conditions) again produces divergent results by the RCMs. While RegCM indicates delayed RCDs over the reforested area and early RCDs over Sahel, WRF produces delayed RCDs over all the climatic zones.

P-1102-12

Spatial and temporal variability in observed and future projected precipitation in Bia basin (Ivory coast-Ghana)

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The phenomena of drought and desertification that affected many African countries south of the Sahara have not spared the Ivory Coast, especially from the 1980s. The impact of these events resulted in significant climatic disturbances including abnormal extension of the dry season, the irregularity and the poor distribution of rainfall and significant reductions in agricultural yields in the southeast zone. The question is to know is that these same phenomena will repeat in the future in the medium term (2030-2050) or long-term future (2070 and beyond).

Attempts to assess the changes between the observed (or historical) and future projected monthly rainfall for six stations throughout Bia basin have been made with descriptive statistics and value analysis. We obtained the monthly rainfalls data from Coupled Model Intercomparison Project Phase 5 (CMIP 5) dataset. These data is downscaled using the change factor approach for 30 1981 to 2010 (period 0), simulation from 2021 to 2050 (period 1) and from 2070 to 2099 (period 2). The historical and projected rainfalls are obtained from RCP 2.5, RCP 4.5, RCP 6 and RCP 8.5 scenarios, which are based on a model HadGEM2-ES and model IPSL-CMSA-MR. The first order Markov chain model was used to describe the occurrence of sequences of wet or dry years. For the comparison of values, the return period estimates are obtained. To examine temporal changes in drought, a cluster analysis was conducted by Self Organizing Map (SOM) for Matlab. The within-group linkage and the hierarchical clustering analysis method were performed using the value of the monthly. The number of optimum cluster was determined when the similarity between merged clusters decreased sharply according to the number of groups. HadGEM2-ES and IPSL-CMSA-MR represents the precipitation annual cycles quite well in Bia basin with the respective average correlation coefficients of 0.78 and 0.80. From the descriptive statistics, we find that the numbers of heavy rainfall events will increase in the future. The total precipitation is projected to remain unchanged or slightly increased, compared to the observation. From the annually value analysis, we can observe that expected return periods for dry episodes are almost constant, ranging from 1.20 to 1.45 years. In accordance with this we should conclude that no significant differences could be established among the different stations of the basin. The short return period (1.05 years), reflecting the state of having a new dry episode, is observed in the Bia region during the period 2071 to 2099.

Subsequently, the monthly values with similar trends were grouped into two different clusters where the region G1 corresponds to Northern and G2 the Southern region. The map shows that future droughts are projected to frequently occur in all regions, especially from the -2021s to the early 2050s. The droughts in the Bia basin between the year 2026 and 2027 are distinct from the other regions in the same period. These were previously confirmed to be quite intense over annual timescales. For the period 2032-2035, intense droughts are expected to occur nationwide, which may also continue in the regions. After this period, sporadic drought is expected to occur in some regions, with more intense ones from the 2070s in the region G1 and G2. Lastly, in the year 2099, a short, intensive drought is expected to occur in all regions.

P-1102-13

Response of North Atlantic storm track to climate change in the CNRM-CM5 simulations

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Climate variability in Europe is largely controlled by North Atlantic storm tracks. They are associated with transport of energy, momentum, and water vapour, between the equator and the pole. Extratropical cyclones have caused severe damages over some regions in north-western Europe, since they can combine extreme precipitation and strong winds. This is why it seems relevant to study the impact of climate change on the extratropical cyclones, principally on their intensity, position or lifespan. Indeed, several recent studies have focused on this subject by using atmospheric reanalysis and general circulation models (GCMs). The main conclusions obtained from the CMIP3 simulations showed a decreasing of the total number of cyclones and a poleward shift of their tracks in response to global warming. In the recent CMIP5 exercise, the consensus is not so clear, probably due to more complex retroactions acting in the different models. Thus, the question of changes in North Atlantic storm-tracks with warming remains unanswered.

The main goal of this work is to explore the changes in the North Atlantic storm-tracks in the past decades and to analyze the role of the external versus the internal variability on these changes. We will use different sets of atmospheric reanalyses and the climate simulations performed with the climate model CNRM-CM5, built up by the CNRM-CERFACS modelling group as a contribution to CMIP5. To characterize the extratropical cyclones and their tracks, the tracking scheme developed at Meteo France by Ayrault (1995) has been used. It is based on the detection of maximum of relative vorticity at 850 hPa.

The algorithm has been applied to the ERA40 and 20CR reanalyses. Even though the 20CR reanalysis covers the whole 20th century, we show, in this study, that it is not adapted to assess trends in the atmospheric fields before 1950, due to some discrepancies in the assimilated observations. However, in the second part of the 20th century, the 20CR reanalysis seems coherent to ERA40.

In a second part, we investigate the effect of external forcings on the North Atlantic storm tracks recent trends in the simulation performed with CNRM-CM5. We compare a control simulation with the historical simulation, in which all the external forcings have been prescribed. We show that the model fairly well reproduces the storm genesis locations as well as the following tracks. In the historical period (1850-2005), the model shows a decrease in the number of storms in the southern North-Atlantic, when all the forcings (anthropogenic and natural) are prescribed. In the scenario (RCP8.5), the tendency seen in the all-forcings historical run is confirmed and reinforced.

Finally, we use the idealized simulations to study the effects on storm-tracks when only one kind forcing is prescribed to the climate model. Here we show that the response of North Atlantic storm-track is coherent to the one found in the

historical simulation when only an increase of 2% CO2 per year during 30 years is precribed, suggesting that, in the CNRM-CM5 model, the impact of the CO2 forcing is the dominant to explain the trends in the North Atlantic storm-tracks.

P-1102-14

Impacts of natural external forcings on the Amazon regime rainfall modulated by the tropical Atlantic Ocean during the past millennium

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Tropical climates are strongly influenced by the moisture influx from the adjacent oceans. In 2005 and 2010, dryness events observed in the Amazon Basin were strongly related to positive anomalies of sea surface temperature over the tropical North Atlantic. These changes in the Amazon water cycle had important consequences to the population, economy and ecosystems. In recent past climates, there is evidence of drier conditions in the Amazon Basin during the Little Ice Age (1400 to 1700 Common Era, C.E.) and wetter conditions during the Medieval Climate Anomaly (950 to 1250 C.E.). These periods were associated with variations of natural external forcings, as the solar and the volcanic forcings. The variability of tropical oceans is influenced by the amount of energy received by the Sun and also by atmospheric changes due to volcanic eruptions, because both consist of radiative forcings. As the Amazon Basin moisture influx is related to the tropical Atlantic conditions, any changes in this ocean will impact on the Amazon rainfall regime. Here we will present the effects of the solar variability and the volcanism of the past millennium (850-1850 C.E.) on the tropical Atlantic conditions and consequent impacts on the Amazon rainfall regime. We will use single-forcing experiments monthly outputs from the National Center for Atmospheric Research-Community Earth System Model (NCAR-CESM) to the past millennium, when natural external forcings prevailed over the anthropogenic forcing. Air-sea interaction processes in the tropical Atlantic will be estimated from the model outputs, and then related with changes in the rainfall regime over the Amazon Basin. These results will contribute to a better understanding of the natural forcings on the tropical climate.

P-1102-15

Impact of climate variability and change on meteorological droughts over Southern South America

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Droughts are perceived as one of the costliest and least understood natural disasters, given the difficulty in defining its beginning and end, its slow development and its multiple regional aspects. Southern South America (SSA) was no exception to this hazard, whose impacts were evident in the reduction in crop yields, reduced cattle products, streamflow deficiencies and consequently problems for hydroelectric power generation. This research addresses the observed spatial and temporal variability of precipitation and meteorological drought over SSA during the 20th century, and the expected impacts of climate change on these variables. The Standardized Precipitation Index (SPI) was used as a short- and long-term drought indicator, given its suitability for the study region. Observed trends in the area affected by drought conditions were assessed through a non-linear approach based on the residual of the empirical mode decomposition, a recently proposed methodology which is robust in presence of non-stationary data. Trends indicate the existence of a low-frequency variability that modulates regional precipitation patterns at different temporal scales, and warns about possible future consequences in the social and economic sectors if trends towards an increase in the drought affected area continue. This non-linearity was also evident on the temporal behavior of other hydrometeorological variables, like the annual number of dry days over Argentina, and on the streamflow deficiencies over the central Andes and Patagonia. Moreover, links with decadal oscillations as the PDO were identified in the modulation of the decadal component of the annual cumulated deficit volume in the central Andes of Argentina.

The future assessment of precipitation and meteorological drought conditions was performed through a CMIP5 multi-model ensemble based on 15 Global Circulation Models (GCMs) forced under two future scenarios (RCP4.5 and RCP8.5). Changes in meteorological drought characteristics were identified by the difference for early (2011-2040) and late (2071-2100) 21st century values with respect to the 1979-2008 baseline. Future climate conditions are expected to modify the regional characteristics of meteorological droughts over SSA, but the range of uncertainty in the expected changes is high. A significant increase in the number of drought events for most of the 21st century sub-periods and scenarios is projected for the multi-model ensemble outputs. The mean duration of drought events will be shorter, with no significant changes in the severity of droughts and the occurrence of multi-decadal changes in the number of critical dry months is likely, although the significance in the changes depends on the region, future time horizon and scenario. These results overlap with a projected increase in precipitation over most of the regions, which has a strong seasonality and, therefore, will have some implications upon the future meteorological drought developments and the agricultural and hydrological practices in SSA. It is expected that the outcomes of this study will provide a measure of the likelihood of further drought changes under the CMIP5 framework, which was a key factor of the IPCC's AR5.

P-1102-16

Comparaison de méthodes de réduction d'échelle pour des moyennes et des extremes de précipitations au Sénégal

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Au Sénégal, les chutes de pluie au cours de ces dernières années provoquent régulièrement des dégâts importants dans divers secteurs. Ainsi, il est donc important de comprendre l'évolution future des régimes de précipitations extrêmes pour fournir des outils à la prise de décisions.

Deux techniques différentes de réduction d'échelle ont été appliquées aux sorties de quatre (4) Modèles Climatiques Régionaux (MCR) à six (6) stations sélectionnées au Sénégal. La première technique de réduction d'échelle est la méthode Delta-Change. Elle est appliquée sur la moyenne annuelle des précipitations ainsi qu'aux périodes de retour calculées sur 5, 10, 20, 50 et 100 ans sur la base des précipitations quotidiennes. La seconde technique utilise la méthode de transformation Quantile-quantile qui permet de modifier les distributions mensuelles de précipitations simulées du MRC et ensuite calculer les périodes de retour de 5, 10, 20, 50 et 100 ans des précipitations journalières. Tous les événements de précipitations extrêmes sont calculés par l'ajustement de la distribution de GEV. Un test de Kolmogorov-Smirnoff est utilisé pour évaluer la performance de la transformation de Quantile-quantile ainsi que l'ajustement de la distribution de GEV pour les précipitations quotidiennes maximales.

Les résultats montrent que les deux méthodes, appliquées aux sorties du même modèle climatique, sont généralement homogènes sur la direction du changement. En revanche, elles conduisent à de différentes projections dans la direction et dans l'intensité du changement des précipitations extrêmes. Les changements projetés dans les précipitations moyennes sont à la baisse, excepté pour un MRC sur une station. Les changements projetés dans les précipitations extrêmes ne sont pas uniformes ni à toutes stations, ni à toutes les périodes de retour. Les résultats suggèrent également que le choix de la méthode de réduction d'échelle a plus d'effet sur l'estimation des précipitations quotidiennes extrêmes des périodes de retour égales ou supérieures à dix ans que le choix du modèle climatique.

P-1102-17

Bidecadal North Atlantic ocean circulation variability controlled by timing of volcanic eruptions

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Understanding the mechanisms driving Atlantic Meridional Overturning Circulation (AMOC) decadal variability is critical for climate predictability in the Northern Hemisphere. North Atlantic paleoclimate proxy records exhibit variance at the bidecadal scale but the drivers of this variability remain poorly understood. Here we show that the subset of CMIP5 historical simulations that produce such bidecadal variability exhibit a robust maximum in AMOC strength 15 years after the 1963 Agung eruption, followed by a second maximum in the 1990s, caused by the reset of a bidecadal cycle. The mechanisms at play involve salinity advection from lower latitudes and explain the timing of Great Salinity Anomalies observed in the North Atlantic in the 1970s and 1990s. Simulations as well as Greenland and Iceland paleoclimate records indicate that coherent bidecadal cycles were excited following five Agung-like volcanic eruptions during the last millennium. Over the last decades, climate simulations and a conceptual model reveal interference patterns associated with the timing of subsequent volcanic eruptions. Destructive interference caused by the Pinatubo 1991 eruption may have led to a stable AMOC in the 2000s. Our results imply a long-lasting impact of volcanic eruptions on AMOC, North Atlantic Ocean and climate, and potentially significant multi-decadal predictability following the next large volcanic eruption.

P-1102-18

The CMIP5 GCMs ensemble climate change scenarios for Republic of Moldova's vulnerability and adaptation assesssment

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In the present study we assessed the patterns of climate change computed from global climate model output gathered as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor et al., 2012) in temperature and precipitation conditions over the Republic of Moldova (RM) Agro-Ecological Zones (AEZs) as a consequence of the enhanced greenhouse gas (GHG) concentrations until the end of the 21st century. Totally, 21 global coupled atmosphere ocean general circulation models (GCMs) were downloaded and assessed. The projections were made under the Representative Concentration Pathway (RCP) scenarios RCP 2.6, RCP 4.5, and RCP 8.5 and climatic changes over the RM's AEZs for the near term (2016-2035), midterm (2046-2065) and long term (2081-2100), which are given relative to the reference period of 1986-2005. The CO2-equivalent concentrations in the year 2100 for RCP 2.6, RCP 4.5 and RCP 8.5 are 421 ppm, 538 ppm and 936 ppm, respectively (Meinshausen et al., 2011). The first feature to highlight is that, for temperature, the ensemble average changes consistently have the same sign across scenarios and their magnitude increase from the low RCP 2.6 radiative forcing pathway to the high GHG ones RCP 4.5 and RCP 8.5, as we move into the later decades of the 21st century.

The CMIP5 projections reveal warming in all seasons for the three RM's AEZs, while precipitation projections are more variable across scenarios, sub-regions and seasons. Annual changes for temperatures are very homogeneous over the RM's AEZs. The rate of warming is higher under RCP 8.5 scenario reach +4.6 °C; medium +2.4 °C under RCP 4.5; and smaller +1.3 °C under the RCP 2.6 scenario by 2100. The ensemble, driven by RCP 8.5 emission scenario, estimate that the RM's AEZs will experience the most significant warming during summer from +5.9 °C in Northern up to +6.1 °C over Southern AEZ's by 2100. The pattern of change derived from the ensemble RCP 2.6 models is quite similar, but the magnitude of change is lower from +1.3 to +1.5 °C. The warming would be higher during winter up to +4.6 °C over Northern, although in Central and Southern AEZ's temperature rise will be lower up to +4.2 °C according to the RCP 8.5 scenario. The RCP 2.6 scenario reveals less intense warming over the RM's AEZs from +1.2 to +1.4 °C.

The ensemble projections from the RCP 8.5 forcing scenario that the RM's AEZs would exhibit a general annual decrease in precipitation varying from 9.9% in Northern to 13.4% to Southern AEZs. Controversially, according to RCP 2.6 scenario is projected moderate increase in precipitation from 3.1% in Northern to 5.1% to Southern AEZs by 2100. Winters have been estimated to be wetter in the RM by the end of the 21st century. The ensemble projections show the largest increase in precipitation from 4.0% (RCP 2.6) to 11.8% (RCP 8.5) in winter over Northern and the lowest one from 3.0% (RCP 2.6) to 7.4% (RCP 8.5) in Central parts of the country by 2100. The precipitation decrease will be more extended in the RM's AEZs during summer; the greatest rainfall reduction from 13.2% (RCP 4.5) to 25.1% (RCP 8.5) is projected in Central AEZs and the lowest one from 7.4% (RCP 4.5) to 18.1% (RCP 18.1) in Northern areas. Obtained scenarios is planned to use in near future for vulnerability and adaptation assessments of key socio-economic sectors.

P-1102-19

South American precipitation changes simulated by PMIP3/CMIP5 models in past and present climates

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Significant precipitation changes have been identified in many regions of South America using both, paleoclimatic proxy records of the last 700 years and instrumental observations of the more recent decades. Such changes are not clearly understood yet, besides that they largely impact the socio-economic activities of the countries that the regions encompass. The availability of the climate simulations included in the Fifth Phase of the World Climate Research Program-Coupled Model Intercomparison Project (CMIP5) and the Third Phase of the Paleoclimate Modelling Intercomparison Project (PMIP3) provides an excellent opportunity to assess the ability of current models in representing those precipitation changes. Therefore, that assessment is briefly discussed here as well as the exploration of the main dynamic mechanisms that might explain them.

The following experiments of the PMIP3/CMIP5 set were considered: the pre-industrial experiment, which not include any external forcing; the Historical experiment, which was obtained forcing models by both, natural and anthropogenic sources, observed between 1850 and 2005; and the Last Millennium which which span the period from 850 to 1850 and is obtained considering the natural forcing estimated for that period. Multi-model ensemble means (MEM) were computed for each experiment over the periods under study.

The Andes Mountains are one of the regions in South America in which paleoclimate studies have been focused on. In particular, in both, the Altiplano, a high-level plateau (around 3800 m), located in the Andes between 15°S and 21°S, and the subtropical Andes, located in central Chile at around 33°S, wetter-than-normal conditions were identified during the 17th century within the period known as Little Ice Age (LIA). On the other hand, drier-than-normal conditions were detected at both regions in the second part of the 20th century in association with the more recent global warming period (GWP). Although MEM are capable of representing the thermal changes in South America estimated in both periods, they do not properly represent the expected precipitation changes, except in the subtropical Andes during the GWP. The large uncertainties associated with the model simulations might be due to their limitations in reproducing the regional precipitation, especially over complex topography. On the other hand, models seem

able to represent the large-scale circulation changes that would explain the precipitation changes observed at those two regions in a physically consistent way. It was found that in the Altiplano, wetter (drier) summers in LIA (GWP) seem to be related with a stronger (weaker) upper-level eastward zonal flow, well represented by the MEM. On the other hand, models consistently show that wetter (drier) winters in the subtropical Andes in LIA (GWP), seem to be associated with a stronger (weaker) westward zonal flow in the low troposphere, induced in turn by hemispheric changes related to a negative (positive) phase of the Southern Annular Mode (SAM).

Southeastern South America (SESA), encompassing the most productive economic areas of 6 different countries (Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay), is another region in which available records show a significant precipitation increase by the end of the XX century not only as as compared to that observed at the beginning of that century, but also to that estimated by paleoclimatic records at around 700 years ago. Both precipitation and circulation changes simulated by the models at that early period are highly uncertain. However, the MEM for the Historical experiment are able to reproduce precipitation changes observed in SESA during the GWP, although they are weaker than observed. In fact, most of the simulations reproduce the right sign of the precipitation changes in SESA during that period. However, associated uncertainty ranges (due to both inter-model dispersion and internal climate variability), are still large. In addition, it was found that mean positive precipitation trends in SESA for the Historical experiment are statistically distinguishable from those obtained for the natural-forcing-only experiment made over the 20th century, which exhibit negligible mean values. Results allow concluding that the anthropogenic forcing has at least a partial contribution in explaining the precipitation changes observed in both SESA during the GWP.

1103 - Climate variability and external forcings of the Common Era with special focus on the role of volcanic eruptions

ORAL PRESENTATIONS

K-1103-01

Robust ocean cooling trend for 0-1800 CE and the role of volcanic forcing

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The oceans mediate the response of global climate to natural and anthropogenic radiative forcing, yet observations of global maritime surface climate variations in the late Holocene, and the mechanisms that drive the variations, are relatively unknown. Here we synthesize 57 sea surface temperature (SST) reconstructions, sourced from all major ocean basins, and spanning at high resolution some or all of the past 2000 years. The reconstructions are derived from marine archives (Mg/Ca, alkenones, TEX86, faunal assemblages in sediment cores, and coral), and meet strict chronological control criteria. The reconstructions are geographically sparse, however analysis of multi-millennial AOGCM output and historical gridded SST observations suggest the reconstructions are spatially sufficient to resolve global mean SST.

The reconstructions were standardised into 200-year bins and the resulting Ocean2k SST synthesis reveals a robust SST cooling trend for 0-1800 years of the Common Era (CE), with the strongest cooling after 1100 CE. The cooling trend is not sensitive to localized upwelling, marine archive type, seasonality of response, chronological control, water depth, sampling resolution, sedimentation rate, basin, latitude or hemisphere.

The Ocean2k SST cooling trend is qualitatively consistent with an independent synthesis of terrestrial paleoclimate data, and with simulations from the multimodel PMIP3 ensemble, driven by the full suite of hypothesized radiative forcings. Comparison with ensembles of single and cumulative radiative forcing simulations suggests that the cooling trend arises not from orbital forcing, but from the increased frequency of explosive volcanism and/or land use change in the most recent millennium. We find that episodic volcanic eruptions induce a net negative radiative forcing that results in a centennial and global-scale cooling trend via a decline in mixed-layer oceanic heat content.

K-1103-02

Climate impacts of volcanic double events during the Common Era

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Volcanic eruptions are known to be a major driver of climate variability during the last millennium (the Common Era). Recent high-resolution polar ice core data reveal new insights into volcanic forcing during this period, improving our knowledge of the timing and the amount of sulfur released by past volcanic eruptions (Sigl et al., 2014). Here we focus on the effect of volcanic "double events", such as the major eruptions of 1808/1809 (Unknown) and 1815 (Tambora). The close temporal proximity of two eruptions creates the potential for climate impacts to superimpose. Ice core records provide evidence of other such double events, and climate proxy records are used to assess the climate impact of double compared to single eruption events. We perform climate model simulations to investigate specific volcanic double events, reconstructed from ice core records, and assess the potential for additive climate impacts. In particular, simulations are used to investigate the impact of decadal scale volcanic radiative and dynamical anomalies on the coupled climate system including vegetation, sea ice and ocean circulation changes. Our model results show that given certain conditions, two closely spaced eruptions of Tambora magnitude could have a larger cumulative climate impact than a single eruption of much greater magnitude. Based on the observational records and model results, we propose that volcanic double events are a likely agent for abrupt (decadal) climate changes, and may have had significant impacts on past civilizations.

Sigl, M., J.R. McConnell, M. Toohey, M. Curran, S.B. Das, R. Edwards, E. Isaksson, K. Kawamura, K. Krüger, L. Layman, O. Maselli, Y. Motizuki, D. Pasteris, Rewriting the history of volcanic forcing during the Common Era using new ice cores, Nature Climatic Change, 10.1038/nclimate2293, 2014.

O-1103-01

Climate change making impacts on societies in the European/Mediterranean region during the past two millennia as seen by land-ocean palæoarchives

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A composite of sea surface temperature (SST) reconstructions from the Mediterranean/Eastern Atlantic basins (this study; McGregor et al., 2015, submitted) is compared with a stack of terrestrial records selected to describe the temperature variability in the European region over the past 2000 years (PAGES 2k consortium, 2013, NATURE GEO.). Prior to 800 CE, the scarcity of measurements prevents us from making sound inferences about climatic changes during this interval. From 800 to 1800 CE, both land and ocean signals present common significant cooling trends (up to -1 s. d. units/millennium, $R2>0.67$, $p<0.01$), attributable to the anomalous cold temperatures registered during the Little Ice Age. The latter is a well-documented anomaly, which had strong impacts on European societies and stands out in both composites, particularly after 1600 CE. Ensembles of forcing simulations suggest that this is consistent with a global cooling trend, which arises from increased frequency of explosive volcanism and possible land use change. During the post-industrial time interval, the terrestrial composite registers almost +2 s. d. units warming since 1800 CE, in remarkable agreement ($R2=0.81$, $p=0.01$) with a reference Central England temperature record estimated independently (Met Office Hadley Centre for Climate Change, 2014). The warming is of lower amplitude in the ocean composite, only +1 s. d. units, in line with historical sea surface temperatures (Kaplan et al., 1998, J. GEOPHYS. RES.). The 20th century warming amplitude seems more pronounced as more low-latitude and close-to-land records are taken into consideration, whereas inclusion of high-latitude and/or upwelling locations attenuates it. Given the uncertainties inherent in the reconstructions available and the variety of responses to climate changes during this interval, the answer to the question whether the last century is likely the warmest climatic period of the latest 2000 years appears elusive in the Europe/Mediterranean region.

O-1103-02

Volcanic Eruptions and Global Climate Impact

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Early documentary records report of a mysterious dust cloud that was covering Europe for 12 months in 536-37 CE, which was followed by climatic downturn and societal decline globally. Tree rings and other climate proxies have corroborated the occurrence of this event as well as characterized its extent and duration, but failed to trace its origin.

By using a multi-disciplinary approach that integrates novel, global-scale time markers with state-of-the-art continuous ice core aerosol measurements, automated objective ice-core layer counting, tephra analyses, and detailed examination of historical archives, we developed a new volcanic forcing series from bipolar ice-core arrays back into Roman times. We revised the timing of major volcanic eruptions and reconstructed atmospheric aerosol loading and the spatio-temporal distribution of volcanic sulfate and tephra. Precise ice-core timescales for Greenland and Antarctica enabled us to discern tropical from Northern Hemisphere eruptions, and to identify the climate-altering role of non-tropical eruptions, such as those causing the "mystery cloud" in 536-37 CE.

Our study reconciles human and natural archives - demonstrated by the synchronicity of major volcanic eruption dates to historical documentary records and the (now) consistent response of tree-ring-reconstructed cooling extremes occurring in the immediate aftermath of large volcanic eruptions throughout the past 2,000 years.

These findings have significant implications in multiple research fields including quantification and attribution of climate variations to external forcing, and will be of benefit for historians, volcanologists as well as climate scientists.

O-1103-03

Geochimical DNA or the identification of 1259AD volcanic glasses in ice cores

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The 1259 AD unknown volcanic eruption found in polar ice cores is considered as the most powerful eruption of the last 7 000 years and could have triggered the little ice age as well as profoundly changed the political and sociological organization of the middle age. Despite its relative young age and power, the origin of this eruption has remained elusive. For years, volcanologists and glaciologists have searched for the possible origin of this mega eruption with little results. This event has thus remained as the unknown 1259AD event, limiting a possible examination in great details of the climatic consequences of this eruption. After decades of research, based on datation, geomorphological considerations and historical archives, Lavigne et al [1] have recently proposed the Salamas/Rinjani (Indonesia) as the possible volcano for this eruption.

In order to validate this proposition, we have undertaken a thorough and meticulous analysis of the geochemical composition of the tiny volcanic glasses found in the ice layer corresponding of this eruption. With a great level of certainty, the chemical fingerprint of the tiny glasses in ice is found to match the chemical compositions of the ashes layers found around the volcano. This result should open a complete review of the climatic impact of this volcano and demonstrated the feasibility of identifying the origin of volcanoes in ice cores from their geochemical fingerprint.

Lavigne, F., et al. (2013), Proceedings of the National Academy of Sciences, doi: 10.1073/pnas.1307520110.

O-1103-04

A reconstruction of terrestrial volcanism over the last 2500 years using sulfur isotopes in ice-cores

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Ice cores provide an opportunity to reconstruct a history of Earth's volcanic activity. Many attempts have been made in the past to build a robust volcanic climate forcing model based on the ice records, but the robustness of this model depends on the statistical significance of usually a single record and on discriminating between large distant eruptions and closer, smaller eruptions.

We used ice cores drilled at Dome C (Antarctica) to measure first, the statistical weight of a single ice core record and second, to measure the non-zero $\Delta 33S$ of ice-core sulfate as a proxy for stratospheric volcanic eruptions. SO2 emitted by these events can be mass-independently fractionated ($\Delta 33S \neq 0$) during photolysis reactions in the stratosphere [1], [2], [3], [4]). The signal, recorded

in aerosol sulfate, is preserved in ice cores. The sulfur anomaly allows identification of eruptions very likely to be stratospheric, with potential climatic impact, regardless to the ice core location, the age or the magnitude of the recorded event.

In 2010-2011, five 100m-long ice cores from Dome C, Antarctica, separated by 1m, were collected to reconstruct the history of volcanism over the last 2500 years. Assumed volcanic events were identified through sulfate concentration measurements in the field, and located on the cores. We used an algorithm for the peak detection, and 51 potential volcanic events were identified. Based on this detection, a statistical evaluation of the occurrence of these 51 events in each ice core was conducted and allowed measuring the representativeness of a single ice core to reveal a history of volcanism. Following this statistical work, volcanic sulfate contained in snow and ice have been isolated, decontaminated, melted, concentrated and extracted using ion exchange methods. Each presumed volcanic event has been subdivided in 5 fractions at least, in order to differentiate the background isotopic signal from the sulfate peak. The peak itself has been divided into three portions. The results show that Δ33S and Δ36S are anti-correlated, and allow to discriminate stratospheric and tropospheric events, with the former having isotopic systematics that vary first with a positive Δ33S at the beginning of deposition and with a negative Δ33S at the end of the volcanic deposition. Such unique feature should allow us to reconstruct a robust volcanic forcing signal, independent of the size of the event record in ice.

[1] Farquhar et al. (2001), J. Geophys. Res. 106, 32829-32839. [2] Savarino et al., (2003), J. Geophys. Res. 108(D21), 4671.[3] Baroni et al. (2008), J. Geophys. Res. 113(D20), 1-12. [4] Baroni et al. (2007), Sciences 315, 84-87.

O-1103-05

Effect of large volcanic eruptions on climate variability from inter-annual to decadal timescales: Towards a coordinated modeling assessment

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It is now generally recognised that volcanic eruptions have an important effect on climate variability from inter-annual to decadal timescales. At the decadal scale, CMIP5/PMIP3 simulations have highlighted that clusters of eruptions can produce a long-lasting cooling such as during the 13th and the 19th centuries. This has led to the hypothesis that enhanced volcanic activity during the second half of the 13th century played a significant role in the transition towards the Little Ice Age through its impact on the thermohaline oceanic circulation and on Arctic sea ice. This hypothesis remains however speculative, as paleoclimatic reconstructions and climate simulations yield partly contradictory results.

Concerning the short-term hemispheric response to sulphur-rich volcanic eruptions, CMIP5/PMIP3 climate simulations show stronger cooling than tree-ring based reconstructions. Scarce information about the medieval and 19th century eruptions (i.e. magnitude, timing and location) have so far hampered a realistic assessment of the climatic impacts of decadally-paced volcanic events. Another possible reason for the mismatch is our limited understanding of the evolution of stratospheric aerosol formed after strong eruptions of pre-instrumental period, such as Tambora in April 1915, for which no direct observations are available.

It is therefore necessary to frame future modeling activities within common designs that separately tackle the two major steps linking sulfur emissions by volcanic eruptions and climate response: first, the chemical and microphysical transformation occurring within the stratospheric volcanic cloud; then, the aerosols' direct radiative effects and associated feedback mechanisms activated in the coupled ocean-atmosphere system. The coordinated modeling initiative within VOLMIP (Model Intercomparison Project on the climatic response to Volcanic forcing, an activity for CMIP6-) has been motivated by such necessity. VolMIP will provide new consensus forcing input data and related coupled climate simulations for some of the major volcanic eruptions that occurred during the pre-industrial period of the last millennium.

This contribution presents ongoing activities and research highlights achieved within VolMIP, illustrating how these coordinated modeling assessments are contributing towards constraining uncertainties in the climate response to volcanic forcing, improving the evaluation of climate models, and advancing our understanding of past, current and future climates.

1104 - Climate services and information: from global change to local decisions

ORAL PRESENTATIONS

K-1104-01

USe of Climate Information in the context of helping prepare American military bases for climate change

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We will describe the work we have performed in two projects through the Strategic Development and Research Propogram of the US Department of Defense. We are providing future climate information to a total of eight different miliarty bases in the continental US. The kinds of impacts include damage from storm surges due to sea level rise, increased hear stress and potential increased damage from erosion because of increased extreme precipitation, increased extreme fire risk, and potential changes in severe storms. We discuss how we present uncertainty information to the stakeholders (military personnel) are each base, and discuss the different levels of interest or concern we found among the stakeholders based on their prior experience with extreme events.

O-1104-01

Climate Science for Climate Services: Creating capacity within CORDEX-Africa

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Within the Co-ordinated Regional Downscaling Experiment (CORDEX), the Cordex-Africa initiative has been developed to analyze downscaled regional climate data over the African domain of CORDEX, train young climate scientists in climate data analysis techniques and engage users of climate information in both sector specific and region/space-based applications. A series of engagements between African climate scientists and users of climate information under the CORDEX-Africa banner has begun and we report on the outcomes of these as well as the future plans of the programme. Established and young climate scientists from west, east central and southern Africa have analysed downscaled data from the CORDEX Africa domain and produced 9 scientific journal papers to date through a series of highly successful workshops, all first authored by early-career scientists or students. These papers have greatly enhanced the understanding of climate processes in each of the regions. Additionally, members from each region have been involved in workshops that engage users of climate information to co-explore the climate information needs of these communities. These

included (a) engagements with ecological, hydrological and agricultural scientists that helped refine some of the research questions to be addressed in later CORDEX activities, (b) with health sector practitioners in West Africa to understand their needs with respect to climate information and (c) representatives from five African cities to understand city-scale climate vulnerabilities and information needs. Planned activities include a series of workshops to analyse climate projection data in the 4 regions with input from climate information users to assess potential effect of global warming on atmospheric process and the impacts these may have in the engaged user communities.

O-1104-02

The FODAS based climate prediction services in China

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The structure of China Framework of Climate Service, what we called CFCS to compare to the GFCS is building in China. Based on climate database and climate system model, climate monitoring and prediction products is issued. We focus on climate security and disaster risk reduction. Climate security is a new concept developed by Dr. Zheng Guogang. who is the Administrator of China Meteorological administration. Climate is really related to food security, water security, energy security and ecological security, and so on. We need to assess climate impact, climate capacity, to analyze climate resource and provide climate proofing to support sustainable development of social-economy in china. As China belongs to monsoon climate and is a very vulnerable country suffered from different kinds of meteorological disasters. Therefore, Beijing Climate Center (BCC) are facing big challenge of disaster risk reduction. We need to do disaster survey, to assess vulnerability, to issue risk warning even support risk transfer. Through the user interface plan and partnership, we provide all of those climate services to decision makers, public community and economic sectors. Besides, in order to surport the capacity development of CFCS, the forecast system on dynamical and analogy skill (FODAS) is developed by BCC, which is used for supplying monthly and seasonal climate prediction services to the govement and public. FODAS is also been generalized in more than 30 provincial climate centers in China and used for regulary climate business. We are also working on developing a English version of FODAS to surport some international trainning courses held in CMA etc.

O-1104-03

The fourth generation of European-wide climate change impact assessments – lessons and outlook

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The European Environment Agency (EEA) is a boundary organization that bridges between data providers, including the scientific community, and policy makers. Its mandate is to provide timely, relevant and quality-controlled information on the environment to European policy makers (in particular the European Commission and the European Parliament), to national and sub-national policy-makers in its 32 member countries and 7 cooperating countries, and to the broader public. In 2012 the EEA published its third indicator-based report on climate change, impacts and vulnerability, following earlier reports in 2004 and 2008. The next report is scheduled for publication in 2016, and its preparation has already started.

The 2012 EEA report presents more than 40 quantitative indicators on observed and projected climate change and its impacts, most of them with European-wide coverage. The systems and sectors covered include coastal zones, terrestrial and marine ecosystems, agriculture, forests and forestry, fisheries and aquaculture, human health, energy, transport, and tourism. However, some important impact domains are not covered because information is not readily available at the European level, impacts are hard to quantify or to measure, and/or because the influence of climate change is hard to disentangle from socio-economic, technical, cultural and political developments. Under-reported impact domains include industry and manufacturing, insurance, infrastructure (except transport infrastructure), livestock production, cultural heritage (with some exceptions), migration, and general human wellbeing. Furthermore, the report presents cross-sectoral information with a focus on territorial impacts, on the vulnerability of cities and urban areas, and on climate change costs. The cross-sectoral assessments rely on information that is not fully consistent with the sector-based indicators, because these indicators are often not amenable to aggregation due to differences in climate change scenarios, non-climatic scenarios, impact metrics, and/or incompatible modelling and assessment approaches.

This paper summarizes the availability of consistent information on observed and projected climate change and its impacts across climate-sensitive sectors and systems in Europe and identifies major knowledge gaps. It also presents the planning of the 2016 EEA report, including efforts for refocussing the indicator set in order to increase its policy relevance, improving coverage of information related to extreme weather and climate events, expanding consideration of cross-sectoral effects, and strengthening links between information on climate change impacts and adaptation-related issues. We also report on past and planned efforts at improving the assessment and reporting of uncertainties in observed and projected climate change and its impacts.

O-1104-04

Innovation in French climate services thanks to service design

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Within the framework of the French National Adaptation to Climate Change Plan, the "Drias, the futures of climate" service provides support and easy access to the French regional climate projections. Users worship the unleash of such essential materials and rank Drias as one of the major recent steps toward the development of French Climate Services. Noteworthy, Drias is a joint initiative from the French community, gathering the meteorological service, Météo-France, with the main providers of regional climate scenarios in the country, CERFACS, IPSL and CNRM.

However necessary and successful the initiative might have been, many questions arose. Some came from the scientists whereas others were raised by users. How really useful was this service for the end-users and decision makers involved in adaptation planning at local scale? Did it help them to figure out what kind of climate change was happening and what could be thought to cope with it? Had the French scientific community made all possible efforts and released the information available in the laboratories? Taking advantage of all the assets worked out in the field of climatology, could it be possible to improve the delivery? Did we miss something believing we were doing our best? With many such questions in mind, soon after the opening of the Drias service, a review and reflection exercise was initiated.

The Viaduc project has this target: to evaluate and enhance Drias, as well as to imagine future developments to support adaptation. Users had been closely associated to the building of Drias, but they were not end users. Viaduc chose to address adaptation with local communities, thinking about real needs at the end users' level. The chosen end-users are three Natural Regional Parks located in the South West region of France. Such parks are administrative entities which gather together municipalities defined by a common natural and cultural heritage. They are also rural areas in which economic activities do take place, and therefore concerned and involved in both protecting their environment and setting up sustainable economic development. Climate researchers work together with a service designer. The designer's role consists in proposing an innovative approach based on the interaction between scientists and citizens. Actually, the designer observes both partners: scientists and end users.

The first part of the project has been dedicated to investigation and questioning with relevant representatives. The Viaduc team did not initiate new actions in the parks, but insert into existing ones, trying to ease them. Three

key local economic sectors have been selected, which are forestry, agro-pastoralism and construction, relevant for each of the parks. Working groups composed of expert technicians, administrative and maintenance staff, politicians and climate researchers have been created. The sectors needs for climate information have been gauged, and concrete actions are now undertaken. They will be presented in this communication, together with lessons learnt. The second part of the project has focused on the transfer of ideas to the operational teams, in order to give life in next generation of products to some of the recommendations that came out of this thinking exercice.

The feedback from the designer and the Viaduc team on the services delivered by scientific agencies and the meteorological service do modify the classical views. It concerns all aspects of the products and services, and addresses many various subjects, from the relationship between weather and climate, the need for local and perceivable information and messages, to the necessity of a greater coherency and simplicity of the message...

A quick introduction to Drias will be made, and the Viaduc project and outcomes will be presented.

O-1104-05

World Weather Attribution: A Real-Time Effort to Assess the Influence of Climate Change on Extreme Weather and Climate Events

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Climate Central and its partners at the University of Oxford Environmental Change Institute, the Royal Netherlands Meteorological Institute (KNMI), the University of Melbourne, and the Red Cross/Red Crescent Climate Centre have established a new initiative called World Weather Attribution. World Weather Attribution aims to apply recent advances in the science of probabilistic extreme event attribution to build a real-time attribution capability designed to provide objective, science-based connections between rising greenhouse gas concentrations in the atmosphere and extreme weather and climate events, including sea level rise and its contribution to storm surges, extreme heat events, heavy rainfall events/flooding, and droughts in real-time. The goal is to design and implement a coordinated, transparent, multi-method approach that incorporates observational data, modeling studies, existing peer-reviewed research (i.e., IPCC SREX, etc.) and on the ground reports in order to better answer pressing questions about trends in risk and the role of human activity in extreme weather.

Assessing the influence of global warming in individual extreme weather events has been a goal of the scientific community for more than a decade. Advances in the field have prompted numerous studies, leading the Bulletin of the American Meteorological Society (BAMS) to dedicate an annual special issue to extreme event attribution for the past three years. Currently, these studies require months to complete and are published well after public attention to the event has peaked, and when decisions on how to rebuild, for example, have already been finalized, often without attention to climate information on how risks of such events may have changed over time.

In fact, an analysis of media coverage of three recent extreme weather and climate events (2014 UK floods, 2013 Australian heat wave, ongoing California drought) conducted by Climate Central suggests that, despite strong public interest in better understanding the underlying cause of extreme weather and climate events, a significant majority of extreme event coverage fails to provide the broader climate context. While overall weather and climate coverage results in a large number of stories in the days to weeks following the event, attribution statements are rarely provided and often inaccurate as analyses are not available until several months later, after the media and public conversation is largely over and many recovery and reconstruction decisions have already been made, often based on limited information on changing risks.

Our goal is to apply established peer reviewed methodologies developed by the attribution community over the past decade - in an accelerated manner - so as to objectively assess the event in question and equip journalists, the public and decision makers with the broader context of changing risks, in some cases specifically due to global warming. To this end, the World Weather Attribution program will make extensive use of social science through experiments and robust literature reviews on the presentation of risk, probabilities, and uncertainty to guide the most effective deployment and presentation of these accelerated attribution statements. Here we discuss ongoing research that seeks to understand public understanding of the changing statistics of certain extreme weather and climate events and how best to communicate and apply attribution information.

1104-POSTER PRESENTATIONS

P-1104-01

Spatiotemporal Visualization Method for Interrelation-based Analysis of Agriculture's GHG Emissions and Agricultural Productivity in Asian Region Using the 5D World Map System

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According to the Food and Agriculture Organization of the United Nations (FAO), anthropogenic Greenhouse Gas (GHG) emissions originated from agricultural activities have increased approximately two times over the past five decades. Mitigation and adaptation countermeasures must be taken to reduce or slow down the increment of GHG level as a result of unhealthy agriculture practices especially in most developing countries. Conversely, further increment in GHG emissions results in climate change and eventually affects the agricultural sustainability and food security.

To understand the complex system between GHG emissions and agriculture productivity, a regional and historical analysis is compulsory as well as for finding more viable solutions. By applying the 5D World Map system, we demonstrate spatiotemporal visualization to analyze the interrelation between agriculture's GHG emissions and agricultural productivity. In this analysis, we focus on Asian region since it is one of the largest contributors of global GHG emissions from agriculture sector itself.

The most significant contribution of this research is to unveil the interrelation-based analysis between GHG emissions and agriculture, considering the Asian countries geographical aspect and historical data records. We mapped the pre-sorted text data of Asian countries in Eastern Asia, South-Central Asia, South-East Asia and Western Asia from 1963 to 2013. Then, we visualized and analyzed the data by comparing various attributes, namely; types of GHG (CO_2, CH_4 and N_2O) and annual crops yield. As results, we are able to observe that the spatial pattern of CO_2 and CH_4 emissions are relatively similar but slightly different in N_2O emission. The temporally increasing trend of GHG emissions in some countries is observed as expected, as well as the decreasing trend in other countries, while we discovered that the spatial pattern of crop yield is contrary to expectations. Also, we emphasize the fact from real cases that the interrelation between crops yield and GHG emissions could be observed explicitly by the spatiotemporal visualization of the data. As an insight from these results, we consider to classify these countries into four clusters: 1) cluster with high agricultural productivity and high GHG emissions, 2) cluster with high agricultural productivity but lower GHG emissions, 3) cluster with low agricultural productivity and low GHG emissions and 4) cluster with low agricultural productivity but higher GHG emissions.

In this research, the visualization of specific GHG emission density by each country and its' crop yield were made possible through the 5D World Map system. The index ranking of each country in each attribute is also visualized. Besides, new knowledge and possibilities existing between climate change and agriculture sector are discovered and

extracted from the visualization. Through this analysis, the countries which appear as more effective or less effective in both interrelated agricultural productivity and environmental management were clarified in this knowledge-sharing system for encouraging a deeper analytic process of regional policy making in agricultural GHG emissions and future agriculture management.

P-1104-02

Connecting the Dots: An Initiative on Communicating Complex Climate Science to Local Communities through Climate Change Services

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Article 6 of the United Nations Framework Convention on Climate Change addresses the importance of climate change communication and engaging stakeholders in this issue. It highlights the responsibility of participating countries at the national, sub-national and local levels, to ensure public access to information and to promote public participation. However, this is a challenging task particulaly for developing countries like India despite of other emergent and on-going developmental challenges. In this context, this article addresses an initiative taken by the Government of Tamil Nadu, India at the local level to address the global challenge of climate change, in a case study approach. The main objective of this contribution is to showcase a method/approach to connect the dots i.e. climate change «science-policy-society» and build capacity by communicating complex climate change science and its information at local level through effective climate change services, particularly, from the perspective of developing country's initatives on tackling climate change. Thus, realizing this urgent importance, Tamil Nadu State Climate Change Cell (TNSCCC) at the Department of Environment, Government of Tamil Nadu, India has laid a road map as «Tamil Nadu State Climate Change Services (TNSCCS)» based on the guidelines of the Global Framework for Climate Services of World Meteorological Organization (WMO). This has been iniated as envisaged in Tamil Nadu's State Action Plan on Climate Change (SAPCC) in par with India's National Action Plan on Climate Change (NAPCC). TNSCCS acts as a central hub of information, data and reports about climate change of entire Tamil Nadu State. It is considered as one of the major principal mechanisms through which information about the climate of the past, present and future is routinely archived, analyzed, modeled and exchanged. Tamil Nadu State Climate Change Knoweldge Management System (TNSCCKMS) has been established and serves as a store house of locally observed and projected climate change information for the state of Tamil Nadu. Importantly, it provides a "web-based platform" and "user friendly interface" to disseminate and exchange climate change information for various communities ranging from bureaucrats, policy planners, decision makers to farmers, fishermen, students, children, general public and others. It is hoped that the information gleaned from the above mentioned method/approach of climate change services witness how best the complex climate change science can be tailored and communicated at local level. Importantly, it showcases a method/approach on capacity building through effecitive climate change information and services from global to local level.

P-1104-03

Role of social media networking in Climate policies Awareness in Sub- Saharan Africa

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Climate policies awareness and/or knowledge are much required for the based-communities to mitigate the risk based on climate change and adaptation. In this respect, to spread awareness and/or knowledge of climate policies amongst African population by using social media is critical in raising ranks of awareness on the consequences related climate change. This research surveys the role of Social media networking in contributing to climate change awareness in rural areas especially; African population living in sub-Saharan Africa where, the impact of climate change disrupts subsistence farming activities. In fact, Economy in Africa is mainly focused on agriculture and peasant activities. On the one hand, many Africans are still unaware of climate policies developed neither in the national or international scale that fit with climate change. In the other hand, Aboriginal people living in forest areas have trouble with the acceptance of certain prohibitions to hunt and harvest the wild fruits in parks and other protected areas. That is why, This study found out that, The ubiquitous of internet facilities in African continent based on mobile application are tools that can facilitate information propagation and communication, even though, these technologies practice and abilities are utilised independently by the hand users. As the rural people are vulnerable to climate change, they are also considered as key players for emerging climate policies to mitigate and cope with climate change's effects. It is a need to use Social media networking in a number of operative ways to enhance climate policies awareness or knowledge amongst them. Thus, Climate policies awareness remains the foundation of all other answers to climate change.Therefore, the main objective of this research is to interest African governments to adopt the information and communication technologies such as social media networking to conduct a viral campaign enhancing knowledge and awareness related climate policies and sustainable development in order to foster the based-communities to mitigate the risk based on climate change and to support farmers' abilities to adapt to climate change. As for the methodology that is used, this study employs both qualitative and quantitative research techniques and data are collected through semi-structured interviews with some sub-Saharan African small-scale farmers, local governments and non-profit organizations focusing on climate change and furthermore, questionnaires will be designed based on Five-point Likert scale on an interval level ranging from ''strongly disagree'' to ''strongly agree'').

P-1104-04

The WASCAL regional climate simulations for West Africa - how to add value to existing climate projections

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With climate change being one of the most severe challenges to rural Africa in the 21st century, West Africa is facing an urgent need to develop effective adaptation and mitigation measures to protect its constantly growing population. The below-average rainfall in large parts of West Africa during the previous and the current monsoon season and the associated scarcity of food and fresh water highlight the importance of accurate predictions of future monsoon circulation for the people of this region.

WASCAL (West African Science Service Center on Climate Change and Adapted Land Use) is a large-scale research-focused program designed to help tackle this challenge and thereby enhance the resilience of human and environmental systems to climate change and increased variability. An integral part of the climate services offered by WASCAL is the provisioning of a new set of high resolution, ensemble-based regional climate change scenarios with a special focus on West Africa. These are thought to complement and provide added value t current medium-resolution climate change simulations for the region such as the CORDEX-Africa projections. The WASCAL climate change simulation experiments utilize a multi-model ensemble approach to refine RCP4.5 scenarios provided by three state-of-the-art global circulation models (MPI-ESM, GFDL-ESM2M, HadGEM2) using three regional climate models (WRF, COSMO-CLM, RegCM). Spanning an area from 25°W to 25°E and 5°S to 25°N, and providing a large number of variables at 3-hourly time steps at a horizontal resolution of 12km, these regional climate simulations will be used to assess amongst others the impact of climate and land use change on temperature, precipitation, and on onset and duration

of the rainy season.

The credibility of regional climate simulations over West Africa stands and falls with the ability to reproduce its key climatic feature, the West African Monsoon. This seasonal shift in large-scale wind patterns plays a pivotal role in every day's life, and any shift caused by climate change will greatly impact the future of this region. In our analysis, we therefore focus on the representation of the WAM in the regionally downscaled models. For the validation of the models, ERA-Interim re-analysis data is used as lateral boundary condition for the period from 1980 to 2013. We verify the models against observational data from gridded climate observational products such as GPCC, TRMM, and CRU. In addition, we employ a novel gridded precipitation database for the West African region, which is compiled from daily and monthly in-situ observations merged from various global and regional meteorological archives (GHCN, GSOD, AMMA, GLOWA) and from precipitation data provided by the national weather services and the novel WASCAL observation network.

In this contribution, we present the overall concept of the WASCAL regional climate projections and provide information on the availability of the data and its dissemination to the community. We discuss the model performance over the validation period for two of the three regional climate models employed, the Weather Research and Forecasting tool (WRF) and the COSMO model in CLimate Mode (COSMO-CLM), and give details about the novel precipitation database used to verify the models. We further present results on the climate change signal obtained from the WRF model runs for the periods 2020-2050 and 2070-2100.

P-1104-05

Challenges of scales

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There are several aspects of governance related to adaptation to climate change that need to be addressed to ensure equity and fairness in the way adaptation is implemented on the ground. Firstly, at the global level, there is the issue of governing climate change funding for adaptation in an equitable manner to ensure that the most vulnerable countries and communities are prioritised for receiving adaptation funds.

Similarly, at national level, it is important for national decision makers to also prioritise the needs of the most vulnerable communities within each country. This is true for both developing as well as developed countries.

One of the main issue in current climate governance is that the poorest communities within countries, and the poorest countries globally, possess a relatively less important voice in decision making at global and national scales. Hence, in order to adapt successfully to the adverse impacts of climate change, the empowerment of the most vulnerable within the climate governance system is a precondition.

P-1104-06

The Contribution of Climate Services to Climate Change Adaptation through the Global Framework for Climate Services (GFCS)

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Climate determines the extent to which human kind can sustain livelihoods and well-being. Thus, as the effects of climate change are becoming more evident and acute, the need for effective climate services is greater than ever before. Climate services here are considered to be the provision of climate information to assist decision-making in climate sensitive-sectors. Climate services require a range of activities from generating to providing information based on past, present and future climate and its impacts on natural and human systems. These services can range from simple information such as historical climate data sets to more complex products such as predictions on monthly, seasonal and decadal time frames. Ultimately, climate services provide information and expert advice that help users make the right decisions for climate change adaptation.

Seasonal to multiyear climate forecasting has advanced to a point where it can now provide actionable information. Sophisticated climate services combine climate forecasts with information from other sectors to inform decisions on public health, agriculture, water management, disaster risk and other climate-sensitive sectors.

Recognizing the value and contribution of climate services, the international community established the Global Framework for Climate services (GFCS) at the Third World Climate Conference (WCC-3, 2009) to promote operational climate services at the national and regional levels. The GFCS aims at facilitating the development and use of services to ensure that best efforts are made to reduce the impacts of climate-related disasters and to adapt to climate change. It is catalyzing a paradigm shift from supply-driven service provision to the creation of services driven by user needs, by orienting scientific research towards practical applications to respond to those needs. Building on past and current climate service initiatives, it is enabling new services to be developed to increase the value and access to climate knowledge products for those who need them the most.

Climate services underpin climate action and adaptation in climate sensitive sectors; contribute to enhancing disaster preparedness and planning for effective response and to allow societies to build back better after a disaster.

An essential starting point for adaptation is a quantitative assessment combining characterization of hazards with vulnerabilities to derive specific services to various users. This is often hampered by the capabilities to conduct effective analysis of past data and assess changing characteristics and trends of hazards in light of climate change to support risk and impact assessment.

This paper provides an account of how the GFCS is supporting countries in the development and use of climate services for climate change adaptation.

P-1104-07

Appraising the climate services accessible to indigenous communities in Uganda

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Climate change is one of the most pressing challenges of our generation. Scientists predict that it will even have more adverse effects on the population in the future. Studies indicate that climate change impacts most affect people in the developing countries especially the women, elderly and children because these groups have little access to the information on climate change, they are illiterate and are concealed in poverty. Yet a big constituent of these groups especially the women are by default key resource managers whose knowledge and actions are critical in environment and natural resource management. Climate services are seldom offered in Uganda and as a result climate change is as much abstract to a wide section of people. This study will urge that in circumstances where climate services have been offered they have not been conceptualized for comprehension by the masses. Climate change continues to be portrayed as a highly scientific phenomenon far and above the indigenous communities yet they are the most affected by its impacts. The examples used in talking about climate change are distant and unfamiliar that people hardly make sense of them. Besides climate change is only linked to anthropogenic activities yet natural phenomenon like local land-use changes can have a serious impact.

With data collected through Focus Group Discussions and Key Informant Interviews, this study urges that robust climate services are urgently needed in Uganda to tackle the serious adverse effects of climate change that is choking the local communities. Disastrous effects like floods and landslides as a result of heavy rains in the Mountain Elgon region have continuously led to fatalities yet the local communities are unaware and cannot devise adaptive and mitigation strategies. Correspondingly the seasons have changed but the local farmers continue to plan their planting seasons basing on the previous seasons that has eventually led to a decline in crop yields resulting into food shortages and its associated ills of malnutrition.

It is critical that climate services are customized to the local situations for long lasting impact.

P-1104-08

Decadal climate information for improved decision-making and resilience in small-scale farming systems in Africa: Lessons from East and Southern Africa

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Small-scale farming systems in Africa are facing increasingly erratic and variable climate dynamics, in addition to other multiple and reinforcing non-climatic stresses and shocks. Effective responses and ultimately resilience to these adversities require, among other factors, access to and use of adequate climate information for the coming seasons and years to enable players within these systems to make informed, timely and appropriate decisions not only in the short term, but also in the medium to long term. Climate information is used in agriculture on a range of timescales, from days (weather), months (seasonal outlooks) to decades (climate change scenarios) (Hellmuth et al. 2011). In most African countries, adaptation to climate risk has focused either on the seasonal timescale or the assessment of climate change impacts several decades into the future. Awareness of and adaptation to climate risk on the decadal timescale (up to 10 years) has received less attention. Yet much policy, planning and investment decision-making falls into this time horizon, especially in areas of importance to small-scale farming systems in developing countries such as farm planning cycles, introduction of new varieties and the setting up of such projects as catchment-wide infrastructure for irrigation and water storage (Goddard et al. 2010; Stafford-Smith et al. 2011, Vermeulen, 2012). There is also increasing evidence that climate change is altering the likelihood of extreme events that impact on agriculture within the decadal timescale (IPCC 2012). It is against this background that this analysis explores the utility of climate information in small-scale farming systems in Africa on the decadal timescale. Using cases of small-scale farming systems in the Kilimanjaro Region of Tanzania, the mid-Zambezi Valley Region of Zimbabwe, and the Southern Region of Malawi, the analysis shows decadal climate information as potentially providing opportunities for innovative, flexible and proactive decision-making in response to projected climate and related dynamics. The analysis shows that although farmers will be the major beneficiaries of decadal climate information, other players, particularly service providers and intermediaries, also stand to gain thus providing a holistic perspective in dealing with the decision-making context of small-scale farming systems in Africa. The paper however also points on the need for building institutional capacity vis-à-vis coming up with stronger knowledge and information networks between climate scientists, policy makers and local communities as well as attending to issues of credibility, legitimacy and scale in the production and dissemination of decadal climate information in Africa so as to ensure uptake and appropriate use. The discussion, therefore, brings to the fore the need for the recognition of the increasing importance and role of decadal climate information vis-à-vis decision making towards resilient and adaptive small-scale farming systems in Africa.

P-1104-09

Drias, the futures of climate: a service for the benefit of adaptation

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The project Drias for 'Deliver Regional climate scenarios for Impacts and Adaptation of our environment and Society' was built with the basic idea that a facility was now needed for climate information delivery. Drias was funded by the Management and Impact of Climate Change programme of the French Ministry for Sustainable Development. It focuses on existing French regional climate projections obtained from national modelling groups: IPSL, CERFACS, and CNRM and was coordinated by the Department of Climatology at Météo-France, which is in charge of climatological operations and services

The resulting portal, opened in 2012, offers easy access to data and products, including a quick-look discovery, as well as the associated expertise to facilitate impact and adaptation studies:

- Several greenhouse gas emission scenarios, using different regional climate models and downscaling methods, because it is critical that users work with the idea that climate projections have to be addressed in a probabilistic mode
- Standard formats, easy access, quick looks and simple products for a wide range of users, baring in mind that many communities do not share the technical skills of climate modellers
- Expertise and guidance, especially addressing the various sources of uncertainty, and promoting best practices and know-how - one of the first requirements of users, as shown in every user needs survey.

The Drias web portal comprises three main areas: Delivery, Support, and Discovery. The Discovery area contains general information for a wide range of people, allowing them to grasp climate scenarios and visualize outputs. In the Support area, a range of documents is offered to help users make the best use of available climate information (glossary, description of methods and climate models, frequently asked questions). A hotline mechanism involving experts is also implemented at this level. The Delivery area enables users to order, in digitized format, data and products they have identified in the Discovery area.

A user committee was created at the beginning of the project, to help define effective and strategic needs, evaluate prototypes using beta testers, validate the choices made by the project team, and ensure that Drias will continue to meet user's expectations.

Drias is positioned at the interface between actors. A layer of intermediate users - or translators - is appearing in the form of engineers from the meteorological service, or from private companies already deploying activities in the field of environment, or climate experts hired by local organizations.

The partnerships around Drias must also be highlighted. Nothing could be done without the research groups or the meteorological service. A strong tribute must be paid to the governing bodies that have supported the initiative, and have placed it high on the agenda at the ministerial level, making Drias one of the most prominent actions of the French National Plan for Adaptation.

New indices, dataset and other enhances have been gradually introduced for the last three years, with confidence intervals instead of the single scenario originally, results of impact studies on water resources (ClimSec project) and more recently with the newest regionalized scenarios for France, based on the 'Representative Concentration Pathways.

But can we say that we are on the right track? Will our co-citizens be more convinced because such facilities are now in place? Undoubtedly there are many aspects of the human conscience that must be activated in order to reach the appropriate level of commitment regarding climate change. The real challenge for climate services may also appear in the training and education arena, and definitely has to deal with a wide range of human and political sciences.

P-1104-10

Climate Information for Public Health in Africa in the context of Climate Change Adaptation

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Climate impacts on health are well established. Building climate smart and resilient communities is therefore essential in the face of climate variability and change. Climate information can play a role in helping societies to better manage health risks brought about by climate variability and change. However, for climate informed health decision-making to become an everyday reality, a broad coalition of partners focused on improved health adaptation and mitigation strategies is essential.

This paper describes the approach taken at the International Research Institute for Climate and Society (IRI)[1] and its partners to integrate research, operational applications and capacity building alongside policy development and advocacy in the area of climate and health in Africa. The initial focus of the IRI's health work on the development of early warning systems for climate-sensitive diseases (for example malaria and meningococcal meningitis) was built upon the institute's applied research capacity in seasonal climate forecasting. However, over time, the agenda has broadened in response to articulated user needs for information on the past, present and future climate to also better understand the mechanisms by which climate impacts on disease, map populations at risk both geographically and by season, develop early warning systems, better understand trends in disease incidence associated with climate shifts and improve the evaluation of the impacts of climate-sensitive interventions.

Central to IRI's experience throughout has been a keen awareness that climate information and products, in Africa as elsewhere, must be relevant to the health community and development partners and reflect prioritized needs within political and donor processes, while also offering innovations grounded in relevant and reliable observational data obtained through effective, efficient, credible and transparent means. The relevance of this approach to infectious disease, health outcomes of disasters and nutrition will be presented.

[1] IRI is a WHO/PAHO Collaborating Center for Malaria Early Warning and Other Climate Sensitive Diseases.

P-1104-11

Using agro weather tool for enhanced productivity under climate change and variability by communities in Kenya

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The farming communities in Kenya produce 65% of Kenya's exports and offer employment to 80% of the population therefore ensuring food security. A survey from three counties of Machakos, Nakuru and Kakamega predominantly growing Maize-Beans-Pigeon peas, Maize-Beans-Irish potatoes and Maize-Beans-Sweet potatoes respectively showed heavy reliance on rainfall (>90). These rains have however become increasingly variable spatially shattering for example the average maize yields of 3.1, 10.4 and 5 bags-1 acre at the respective sites. Spatial and temporal changes of seasonality under climate change and variability call for changing methods to maintain these cropping systems and alternative varieties and agronomic practices as adaptation strategies for sustainable realization yield variations.

The information required by these communities need to be accurate and timely and manageably packaged and presented in easily interpretable and understandable manner. It should additionally factor indigenous knowhow and include insurance possibilities to enable confidence in its utility. An agro-weather tool using the mobile phone owned by a majority of rural folk jointly developed for this purpose. It involved collaboration with World Bank as development partner, Government of Kenya lead-departments of agriculture and meteorology, mobile line service provider Safaricom and local agro-dealers targeting 5000 households in its pilot phase and was successfully unveiled for Embu County in 2014. The tool targeted coffee and tea as cash crops and maize and beans subsistence crops dominantly grown in this county and is scheduled for up-scaling in other areas.

Beneficial information relayed included daily, weekly and seasonal forecasts, possible disasters, climate stress severity with direct and indirect severe impacts on crop production. It also offered interventional measures of suitable varieties and their productivity potential and appropriate farming activities to be undertaken to reduce, adapt and/or mitigate the negative impacts related to weather and climate.

The use the tool will be out scaled to other counties but also for pastoral communities who will require weather-related information on areas of depressed rainfall, periods of availability, frequency/resurgence of pastures/forage and the likely occurrence of killer diseases and environmental degradation. Also necessary is weather information that would cause floods/drought that would drown/kill livestock and potential benefits of using alternative methodologies.

1105a - Assessing climate observations

ORAL PRESENTATIONS

K-1105a-01

Space-based Climate Observing systems

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The Global Climate Observing System (GCOS) provides a framework for the coordination of observations in support of the UNFCCC. The 2003 GCOS Adequacy report to UNFCCC SBSTA introduced the concept of Essential Climate Variables, variables which were considered fundamental to the understanding and reporting of climate. These were updated in the GCOS 2010 Implementation Plan, and currently comprise a list of some fifty variables. A satellite supplement focussing on the needs of the climate community for observations from Earth observing satellites was produced by GCOS in 2011, and this forms the basis for the current support of space agencies to GCOS. The Commite on Earth Observation Satellites (CEOS) has formally responded ot his with a document published in 2012. Satellite observations are critical for about two thirds of the fifty ECVs. In addition, the Committee on Space Research (COSPAR) has sponsored a roadmap study for Integrated Earth System Science in the period 2015-2025.

This paper will describe briefly the status of the GCOS and highlight the needs for satellite data which derive from it. An overview of current Earth observion satellite systems will be given, together with an analysis of how these contribute to the provision of the ECVs. Examples of satellite observations and key derived products for climate will be given.

K-1105a-02

Climate Observing Systems: Where are we and where do we need to be in the future

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Climate research and monitoring requires an observational strategy that blends long term, carefully calibrated measurements as well as short-term, focused process studies. Operating climate observing networks and providing climate services, have a significant role to play in assisting the development of national adaptation policies and in facilitating national economic development. Climate observing systems will require a strong research element for a long time to come. This requires improved observations of the state variables and the ability to set them in a coherent physical (and chemical and biological) framework with models. Climate research and monitoring

requires an integrated strategy of land/ocean/atmosphere observations, including both in situ and remote sensing platforms, and modeling and analysis. It is clear that we still need more research and analysis on climate processes, sampling strategies, and processing algorithms.

K-1105a-03

Sea Level, an Essential Climate Variable and an integrator of climate change

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Sea level is an important climate variable and a major indicator of climate change. In effect, sea level integrates changes and interactions of all components of the climate system (ocean, atmosphere, cryosphere, hydrosphere); it varies globally and regionally in response to internal climate variability and external -natural and anthropogenic- forcing factors. Sea level is one of the 50 Essential Climate Variables (ECVs) defined by the Global Climate Observing System for climate change monitoring and one of the 15 ECVs accurately measured from space within the ESA Climate Change Initiative (CCI) project. While sea level is routinely measured by high-precision satellite altimetry since 20 years, providing a long, homogeneous and accurate sea level record using all altimeters satellites in orbit is the objective of the CCI 'Sea Level' project. This allows addressing major issues related to climate change and sea level (e.g., how much is the global mean sea level currently rising? Has it accelerated during the 20th century? Can we close the sea level budget? What are the factors causing non uniform sea level change? Are observed spatial trend patterns due to internal climate variability only or can we already detect the signature of anthropogenic forcing?, etc.). The sea level products already obtained in the context of the CCI project have been proved to be superior to other existing products and are of great value for climate change studies. Moreover, combining different CCI-based ECVs (e.g., glaciers and ice sheet mass balances, in addition to the sea level ECV) plus Argo-based ocean thermal expansion leads to better closure of the sea level budget, allowing addressing important new issues, such as the amount of deep ocean warming (not measured by Argo) and its role in the present 'hiatus'. Finally, such long, accurate new ECV records are essential to validate climate models used to simulate future changes expected in response to anthropogenic global warming.

1105b - Quality and availability of data for global sustainability

ORAL PRESENTATIONS

K-1105b-01

Parameterisation, ground-truthing and benchmarking: the importance of in-situ data for global sustainability

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Many key aspects of the global system can only be measured in-situ. In-situ measurements are required for ground-truthing remotely-sensed products. More importantly, they are vital for developing process-based models and individual model parameterisations. Furthermore, in-situ measurements are used as benchmarks for model evaluation, including the historical and palaeoclimate observations used for out-of-sample model testing. Problematic features of in-situ data include being collected by individuals, using different and evolving methods, and often the same type of data is collected for different purposes. Thus, key steps in using such data are documentation, harmonization and synthesis. There has been considerable progress in creating unified data sets of in-situ measurements, but more effort is required specifically in terms of data rescue, data documentation, communal access and data stewardship. Given the utility of in-situ data in developing and evaluating models that are used to predict the likely trajectory of future climate and environmental changes, organisations such as the World Data Service and Future Earth need to provide attention to and support for data rescue, synthesis and sustainability of in-situ data.

K-1105b-02

Future Earth data and information needs

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Future Earth has been set up as a platform to deliver solution-orientated research for sustainability, linking environmental change and development challenges to satisfy human needs for food, water, energy, health. This will require an effective interdisciplinary collaboration across natural and social sciences, humanities, economics, and technology development, to find the best scientific solutions to multi-faceted problems. The main aim is to provide timely information for policy-makers by generating the knowledge that will support existing and new global and regional integrated assessments. Therefore the main stakeholders are a heterogeneous group of researchers (all scientific disciplines) and policy-makers, all of them working jointly in co-designing and co-producing research agendas and knowledge. One particular priority is in developing countries, mainly in support to the Sustainable Development Goals (SDGs).

Recent advances in data collection and analysis provides a unique opportunity to observe, detect and analyze the earth dynamics at multiple scales and across interacting social ecological system processes. This data explosion has emerged through advances in remote sensing, citizen science networks, and census efforts. These data are being used in ways to enhance our understanding and to inform management decisions on ways to reduce the impact and reducing the harmful consequences and enhancing opportunities as they arise. This information era has benefits to food and water management, response to hazard, forecasting of weather and extreme events, alerting communities of dangers associated with plumes of pollutants, and detecting the presence and movement of rate and sensitive wildlife on land and in the seas. A variety of biophysical and social-economic data sets and observations are available and through coordinated integration provide additional knowledge of the state and transition of social-ecological systems across the globe in order to better inform decision makers.

Such a very ambitious goal requires a wide range of data and information. Jointly with data, it also requires the expert knowledge networks associated with such data. The main challenge is for each individual scientific discipline, to further add value to their data and to re-packaged it, so that it can be understandable, usable and integrated with the data coming from all other disciplines and what is more important accessible to decision makers.

Future Earth hopes to initiate a suite of activities, such as:

- Data inventory, integration, harmonization and experts networks of data-knowledge to support Sustainable Development
- Co-development of data harmonization to facilitate integration of social-biophysical data to derive information in support of transformations toward sustainability
- Assessing data and information needs, and data use in support to the UNFCCC Adaptation activities

Enhancing capacity to enable the flow of interdisciplinary science in support of the decision making process (resilience, water management, sustainable development).

O-1105b-01

Developing Indicators to Support Climate Adaptation and Sustainability Decision Making

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Every day, decision makers ranging from individuals to governments make important decisions based on composite economic and social indicators on topics such as unemployment, inflation, trade, debt, and prices. These indicators reflect the shared understanding that our global economy is a very complex, interconnected system that operates on multiple temporal and spatial scales. Yet, even though the global environment is at least as complex and interconnected as the global economy—and equally critical to humanity's survival—the world lacks integrated indicators of critical environmental systems and climate change that have the quality, reliability, resolution, and relevance to support both individual and collective decision making on both short and long time frames.

We summarize experience to date in developing policy-relevant environmental indicators at global, national, and subnational levels and in tackling a range of scientific, technical, and institutional challenges related to designing and implementing useful indicators. Despite the growing diversity and volume of environmental data becoming available through new technologies, mobilizing and harnessing this "data revolution" to support sustainability science and decision making requires careful attention to user needs, establishment of suitable organizational and review processes to ensure "buy in" by stakeholders, and close collaboration with the relevant scientific communities and observational and data networks.

The ongoing development of a new set of Sustainable Development Goals (SDGs) and associated targets provides a unique opportunity to promote the integration of environmental, socioeconomic, and health data within a coherent framework of policy-relevant indicators. Such a framework would not only provide justification for continued or expanded investment in data collection and integration, but also a means to prioritize data collection efforts and improve their efficiency and efficacy. As with conventional economic indicators, the development of integrated environmental indicators is also likely to promote their use in both formal and informal decision making in both the public and private sectors.

O-1105b-02

Marine community initiatives building biodiversity data systems and products in support of global change research

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Global change research requires high quality and readily available biodiversity datasets that are standardized based on internationally accepted standards and can easily be used in integrative analyses that transcend geographic or administrative boundaries. The marine biodiversity community is progressively organizing itself to offer advanced data services and high quality data products. Diverse aspects of this work are ongoing in the framework of initiatives like the World Register of Marine Species (WoRMS), the Ocean Biogeographic Information System (OBIS), the European Marine Observation Network biological (EMODNet Biology) project and the LifeWatch European Research Infrastructure on biodiversity and ecosystem research.

The World register of Marine Species is an authoritative list of names of marine organisms. The content of WoRMS is controlled by more than 200 taxonomic experts, each of them responsible for a specific taxonomic group. The register currently holds over 419,000 species names described in literature worldwide, of which 190,400 (45%) were deemed duplicate identities. The register is a key instrument in biodiversity research, as it is used on a daily basis for taxonomic standardization and quality control of biological research and monitoring datasets.

The Ocean Biogeographic Information System is a network of OBIS nodes integrating biogeographic information for marine organisms on a global scale. Individual nodes contribute local or thematic datasets to the global system after standardizing these data based on OBIS and Darwin Core data schemas. OBIS holds 41.93 million distribution records of marine organisms from over 1,700 individual datasets.

In the framework of the LifeWatch taxonomic backbone and the EMODNet biology project large scale efforts are being initiated to collect species traits information and link this ecological attribute information to WoRMS and OBIS. These recent developments allow the creation of specific tools that have large potential for supporting applied global change research. An example is the World Register of Introduced Species, a newly launched portal that in its current state already lists over 1,400 introduced and invasive alien marine species worldwide, compiled through study of over close to 2,500 publications and collaboration with related international initiatives. In the framework of EMODnet a series of DIVA interpolated gridded abundance maps is being created for selected species reconstructing remarkable distribution patterns over time.

The generated data products are of direct relevance to global change studies on aspects like species distribution shifts, species extinction and migration, exploitation of ocean ecosystems and fish stock collapse, etc…

O-1105b-03

Multi-Disciplinary Framework for BioEnergy Assessment

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The BioEnergy Atlas for South Africa is the result of a project funded by the South African Department of Science and Technology, and executed by SAEON/ NRF with the assistance of a number of collaborators in academia, research institutions, and government.

Bioenergy assessments have been characterized in the past by poor availability and quality of data, an over-emphasis on potentials and availability studies instead of feasibility assessment, and lack of comprehensive evaluation in competition with alternatives - both icompeting bioenergy resources and other renewable and non-renewable options. The BioEnergy Atlas addresses some of these deficiencies, and identifies specific areas of interest where future research and effort can be directed.

We develop an approach that successively constrains biomass that is potentially available with environmental, social, financial, technical, and economic constraints, leading to an objective selection of appropriate feedstocks, land allocation, techology, and feasible projects for detailed investigation. We discuss methodology, availability of biomass and potentials, and the feasibility results of four case studies in respect of biomass application: (1) co-firing of woody biomass for electricity generation; (2) use of oil-bearing crops for biodiesel producion, (3) applications for organic components of domestic solid waste and wastewater; and (4) use of woody biomass as a feedstock for an existing GTL refinery.

Findings include

- Availability is not a fixed quantum. Availability of biomass and resulting energy products are sensitive to both the exclusionary measures one applies (food security, environmental, social and economic impacts) and the price at which final products will be competitive.
- Availability is low. Even without allowing for feasibility and final product costs, the availability of biomass is low.
- Waste streams are important. There are significant waste streams from domestic solid waste and sewage, some agricultural production, and commercial forestry.
- Rural firewood use is problematic. This is a significant resource, plays a large role in the energy budget of poor and rural households, and current use means that it will have little impact on the GHG emissions balance.
- Process technologies are not all mature, cost-competitive or efficient: We have investigated 52 different process technologies in respect of costs, economy of scale,

energy efficiency, greenhouse gas emission and job creation impacts, and maturity of technology.

- Solutions are probably 'packages'. One has to balance the diversity of available resource streams and processing technologies against the need to focus resources on development of critical mass (workforce skills, support industries, expertise). Combining feedstocks and aligning with other government initiatives or subsidies can achieve such critical mass more easily.

- Solutions must be robust in future too. Feasibility studies that focus on the current situation only ignore the fact that future sustainability is strongly dependent on assumptions on relative economic growth (influences household and industrial energy consumption, and the limiting cost for energy), cost of capital and inflation (affects choices of labour- or capital-intensive industries), exchange rates and fossil fuel prices (huge effect on selection of alternatives).

- The most promising biomass source is medium-term mining and eradication of invasive alien plants, but this source is limited in time and, if exploited as proposed, will not be available after about 20 years.

There is a need to focus research and development efforts in respect of specifc technology/ feedstock combinations hat show future promise.

O-1105b-04

Soil data harmonisation and geostatistical modelling efforts in support of improved studies of global sustainability

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Future Earth and other large international research and development programmes aim to provide the scientific evidence base required for developing into a sustainable future. Soil, which is an important provider of ecosystem services, remains one of the least developed data layers in global land models and uncertainties are large. In this context, there is a pressing need for improved, quality-assessed soil information at multiple scale levels. ISRIC - World Soil Information, in its capacity of World Data Centre for Soils within the ICSU World Data System, is developing inter-operable web-based facilities aimed at facilitating collaborative soil mapping. The Global Soil Information Facilities (GSIF) provide a global spatial framework for collating, standardising resp. harmonising, and analysing soil data profile obtained from disparate sources. At present, the facility includes a 3D soil information services for the world at 1 km resolution (SoilGrids1km), which draws on analytical data for some 100,000 soil profiles and over 70 co-variate layers representing soil-forming factors. Global regression models were used to predict values (mean and 90%-confidence interval) for selected soil attributes (e.g. soil pH, clay content, bulk density, and organic carbon content) for six depth intervals up to a depth of 2 meter. Cross-validation for the initial run showed prediction accuracies of 23%-51%, which is promising. Being based on reproducible automated procedures, the geo-statistical predictions are improved on a regular basis. New releases will consider a larger complement of harmonised soil profiles for the World, as collated and shared for example within the broader collaborative framework of the Global Soil Partnership (GSP), as well as more advanced geo-statistical approaches that may be targeted at specific agro-ecological regions. Confidence limits generated by the SoilGrids model may be used to assess the impact of uncertainty in soil property predictions (means) during scenario/model testing — data are freely available for visualization and download at http://soilgrids.org. The SoilGrids procedure has already been applied at various resolutions, depending on specified user needs. For example, a 250m product in support of agricultural planning in Africa versus a 50 km (or 0.5 by 0.5 arc degree) product for Global Land Models that underpin IPCC-related assessments. Further, development of the overall system is already catalysing institutional collaboration and data sharing. Capacity building and collaboration with (inter)national soil institutes around the world on data collection and sharing, data screening and harmonisation, mapping and the subsequent dissemination of the derived information will be essential to create ownership of the newly derived soil information as well as to create the necessary expertise and capacity to further develop and test the system worldwide. The system can also be used as the basis for a distributed system, where national soil institutes build and provide standardised databases and digital soil maps for their respective regions, which can then be 'combined' with the SoilGrids-derived information to arrive at a product with global coverage and local ownership, possibly within the framework of the Global Soil Partnership.

O-1105b-05

Supporting Climate Science with Cryospheric Data from the National Snow and Ice Data Center DAAC

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Global satellite observations are central to understanding and monitoring our climate system. The physical processes operating in the Earth's cryosphere and their interactions with climate are tightly coupled. A change in one of its component will drive change in another. To improve our understanding of how a changing climate may drive these changes and how feedback processes in the cryosphere affect climate requires continuation of long-term satellite observations, intensive field and airborne campaigns and new ways to analyze observational data and to integrate them with large-scale Earth system models. Polar science has historically involved interdisciplinary research programs, and the collection and management of large, diverse data sets.

The National Snow and Ice Data Center (NSIDC) at the University of Colorado at Boulder is a primary archive for snow and ice data in the United States. NSIDC's mission is to improve understanding of the Earth's frozen realms. This includes floating sea ice, lake ice, glaciers, ice sheets, snow cover, and frozen ground, collectively known as the cryosphere. The NSIDC Distributed Active Archive Center (DAAC) is one of NASA's Earth Observing System Data and Information System (EOSDIS) Data Centers archiving, documenting, and distributing data from NASA's Earth Observing System (EOS) satellites and field measurement programs. NSIDC DAAC data management involves activity at all stages of the data lifecycle, from planning through acquisition, preservation, publication, and distribution. A key goal for NSIDC is to meet our data user needs in a way that facilitates data use. This is accomplished through improvements in data inter-operability, usability, data searching, and visualization and analysis tools.

O-1105b-06

The World Data Service at the University of Colorado Boulder and National Snow and Ice Data Center: Data and services supporting science

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The World Data Service at the University of Colorado Boulder (UCB) led by the National Snow and Ice Data Center (NSIDC) is a leader in connecting data and science. These connections are built through targeted programs brought together under the NSIDC umbrella categorized into three high-level categories: curated data products, research partnerships, and cyberinfrastructure research and development:

The 432 datasets in the WDS-UCB/NSIDC catalog include some of the most popular and visible datasets at the Data Center, for instance the NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice Concentration as well as decades-long sea ice extent, concentration, and thickness time-series. The Frozen Ground Data Center at WDS-UCB/NSIDC is in the process of being updated and integrated with the new Global Terrestrial Network for Permafrost system. In-situ field data such as from the Snow Data Assimilation System (SNOWDAS) are available alongside products such as the MODIS Mosaic of Antarctica Image map. All of the digital datasets are augmented by critical legacy data often in analog form, for instance the global Glacier Photo collection as well as many resources from

the rich history of the International Geophysical and Polar Years.

Ensuring a strong connection with not only scientists in both the data contributor and data re-user roles, but also the general US public and indigenous Arctic communities, WDS-CU researchers maintain tight partnerships with stakeholder communities. The Exchange for Local Observations and Knowledge of the Arctic (ELOKA) program has spent years building relationships that support and connect Community-Based Monitoring programs embedded in Arctic communities with each other and with environmental scientists. Projects looking to document sea ice knowledge, partner WDS-UCB/NSIDC researchers with shipping operations, Arctic community, and semantic experts to map understandings and advance understanding across different perspectives. A growing Arctic social science data program at WDS-UCB/NSIDC reaches out to another domain community to expand interdisciplinary context and participation in data sharing efforts. Connecting WDS-NSIDC resources to stakeholder communities requires clear communication and a shared understanding of use cases and stakeholder needs. An emphasis on usability work with website interfaces has improved connections and communication of content.

Supporting and leveraging both the management of well-described data holdings and tight connections with partners and stakeholders, WDS-UCB/NSIDC maintains a strong cyberinfrastructure research and development focus. Expertise in metadata and data brokering enables distributed data search and has been showcased in diverse venues over recent years. Web crawling for science data of relevance moves the community closer to ubiquitous data discovery. Once relevant data are found, reading and analysis tools support data use and integration for new scientific discoveries.

All of these targeted programs and more come together under the virtual umbrella of the WDS-UCB/NSIDC. Active participation in the WDS community and connections to the many aligned WDS activities and systems are key to advancing our common vision.

1105 - POSTER PRESENTATIONS

P-1105-01

WDC - Solar Activity/BASS2000

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The understanding of space weather, solar-terrestrial relationship as well as the possible correlation with Earth's climate and solar activity is related to the possibility to study long-term behaviors. World Data Centre for Solar Activity BASS2000 (http://bass2000.obspm.fr) provides added-values on solar activity that can be used for such studies. It provides daily observations of the Sun for about 20 years, and older images, starting in 1919 are currently digitalized.

Moreover, in collaboration with the European HELIO project, a features catalogue has been developed giving detailed information on various solar and heliospheric features (filaments, prominences, sunspots, active regions, coronal holes, radio sources, type III bursts) for near 20 years also for some of them. And previous data have been digitalized from tables obtained from the Synoptic Maps of Solar Activity since 1919. When the insertion of those data in the features catalogue will be done, nearly one century of data will be available, providing the longest time signature of Solar activity, with around 8 solar cycles available.

P-1105-02

The role of the GCOS Reference Upper-Air Network (GRUAN) in climate research

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Measurements of primary state variables of the troposphere and stratosphere (primarily temperature, water vapour and pressure) are typically made to provide the input required by numerical weather prediction models. These same measurements then also constitute the primary source for meteorological reanalyses and climate analyses. The balloon-borne, ground-based and satellite-based systems used to make these measurements often undergo changes in instrumentation, data processing methods, retrieval techniques, and calibration. These changes are often poorly documented and very seldom are measurement series reprocessed to ensure long-term homogeneity of the climate data record. Such unphysical discontinuities in measurement can lead to deterioration of the quality of meteorological reanalyses. To address this specific deficiency of the global climate monitoring network, WMO and GCOS called for the establishment of a new state-of-the-art global network of high quality measurements of essential climate variables in the upper atmosphere, through the 2004 GCOS Implementation Plan (GCOS-92). The establishment of GRUAN (GCOS Reference Upper-Air Network) is now underway and sites are providing reference quality measurements that adhere to GRUAN operating protocols.

This presentation will provide an overview of the achievements of GRUAN to date as summarized in Bodeker et al. (in press 2015). It highlights:

- the protocols that have been established to ensure that measurements are of reference quality;
- what measurement systems are (and will be) operating at GRUAN sites;
- what data products are expected to flow from those systems;
- the data currently flowing from GRUAN sites, technical advancements within GRUAN to meet the needs of user of GRUAN data products; and
- research that has been conducted in support of GRUAN operations.

A network expansion workshop held in June 2012 provided a scientific context for the expansion of GRUAN and this presentation will include an update on how the outcomes of that workshop have guided GRUAN expansion to date. The goal of GRUAN is not only to produce long-term, carefully calibrated measurements with well-defined measurement uncertainties, but to also produce high quality data suitable for focussed process studies. How GRUAN balances operational and research goals will be included in the presentation. A key user of GRUAN data is the satellite calibration and validation community. Progress within GRUAN to meet the needs of this community will also be addressed. The presentation will finish with an overview of the challenges that GRUAN faces and plans for overcoming those challenges.

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P-1105-03

A Climate Observatory in South West Indian Ocean: The Maïdo Observatory in La Réunion. Current achievements and Future Prospects

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Observatories of the climate system are essential to assess future climate predictions that are central and fundamental requirements for determining future mitigation strategies. Such observing platforms are very few ones in the tropical southern hemisphere. CNRS, Université de La Réunion, Région Réunion and the European FEDER program support together the construction of a high-altitude observatory which is operational since October 2012 in La Réunion (South West Indian Ocean, 2160 m asl, latitude 21°S, longitude 55°E). The Maïdo observatory takes over from its predecessor programs at sea level over the island who started long-term observation data of atmospheric chemical composition since 1994. The Maïdo observatory is an ideal platform to sample the atmosphere with different techniques (in-situ analysers, radiosounding, passive and active remote sensing) and to record surface measurements and vertical profiles from ground to the mesosphere over a subtropical latitude band poorly sampled by other international programs. The Maïdo observatory hosts lidars, one UV spectrometer, one radiosonding station, FTIR spectrometers, microwave radiometers, one lightning antenna, cameras, one GNSS station, microbarometers, etc. These devices sample many atmospheric parameters (e.g., meteorological parameters, reactive and greenhouse gases, aerosols, lightning and transient luminous events, infrasounds, etc). Part of this very extensive range of instruments is approved and belongs to international networks like NDACC (Network for the Detection of Atmospheric Composition Change), SHADOZ (Southern Hemisphere ADditional OZonesondes), TCCON (Total Carbon Column Observing Network), and WWLLN (World Wide Lightning Location Network). In-situ analysers regroup measurements of reactive and greenhouse gases, and aerosols measurements approved by or applying to networks like GAW/WMO (Global Atmospheric Watching / World Meteorological Organization), ICOS (Integrated Carbon Observing System). The Maïdo observatory is currently the only way to provide regular remote and in-situ atmospheric observations at subtropical latitudes and at high resolutions (seconds in time, few tenths of meters vertically) over a marine-remote region poorly sampled by other programs. It provides data for users in science and policy including air quality forecasting, verification of CO2 emissions and Kyoto monitoring, numerical weather prediction, and validation of global chemical transport model, global climate chemical model and satellite products. Since its participation in on-going European projects (NORS, ACTRIS-2, ARISE-2), and thanks to the start of delivery of data in near real time, the Maïdo observatory will largely contribute to the Copernicus Atmosphere Monitoring Services (CAMS). The Maïdo observatory is open to transnational access thanks to its participation in european programmes like ACTRIS-2 and ENVRIplus. This presentation will give an overview of results achieved so far and a number of highlights to illustrate the promise Maïdo observatory data hold for the future, allowing new applications and analysis for a broad community of users.

P-1105-04

Satellite-derived aerosol climate data records in the ESA Aerosol_cci project

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Within the ESA Climate Change Initiative (CCI) project Aerosol_cci (Phase 1: 2010 -2014; Phase 2: 2014-2017) intensive work has been conducted to improve algorithms for the retrieval of aerosol information from European sensors ATSR-2 (ERS-2), AATSR (3 algorithms), MERIS (3 algorithms), synergetic AATSR/SCIAMACHY, GOMOS (all on ENVISAT), PARASOL and OMI (EOS-Aura) (both part of NASA's A-Train). Whereas OMI and GOMOS were used to derive absorbing aerosol index and stratospheric extinction profiles, respectively, Aerosol Optical Depth (AOD) and Ångström coefficient were retrieved from the other sensors. The cooperation between the project partners, including both retrieval teams and independent validation teams, has resulted in a strong improvement of most algorithms. In particular the AATSR retrieved AOD is qualitatively similar to that from MODIS, usually taken as the standard, MISR and SeaWiFS. This conclusion has been reached by several different ways of validation of the L2 and L3 products. Using AERONET sun photometer data as the common ground-truth both 'traditional' statistical techniques and a 'scoring' technique based on spatial and temporal correlations were applied. Quantitatively, the limited AATSR swath width of 512km results in a smaller amount of data. Nevertheless, the assimilation of AATSR-retrieved AOD, together with MODIS data, contributes to improving ECMWF / MACC climate model results. In addition to the multi-spectral AOD, and thus the Ångström Exponent, also a per-pixel uncertainty is provided and validated. By the end of Aerosol_cci Phase 1 the ATSR algorithms have been applied to both ATSR-2 and AATSR resulting in an AOD time series of 17 years dating back to 1995.

In phase 2 this work is continued with a focus on the further improvement of the ATSR algorithms as well as those for the other instruments and algorithms, mentioned above, which in phase 1 were considered less mature. The first efforts are on the further characterization of the uncertainties and on better understanding of the cloud screening in the various algorithms. Other efforts will focus on surface treatment and possible improvement of aerosol models used in the retrieval. A yearly re-processing of the full 17-year global ATSR-2/AATSR data set with three different algorithms is planned to evaluate the effect of different changes and to monitor further improvement. A new focus in phase 2 is the production of a full-mission dataset of dust AOD from IASI with four different algorithms, which are based on very different retrieval techniques. A major task within the project is the first inter-comparison of those IASI dust retrieval algorithms on the basis of a large set of observations. For this purpose, one year of IASI observations (2013) over the major dust belt of the Northern hemisphere, including the Northern Atlantic Ocean, the Sahara desert, the Arabian Peninsula as well as the Central Asian desert regions, will be provided from all four algorithms and similar retrieval output (visible and infrared AOD, AOD uncertainty, retrieval quality, cloud flags) is generated in order to facilitate the comparison of results. Another new aspect is the production of a diagnostic time series over four regions in Africa, Asia and North America where other reference data are sparse, from POLDER (on ADEOS1 and 2) and PARASOL data. The application of the multi-pixel GRASP algorithm to data from these instruments, which combine multiple wavelengths and multiple viewing angles with polarization information is expected to provide an independent data set as reference for retrieval products from other instruments with less optimum characteristics for aerosol retrieval.

An important aspect is the use of the climate data records (CDRs) produced in the Aerosol_cci project and the interaction with the user community to further improve the products. To this end representatives of different user communities are tasked with applications such as trend analysis, use of the CDRs in climate modeling, studies on aerosol-cloud interactions and stratospheric chemistry. The presentation will summarize the concept and status of the Aerosol_cci project in both phases and discuss in particular the achievements regarding the 17 year ATSR time series and its significance for climate studies in different parts of the world.

P-1105-05

Expanding the Network of Precise Seawater Temperature Measurements for Fijian Coral Reefs

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As part of the Pacific-wide ReefTEMPS Monitoring Network, the University of the South Pacific in collaboration with the South Pacific Integrated Observatory for the Environment and Terrestrial and Marine Biodiversity (GOPS) and the Institut de Recherche pour le Developpement (IRD), deployed for the first time high-precision (+/- 0.002°C) SBE-56 thermistors in Fiji waters since November 2012,

in order to continuously monitor shallow (-10 to -16 m) seawater temperature for use in climate and tropical cyclone prediction models. The shallow water thermistors monitor temperature on a 600-second sampling interval and are rotated every 6 to 10 months, with the data being uploaded on the GOPS/ReefTEMPS data portal for free use by researchers and students. Currently the Fiji monitoring network consists of 10 sites (both in the lagoon and outer reef slope) spanning the northermost isolated island of Rotuma to Kadavu Island in the south. Futher shallow-water sites to be deployed this year (including the southernmost Ceva-i-Ra reef) should bring the total to 14. To date, some 13 datasets representing over 100 months of continuous seawater temperature monitoring for Fiji have been obtained in the context of this ongoing project. Preliminary analysis of the data has shown that the highest seawater temperatures occur in the months of February and March, with episodes that can last several days above 29°C, creating favourable conditions for tropical cyclone generation and also heightening the risk of major coral bleaching events. Such in-situ data is also essential to ground-validate data from the Satellite Virtual Station time series graphs of sea surface temperature (SST) and Coral Bleaching Degree Heating Weeks (DHW) provided by the US National Oceanographic and Atmospheric Administration (NOAA) Coral Reef Watch Satellite Virtual Station in Fiji (BEFJ1 -18.5 ° lat, 178.5 ° lon). Over the course of 2015, the monitoring network will be further expanded in depth, with a line of thermistors deployed at -55, -75 and -90 m to measure rapid temperature variations, helping to monitor ENSO effect on the thermocline depth in coastal areas, with implications for the distribution of fish and marine invertebrates and the detection of seasonal upwelling zones of cooler waters that could mitigate coral bleaching. The deeper sensors, with sampling intervals of 30 to 60 seconds, will also help to monitor rapid variations in temperature linked to internal waves in Fijian coastal areas, with implications for the understanding of the deep transfer of mass, momentum and heat which is critical for developing more accurate climate models. This would be the first time such a study is carried out in the Southern Pacific Ocean.

P-1105-06

Monitoring the Climate of the Upper Troposphere and Lower Stratosphere with Radio Occultation Data

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The Radio Occultation (RO) technique has originally been developed in the 1960s for the study of planetary atmospheres and ionospheres. Accurate RO measurements of the Earth's atmosphere became feasible in the 1990s, with the precise radio signals of the GPS satellite system (guaranteed by on-board atomic clocks). A few hundred times per day, a satellite in low Earth orbit (LEO) sees one of the GPS satellites setting or rising behind the Earth's horizon. In this "occultation" geometry, the GPS signals have to pass through the Earth's atmosphere and they are characteristically influenced (slowed and bent), depending on the density of the atmosphere. The respective motion of the satellites provides a scan through the atmosphere. Accurate measurements of the change in the GPS signal (onboard the LEO satellite) therefore allow to reconstruct the atmospheric density and, subsequently, profiles of pressure as well as temperature. RO measurements can be performed during day and night, over oceans and land, and even inside clouds. During the last few years, RO measurements have been increasingly used by weather centers around the globe, and they a surprisingly large positive impact on the quality of atmospheric analyses (which are used as starting points for weather forecasts).

RO data a very well suited for climate applications, since they do not require external calibration and only short-term measurement stability over the occultation event duration (1 - 2 min), which is provided by the atomic clocks onboard the GPS satellites. With this "self-calibration", it is possible to combine data from different sensors and different occultation missions without need for inter-calibration and overlap (which is extremely hard to achieve for conventional satellite data).

Using the same retrieval for all datasets we obtained monthly refractivity and temperature climate records from multiple radio occultation satellites, which are consistent within 0.05 % and 0.05 K in almost any case (taking global averages over the altitude range 10 km to 30 km). Longer-term average deviations are even smaller. Even though the RO record is still comparatively short, its high quality already allows to see statistically significant temperature trends in the lower stratosphere.

P-1105-07

Aerosol optical properties and dynamic variability of climatic seasons in west Africa: Case study of Ouagadougou

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We present in this paper a climatological study of the optical properties of the atmosphere in West Africa. Using the measurement and photometric inversions data of AERONET in Ouagadougou, we analyze the main optical characteristics such as optical thickness, Angstrom exponent, the single scattering albedo and the asymmetry factor. These properties give quite varied information about the size and chemical nature of atmospheric aerosols in West Africa, particularly in the Sahel region. A study of different variabilities of these properties on a monthly and yearly scale, shows a strong connection with the seasonal succession of dry period marked by the predominance of harmattan winds from the Sahara Desert, laden with dust and wet period characterized by the thrust of the monsoon flow laden with moisture, specific to this part of the world. The spatial and temporal evolution of these atmospheric variables coupled with the dynamics of West African climate allows monitoring of the ascent to the north of the intertropical front marking the beginning of the wet season and its come back to the south at the end of this season. An appropriate positioning of AERONET photometric measurements points can allow a long-term monitoring at the regional level of the beginning, the end and the length of seasons and as such appears as a real tool for monitoring climate change in West Africa.

P-1105-08

Geospatial land use analysis and its relation to the climate change

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Land use analysis plays an important role in studying and understanding processes in ecosystems and solving many applied problems based on satellite monitoring. In particular, it allows to improve the accuracy of classification and areas estimation and to analyze climate change and its impact on agricultural production and whole biosphere. Since the 1980s there are many land use datasets based on satellite images, but they had low spatial resolution and accuracy. Also, in 2013-2014 years, several global maps have been made available, but they are not accurate enough at regional level. Low-resolution maps underestimate or overestimate certain land cover types. Therefore, creation of global and regional land cover maps based on high-resolution satellite images (such as Landsat series at 30 m) is an extremely important task. In this study, we produced land cover maps for the whole territory of Ukraine based on the Landsat-4/5/7 images for three decades: 1990s, 2000s and 2010s. These maps allow estimation of the general trends of land cover/use in Ukraine and discovering how geospatial land use influence on the climate change. This paper discusses methodological aspects to obtain a retrospective maps of land cover based on Landsat images at regional scale, including all preprocessing steps for satellite imagery, formation of training and test sets, classification method and result analysis.

Training (50%) and test (50%) sets consist of six main land cover classes: artificial surface, cropland, grassland, forest, bare land and water. We formed sets using a photo

interpretation method with uniform spatial distribution over the target territory and proportional representation of all classes. Images contained six spectral bands and three bands with shadow, cloud and cloud contours masks. We selected images with less than 50% of cloud cover for classification. First, we restored cloudy pixels from time-series of images using self-organizing Kohonen maps (SOMs). After that, we provided classification based on the time-series of restored images available for the certain year [1]. Classification was done using an ensemble of neural networks, namely multilayer perceptrons (MLPs) and such an approach have been provided better result than single neural network. After classification, each neural network gave a posteriori probability of the input pixel belonging to each class. In an ensemble, we estimated the average a posteriori probability from all networks and assign to the pixel class with the highest probability.

We estimated the accuracy of classification on independent test set. The overall classification accuracy achieved in the study was approximately 95%. Accuracies for each individual class were more than 70%. The lowest accuracy was for grassland since it is difficult to separate grassland from cropland. At the same time, we compare the obtained areas and official statistics for each oblast and for the whole territory of Ukraine for each time period (1990, 2000, 2010). In addition, we compared the accuracy of our classification for Ukraine with global land cover map GlobeLand30-2010 at 30 m resolution. The overall classification accuracy for Ukraine was 5% higher than GlobeLand30-2010. Accuracy of grassland classification was +10% (producer accuracy) and +45% (user accuracy) better than GlobeLand30-2010.

This paper presented a retrospective land cover mapping methodology for the territory of Ukraine based on Landsat data at 30 m resolution. The proposed methodology involved classification of multi-temporal satellite images with neural networks on previously restored cloudy pixels. The map was produced for the whole territory of Ukraine. The use of the proposed approached allowed us to achieve overall classification accuracy of 95% for three different time periods and improve quality of maps comparing to other land cover maps available for Ukraine, namely GlobeLand30-2010. At the presentation the results of climate changes influence on land use will be discussed in more detail.

[1] F.J. Gallego, N. Kussul, S. Skakun, O. Kravchenko, A. Shelestov, and O. Kussul, "Efficiency assessment of using satellite data for crop area estimation in Ukraine," International Journal of Applied Earth Observation and Geoinformation, vol. 29, pp. 22-30, 2014.

P-1105-09

The BIOMASS satellite mission: quantifying global biomass, an essential variable of the climate system

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Quantifying the global carbon cycle is essential to understanding many of the changes taking place in the Earth system and improving future projections. There is strong evidence that over the last 50 years, the terrestrial biosphere has acted as a net carbon sink, removing from the atmosphere approximately one third of the CO2 emitted by fossil fuel combustion. However, the status, dynamics and evolution of the terrestrial biosphere are the least understood and most uncertain element in the carbon cycle. Coupling between the terrestrial carbon cycle and climate has been identified by the IPCC as one of the major areas of uncertainties in the distribution of carbon stocks and carbon exchange, in the estimates of carbon emissions due to forest disturbances, and in the uptake of carbon through forest growth. A fundamental parameter characterising the spatial distribution of carbon in the biosphere is biomass, and forest comprise~80% of the terrestrial above ground biomass. Most of the biomass is in tropical forest that are projected by models to be vulnerable to drought in the future.

Because of its importance for climate, biomass is identified by the UNFCCC as an Essential Climate Variable needed to reduce uncertainties in our knowledge of the climate system (GCOS, 2010). Furthermore, sequestration of carbon in forest biomass is a critical mechanism for mitigating climate change, as recognised by REDD+ initiatives, which use market and financial incentives to reduce the emissions of GHG from deforestation and forest degradation.

The BIOMASS mission is the Seventh ESA Earth Explorer mission, selected in May 2013, for a launch in 2020. The primary aim of the BIOMASS mission is to determine, for the first time and in a consistent manner, the global distribution of above-ground forest biomass (AGB) and its changes in order to provide greatly improved quantification of the size and distribution of the terrestrial carbon pool, and much improved estimates of terrestrial carbon fluxes. In particular, by monitoring and quantifying disturbances and growth in forests, BIOMASS will yield new knowledge about the size and location of terrestrial carbon sources and sinks, and how forest disturbance trigger loss of biomass and subsequent forest regeneration.

Biomass will measure and map forest carbon stock, as well as forest height, over tropical, temperate and boreal forests at a spatial resolution of around 200 m every 6 months throughout the five years of the mission. However, the particular focus is on the carbon-rich dense tropical forests which contribute by far the largest current stock of biomass, but also the largest proportion of carbon emissions from deforestation and forest degradation. By using a long wavelength Synthetic Aperture Radar (SAR at P-band), BIOMASS allows high values of AGB in tropical forests to be measured.

The combination of three measurement techniques, namely polarimetric SAR, polarimetric interferometric SAR and tomographic SAR all using the same sensor, will significantly reduce the uncertainties in biomass retrievals and contribute to meeting the target of 20% accuracy in AGB at a resolution of 200 m. The spatial consistency of these products together with their provision as time series, means that they will contribute significantly to improving the accuracy of the Land Use Change flux and better quantifying dynamic spatial processes in the world's forests. These BIOMASS products can also be used as unbiased reference data for national reporting for initiatives such as REDD+.

Comparing BIOMASS data with biomass calculated by carbon models, or assimilating biomass in those models, will provide a way of testing the models and also give indications on the sources of discrepancy. Comparison of existing models indicates that they are very dissimilar regarding the absolute magnitude of biomass and its spatial distribution, and that a large part of the misrepresentation of biomass comes from the lack of considerations of disturbances and land use change and incorrect modeling ecosystem processes such as mortality.

The paper will present an overview of the BIOMASS mission, and will discuss the use of BIOMASS data to improve forest productivity modeling and to allow forcing of Dynamic Vegetation Model simulations under future climatic scenarios.

P-1105-10

The Pacific Islands Global Climate Observing System (PI GCOS): Where to Next?

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The Tropical Western Pacific (TWP) is the 'ground zero' engine of the global climate system. It is home to some of the largest natural drivers of the climate system; the biggest ocean on the planet, including the El Nino Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO). Despite this, the TWP is one of the least observed and monitored regions of the world. Yet, the needs for climate system monitoring, climate change detection and monitoring the impacts of and the response to climate change, especially marine ecosystem, ocean acidification and mean sea level rise, and research toward improved understanding, modelling and prediction of the climate system are fundamental in understanding the properties and evolution of the earth's climate system.

The Pacific Islands-Global Climate Observing System (PI-GCOS) is one of only a few international-sponsored regional programs established in the early 2000s to assist

Pacific Islands and the international scientific community to observe and monitor the TWP region. The PI GCOS program started in Apia, Samoa, in 2000. It is a sub-program of the international GCOS aimed specifically at meeting climate and related observing needs of Pacific Islands. The outcomes of the Apia GCOS workshop, combined with the findings and recommendations of the Secretariat of the Pacific Regional Environmental Program (SPREP)/World Meteorological Organization (WMO) led Pacific Meteorological Services Needs Analysis Project (PMSNAP) report in 2000, provided the foundation for the development of the PI-GCOS Program. As a result, a PI GCOS Action Plan (Salinger et al., 2002) was developed to help establish and guide the program by identifying GCOS requirements in the region and outline an approach to address these needs in a short strategy document (see http://www.wmo.int/pages/prog/gcos/documents/PI-GCOS AP.pdf). A regional PI GCOS Officer was hired and hosted by the SPREP in Apia, Samoa from 2004 to 2012 to manage the program. Unfortunately, due to a lack of sustained resources, the program was only active until 2012 at which point it went dormant.

This presentation will summarise key preliminary findings & recommendations of the Review of the PI GCOS ("the Review") that is currently underway to look at resurrecting the program on behalf of the region as part of a formal bilateral climate activity between New Zealand and the United States agreed to in September 2014. The Review assesses the balance and relevance of the PI GCOS, its achievements, relations between PI GCOS and partner organizations and Members, its functions and governance mechanisms, and vision and future plans. The Review arises from the realization that there is an urgent need to re-establish the PI GCOS Program in light of the increasing demand for climate and related services in the Pacific Islands and internationally. The need for improved climate observations in the Pacific region has already been identified and if efforts such as the delivery of climate monitoring, research and services in the Pacific through the UNFCCC, the IPCC and Global Framework for Climate Services (GFCS) are to be successful, then re-establishing the PI GCOS is an essential pre-requisite.

P-1105-11

Tipping point analysis of atmospheric oxygen concentration

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We apply tipping point analysis to nine observational oxygen concentration records around the globe, analyse their dynamics and perform projections under possible future scenarios leading to oxygen deficiency in the atmosphere. The analysis is based on statistical physics framework with stochastic modelling, where we represent the observed data as a composition of deterministic and stochastic components estimated from the observed data using Bayesian and wavelet techniques.

P-1105-12

OneGeology - A distributed data system that enables access to up-to-date global geoscience data

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OneGeology is an initiative of Geological Survey Organisations (GSO) around the globe that dates back to Brighton, UK in 2007. Since then OneGeology has been a leader in developing geological online map data using a new international standard - a geological exchange language known as the 'GeoSciML' (currently version 3.2 exists, which enables instant interoperability of the data). Increased use of this new language allows geological data to be shared and integrated across the planet with other organisations. One of very important goals of OneGeology was a transfer of valuable know-how to the developing world, hence shortening the digital learning curve. In autumn 2013 OneGeology was transformed into a Consortium with a clearly defined governance structure, making its structure more official, its operability more flexible and its membership more open where in addition to GSO also to other type of organisations that manage geoscience data can join and contribute. The next stage of the OneGeology initiative will hence be focused into increasing the openness and richness of that data from individual countries to create a multi-thematic global geological data resource on the rocks beneath our feet. Authoritative information on hazards and minerals will help to prevent natural disasters, explore for resources (water, minerals and energy) and identify risks to human health on a planetary scale. With this new stage also renewed OneGeology objectives were defined and these are 1) to be the provider of geosciences data globally, 2) to ensure exchange of know-how and skills so all can participate, and 3) to use the global profile of 1G to increase awareness of the geosciences and their relevance among professional and general public. We live in a digital world that enables prompt access to vast amounts of open access data. Understanding our world, the geology beneath our feet and environmental challenges related to geology calls for accessibility of geoscience data and OneGeology Portal (portal.onegeology.org) is the place to find them.

P-1105-13

Getting Back to the Source: A review of Earth science data citation and access

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Creating a great data set can be a life's work (consider Charles Keeling). Yet, scientists do not receive much recognition for creating rigorous, useful data. At the same time, in a post "climategate" world there is increased scrutiny on science and a greater need than ever to adhere to scientific principles of transparency and reproducibility. In this sense it is clear that scientific assertions must be backed up by precise pointers to the actual evidence used. In many cases this should take the form of a data citation. Indeed the IPCC has increasingly rigorous data citation requirements for its assessment.

The concept of data citation has gained significant traction in recent years. This is most apparent in the Joint Declaration of Data Citation Principles. Some communities such as DataVerse, DataCite, and the Earth Science Information Partners have developed specific guidelines on how to actually cite data. Challenges remain, however, on how to precisely cite specific subsets of very dynamic data. Moreover, there is still some confusion on the purposes of data citation.

This presentation will review the current state of the art in data citation with a special emphasis on new developments coming out of the Research Data Alliance, Force11, and elsewhere. It will make concrete recommendations on the purposes and approaches of data citation, especially in the context of climate research and assertions.

P-1105-14

ICOS Atmsopheric Thematic Center

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ICOS is a recently-launched, world-class research infrastructure dedicated to the monitoring and improved understanding of carbon sources and sinks. It consists of complementary, harmonized networks of long-term monitoring stations focusing on Europe and adjacent regions. The ICOS networks will comprise about 40 operational atmospheric stations (measuring atmospheric composition in greenhouse gases and other core parameters), 40 ecosystem stations (measuring fluxes from ecosystems) and about 20 oceanic measurement platforms.

The networks are coordinated through a set of central facilities: three thematic centres respectively for atmospheric, ecosystem and ocean data, and a central analytical lab.The Atmospheric Thematic Center (ATC) has

two main functions:

1.Operate the atmospheric data processing chains, going from data transmission from stations to the routine delivery of quality checked data-stream

2.Carry out regular measurement technology survey, analysis and enable development of new sensors and their testing prior to field deployment in ICOS

The presentation will describe state of the art of atmospheric GHG measurement and data processing with a special focus on quality assessment. It will also present new measurement technique, like isotopic measurement, that can attribute GHG concentration changes to different emission sources.

P-1105-15

Steps toward effective multi-disciplinary research data management systems

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Astronomy is often viewed as a discipline whose data management needs are well taken care of whereas a great many other research disciplines (the "long tail") are suffering from the absence of good data management systems. Technology and data management practice evolve rapidly and I would argue that no area of research, including astronomy, has any real degree of security for the future of its data collections. Nevertheless, astronomy has a long history of digital data handling and thus has considerable experience and expertise that should be shared with other fields. It is important to acknowledge that astronomy is only one of many disciplines that could collectively share experience with other, less "well-served" communities. It is also important to recognize that we all have much to learn from one another and that interaction with "long tail" research communities will result in better data management practices for astronomy.

Astronomy was part of the "long-tail" or research data 25 years ago. It's data collections were small, heterogeneous, lacked common standards, and were not interoperable. These properties of astronomy data management have changed dramatically (although we still face many challenges) and they have changed because of the hard work of dedicated cross-disciplinary teams of scientists and technologists. But our field has some demonstrable successes to our credit and has learned some profound lessons.

The central problem in creating multi-disciplinary data management systems is the development of Common Data Models that cross disciplinary boundaries. That means managing metadata in a way that supports the use cases of the multi-disciplinary research communities. This is true for all fields, including those that address climate change. The reality of astronomy data is that it is still produced in formats that represent thousands of "native data models" from thousands of different instruments. (A "data model", in our vocabulary, is the structure that carries the meaning of the data and metadata.) The challenge is to develop a data model that supports the transformation of a large set of heterogenous native data models into a Common Data Model. The Common Data Model (CDM) supports the data management functions (curation, discovery, data access, data security) spanning diverse data collections.

This is the same problem that we face in creating multi-disciplinary data management systems. The process for solving the problem will be very similar. Collect research use cases and define requirements. Identify the metadata elements that are required to satisfy those requirements. Analyse where, in the native data models, those elements can be sourced or which elements can be transformed to produce the needed elements. It is true that we have diverse ways of representing even fundamental quantities like time and place (astronomy faces the same problem itself) but these can be reconciled.

Two points are worth mentioning with respect to Common Data Models. First, there exists no ideal, complete, and all-encompassing Common Data Model. Second, there is no "lossless" Common Data Model. Compromises are involved and loss of information may take place. A Common Data Model is implemented for the purpose of unifying diverse data collections. At the Canadian Astronomy Data Centre we ended 25 years of creating silos for each data collection by integrating 119 native data models into a single common model. Now there is a single path (shared by all interfaces) to using our data collections. The next step is to move into other research domains by building significant collaborations with other data management communities.

P-1105-16

Current status and stratigies of biodiversity data integration in Taiwan

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The integration of Taiwan's biodiversity databases started in 2001, the same year that the Ministry of Science & Technology launched the National Digital Archives Program, the Executive Yuan began the Biodiversity Promotion Plan, and Taiwan joined GBIF as an Associate Participant. Taiwan, hence, embarked on a decade of integrating biodiversity data. Afterward, the "Catalog of Life in Taiwan" (TaiCOL) [57,000+ native species], "Taiwan's node of GBIF" (TaiBIF) [2.8 M+ georeferenced distributional data], the "Cryobanking and Barcode of Life for Wildlife Genetic Material in Taiwan" (TaiBOL) [3,000 species with 12,000 barcode] and "Taiwan Encyclopedia of Life" (TaiEOL) [18,000+ species pages] are established, integrated and open to public access. The databases aim to promote the collection and integration of national biodiversity data and should be useful for future climate change researches. These databases intimately collaborate with their corresponding global databases of COL, GBIF, BOL and EOL, respectively. Raw data, especially those of ecological distribution generated by different government agencies or NGOs, are nevertheless still dispersed due to assorted reasons. Most people agree that it is imperative to integrate databases, but many researchers are unwilling to invest in database building — a kind of academic services — under the current academic evaluation system. Thus a cross-agency committee of GBIF / Chinese, Taipei was established in Academia Sinica in 2008 to formulate policies on data collection and integration, and the mechanism to make data available to the public. Any commissioned project was hereafter asked to include these policy requirements in the contract. Furthermore, a new project to build the "National Biodiversity Monitoring and Reporting System" (TaiBON) will be initiated soon which will integrate all the long-term biodiversity monitoring and bioindicator data from various agencies in Taiwan as well as collaborate with AP-BON and GEO BON.

P-1105-17

Climate change revealed from mass balance of mountain glaciers and polar ice sheets - GLACIOCLIM, the French Glaciers Observatory

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Mountain glaciers are widely recognized as excellent indicators of climate change over recent centuries (e.g. IPCC, 2013). Glacier mass balance variations are a useful tool to assess climate changes over the 20th and 21th centuries and anticipate future challenges related to water resources and sea level rise.

A multi-level monitoring combining in-situ and remotely-sensed measurements within different climate regions constitutes the strategy recommended by the Global Terrestrial Network for Glaciers (GTN-G) supported by the United Nations Framework Convention on Climate Change (UNFCC). It should provide the basic data sets required for integrative studies and assessments of the distribution and changes of glaciers and ice caps.

In this context, the French national observatory of glaciers "GLACIOCLIM", supported by INSU, IRD, IPEV and University of Grenoble in collaboration with local partners, has been developing such a strategy for several decades

on glaciers in the French Alps, the tropical Andes, the Antarctic and the Himalayas. The policy supported by GLACIOCLIM in terms of data sharing relies on: (1) free access through an interactive database which has been recently redesigned; (2) a contribution to the World Glacier Monitoring Service database, sustained by a MoU; and (3) a contribution to the GLIMS initiative for multi-temporal glacier inventories. Our monitoring strategy is based on a comprehensive, consistent set of data, including glaciological measurements (mass balance, ice velocity, length and thickness variations), along with hydrological and meteorological measurements. Contrary to the length variations which result from complex ice flow dynamics, mass balance fluctuations are direct indicators as they record solid precipitation via accumulation and surface energy fluxes via ablation. Given that most mountainous glaciers are temperate (i.e. close to the pressure melting point), the excess energy flux at the glacier surface during the ablation season serves mainly for melting. Consequently, it is necessary to measure both winter and summer mass balance terms over long periods to investigate long-term climate trends. The full network then provides the opportunity to thoroughly analyze the relationships between surface mass balance and meteorological variables on selected glaciers in the world.

Most of the glaciers in the world have been decreasing over the last decades and ice temperature measurements in boreholes at very high altitudes provide a clear evidence of atmospheric warming. The goal of this presentation is to analyze the climate - glacier relationships and to provide the cause of this decrease in selected mountainous regions (Alps, Himalayas and Andes) based on in-situ measurements, remote sensing data and results from simple to complex models. The surprising paradox of East Antarctica, where surface mass balance changes are still limited will also be justified in view of data from the GLACIOCLIM observatory.

P-1105-18

Observing Climate Variability and Change with GPS Radio Occultation

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Overall agreement on global warming of the troposphere and cooling of the stratosphere exists from conventional observations. However, uncertainty in trend rates and their vertical structure limits the ability to draw robust and consistent inferences about long-term trends, a key issue as stated in the recent report of the Intergovernmental Panel on Climate Change. Monitoring atmospheric variability and climate change requires climate data records which are continuous and homogeneous, long-term stable, and traceable to standards of the international system of units (SI). The uncertainty of essential climate variables, such as temperature, must be smaller than the signals expected from long-term change.

Radio Occultation (RO) observations based on Global Positioning System (GPS) signals meet these requirements. The traceability to fundamental time standards with precise atomic clocks assures a long-term stable and consistent data record with global coverage and all-weather utility. RO data are available from 2001 onwards. Information on error characteristics is provided as well. Data products comprise vertical profiles and gridded climatological fields of key atmospheric variables including bending angle, refractivity, pressure, geopotential height, temperature, and specific humidity. Derived quantities such as tropopause parameters or geostrophic winds are also available. Highest quality and vertical resolution (about 0.5 km to 1.5 km) is delivered over the upper troposphere and lower stratosphere, offering the distinct advantage to assess the vertical thermodynamic structure.

We present an overview on the accomplishments and diverse applications of the RO record for monitoring climate variability and climate change in the atmosphere. Results show the ability of RO to capture the El Niño-Southern Oscillation (ENSO), Quasi-Biennial Oscillation (QBO), atmospheric waves and thermal tides, and extreme weather events such as tropical cyclones with unprecedented vertical resolution. Despite of the relatively short RO record, its utility for climate change detection is demonstrated as a global climate observing system. Current and future challenges are discussed for the establishment of an RO climate data record, which will contribute to improving our knowledge on atmospheric structure and trends.

P-1105-19

Global-Scale Atmosphere Monitoring by In-Service Aircraft - Current Achievements and Future Prospects of the European Research Infrastructure IAGOS

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Reliable predictions of the future climate using climate models are central and fundamental requirements for determining future mitigation strategies. The use of commercial aircraft allows the collection of highly relevant observations on a scale and in sheer quantity impossible to achieve using research aircraft, and at altitudes where other measurement methods (e.g., satellites) fall short. It has been extensively demonstrated by 3 ongoing international projects in Europe and Japan now that commercial aircraft are ideal platforms to record vertical profiles from ground to 12 km to the tropopause region over areas never or poorly sampled by other programs (e.g. surface or radio soundings network) and to sample the atmosphere between 9 and 12 km at high horizontal and vertical resolution corresponding to the critical upper troposphere / lower stratosphere (UT/LS) region at mid-latitudes, where most long-range aircraft fly. The European Research Infrastructure IAGOS (In-service Aircraft for a Global Observing System; www.iagos.org) operates a global-scale monitoring system for atmospheric composition, aerosols and clouds by using Airbus A340 and/or A330 long-range aircraft performing regular intercontinental flights. Today's participating airlines, Lufthansa, Air France, China Airlines, Cathay Pacific and Iberia, ensure global-scale coverage by the infrastructure (see map of the flight on htt://www.iagos.fr), which is designed for a lifetime of at least 20 years. IAGOS complements the global observing system in addition to ground-based networks, dedicated research campaigns, satellites, balloons, and ships. The infrastructure builds on the heritage of former research projects MOZAIC (Measurement of Ozone and Water Vapour on Airbus In-service Aircraft; http://www.iagos.fr/mozaic) and CARIBIC (Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container; http://www.caribic-atmospheric.com). IAGOS is now the European Research Infrastructure combining and coordinating these two different and complementary approaches/methodologies which comprise (i) IAGOS-core based on MOZAIC (a fleet of 15 to 20 aircraft flying a reduced set of automatic instruments) and (ii) IAGOS-CARIBIC based on CARIBIC (1 aircraft flying a 1.5 ton laboratory with 16 instruments deployed once a month for 4 flights). IAGOS combines research centres, universities, national weather services, airline operators and aviation industry. It provides data for users in science and policy including air quality forecasting, verification of CO2 emissions and Kyoto monitoring, numerical weather prediction, and validation of global chemical transport model, global climate chemical model and satellite products. Since its participation in the on-going MACC projects (http://www.iagos.fr/macc), and demonstration

and delivery of core data in near real time (NRT) and soon in real time for a subset of information, IAGOS is considered a major contributor to the in-situ component of Copernicus Atmosphere Monitoring Services (CAMS). The IAGOS infrastructure is currently the only approach to providing regular in-situ observations in the UT/LS over mid-latitudes at high spatial resolution (4 seconds or 1 km horizontally) and vertical profiles (4 seconds or 30 meters vertically) of reactive gases, greenhouse gases, and aerosol concentration in the troposphere over continental sites, never or sparsely sampled by other programs, (e.g. in Africa, South East Asia, and South America). In combination with its predecessor programs MOZAIC and CARIBIC, IAGOS has been providing long-term observational data of atmospheric chemical composition in the UT/LS since 1994 with to date 20 year time series of temperature, H2O and O3, and 9-15 years of aerosol, CO, NOy, CO2, CH4, N2O, SF6, Hg, acetone, ~30 HFCs, ~20 NMHC data. This presentation will give an overview of the original results achieved so far and a number of highlights to illustrate the promise IAGOS data hold for the future (new measured compounds along with near real time and real time transmission of data), taking full advantage of coupled chemistry-dynamics atmospheric models, allowing new applications and analysis for a broad community of users. One of the most striking examples we will highlight concerns evaluation of forecast runs with IAGOS NRT data as proposed in the frame of CAMS.

P-1105-20

Toward improved metadata catalogue services for WDS members in China

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There are about 9 regular members of WDS in China, which covers multi-disciplines, such as geography and environment, space, astronomy, ocean, polar, microbe, and so on. It is difficult to provide uniform metadata catalogue services and update the related information dynamically. Face to this problem, WDS China family design and build the clearing house for metadata inter-operability. It includes three important part, i.e., metadata standard, data update mechanism, clearing house portal. A uniform metadata exchange standard is designed for WDS members in China. In order to advance the data and metadata services quality, an integrated data and metadata update mechanism are proposed based on the review and training mechanism supported by WDS China secretary office. Finally, a new clearing house portal is provided which can be accessed by WDS portal directly.

P-1105-21

60-year Database of Cosmic-Ray Neutron Fluxes held by the WDC for Cosmic Rays

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It has been suggested by a number of authors that fluctuations in the cosmic-ray, which are known to be caused by changes in solar activity with the time scale of eleven years or longer, could play a role in climate change. The World Data Center (WDC) for Cosmic Rays of Solar-Terrestrial Environment Laboratory, Nagoya University, is almost unique data center providing with pressure-corrected and scale-adjusted one-hour fluxes of cosmic-ray, supplied by ground-based stations (about 50 at present) distributed in a wide range of the longitude and the latitude, including polar and equatorial regions. Quality controlled data since 1953 in unified formats are opened through the Web page whose ULR is given below. Beside of well-known "11-year" solar-cycle variations of the cosmic-ray flux, appearing in the opposite sense of the variations of sunspot number, a weak increasing trend can be recognized in this several solar cycles, reflecting a weakening tendency of the solar activity. Although a weak inverse correlation is seen between the cosmic-ray flux and the global temperature in 1953-2006, the correlation analysis is strongly affected by the global cooling presumably caused by two major volcanic eruptions (El Chichon in 1982, and Pinatubo in 1991). Both eruptions were "accidentally" taken place in two subsequent solar-cycle maxima.

http://center.stelab.nagoya-u.ac.jp/WDCCR/.

1106 - The Earth's energy imbalance and exchanges at the atmosphere-ocean interface: from fundamental research to societal concern

ORAL PRESENTATIONS

K-1106-01

Earth's energy imbalance: current knowledge and future challenges

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Anthropogenic climate change arises from the accumulation of excess solar energy in the Earth system through increases in heat-trapping greenhouse gases associated with human activities. The various aspects of observed climate change (surface temperature rise, increased rainfall rates, loss of glaciers, global sea level rise, changes in climatic extremes) are all symptoms of this accumulation of energy, of which > 90% is manifested in increased ocean heat storage. The rate of climate change is defined by Earth's energy imbalance (EEI) and this represents the most fundamental quantity for monitoring ongoing global warming.

Ultimately, the impacts of climate change will be determined by the future evolution of EEI and how this additional energy interacts with the flows of energy within the Earth system. In this talk, I will outline the scientific motivation for better monitoring of EEI and review the recent progress that has been made through improved Earth system observations. I will discuss the future challenges in improving our estimates of this critical aspect of global change and advocate for EEI and ocean heat storage becoming central to both our thinking and communication on climate change.

K-1106-02

SOLAS, a decade of international research at the air-sea interface: main accomplishments and future goals

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The surface ocean and lower atmosphere domain is a complex, highly dynamic component of the Earth system. Air-sea fluxes of biogeochemically-active materials and energy exert a major impact on global biogeochemistry and climate. Some of the largest uncertainties in projecting future global environmental trends are attributable to an insufficient understanding of the physical and biogeochemical interactions and feedbacks between the ocean and atmosphere (IPCC, 2013).

The overarching goal of SOLAS (Surface Ocean-Lower Atmosphere Study) international program launched in 2004, is to achieve a quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and how this coupled

system affects and is affected by global change. Our understanding of the exchanges of energy, gases and particles at the atmosphere-ocean interface has advanced over the past decade but there are still large uncertainties to adequately parameterize fundamental controlling processes as identified in the new research strategies of the international SOLAS group (Law et al., 2013). In this context, the scientific questions driving SOLAS research are highly challenging, inherently multidisciplinary, and broad in scope. They include: (1) What controls the ocean/atmosphere exchange of climate-relevant gases and particles? (2) How does the atmospheric deposition of materials impact ocean biogeochemistry? (3) What are the links between ocean biology, aerosols, and clouds? (4) What are the biogeochemical controls on emissions of highly reactive gases that impact atmospheric photochemistry and stratospheric ozone?

Climate mitigation policies based on greenhouse gas budgets must take into account the role of ocean-atmosphere fluxes for future projections. In that context, several of the geoengineering schemes currently debated for climate mitigation are directly linked to the ocean-atmosphere system, including ocean iron fertilization, sea spray generators, ocean foams, and modification of the ocean upwelling. Informed assessment of their feasibility, efficacy and potentially unintended effects will derive from SOLAS science.

This presentation will overview the SOLAS 2004-2014 goals and main accomplishments and present the SOLAS 2015-2025 rationale and scientific scope.

O-1106-01

Origin of the Recent Tropical Atlantic SST warming: the role of ocean dynamics?

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During the last decades, the sea surface temperatures (SSTs) of the whole tropical Atlantic has substantially increased. Since the 1960s, the mean SST series of the tropical Atlantic [30°N-20°S, 60°W-15°E] has gained some 0.8°C. Moreover, when considering the main break points which affect the time series, the most significant trend occurred since 1995, at a rate of 0.25°C per decade for the whole basin. When regionalyzed, the most severe warming affects the north-western part of the basin with values up to 1°C, as well as the coastal upwelling regions offshore Africa. Surprisingly the trade wind system, that drives the equatorial upwellings, strengthened since the 1960s and specially since the 1980s. These changes has been established by considering various independent observational data sets, allowing to prove the robustness of the results.

The origin of the SST change has been investigated by analyzing the changes of the air-sea surface fluxes and of the water column by considering integral quantities like sea level anomalies and upper level heat contents. It appears that the SST warming is not directly related to the local surface heat fluxes, which tend to increase the ocean heat loss. This implies that the signal is not coming from the atmosphere but rather from the ocean itself, i.e. due to recent changes in the ocean dynamics. Moreover, lagged correlation patterns between heat content and SSTs, suggest the existence of a relationship between the SST warming and the circulation in the northern tropical Atlantic. Finally, several hypotheses are presented to conciliate both the strengthening of the wind-stress, the SST and upper-water warming, as well as the break point dates which affect the trends.

O-1106-02

Oceanic biotic components, production mechanism of organic aerosol in Marine Boundary Layer ans cloud-climate system

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Studies performed during the past years strongly suggest that biogenic organic compounds play an important role in submicron marine aerosol chemical composition over biologically productive, high latitude, marine regions, in both hemispheres and new biogenic oceanic sources of primary and secondary origin of OA were revealed. We discuss on the global importance of biogenic OA marine sources and their high spatial and temporal variability and the complex interaction with gaseous biogenic precursors and oceanic biotic components (Phytoplankton, viruses and bacteria). Submicron marine organic aerosol are a complex mixture of biogenic materials transferred from the ocean surface by the sea spray or by oxidative gas to particle conversion of volatile organics emitted by decomposition processes of oceanic dissolved organic carbon. The role of marine biota on the evolution of plankton bloom and on the partitioning of oceanic organic carbon in POC and DOC reservoirs and transfer mechanisms into MBL will be discussed.

1106-POSTER PRESENTATIONS

P-1106-01

Comparative assessment of surface fluxes from different sources: a framework based on probability distributions

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Surface turbulent heat fluxes from modern era and first generation reanalyses (NCEP-DOE, ERA-Interim, MERRA NCEP-CFSR, JRA) as well as from satellite products (SEAFLUX, IFREMER, HOAPS) were intercompared using framework of probability distributions for sensible and latent heat fluxes. For approximation of probability distributions and estimation of extreme flux values Modified Fisher-Tippett (MFT) distribution has been used. Besides mean flux values, consideration is given to the comparative analysis of (i) parameters of the MFT probability density functions (scale and location), (ii) extreme flux values corresponding high order percentiles of fluxes (e.g. 99th and higher) and (iii) fractional contribution of extreme surface flux events in the total surface turbulent fluxes integrated over months and seasons. The latter was estimated using both fractional distribution derived from MFT and empirical estimates based upon occurrence histograms. The strongest differences in the parameters of probability distributions of surface fluxes and extreme surface flux values between different reanalyses are found in the western boundary current extension regions and high latitudes, while the highest differences in the fractional contributions of surface fluxes may occur in mid ocean regions being closely associated with atmospheric synoptic dynamics. Generally, satellite surface flux products demonstrate relatively stronger extreme fluxes compared to reanalyses, even in the Northern Hemisphere midlatitudes where data assimilation input in reanalyses is quite dense compared to the Southern Ocean regions. Our assessment also discriminated different reanalyses and satellite products with respect to their ability to quantify the role of extreme surface turbulent fluxes in forming ocean heat release in different regions.

P-1106-02

The New Planetary Energetic Budget, the New Climate and the New Water Cycle in the North Atlantic Ocean and its edges

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Global warming has now reached the energetic phase of H2O's return to the ground after the saturation of the atmosphere in evaporation since the 80s and 90s of the last century, which were characterized by severe droughts, mainly in Africa.

This phase is the result of the accumulation of thermal energy exchanges in the Earth-Ocean-Atmosphere system that resulted in the thrust reversal of the energy balance toward the poles. This situation is characterized by a new thermal distribution: above the ocean, the situation is more in surplus compared to the mainland, or even opposite when the balance is negative on the land, and in the atmosphere, warm thermal advection easily reach the North Pole (planetary crests), as well as cold advection push deep into North Africa and the Gulf of Mexico (planetary valleys).

This «New Ground Energy Balance» establishes a «New Meridian Atmospheric Circulation (MAC)» with an undulating character throughout the year, including the winter characterized by intense latitudinal very active energy exchanges between the surplus areas (tropical) and the deficit (polar) on the one hand, and the atmosphere, the ocean and the continent on the other.

The excess radiation balance increases the potential evaporation of the atmosphere and provides a new geographical distribution of H2O worldwide: the excess water vapor is easily converted by cold advection (polar vortex) to heavy rains that cause floods or snow storms that paralyze the normal functioning of human activities, which creates many difficulties for users and leaves damage and casualties, but ensures water availability missing since a long time in many parts of the world, in Africa, Europe and America.

The new thermal distribution reorganizes the geography of atmospheric pressure: the ocean energy concentration is transmitted directly to the atmosphere, and the excess torque is pushed northward. The Azores anticyclone is strengthened and is a global lock by the Atlantic ridge at Greenland, which imposes on the jet stream a positive ripple, very strongly marked poleward, bringing cosmic cold advection of polar air masses winter over from Europe to North Africa. Hence the enormous meridian heat exchanges north-south, and south-north.

This new spatial thermal provision therefore imposes on the jet-stream a positive ripple on the North Atlantic (Greenland) and eastern Pacific (Alaska); this is the cause of the heat and drought of California, followed by negative waves in eastern US, and Europe.

This is the «New Atmospheric Circulation» predominantly «Meridian», due to the «New Climate» caused by global warming.

P-1106-03

Changes in global energy imbalance at the top of atmosphere and surface 1985-2014

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Combining satellite data, atmospheric reanalyses and climate model simulations, variability in the net downward radiative flux imbalance at the top of Earth's atmosphere (N) are reconstructed and linked to recent climate change. Over the period 1985-2012 we estimate N=0.47±0.54 Wm−2 (uncertainties at 90% confidence level). Variability relates primarily to the eruption of Mt. Pinatubo in 1991 and El Niño Southernn Oscillation with good agreement (r~0.6) between the monthly reconstruction and atmospheric simulations using prescribed sea surface temperature and radiative forcings. Combining with a simple energy balance climate model we argue that increased ocean heat uptake below the mixed layer is required to reconcile changes in N and surface temperature since 1985.

The surface net fluxes can be estimated based upon the reconstructed N and the atmospheric energy tendencies and transports from the ERA-Interim reanalysis. The energy divergences over the oceans are adjusted to remove an unphysical residual global mean atmospheric energy divergence. The estimated net surface energy fluxes are compared with reanalysis and atmospheric model simulations. The spatial correlation coefficients of multi-annual means between the estimations made here and other data sets are all around 0.9. There are good agreements in area mean anomaly variability over the global ocean. The inter-hemispheric heating differences and precipitation biases are also discussed.

P-1106-04

Uncoupling the ocean and sea-ice from the atmosphere: Challenges of Coordinated Ocean-ice Reference Experiments (COREs)

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Earth system models are complex, and the interactions and nonlinear feedbacks between their different components are poorly understood. Climate predictions benefit from an independent validation of each component model, before coupling them together. Atmospheric Model Intercomparison Projects, which involve forcing the atmospheric models with observed sea surface temperatures (SST) and sea-ice cover, have existed since the early days of IPCC. In contrast, a similar exercise for ocean - sea-ice models has been difficult to implement, because there are long time scale interactions between the ocean-ice-atmosphere system and there are large uncertainties in observations within the atmospheric boundary layer.

Under the umbrella of the World Climate Research Program's (WCRP) Climate and Ocean Variability, Predictability and Change (CLIVAR) Project, the Ocean Model Development Panel (OMDP) has worked for over a decade to develop a meaningful validation of ocean - sea-ice models for our present climate and has produced a common protocol: Coordinated Ocean-ice Reference Experiments (COREs). CORE consists of running ocean - sea-ice coupled models with a fixed atmospheric state (observed air temperature, humidity, boundary layer winds, downward radiation, precipitation, and river runoff). This atmospheric state has been obtained in such a way to produce realistic globally averaged heat and freshwater fluxes when combined with observed SST. Existing atmospheric reanalysis products such as NCEP or ERA are not yet suitable for this purpose without corrections. Prescribing the air temperature, rather than heat flux, is necessary in order to allow the feedbacks between the evolving SSTs and the air-sea heat fluxes: this feedback is essential to ensure the stability of the ocean-ice system.

The main challenge in the CORE framework stems from the lack of sufficient feedbacks in the water cycle. If evaporation increases over the ocean, the extra water is likely to return to the ocean as rain or runoff on long time scales. Because this nonlocal feedback is neglected when the atmospheric state is fixed, it has been necessary to introduce an arbitrary relaxation of the surface salinity to observations. In part due to this salinity forcing, CORE simulations subject to the same atmospheric state exhibit very different large scale ocean circulations: this finding underlines our limited capacity to fully validate the ocean - sea-ice components of earth system models used for climate scenarios, independently of the atmosphere. Nevertheless, a recent suite of CORE experiments carried out with over 20 different models brings new insights into the reproducibility and robustness of essential climate variables such as regional sea level patterns and the North Atlantic overturning circulation.

1107 - Sea level rise and ice sheets

ORAL PRESENTATIONS

K-1107-01

Measuring Earth's polar ice sheets from space

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Earth's ice responds rapidly to climate forcing, and satellite observations have become an essential tool with which to measure and understand these changes. Although considerable progress has been made in quantifying recent fluctuations in ice sheet mass balance, significant challenges remain in attempting to predict future ice sheet losses. This is because past changes have been too small to reliably judge the performance of the ice sheet models upon which predictions are currently based. In consequence, there is a continued need for satellite-based observations of the polar ice sheets - both to inform the development of ice sheet models, and to deliver synoptic assessments of their contribution to contemporary sea level rise.

There are three popular satellite-based techniques for estimating the sea level contribution due losses from the polar ice sheets; satellite altimetry can measure changes in ice sheet volume; satellite interferometry can measure outlet glacier discharge, and satellite gravimetry can measure fluctuations in ice sheet mass. Although all three approaches are technically sound, in the past there has been poor agreement between independent assessments. The Ice Sheet Mass Balance Inter-Comparison Exercise (IMBIE) was established in 2011 as a joint initiative of the European Space Agency (ESA) and the US National Aeronautics and Space Administration (NASA) as an attempt to resolve the apparent disagreement between geodetic estimates of ice sheet mass balance. Within IMBIE, estimates of ice sheet mass balance are developed from all three geodetic techniques using a common spatial and temporal reference frame and a common appreciation of the contributions due to external signals. The project brings together the laboratories and space agencies that have been instrumental in developing independent estimates of ice sheet mass balance to date.

In 2012, the first IMBIE assessment was delivered. It included 19-years of satellite radar altimeter data, 5-years of satellite laser altimeter data, 18 years of satellite radar interferometer data, 7-years of satellite gravimetry data, 32-years of surface mass balance model predictions, and predictions from a suite of post glacial rebound models. Since then, further changes have occurred in Antarctica and Greenland, and the record of satellite observations has been extended through continued operation of existing missions, such as GRACE, and through the availability of measurements from new sensors, including CryoSat-2 and Sentinel-1a.

This presentation will review the latest satellite measurements of Antarctica and Greenland, and will outline progress towards a second ice sheet mass balance inter-comparison exercise.

K-1107-02

Polar ice sheets and sea-level rise: threats and uncertainties

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During the last 20 years, the Greenland and Antarctic ice sheets have been loosing mass with an increasing rate. They now significantly contribute to sea-level rise and will most probably continue in the foreseeable future. Their potential total contribution is tremendous as ice sheets contain tens of meters of sea level equivalent. However, the rate of their coming outflow remains speculative. In particular both ice sheets may exhibit some instability processes that could be initiated once oceanic or atmospheric perturbations exceed a given threshold. Once engaged in such instabilities, ice sheet mass loss is self-entertained and large regions may collapse. This lecture will describe the essential processes at the origin of the observed ice sheets' imbalance, our current knowledge on potential tipping points and highlight the main reasons of the uncertainties in the projection of ice sheets' contribution to sea level.

O-1107-01

Present-day sea level rise

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We review most recent progress realized in measuring global mean sea level (GMSL) over recent decades and satellite altimetry era (starting in 1993), as well as in understanding the causes of the observed rise (i.e., ocean thermal expansion, land ice loss and terrestrial water storage change). The IPCC 5th Assessment Report revisited the sea level budget for the last few decades and came to rather good agreement between observed GMSL rise and sum of climate and non-climate contributions. Over the satellite altimetry era, GMSL rise (of 3.2 mm/yr) is reasonably well explained by ocean thermal expansion (contributing ~ 37%) and land ice loss from glaciers and ice sheets (contributing ~ 55%). Terrestrial water storage change (mostly due to ground water pumping) is supposed to explain the remaining, but this component is quite uncertain. For about 10 years, new observing systems from space and in situ (e.g., GRACE space gravimetry, Argo profiling floats) allow improved estimates of the various contributions to sea level rise, in particular direct estimate of ocean mass change. These observations indicate that over 2005-2013, ocean thermal expansion rose less rapidly than during the 1990s (with a contribution of only 28%) while the ocean mass increase now explains ~ 66% of the GMSL rise. This mostly results from ice mass loss acceleration from the ice sheets. This improved sea level budget approach allows us to put constraints on the contribution of the deep ocean (not seen by Argo) and its role in the current 'hiatus'.

O-1107-02

Projections of sea level change

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It is very likely that the rate of global mean sea level rise (GMSLR) during the 21st century will exceed the rate during 1971-2010, due to increases in ocean warming and loss of mass from glaciers and ice sheets. Ocean thermal expansion is the largest contributor to projections of GMSLR during the 21st century. For a given scenario, there is a substantial spread in climate model projections of thermal expansion, and in the geographical pattern of sea level change due to ocean density and circulation change. Larger uncertainty in projections of GMSLR comes from the land-ice contributions, especially ice-sheet dynamical change. These contributions also influence regional sea-level change, through their effect on gravity and the solid Earth. GMSLR by 2100 is likely to be in the range 0.28-0.61 m above the 1986-2005 mean under a scenario of strong mitigation (RCP2.6), and 0.52-0.98 m under a scenario of high emissions (RCP8.5). Unlike surface temperature change, GMSLR depends on the pathway of CO2 emissions, not only on the total; earlier emissions of the same total lead to greater GMSLR. By the end of the century, the rate of GMSLR under RCP2.6 could stabilise at rates similar to those of the early 21st century, while under RCP8.5 it could approach the average rates that occurred during the last deglaciation. It is very likely that regional sea level rise will be positive over about 95% of the world ocean, and about 70% of the global coastlines are projected to experience a relative sea level change within 20% of the global mean. Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause GMSLR above the likely ranges during this century, but GMSLR

will continue for many subsequent centuries, because of the long timescales of ice-sheet change and deep-ocean warming, and could be partly irreversible.

1107-POSTER PRESENTATIONS

P-1107-01

Two Decades of Global and Regional Sea Level Observations from the ESA Climate Change Initiative Sea Level Project

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Sea level is a very sensitive index of climate change and variability. Sea level integrates the ocean warming, mountain glaciers and ice sheet melting. Understanding the sea level variability and changes implies an accurate monitoring of the sea level variable at climate scales, in addition to understanding the ocean variability and the exchanges between ocean, land, cryosphere, and atmosphere. That is why Sea Level is one of the Essential Climate Variables (ECV) selected in the frame of the ESA Climate Change Initiative (CCI) program. It aims at providing long-term monitoring of the sea level ECV with regular updates, as required for climate studies. After a first phase (2011-2013), the program has started in 2014 a second phase of 3 years. The objectives of this second phase are to involve the climate research community, to refine their needs and collect their feedbacks on product quality, to develop, test and select the best algorithms and standards to generate an updated climate time series and to produce and validate the Sea Level ECV product. This will better answer the climate user needs by improving the quality of the Sea Level products and maintain a sustain service for an up-to-date production. To this extent, the ECV time series has been extended and it now covers the period 1993-2013.

We will firstly present the main achievements of the ESA CCI Sea Level Project. On the one hand, the major steps required to produce the 21 years climate time series are briefly described: collect and refine the user requirements, development of adapted algorithms for climate applications and specification of the production system. On the other hand, the product characteristics are described as well as the results from product validation, performed by several groups of the ocean and climate modeling community. At last, the work plan and key challenges of the second phase of the project are described.

P-1107-02

Error characterization of global Mean Sea Level time series deduced from TOPEX, Jason-1 and Jason-2 altimeter missions

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With the satellite altimetry missions, the global mean sea level (GMSL) has been calculated on a continual basis since January 1993. 'Verification' phases, during which the satellites follow each other in close succession (TOPEX/Poseidon--Jason-1, then Jason-1--Jason-2), help to link up these different missions by precisely determining any bias between them. The global mean sea level (MSL) deduced from these 3 altimetric missions provides a global rate of 3.2 mm from 1993 to 2013 applying the post glacial rebound (MSL AVISO website http://www.jason.oceanobs.com/msl).

Within the ESA Climate Change Initiative program, the users requirements have been collected and for the users of the Sea Level ECV, it is crucial to know as much as possible the errors impacting the MSL calculation in order to analyze the MSL variations and in fine to interpret correctly the geophysical mechanisms underlying these variations. The characterization of these errors was performed over the whole altimetric period separating several time scales as the long-term evolution (mean sea level trend), but also the inter-annual and periodic signals.

However, it will also be very useful to provide the confidence envelop (or error envelop) of the global MSL time series in order to know the exact error level at each time step. In this paper, we propose to describe in details the approach developed to compute this confidence envelop. We will also present the results obtained and how to interpret them.

P-1107-03

Altimeter sea level rise assessment with tide gauge measurements

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Since the first altimeter missions and the improvements performed in the accuracy of sea surface height measurements from 1992 onwards, the importance of global quality assessment of altimeter data has been increasing. Global CalVal studies usually assess this performance by the analysis of internal consistency and cross-comparison between all missions. The overall quality assessment of altimeter data can be performed by analyzing their internal consistency and the cross-comparison between all missions.

As a complementary approach, tide gauge measurements are used as an external and independent reference to enable further quality assessment of the altimeter sea level and provide a better estimate of the multiple altimeter performances. In this way, both altimeter and tide gauge observations, dedicated to climate applications, require a rigorous quality control. The tide gauge time series considered in this study derive from several networks (GLOSS/CLIVAR, PSMSL, REFMAR) and provide sea-level heights with a physical content comparable with altimetry sea level estimates.

Concerning altimeter data, the long-term drift assessment can be evaluated thanks to a widespread network of tide gauges. Thus, in-situ measurements are compared with altimeter sea level for the main altimeter missions. If altimeter time series are long enough, tide gauge data provide a relevant estimation of the global Mean Sea Level (MSL) drift calculated for all the missions. Moreover, comparisons with sea level products merging all the altimeter missions together have also been performed using several datasets, among which the AVISO delayed-time Sea Level Anomaly grids.

P-1107-04

Probabilistic surface reconstruction of coastal sea level rise during the twentieth century

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We present a new surface reconstruction procedure based on the Bayesian inference method for coastal relative sea level variation during the twentieth century. Average rates are computed from tide gauge records. Models based on a Voronoi tessellation adapt to the level of information which proves well suited to the strong heterogeneity of data. Each point of the reconstructed surface is defined through a probability density function, a format particularly well adapted to this climate-related datum. The resolution of reconstructed surfaces strongly varies among the six large regions considered and within a given region. Anomalous sea level variations recorded locally are shown to reflect either anthropogenic effects or well-identified fast tectonics. For a poor data coverage, these can cause a problematic distortion of the reconstructed surface. Europe, North America, Australia, and Africa present a single trend with a decreasing precision of the reconstructed surface as a function of resolution of the tide gauge record. The most prominent feature in Europe is the pronounced uplift of Fennoscandia. Coasts of United States have the best resolution in North America and present stronger rates of sea level rise on the Atlantic than their European counterparts. Australia (especially in

the North) and Africa are poorly resolved. Asia and South America depart clearly from this trend: a relatively uniform rise is obtained for Asia in spite of a good tide gauge record. Conversely, the reconstructed surface for South America presents an exceptional degree of roughness, at odds with a relatively poor record. Overall, this method not only offers a new assessment of sea level change (validating earlier results) but also quantifies the reliability of estimates.

We finally apply a similar procedure to GPS vertical data. First results on vertical ground motion which therefore allow the local evaluation of absolute sea-level rise during the twentieth century will be presented.

P-1107-05

Climatic information from unexplored areas of East Antarctica: The French ITASE Contribution

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Antarctica is the largest ice reservoir on Earth. In the context of climate change, the surface mass balance (SMB) of Antarctica will play a major role in the evolution of sea level. Knowledge of the current variations of Antarctic SMB is thus a major challenge. However, for Antarctica the spatially averaged SMB is still poorly constrained because field data are sparse. The IPCC fifth assessment report (AR5) has highlighted this uncertainty as one of the main scientific challenges in climate science.

How the surface mass balance of Antarctica will change in the future?

In spite of decades of studies, an international effort is still necessary to reduce the important remaining uncertainties. Especially, large regions of Antarctica are still unexplored. Hence, scientific traverses have been designed in the framework of SCAR-ITASE program (International Trans-Antarctic Scientific Expeditions) to collect invaluable samples and observations in the field. In the context of ITASE project, the French glaciology community has launched a program to get new information on surface mass balance. During the 2009-10, 2011-2012 and 2013-14 summers, scientific traverses have been performed over large distances on the Antarctic plateau. However, the coast-to-plateau transition zone has been largely unexplored, whereas this is where most of future changes are expected to occur. Hence, a new traverse is planned in this area for the summer 2016-17. Using up-to-date techniques, we propose to collect information on snow physical properties to analyze the processes responsible for their spatial and temporal variations. A special attention will be paid on the way to use remote sensing data to infer the physical characteristics of snow. This knowledge is expected to allow us to interpret remote sensing signal in terms of surface mass balance. Getting information on how the origin and transport of moisture affect chemical and isotopic signals stored in firn and ice will also be a priority. This knowledge will help us to validate climate and surface mass balance models, which are used to forecast future surface mass balance. The goal of this presentation is to describe recent results obtained by the French ITASE community, and to describe its strategy for future research performed in Antarctica.

P-1107-06

Testing the sensitivity of the East Antarctic Ice Sheet to Southern Ocean dynamics: past changes and future implications

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The stability of Antarctic ice sheets and their potential contribution to sea level under projected future warming remains highly uncertain. The Last Interglacial (135,000-116,000 years ago) provides a potential analogue, with global temperatures 2°C higher and rates of sea-level rise >5.6 m ka−1, leading to sea levels 6.6-9.4 m higher than present. The source(s) of this sea-level rise remain fiercely debated.

Here we report a series of independent model simulations exploring the effects of migrating Southern Hemisphere Westerlies (SHWs) on Southern Ocean circulation and Antarctic ice-sheet dynamics. We suggest that southerly shifts in winds may have significantly impacted the sub-polar gyres, inducing pervasive warming (0.2-0.8°C in the upper 1,200 m) adjacent to sectors of the East Antarctic Ice Sheet (EAIS), which due to their geometries and connectivity to the Southern Ocean are highly sensitive to ocean forcing. We conclude that the EAIS potentially made a substantial, hitherto unsuspected, contribution to interglacial sea levels, and given 21st-century projections in the Southern Annular Mode and associated SHW migration, we highlight how pervasive circum-Antarctic warming may threaten EAIS stability.

P-1107-07

Uncertainties on the surface mass balance of Antarctica

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On average, the ~12 106 km³ of the grounded Antarctic ice sheet accumulates ~15 cm of water equivalent per year at its surface. The main term in the surface mass balance equation is precipitation, mainly in the form of snowfall. Other terms include evaporation/frost deposition, melting and runoff to the oceans, and blowing snow effects. Climate models may or may not account for these terms, if they do with varying degrees of realism which can only be evaluated against past or present day observations. All climate models simulate precipitation and predict an increase of antarctic snowfall but disagree on the magnitude of the increase. A 20 % increase (everything else unchanged) would induce a ~1 mm/year moderation of sea-level rise due to other causes of sea-level change. Unfortunately, there are no in situ observations of antarctic snowfall that can be used to confidently assess model performance and sort out their reliability. Satellite data suggest that most models overestimate antarctic precipitation. Those models closest to the satellite data predict a larger precipitation increase and impact on sea-level. Blowing snow is a frequent phenomenon on the peripheral slopes of the antarctic ice sheet where catabatic winds blow, but none of the past IPCC climate models have accounted for this process and a possible contribution to surface mass balance change. There are few observations of antarctic blowing snow and those available suggest systematic model biases in blowing snow conditions. Although the current mean surface mass balance of Antarctica is relatively well know from glaciological measurements, there is a deficit of evaluation and validation of the independent components and thus of the physical processes which may be individually and differently altered in a changing climate.

P-1107-08

Avoided Sea Level Rise from thermal expansion for RCP4.5 versus RCP8.5

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Observational evidence shows that as the global mean temperature increases, the global mean sea level is also rising. The rising sea level could impose significant impacts on coastal communities, especially when this rising sea is compounded with storm surges. Here, by analyzing

results from two sets of ensemble simulations using the Community Earth System Model version 1, we study the potential avoided sea level rise over the 21st century on global and regional scales if a climate pathway of RCP4.5 is followed versus RCP8.5. Results show that the global mean sea level rise averaged over 2061-2080 due thermal expansion of sea water can be reduced by about 25% (~3.7 cm). Regionally, this avoided sea level rise can be marginal in some areas, such Melbourne, Australia (14cm vs. 13cm), and can be very large in others, such as New York (35cm vs. 25cm) due to regional changes in dynamical forcing.

P-1107-09

Analyses of altimetry errors using Argo and GRACE data

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Since the first altimeter missions and the improvements performed in the accuracy of sea surface height measurements from 1992 onwards, the importance of global quality assessment of altimeter data has been increasing. Global Cal/Val studies are usually performed by the analysis of internal consistency and cross-comparison between all missions. In this study, the steric and mass contributions to the sea level provided by Argo profiling floats and the Gravity Recovery And Climate Experiment (GRACE) mission respectively are used as independent sources of comparison to analyze the altimetry errors.

Argo profiling floats are spread out over almost the global open ocean since 2004. However, they measure temperature and salinity vertical profiles, providing only the steric contribution to the total sea level content measured by altimeters. The missing mass contribution is derived from the GRACE data set from 2003 onwards.

The comparison is performed with the first objective of detecting global and regional altimeter mean sea level drifts. A second goal is to assess the impact of new altimeter standards (orbit, geophysical corrections, ground processing) and new versions of altimeter merged products such as the 2014 AVISO reprocessing or the Sea Level CCI data set. We also focus our work on sensitivity analyses of the method of comparison to various parameters. In particular, we determine to which extent the altimeter quality assessment is affected by a different pre-processing of altimeter data, a sub sampling of the Argo network and a change of the reference depth used to compute Argo dynamic heights.

P-1107-10

An upper limit of future sea-level rise

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For coastal protection an upper limit of future sea-level rise is of much higher value than the likely range provided by the Intergovernmental Panel on Climate Change AR-5. Based on state-of-the-art process-based simulations and physical considerations, an upper limit for the global mean sea-level rise of the 21st century is presented. It is shown that this upper limit is consistent with the likely range provided by the IPCC-AR5, but far exceeds the upper value of this likely range. For practical purposes a full probability distribution is suggested which is both consistent with the IPCC-range and the upper limit estimate.

P-1107-11

Climate change impacts on Nef Glacier and repercussions on the hydrological regime of Nef River (Patagonia, Chile)

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The Nef River, with its origin in the Nef Glacier, located on the Northern Patagonia Icefield (Chile), drains a glacierized basin of 800 km². In this study, fluctuations between 2005 and 2010 in the discharge of Nef River measured close to the Nef Glacier's front, were analyzed. Throughout the whole data series, the discharge follows a seasonal fluctuation with a mean discharge of 27.1 m3/s and 78.3 m3/s for the fall/winter and spring/summer season, respectively. During autumn, spring, and summer, several floods are related in terms of temperature peaks. The highest flood of the whole period (189 m3/s) was observed on 11 March 2009 and occurred as a result of a significant increased of the air temperature (from -0.9°C to +12.5°C) appeared during the 5 previous days to the flood triggering increase of glacier melting.

In order to quantify the Nef Glacier's melting (in function to the air temperature) during spring and summer seasons, a simplified degree-day method was applied for the 2007-2008 hydrological year (which is the only period without gaps on the data series). The glacier melt water contributed for 30% to the total discharge; meanwhile precipitation represents only a 7.2%.

In addition, we found that Glacial Lake Outburst Flood (GLOF) events occurred at Nef Norte Lake (a small proglacial lake originated on a lateral front of Nef Glacier) can contribute significantly to the total discharge of Nef River. Indeed, the surface area of the lake was monitored using SPOT 5 satellite images and DEMs. By 23th March 2008, the lake lost at least 25% of the surface measured in 13th March and the water level of the lake was 33.6 m lower (equivalent to 6*106 m3). This amount is therefore coherent with the increase of discharge of 25.5 m3/s recorded between 15th and 20st March 2008. In consequence, we suggest that a GLOF event was responsible of the 4th highest flood (156.8 m3/s) of the 2005 - 2010 period.

GLOF events, which increased their frequency in Patagonia during the last decade, are the clear evidence of constant glacier thinning as response to climate change. The ablation area of Nef Glacier thinned 1.8 m between 2001 and 2011.

These results confirm that a hydrological approach applied to the glacial runoffs can correctly estimate glacier melting coming from ablation area, which is largely unknown at basin scale in the Northern Patagonia Icefield.

P-1107-12

Recent acceleration of glacier retreat in the Northern Patagonia Icefield based on an updated decennial evolution

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The glacier length fluctuations and the surface area evolution between 2001 and 2011 of 25 glaciers of the Northern Patagonia Icefield (NPI) were studied: the information extracted from the Landsat ETM+ satellite image of 11 March 2001 was compared to the measurements performed based on the Landsat ETM+ satellite image of 19 February 2011. From a global point of view, the majority of the studied glaciers thinned, retreated and lost surface between 2001 and 2011, only few glaciers (Leones, Nef, Pared Sur and Soler) located on the eastern side of the NPI have been stable. Glaciers located on the western side of the NPI suffered a stronger wasting compared to the glaciers located on the eastern side.

Between 2001 and 2011, a noteworthy retreat of 1.9 km was experienced by Gualas Glacier and by Reichert Glacier with 1.6 km, both located on the north-western side of the NPI. On the south-western side of the NPI, during the same decennia, Steffen Glacier experienced a remarkable retreat of 1.6 km as well. During the 2001-2011 period, Steffen Glacier more than doubled its rate of retreat (compared to the 1979-2001 period) and experienced the disintegration of its main front as well as a lateral tongue that retreated

3.1 km. The most significant retreat observed on the eastern side was experienced by Colonia Glacier (1 km).

Area loss was also relevant during the period 2001-2011. Overall, the icefield experienced a reduction of 50.6 km² which represents a 1.3% relative to the surface area calculated for 2001 year. The most remarkable surface reduction was observed for HPN-1 Glacier that lost 3.2% of its surface estimated in 2001, followed by Steffen Glacier (2.8%).

We suggest that the glacier shrinking observed in the NPI is controlled firstly by atmospheric warming, as it has been reported in this area. Nevertheless, updated climatic studies are needed in order to confirm this suggestion. If the detected past climate trends persist, in the future, glaciers of the NPI will continuous or even increase their rate of shrinking generating important consequences for this region like the production of Glacier Lake Outburst Flood events or the decrease of the melt-water runoff in the long-term future.

P-1107-13

Use of Differential SAR Interferometry for vertical ground motions monitoring in coastal cities

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Before the altimetry era, tide gauge are a unique source of information to evaluate past sea-level changes. However, they can be affected by vertical ground motions acting at different space scales. We use synthetic aperture radar techniques to assess these ground motions and their consequences for geodetic instruments such as Tide Gauge, GPS, Doris stations. Summarizing results obtained at Alexandria (Egypt; Woppelmann et al., 2013), Manila (Philippines; Raucoules et al., 2013) and Dakar (Senegal; Le Cozannet et al., subm.), we identify different situations in terms of data availability and ground motion context: - when strong ground motions affect the tide gauge, the technique can easily help rejecting tide gauges records from the database of reliable datasets (case of Manila) - however, when no ground motions can be observed using InSAR in the vicinity of geodetic instruments (Case of Alexandria and Dakar), it remains challenging to reach the accuracy required to confirm that tide gauge records are indeed suitable for monitoring sea level changes. To reach the required accuracy of this InSAR application, a large set of SAR data must have been acquired over the area. For future science application of Sentinel 1 in the field of geodesy underpinning sea level science, it will be necessary to define appropriate background missions covering coastal sites where key records have been aquired.

P-1107-14

Sea level rise and Geoid: Factor analysis approach

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Sea levels are rising around the world, and this is a particular concern along most of the coasts of the United States. A 1989 EPA report shows that sea levels rose 5-6 inches more than the global average along the Mid-Atlantic and Gulf Coasts in the last century. The main reason for this is coastal land subsidence. This sea level rise is considered more as relative sea level rise than global sea level rise. Thus, instead of studying sea level rise globally, this paper describes a statistical approach by using factor analysis of regional sea level rates of change. Unlike physical models and semi-empirical models that attempt to approach how much and how fast sea levels are changing, this methodology allows for a discussion of the factor(s) that statistically affects sea level rates of change, and seeks patterns to explain spatial correlations.

Cartographers and geodesists, those who study the measurement of the size and shape of the earth, are interested in sea level as an elevation datum. This datum is called the geoid, which is defined as the equipotential gravity surface of the Earth, and theoretically best fits global mean sea level in ocean areas. Hence, the rate of change in mean sea level directly affects changes to the geoid and the elevation datum used as the reference for topographic mapping.

Many methods have been used in sea level rise modeling. These methods can be divided into two categories: physical models, based on the conservation of mass (global water mass and ice mass measurements), and semi-empirical models, studying measured rates of change of sea level and measured changes in global temperatures along with the error estimates of measurements to predict future trends. These two approaches are complementary. For example, no one really understands the dynamics of each and every glacier, so it is quite difficult to calculate melting glaciers from physical models, hence the use of semi-empirical methods described in the majority of studies of sea level rise. This paper introduces a different approach by using factor analysis of regional sea level rates of change as a statistical analysis tool. Instead of answering the question of how much and how fast sea levels are changing, this paper computes and discusses which mathematical factor statistically affects sea level rates of change and seeks patterns to explain spatial correlation. The paper also seeks to hypothesize that any insights into the factors influencing sea level change also apply to the changes to the geoid.

P-1107-15

Strategy and new statistical downscaling method for the on-line derivation of the Greenland ice sheet surface mass balance in a GCM

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Current CMIP5 (Coupled Model Intercomparison Project Phase 5) coupled Global Climate Models (GCMs) cannot realistically represent ice sheet/climate feedbacks. This is due to their coarse horizontal resolution, which hampers the correct representation of Surface Mass Balance (SMB) spatial variability, to weaknesses in the representation of physical processes at the ice sheetsurface and to the lack of interactive ice sheet models which are necessary torepresent the ice loss due to dynamics. As a contribution to the future inclusion of interactive ice sheet models in coupled GCMs, we discuss various potential methods. We present a downscaling method designed for the online derivation of the SMB field over the Greenland ice sheet (GrIS). This method uses statistical relationships between SMB and temperature variations which have been established from off-line simulations of the SMB performed on a high resolution grid with a detailed snowpack model. We used this technique to downscale 150 km horizontal resolution SMB output from the CNRM-CM5.1 GCM to a 15 km resolution grid. A comparison with output from the MAR regional model shows that the downscaling clearly improves the spatial distribution of the SMB, particularly along the GrIS margins, where steep topography gradients are not correctly represented at low-resolution. A simulation where CNRM-CM5.1 was nudged with ERA-Interim demonstrates the ability of the method to reproduce reasonably well the interannual variability of the total GrIS SMB from 1979 to 2012. From a technical point of view, the method is generic enough to be applied to outputs from other GCMs, though it cannot completely filter model biases, especially in the interior of the GrIS.

P-1107-16

Sea-level change and projection for future flooding along the coast off Egypt

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The current study analyses the recent changes in the daily satellite altimetry data along the southern Levantine sub-basin and cost off Egypt over the period 1993-2013. First,

the accuracy of using satellite altimetry data, represented by dynamical topography (DT) as a measure of coastal sea levels, is examined based on tide gauges observations. Second, daily and annual satellite altimetry data are related to five atmospheric/oceanic factors to evaluate their effect on DT changes. Third, the qualities of three realisations of the Geophysical Fluid Dynamics Laboratory (GFDL) global climate model (GCM) are examined by comparing these with the satellite altimetry dataset. Finally, the simulations that best describes the present satellite altimetry data are used to describe the uncertainties in projection of the sea level changes along the study area.

The results indicate that the satellite altimetry data represented by DT can be used to study coastal and deep sea level changes in the study area. Southern Levantine sub-basin sea level display a recent average sea level rise of 3.1 cm decade-1 and exhibits a significant annual sea level variation from -17 cm (deep water) to 8 cm (shallow water). The sea level variations are significantly affected by several factors such as and in order of importance: sea level variations west of Gibraltar Strait, steric sea level variations and sea surface temperature. The GCMs that most realistically describe the recent sea level over the study area is GFDL-CM3, outputs from this model are used to study the projected sea level along the study area for different emission scenarios. GFDL-CM3 model results indicate that the coast of Egypt will experience sea level rise in the current century. Uncertainty in the projected sea level rise over the studied area ranged from 4 to 22 cm rise by 2100 and was explained by three different sources of uncertainties, of which the emission assumed dominated. Comparing of uncertainty in the projected sea level rise with digital elevation data shows that the Egyptian Mediterranean coast will only become safe from flooded by the end of 21st century if effective adaptation methods are applied.

P-1107-17

Earth's changing oceans: Effects and implications for iceberg calving from Antarctica's ice shelves

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Ice shelves are freely floating seaward extensions of the Antarctic ice sheet. They can extend hundreds of kilometers into the ocean and drain the vast majority of ice from Antarctic ice sheet to the ocean. Iceberg calving from these ice shelves is the primary means of discharging ice from the Antarctic Ice Sheet into the Southern Ocean and, although calving events occur sporadically, when they do occur they remove large amounts of mass in a nearly instantaneously. This cycle forms part of the natural cycle of ice shelf advance and retreat with typical recurrence times between major calving events of the order of several decades. However, changes in calving rates have also been implicated in some of the most rapidly changing regions of Antarctica. Scambos et al. (2003) showed that the abrupt disintegration of both Larsen A and Larsen B ice shelves occurred following a series of abnormally warm summers. Not only were these disintegrations surprising in terms of size, but also in the speed at which they occurred; approximately 13,500 km^2 of ice was lost by the collective Antarctic ice shelves due to collapse in the last three decades of the 20th century, deemed to be possibly related to the approximately 3 degrees C increase in temperature at the Antarctic Peninsula over the last half of the century (Steffen et al., 2010). Despite the fact that calving accounts for at least half of the mass loss from the ice sheet (Rignot et al., 2013), but its relation to the changing climate remains poorly understood.

Many major and minor ice shelves of Antarctica exist in a colder climate further South than the peninsular ice shelves and have not experienced comparable surface warming nor are they currently showing any signs of peninsular-style disintegration. They have, however, experienced increased basal melting over the past decade with some speculation that these ice shelves may especially be susceptible to ocean forcing. To realistically assess the evolution of ice shelves it is necessary to investigate the precursor to calving: the initiation and propagation of rifts through the ice. As ice flows toward the open water rifts eventually become the boundaries at which icebergs separate from their parent ice shelf. An example of such a rift was detected in October 2011, at Pine Island Glacier (PIG) in West Antarctica. The PIG flows outward into the Amundsen Sea, creating a 30-km floating ice tongue. As the floating shelf elongates from the grounding line, cracks eventually form and icebergs calve off later. Rifts can initiate far upstream of the calving front and propagate for decades before an iceberg detaches. While many studies have examined the dynamics of vertical crevasse penetration, fewer studies have examined lateral propagation and little is currently known about the forces and underlying mechanisms that drive rift propagation. For example, it has been proposed that rifting is the cumulative result of many environmental factors, such as ocean swell induced flexure caused by pulses of ocean swell or that rifting is primarily the result of internal mechanical stresses acting to fracture the ice.

In this study we continue the monitoring work that was published in 2013, conducting observations of 15 ice shelves around Antarctica over a 15 year period between 2000 and 2015. While previously we only compared tidal swell data with rift propagation data sets, we now use a variety of oceanic data and model results to better characterize the effect of ocean changes on ice sheet and specifically the evolving effect that Earth's changing oceans might have on solid ice discharge rates from Antarctica's ice shelves.

P-1107-18

The Irreversibility of Sea Level Rise

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Recent research has shown that sea level continues to rise even if carbon dioxide emission will be halted completely. Here we explore whether artificial atmospheric carbon dioxide (CO2) removal (also referred to as "negative emissions") has the potential to reverse thermosteric sea level rise on timescales relevant to human civilization. Specifically, we investigate how much CO2 needs to be removed from the atmosphere for sea level rise to be reversed and stabilized permanently, and the degree to which the reversibility of sea level rise depends on the amount and duration of CO2 emissions prior to the time of artificial CO2 removal. To investigate these questions, an Earth System model of intermediate complexity is forced with a range of emission scenarios entailing different amounts of net negative CO2 emissions. We find that in order to reverse and stabilize sea level rise, atmospheric CO2 concentrations need to be returned to pre-industrial levels. Thermosteric sea level rise is linked to the integrated net radiation flux at the top of the atmosphere, and will stop rising only when this flux becomes negative (i.e. when there is a net radiation loss to space). Our results suggest that while sea level rise can be reversed temporarily with negative emission technologies deployed at a scale that is currently deemed to be technologically feasible, reversal and permanent stabilization of sea level rise requires the removal of all anthropogenic CO2 from the atmosphere.

ORAL PRESENTATIONS

K-1108-01

Future stratospheric ozone in a changing climate

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As a result of the Montreal Protocol on Substances that Deplete the Ozone Layer and its subsequent amendments and adjustments that constrained the production and consumption of halocarbons, the decline of stratospheric global ozone seems to have ceased. Model projections suggest a future recovery of the global mean ozone column to levels around the year 1980, when only low levels of ozone depleting substances (ODSs) existed in the stratosphere. However, the timing of the return of ozone to historical levels depends not only on the concentrations of ODSs but is also affected by thermal and dynamical changes associated with increasing greenhouse gas concentrations. For example, while the amounts of ODSs steadily decrease in the stratosphere, with appropriate meteorological conditions and given the long lifetimes of ODSs, individual years with strong ozone decrease still may occur in the near future.

Here, an overview of future projections of the ozone layer based on chemistry-climate model simulations will be presented. The impact of climate change on stratospheric ozone recovery will be discussed.

K-1108-02

Stratosphere-Troposphere Coupling in a Changing Climate

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Stratospheric variability and change has substantial effects on surface weather and climate, especially on the Annular Modes, with shifts in the jet streams, storm tracks, precipitation, and likelihood of blocking events. Despite unambiguous observations of this phenomenon, as well as numerical simulations, a clear physical explanation of this downward coupling has been elusive. In this talk I will discuss recent advances in our understanding—how pressure changes (movement of mass) in the stratosphere affects surface climate. However, movement of mass in the stratosphere is not sufficient to fully explain the observed surface changes—surface effects are than would be expected theoretically, and are larger than at the tropopause. This "tropospheric amplification" is easily quantified, and suggests a role for eddy feedbacks in response to the movement of mass. I will discuss the future implications for surface climate, jets, storm tracks, etc.—assuming that we know how the stratosphere will change during the remainder of this century.

O-1108-01

Sub-seasonal climate predictability associated with an anomalously strong stratospheric polar vortex

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There has been a great deal of recent interest in producing weather forecasts on the 2-6 week sub-seasonal timescale which bridges the gap between medium-range (0-10 day) and seasonal (3-6 month) forecasts. While much of this interest is focused on the potential applications of skilful forecasts on the sub-seasonal range, understanding the potential sources of sub-seasonal forecast skill is a challenging and interesting problem particularly because of the likely state-dependence of this skill (Hudson et al., 2011). One such potential source of state-dependent skill for the Northern Hemisphere in winter is the occurrence of stratospheric sudden warming (SSW) events (Sigmond et al., 2013). Here we show, by analysing a set of sub-seasonal hindcasts, that there is enhanced predictability of surface temperature and circulation not only when the stratospheric vortex is anomalously weak following SSWs but also when the vortex is extremely strong. During the third and fourth weeks following anomalously strong polar vortex conditions northern Europe and northern Russia are on average three degrees Celsius warmer than their climate norm, with similarly sized cold anomalies over northwestern North America. Sub-seasonal forecasts initialised during strong vortex events are able to successfully capture their associated surface temperature and circulation anomalies. This results, for some regions, in a significant enhancement of forecast skill compared to forecasts initialised during cases when the stratospheric state is close to climatology. We demonstrate that the enhancement of skill for forecasts initialised during periods of strong vortex conditions is comparable to that achieved for forecasts initialised during SSW events. this result indicates that additional confidence can be placed in sub-seasonal forecasts when the stratospheric polar vortex is significantly disturbed from its normal state. This presentation will discuss this result and its implications for understanding the impact of stratospheric climate change and its tropospheric impact.

O-1108-02

Characteristics of stratospheric warming events during Northern Winter

P. Maury, (1) ; C. Claud (1) ; E. Manzini (2) ; A. Hauchecorne (3) ; P. Keckhut (4) ; K. Kodera (5)
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The polar mid-stratosphere is characterized by the setting up of westerly winds around the pole during the wintertime; the so-called polar vortex. The polar vortex is one of the most variable features of the zonal-mean circulation of the earth atmosphere, due to a highly non linear interaction between planetary-scale Rossby waves and the zonal flow. Indeed, the interaction between the upward tropospheric propagating waves and the polar vortex leads to a zonal flow weakening, implying a large day-to-day vortex variability. In the most dramatic cases, the polar vortex breaks down, the stratospheric polar flow can reverse its direction and the temperatures can rise locally by more than 50K in a span of a few days. Such phenomena are known as major Sudden Stratospheric Warmings (SSWs) and constitute, since their discovery in 1952 (Scherhag,1952) the most impressive dynamical events in the physical climate system. On the contrary, situations where the temperature increase is not associated to a polar vortex breakdown are known as minor SSWs.

There is actually a renewed interest about SSWs since Baldwin and Dunkerton (2001) have shown that the major SSWs can influence weather in the troposphere. This stratospheric-tropospheric linkage has been statistically highlighted but no physical explanation has been proposed. Also, other studies, that incorporate both major and minor SSWs, show that events in the stratospheric zonal flow associated with SSWs present downward-propagating anomalies that can reach the troposphere (Limpasuvan et al 2004), implying that minor SSWs have to be also considered in the study of the stratospheric-tropospheric dynamical coupling.

In this study, we propose a global characterization of stratospheric warmings situations based on a temperature threshold in the 50-10hPa layer between 70N-90N, in order to better assess the properties of daily stratospheric temperature variability during the northern winter. The originality of this approach consists in evaluating the wintertime positive temperature anomalies in terms of intensity and duration without distinction between minor and major SSWs. We will show that there is a wide

spectrum of warming types, where major SSWs are the most extreme, but other events – the minor SSWs – share some common properties with them. They can even have a surface signature if one look the stratospheric wave reflection on the polar vortex.

O-1108-03

Update of stratospheric temperature interannual variability and trends from space sounders and ground-based lidars observations

A. Hauchecorne (1) ; P. Keckhut (1) ; C. Claud (2) ; B. Funatsu, (3) ; S. Khaykin, (1) ; G. Angot, (1) ; P. Maury, (2)

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The stratosphere is expected to cool, in conjunction with the global warming at the surface and in the troposphere, due to the increase of greenhouse gas concentration in the atmosphere, and also to stratospheric ozone loss. This is already observed but the rate of cooling is not constant and there is still a debate on its amplitude. Several other factors may influence the evolution of the stratospheric temperature. External forcings, like the solar variability that modulate the UV solar flux and strong volcanic eruptions injecting aerosols in the stratosphere, participate to its decadal variability. The variability of the stratospheric dynamics is also adding some complexity to the system. For instance global climate models predicts an increase of the occurrence frequency of sudden stratospheric warming (SSW) events not yet confirmed by the observations. A monitoring of the stratospheric temperature evolution is crucially needed to better understand the complexity of the processes playing a role in the coupling between the stratosphere, the troposphere and the climate.

The stratospheric temperature is measured at a global scale by satellite instruments; mainly microwave sounders AMSU (Advanced Microwave Sounding Unit) on board meteorological satellites. These sounders are very useful to provide the global overview but may suffer from biases and orbital drifts and have a poor vertical resolution in the upper stratosphere. Since 2000 radio-occultation sensors, among them the US-Taiwan COSMIC constellation, provide well-resolved and accurate temperature profiles but limited to the upper troposphere-lower stratosphere. Rayleigh lidars implemented within the NDACC (Network for the Detection of Atmospheric Composition Change) international network measure accurately the temperature profile from the middle stratosphere to the upper mesosphere but in a very few locations. They are used climate change monitoring, dynamics studies and satellite validation.

In this presentation we will present an update of the interannual variability and trends in the stratospheric temperature from AMSU, Rayleigh lidar and radio-occultation measurements. Similarities and differences in the temperature evolution captured by these various sensors will be evaluated. The contribution of anthropogenic and natural forcings to the observed changes will be discussed. A particular focus will be given to the role of SSW events to the stratospheric temperature evolution as a function of latitude and season.

O-1108-04

Role of the middle atmosphere for low-frequency climate variability

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It is commonly believed that the ocean represents the dominant source for climate variability on longer, interdecadal time scales and that this drives the low-frequency variability of the atmosphere. Here, we provide evidence for the existence of opposite pathways. Investigating long control simulations with coupled and uncoupled climate models we find considerable multi-decadal variability in the atmosphere that is independent of the ocean and that influences climate. The middle atmosphere represents one source for such low-frequency variability. The variability is related to relatively long-lived fluctuations in the strength of the stratospheric polar vortex, which in turn project on the state of the North Atlantic Oscillation. This creates signals in ocean temperatures over the deep convective region to the south of Greenland, which, over the course of several years, propagate into the deep ocean. These events modulate and drive intrinsic low-frequency variability in the Atlantic Multidecadal Overturning Circulation (AMOC) and explain about 20% of the natural AMOC variability. Our findings support the view that trends and low-frequency variations in the middle atmosphere extend their influence beyond the troposphere into the ocean and that this constitutes an important source of climate variability. We discuss natural and anthropogenic sources for such low-frequency stratospheric variability.

O-1108-05

The millennium water vapour drop in the stratosphere in chemistry-climate model simulations

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This study investigates the millennium water vapour drop, the abrupt and severe water vapour decline in thestratosphere beginning in year 2000, by means of various simulations using the Chemistry-Climate Model (CCM)EMAC. Since the beginning 1980s, balloon borne stratospheric water vapour measurements and correspondingsatellite measurements starting in the early 1990s indicated a long-term steady increase of water vapour concentrations.However, the multi-year data sets also show significant fluctuations on different time scales. In theyear 2000, an extraordinary sudden drop of stratospheric water vapour concentration has been observed followedby persistent low values for several years. Solomon et al. (2010) showed that this drop slowed down the rate ofincrease in global surface temperature over the following decade by about 25%. So far, the stratospheric watervapour variations observed by satellite from 1992 to 2012 are not reproduced by CCM simulations forced byobserved changes in sea surface temperatures, greenhouse gases and ozone-depleting substances (Gettelman et al.,2010, Randel and Jensen, 2013).However, the CCM EMAC is able to reproduce the signature and pattern of the water vapour disturbances inagreement with those derived from observations. In this paper we present results of a hierarchy of simulationswith the CCM EMAC, demonstrating that it is possible to retrace the observed water vapour fluctuations in thestratosphere (incl. the millennium drop), if suitable inner and outer boundary conditions are applied.

1108-POSTER PRESENTATIONS

P-1108-01

The ARISE project: dynamics of the atmosphere and climat

E. Blanc (1) ; A. Charlton-Perez (2) ; P. Keckhut (3) ; L. Evers (4) ; P. Heinrich (1) ; A. Le Pichon (1) ; A. Hauchecorne (5)

(1) CEA, Arpajon, France; (2) University of Reading, Department of meteorology, Reading, United Kingdom; (3) LATMOS-IPSL, Guyancourt, France; (4) Royal Netherlands Meteorological Institute (KNMI) , De Bilt, Netherlands; (5) CNRS, Latmos, Guyancourt, France

It has been robustly demonstrated that variations in the circulation of the middle atmosphere influence weather and climate throughout the troposphere all the way to the Earth's surface. A key part of the coupling between the troposphere and stratosphere occurs through the propagation and breaking of planetary waves and gravity waves. Limited observations of the middle atmosphere and these waves in particular hamper our ability to faithfully reproduce the dynamics of the middle atmosphere in numerical weather prediction and climate models.

An exciting scientific development in recent years has been the potential for a number of novel ground-

based measurement techniques to give new and complementary measurements of the middle atmosphere. The main challenge of the ARISE (Atmospheric dynamics InfraStructure in Europe) project[1] is to combine for the first time existing national and international observation networks which observe the middle atmosphere including: the International infrasound monitoring system developed for the CTBT (Comprehensive nuclear-Test-Ban Treaty) verification, the NDACC (Network for the Detection of Atmospheric Composition Changes) lidar network, localized European observation infrastructures at mid latitudes (OHP observatory), tropics (Maïdo observatory), high latitudes (ALOMAR and EISCAT), infrasound stations developed at national level in European countries and satellite measurements. This joint network provided advanced data products, with the scope to assemble the derived upper atmospheric wind and temperatures into NWP models.

The ARISE infrastructure is unique because of its coverage (from polar to equatorial and tropical regions in the European longitude sector and adjacent regions), its ability to sense a wide range of altitudes (including stratosphere, mesosphere, lower thermosphere, ionosphere) and the involved scales both in time (from seconds to tens of years) and space (from tens of meters to thousands of kilometers). We are about to embark upon a new phase of development to allow the network be improved by i) including innovative instrumentation for measurements in the middle atmosphere between 40 and 80 km where temperature and wind measurements are especially rare, ii) adding measurements in low latitude African stations where only infrasound observations are currently available, iii) and by automating lidar and radar measurements for routine observations.

The major ARISE objective is to provide a full description of gravity and planetary waves in the stratosphere and mesosphere for wave parameterization and assimilation in the models. This could lead to a better prediction of extreme events such as Sudden Stratospheric Warming and improvement of the tropospheric weather forecasts on weekly time scales. The societal impact is potentially very large, including for sectors such as agriculture, industry, energy consumption, transport, insurance and risk quantification.

ARISE objectives are also i) to better characterize the coupling between atmospheric layers and effects on the global atmospheric circulation and climate, ii) to quantify the trends in extreme events relate to climate, iii) to determine the impact of the Earth's geo-space.

The project is multidisciplinary and includes European groups with complementary expertise in weather forecasting, climate, extreme events monitoring. It has partners in a number of international organizations including the ECMWF (European Centre for Medium-Range Weather Forecasts), WMO (World Meteorological Organization), SPARC (Stratospheric Processes And their Role in Climate), ROSMIC (Role Of the Sun and the Middle atmosphere-thermosphere-ionosphere In Climate), IRGGEA (International Research Group in Geophysics Europe Africa).

This presentation will review recent advances in this topic especially obtained in the framework of the ARISE project. It will also discuss perspectives and future project challenges related to climate.

[1] ARISE is an infrastructure Design Study project funded by the European Commission under the H2020 program.

P-1108-02

Stratospheric chemistry-climate interactions and their importance for the surface climate in Antarctica

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One prominent example of anthropogenic environmental change is the annually recurring ozone hole in the Southern Hemisphere (SH). This systematic change in stratospheric composition affects circulation and tropospheric climate. To improve our understanding of how a stratospheric change induces shifts in tropospheric climate, we investigate model integrations run with the fully coupled chemistry climate model UM-UKCA. Results are confronted, where appropriate, with satellite observed changes from the MIPAS instrument on ENVISAT.

Comparing two climate-equilibrium runs with and without an ozone hole we find statistically significant changes in the models thermal structure and circulation. Polar lower stratospheric cooling, in conjunction with the elevation of the high latitude tropopause and followed by an increase in the vertical component of the EP flux from November to December are consistent with a surface warming of the Antarctic Peninsula in December. The seasonal change of circulation is accompanied by an apparently descending anomaly of the EP flux divergence in the stratosphere, thus suggesting an active role of stratospheric dynamics in the surface response.

The robustness of such a circulation response to ozone changes can be studied diagnosing differences of long-lived trace gas distributions as an indicator for large-scale circulation changes. Here, we contrast the MIPAS observed year-to-year variability in N2O to changes in the seasonal evolution of N2O in different modelled climate equilibrium states with different ozone amounts. We conclude that the climate system can respond sensitively (but coherently) in its seasonal evolution to small chemical perturbations and the circulation adjustments modelled are consistent with observed interannual variability. This finding supports the applicability of the UM-UKCA climate equilibrium runs to the interpretation of the Antarctic Peninsula warming.

P-1108-03

Stochastic parameterizations of the gravity waves emitted from convection and fronts: theory, validation, and impacts of the middle atmospheric circulation

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Internal gravity waves (GWs) propagating vertically from their tropospheric sources impact the circulation of the middle atmosphere, and are crucial for the reversal of the mesospheric jet and the maintenance of the quasi-biennial oscillation. Their spatial scales being too small to be represented in current Earth System models, they need to be parameterized. Nevertheless, mechanisms for GW emission by fronts and jets remain elusive nowadays. As a result, non-orographic GW parameterizations have traditionally assumed an arbitrarily uniform source of waves, which makes them insensitive to the annual cycle of the GW sources or to a changing climate. For these reasons, much effort has been made over the last decade to develop schemes that relate the GWs to their sources.

A recently developed stochastic parameterization of gravity waves is used and adapted to represent the gravity waves produced by convection and mid-latitude fronts. For the fronts, the parameterization uses a theory of the spontaneous adjustment that relates directly the gravity waves field to potential vorticity anomalies. With relatively little modification to the theory, we show that the spontaneous adjustments occurring in the troposphere are sufficient to produce the right amount of waves in the mesosphere. We also predict the gravity wave field present during the Concordiasi long-duration balloon campaign in the lower stratosphere, and show that the gravity waves predicted by the parameterization are quite realistic. The impacts on the climate are also addressed with the General Circulation Model LMDz, with a particular emphasis on the annual cycle in the stratosphere. We also address the significance of including the GWs sources on the middle atmosphere response to a changing climate. Preliminary results show that when GW sources are included, the middle atmosphere response to climate change is stronger than without the sources, the impacts even reaching the surface at least in the Southern Hemisphere.

de la Cámara, A., and F. Lott, 2015: A parameterization of gravity waves emitted by fronts and jets, Geophys. Res. Lett, doi: 10.1002/2015GL063298.

de la Cámara, A., F. Lott, and A. Hertzog, 2014: Intermittency in a stochastic parameterization of non-orographic gravity waves, J. Geophys. Res. Atmos., 119, 11,905-11,919, doi:10.1002/2014JD022002.

Lott, F., and L. Guez, 2013: A stochastic parameterization of the gravity waves due to convection and impact on the equatorial stratosphere, J. Geophys. Res., 118 (16), 8897–8909.

P-1108-04

On the coupling between polar and tropical regions during springtime: variability of tropical intrusion and Frozen In Anticyclones

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Recent observational and modeling transport studies of Arctic stratospheric final warming have shown that tropical/subtropical air masses can be transported to high latitudes and remain confined within a long-lived "frozen-in" anticyclone (FrIAC), embedded in the summer easterlies for several months.

We first present a climatology of these sporadic events over the period 1960–2011 using ERA-40 and ERA Interim reanalyses. This study highlights stratospheric favorable preconditioning for FrIACs occurrence, that is: i) early and abrupt final warming, ii) no stratospheric major warming during the previous winter, and iii) East phase of the Quasi-Biennial Oscillation. We will present in detail the FrIAC in spring 2011, which was the largest ever recorded. Our climatology further suggests that the frequency of occurrence of FrIACs has increased over the last decade (among the nine cases detected over the period 1960–2011, five occurred between 2002 and 2011).

A chemistry climate model is then used for the first time to investigate FrIACs characteristics and variability. Simulations were performed with the NCAR's Community Earth System Model (CESM, version 1.0.2), a coupled model system including the Whole Atmosphere Community Climate Model (WACCM). FrIACs characteristics (i.e. spatial extent and duration), are overall consistent by comparing with FrIACs detected ERA-40 meteorological reanalyses. Dynamical analysis reveals that FrIACs are associated with an abrupt and early winter-to-summer stratospheric circulation transition, characterized by an amplification of planetary wave activity. Furthermore, our model results confirm that FrIACs occur preferentially under the easterly phase of the QBO and in absence of MSW during the preceding winter. Finally, we notice that extreme climate change conditions (RCP8.5 scenario) do not influence FrIACs frequency.

P-1108-05

Stratospheric ozone causes a negative feedback in CO2-driven climate change simulations

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Ozone has been considered mainly as a contributor to climate change in terms of radiative forcing. However, it is also providing a radiative feedback when climate change is induced by, for example, a radiative forcing from CO2 increase. Interactively coupled chemistry-climate models can be used to identify and quantify this feedback. In a set of simulations forced by CO2 increase of different strength we find a negative ozone radiative feedback, which reduces the climate sensitivity compared to a model system where the ozone distribution is prescribed. Stratospheric ozone is more important than tropospheric ozone for this chemical feedback. The feedback mechanisms mainly works through intensification of the Brewer-Dobson circulation as sea surface temperature increases. The stratospheric water vapour feedback is modified by interaction with the ozone feedback, becoming less positive than in simulations with fixed ozone. Hence, a negative ozone feedback and a reduced water vapour feedback overlap constructively in CO2-driven simulations with interactive ozone, giving a global sea surface temperature response that is 4 to 10% smaller than in a corresponding simulation without interactive chemistry.

P-1108-06

Evidence by remote sensing and combined-model approaches for the role of gravity waves in sudden stratospheric warmings

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Observations of absolute values of gravity wave momentum flux (GWMF) from the satellite instruments SABER ad HIRDLS in conjuncture with global stratospheric and mesospheric winds are used to investigate the role of GWs in the different phases of the sudden stratospheric warmings (SSWs) during the recent decade. Both GWMF and its vertical gradient as a proxy for drag are enhanced before the central date of major SSWs. After the central date of the SSW, GWMF and gravity wave drag in the stratosphere are strongly reduced. However, GWs contribute to the downward propagation of newly formed polar jets and of elevated stratopauses to their «climatological» altitude. This is likely at least in part due to poleward propagation of GWs. In order to shed light on the sources, propagation direction and phase speed spectra of the waves we complement the observations by high-resolution global model fields of ECMWF. We use these fields to infer the characteristics of GWs in the lower stratosphere and couple the results to global ray-tracing. This allows us to a) infer sources of GWMF by backward ray-tracing and b) to study the interaction of GWs in the stratosphere and mesosphere by forward ray-tracing in the background of geostrophic winds inferred from MLS and SABER. The current satellite observations can not reveal the propagation direction of the waves and model data need still to be proven to be fully realistic: the advantages of both approaches would be combined in limb-imaging measurements of a future mission. A concept for such an instrument is presented.

P-1108-07

The impact of biogenic bromine emissions from the oceans on the middle atmosphere in a changing climate

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Bromine from very short-lived substances, primarily from natural oceanic sources, contribute substantially to the halogen loading of the free troposphere and stratosphere with an important impact on atmospheric chemistry. This source of atmospheric bromine has so far been ignored in most chemistry-climate model simulations of tropospheric and stratospheric ozone trends. Here we will present chemistry climate model simulations over the past decades including the biogenic emissions of bromine from the oceans and their impact on atmospheric chemistry and ozone trends. We will discuss possible interactions between oceanic emissions, atmospheric chemistry and climate change.

P-1108-08

Network for the Detection of Mesopause Change (NDMC): What can we learn from airglow measurements in terms of better understanding atmospheric dynamics?

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The international Network for the Detection of Mesopause Change (NDMC, http://wdc.dlr.de/ndmc) is a global program with the mission to promote international cooperation among research groups investigating the mesopause region (80-100 km) with the goal of early identification of changing climate signals.

NDMC is contributing to the World Climate Research Program, WCRP.

Measurements of the airglow at the mesopause altitude region (80-100km) from most of the European NDMC stations including spectro-photometers and imagers allow monitoring atmospheric variability at time scales comprising long-term trends, annual and seasonal variability, planetary and gravity waves and infrasonic signals. The measurements also allow validating satellite-based measurements such as from the TIMED-SABER instrument.

Examples will be presented for airglow measurements and for related atmospheric dynamics analysis on the abovementioned spatio-temporal scales and comparisons with satellite-based instruments as well as with LIDAR soundings. Focus will be on climate signals in the mesopause region.

1109 - Understanding the Earth's changing water cycle

ORAL PRESENTATIONS

K-1109-01

Connections between water and energy: Clouds, water vapour, radiation and precipitation

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Water and energy are intimately coupled together in the Earth's climate system. Each controls the other. This talk will concentrate on atmospheric feedbacks that develop between water and energy that influence the global hydrological cycle response in a warming and moistening climate. As the planet warms, the amount the global precipitation increases is determined by the increased emission from the atmosphere that is mostly controlled by the increases to water vapor. The increases to water vapor, especially that transported to the upper atmosphere by convection, fundamentally affects the radiation balance both directly through the influence the clear-sky emission and by enhancing the absorption of radiation by the upper tropospheric clouds that develop as a consequence of the moistened upper troposphere. Thus feedbacks develop between radiation, clouds and precipitation develop that influence how the global hydrological cycle responds to a warmed climate. These feedbacks, and others will be discussed in the context of both global and regional changes to the hydrological cycle.

K-1109-02

Land processes and the global water cycle: Past results and upcoming CMIP6 plans

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Terrestrial processes play an essential role in the global water cycle, through a range of mechanisms. Soil moisture-climate interactions affect both extreme temperatures and precipitation on land (e.g. Seneviratne et al. 2010, Hurk et al. 2011, Seneviratne et al. 2013, Guillod et al. 2015) and also explain discrepancies between global-scale patterns in wetting and drying and respective trends over land (Greve et al. 2014). But recent analyses suggest that models may share common biases in their representation. Snow-climate feedbacks are also of strong relevance, but associated with substantial uncertainties (Derksen and Brown 2012, Brutel-Vuilmet et al. 2013). This presentation will provide an overview on the role of land surface exchanges in the global water cycle and on current perspectives for future research in this field. In particular, it will highlight plans for the Land Surface, Snow, and Soil moisture Multimodel Intercomparison Project (LS3MIP) under the 6th phase of the Coupled Model Intercomparison Project (CMIP6), which will allow a better validation, assessment, and quantification of the underlying processes and feedbacks in current climate models.

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K-1109-03

Changes in continental water cycle and extreme events

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Ongoing and projected changes in continental water cycle are closely connected with extreme events which provide specific mechanisms of water cycle changes. We are going to address observed variability and change in continental water cycle in the context of climate extremes. Although hydroclimate extremes result from many factors that sometimes act together, water is a central component of these extremes via either its excess or scarcity. The major factor underlying hydroclimate extremes is precipitation, closely associated with flooding and droughts resulting from long dry periods and substantial water deficits over large regions. Among the major problems of changes in water cycle associated with extremes we will consider changes in temporal structure of precipitation

or precipitation timing. Over last several decades both wet and dry periods have become longer in several large European regions, specifically in Central and Eastern Europe. This effect is not associated with changes in the number of wet days but, rather, with the grouping of wet days into prolonged wet and dry periods, increasing the likelihood of floods and droughts, respectively. Another critical problem for accurate quantification of the impact of extremes on water cycle is scaling of precipitation. Representation of the impact of precipitation extremes on the water cycle strongly depends on spatial and temporal scales resolved by observational networks and models. With given resolutions we only partly capture the effect of extreme events in changes of hydrological cycle. We will demonstrate potential of very dense observational networks for accurate estimation of the role of hydroclimate extremes in continental scale water cycle. We will also consider the role of atmospheric moisture transport in forming extreme precipitation in different midlatitudinal regions, analyzing mechanisms associated with cyclone activity and transports by the mean flow. Finally, we will discuss the requirements for data characteristics and model resolution for accurate estimation of the strongly localized nature of hydroclimate extremes and their impact on continental water cycle.

1109-POSTER PRESENTATIONS

P-1109-01

Congo Basin precipitation : understanding sources and variability

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The Congo Basin is an extremely interesting and dynamic hydrological region, spanning six countries and a range of ecosystems. It is home to over 75 million people who rely on forest and freshwater resources along with agriculture for subsistence. It has the second largest continuous rainforest in the world, the second largest river by discharge and is one of the main regions of deep convection in the tropics. In many ways the Congo Basin is similar to the Amazon but in comparison is greatly understudied. According to the IPCC 5th Assessment Report agreement between models in CMIP3 and CMIP5 ensembles is low in this region. CMIP5 shows better agreement in boreal winter and worse agreement in boreal summer. Unlike other African regions, there have not been dedicated measurement campaigns, such as the African Monsoon Multidisciplinary Analysis, and the availability of rain gauge and other in situ observations is sparse. An understanding of the current seasonality and variability in Congo Basin precipitation is a step towards good predictions of changes in the future.

We examine the relative importance of vapor from neighbouring regions to precipitation variability in the Congo Basin, using a new water tracer capability in the Community Earth System Model (CESM1.2), in which water is tagged as it is evaporated in geographically defined regions. In this approach, regional vapor tracers are tracked through phase changes until the vapor is precipitated. We employ a small ensemble using CESM1.2 in an AMIP configuration, and results are compared with the ECMWF Interim reanalysis, the Global Precipitation Climatology Project data set and the Climate Research Unit rainfall data set. The tagged water results are compared to results from a stable isotope ensemble using the same model setup, where water isotopes are tagged as they enter the atmosphere. The results from the stable isotope enabled model are evaluated using the International Atomic Energy Agency's Global Network of Isotopes in Precipitation dataset.

A recycling ratio is calculated for the basin during dry and rainy seasons, showing a consistently high ratio with very high recycling during the dry seasons. Although local moisture evaporation does play a large role in the bulk of Congo Basin precipitation, the variability of local moisture sources cannot necessarily account for the total variability or seasonality. We find that the southern and western Indian Ocean are significant sources, providing important contributions to variability in Congo Basin precipitation. We find that the vertical structure of moisture flux convergence is important in determining the rainy seasons and is potentially an explanation for the signature of the vapor source of Congo Basin precipitation. Using tagged vapor and also tagged water isotopes to examine atmospheric vapor, important processes which characterise Congo Basin precipitation can be explored. This will contribute to a better understanding of how precipitation in the region may change in the future.

P-1109-02

Typhoon Bopha: Impact of an extreme tropical cyclone on the atmospheric water and energy cycle

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In a context of global warming, theory and modeling predict that hurricane intensity should increase with increasing global mean temperatures. It is therefore important to better study the extreme cyclones, which could become the average case. Typhoon Bopha formed on November 25 and dissipated on December 9, 2012. It was the strongest tropical cyclone to ever hit the southern Philippine island of Mindanao, making landfall as a Category 5 super typhoon with winds of 280 km/h. Bopha caused substantial damage to Mindanao, leaving behind hundreds of thousands of homeless and more than 500 fatal casualties. During the life cycle of the typhoon, the Megha-Tropiques satellite provided 2 to 5 sampling of the tropical atmosphere per day, thanks to its low inclination orbit (20°). At that time, the two microwave radiometers SAPHIR and MADRAS were both performing measurements thus giving the opportunity to investigate (i) how the typhoon impacted the atmospheric humidity of its environment and (ii) the temporal evolution of its rain field. For this purpose, three different levels of upper tropospheric humidity retrieved from SAPHIR, rain rates and releases of total latent heat estimated from MADRAS were monitored along the storm track. We will discuss the mean behavior of the typhoon that shows strong lagged oscillations of humidity and convection during its life cycle and deepens its spatial asymmetries and their relationship with the nearby environment. This analysis was completed with the use of the traking algorithm TOOCAN that allows to study how each individual convective clusters contributed to the life cycle of the typhoon.

P-1109-03

Cold/Shoulder Season Precipitation Near 0˚C

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Small changes in atmospheric conditions lead to major changes in the types or amount of near-0°C precipitation. For example, if near-surface temperatures are slightly above (below) 0°C, rain or wet snow (snow) occurs; if a slightly above-freezing inversion occurs (or not) aloft, freezing rain (snow) can reach the surface. It also needs to be recognized that solid precipitation amounts near 0°C (such as wet snow) can be the highest in a winter storm.

With global climate change in the extratropics, the 0°C isotherm will not disappear and associated precipitation events will continue to occur. Rain should fall farther upslope in mountainous regions, thereby increasing the risk of flooding. Alterations in temperatures, storm intensity and track will alter the likelihood and occurrence of near-0°C precipitation including freezing rain. Weakening of the atmospheric circulation in the extratropical regions may lead to more polar jet stream meandering that can lead to more persistent near 0°C events. The overall warming, together with a larger influx

of the water vapour in the winter atmosphere from the oceans (including ice-free portions of the Arctic Ocean) will allow more water vapour in the winter atmosphere that can increase the amount of near-0°C precipitation. And, near-0°C temperatures should generally move poleward and arrive at many locations earlier in spring or later in autumn. This could potentially affect the seasonal cycle of near-0°C precipitation.

Despite significant progress in addressing near-0°C precipitation, it remains a challenging issue. Kunkel et al. (2013; Bull. Amer. Meteorol. Soc.) indicated that freezing precipitation was associated with the lowest level of understanding for both detection and attribution amongst several types of hazardous weather conditions affecting the U.S.

The overall issue of near 0°C precipitation is linked with several phenomena. These include blizzards (just snow), rain-on-snow (both phases with a particularly importance of the precipitation interaction with pre-existed snowpack), and freezing rain and drizzle (just liquid). The specific hazards associated with these events include: Heavy snowfall/rainfall transition around °C; Blizzards, Rain-on-snow events, Freezing rain and freezing drizzle, and Ice load on infrastructure.

Our presenttion will overview what we know and what we do not know about changes in these phenomena and formulate major tasks to advance in understanting of near-0°C precipitation, its changes, and impact.

P-1109-04

Current and future changes in precipitation and its extremes across wet and dry regions

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Global warming is expected to enhance fluxes of fresh water between the surface and atmosphere, causing wet years to become wetter and dry years drier, with serious implications for water resource management. Defining wet and dry regions as the upper 30% and lower 70% of the precipitation totals across the tropics (30oS-30oN) each month we combine observations and climate model simulations to understand changes in the wet and dry extremes over the period 1850-2100.

Observed decreases in precipitation over the driest tropical land (1950-2010) are also simulated by coupled atmosphere-ocean climate models (-0.3%/decade) with trends projected to continue into the 21st century. Discrepancies between observations and simulations over the wettest land regions since 1950 are explained by decadal fluctuations in El Niño southern oscillation, the timing of which is not represented by the coupled simulations. When atmosphere-only simulations are instead driven by observed sea surface temperature they are able to adequately represent this variability over land.

By considering changes in the intensity distribution of precipitation, we find that global distributions of precipitation trends are dominated by spatial changes in atmospheric circulation. Unforced variability appears to dominate trends for the present day but land-surface feedbacks and secular changes in atmospheric circulation patterns become increasingly important into the future. Projected increases in extreme precipitation with warming over land are not diagnosed for the present day due to these dynamical influences which indicate that natural variability over land is not a good proxy for future climate change.

Nevertheless, the tendency for the wettest part of the tropical circulation to become wetter (precipitation increases with warming by 3%/K over wettest tropical ocean grid points) and the driest part of the atmospheric circulation to become drier (precipitation decreases of -2%/K over the driest tropical land grid points) is a robust result that emerges over the 21st century in response to the substantial surface warming. This indicates that enhancement in seasonality and wet and dry extremes (flooding and drought) may be anticipated over the coming century.

P-1109-05

Assessment of climate transformation in Belarus according to the COSMO-CLM model simulations

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According to climatic investigations deviations of annual temperature have increased during last decades in Belarus. The period of significant transformation of the temperature regime has been observed since 1970s, and rapidly since 1989.

We used simulations of the COSMO model in CLimate Mode (COSMO-CLM or CCLM) for detailed assessment of climate transformation in Belarus. This is a nonhydrostatic regional climate model developed from the Local Model (LM) of the German Meteorological Service by the CLM-community.

The coastDatII dataset was produced with the COSMO-CLM at the Institute of Coastal Research of HZG to give a consistent and homogeneous database mainly for assessing weather statistics and climate changes since 1948, e.g., in frequencies of extremes for Europe. The simulation was done for 1948 to 2012 and a horizontal grid size of 0.22 degree in rotated coordinates. Global reanalysis data of NCEP1 were used as forcing.

The observed gridded data (E-Obs) was applied in the study for estimation of adequacy of the model simulations. We used the E-Obs v.10.0 gridded dataset (European Climate Assessment & Dataset) for the period of 1950-2012 as an European daily high-resolution gridded dataset the surface temperature and precipitation data.

We calculated means of seasonal temperature and precipitation over Belarus for 1955-2012 period. The calculations of temperature showed differences in the coastDatII and E-Obs varied within 0.6-2 oC depending on season. The largest deviations were obtained in winter and consist of 1.7-2.0 oC, in spring differences were as 0.8-1 oC; in summer were obtained the smallest deviations within 0.6-0.8 oC and in autumn they were about 1.0-1.3 oC. Yearly means differ for both period on 0.9 oC. During the year the E-Obs values were higher than coastDatII except summer when values derived from CCLM exceed the observed ones. Analysis of min/max values of seasonal temperature proved smoothed course of the temperature with less amplitude in CCLM.

Calculated differences of annual sums of precipitation were not significant and lied within 7%. But differences of seasonal sums varied from 10 to 20 %, especially in summer season when difference was about 50 %. It could be explained as an incorrect calculation of precipitation forced by convective process.

Analysis of annual temperature trends according to coastDatII showed statistically significant increasing of temperature over entire territory of Belarus: from 0.22 oC per decade on the West to 0.3 oC per decade of the East of the country. Trends of annual precipitation showed remarkable increasing (up to 12 mm per decade) in the North and North-East part of the Belarus but in the central and southern parts of the country sums of annual precipitation varied within norm.

P-1109-06

Physical properties and evolution of mesoscale high cloud systems

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Representing about 40% of the Earth's total cloud cover, clouds in the upper troposphere play a crucial role in the climate system by modulating the Earth's energy budget and heat transport. These clouds often form mesoscale cloud systems extending over several hundred kilometres. Ubiquitous cirrus (semi-transparent ice clouds in the upper troposphere) evolve as the outflow of convective and frontal systems or form in cold air supersaturated

with water. Both their evolution with climate change and their feedback can only be reliably estimated if these cloud systems are adequately represented in climate models. Only satellite instruments are able to give a picture as a whole of these systems. IR sounders are observing our planet since 1979, with improvements in spectral resolution: from the TIROS-N Operational Vertical Sounders (TOVS) onboard the NOAA polar satellites through the Atmospheric InfraRed Sounder (AIRS) onboard Aqua since 2002, and to the InfraRed Atmospheric Sounding Interferometer (IASI) on board the MetOp platforms since 2006. The good spectral resolution of these instruments allows reliable cirrus identification, both from day and night-time observations. For this study we have developed a novel method to describe mesoscale high cloud systems, taking into account their horizontal extent. The occurrence of convection within these systems will be estimated by using cloud emissivity and a clustering method. This allows a distinction between in situ cirrus and cirrus linked to convective or frontal systems. The vertical extent of these cloud systems, essential for determining the energy balance at the Earth surface, can only be determined from active instruments (CALIPSO lidar and CloudSat radar synchronous with AIRS). This data set will be explored and distributed within the framework of the GEWEX Process Evaluation Study on Upper Tropospheric Clouds and Convection (UTCC PROES).

We will relate the horizontal extent of the anvil to the convective strength of the system and we will present first results on the variability of high cloud systems with their surrounding atmosphere. Analyzing the evolution and properties of mesoscale cloud systems as a whole and their role in generating cirrus clouds will be a major advancement in climate studies, also giving a new impulse in climate model evaluation.

P-1109-07

Long-term changes in snowfall over Japan and its regionality

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We examined the long-term changes in snowfall over Japan for recent 50 years, using observational data and a regional climate model.

Climate change can significantly influence the snowfall on the Japan Sea side of Japan because the seasonal surface air temperature is higher than 0 deg C in northern winter. This side of Japan is one of the heaviest snowfall regions on Earth. These heavy snowfalls are a consequence of the northwesterly flow of the Asian winter monsoon from Eurasia and the region's windward (northwestern side) position along Japan's northeast-southwest trending central mountain range. Two main factors influence precipitation over the Japan Sea side. One is the activity of cold and dry northwesterly winds of the Asian winter monsoon, and the other is sensible and latent heat fluxes on the Japan Sea,which are strongly associated with the sea surface temperature (SST).

The snowfall amount can be influenced by total precipitation amount and ratio of snowfall amount to the total precipitation. Total precipitation is modulated by many factors. On the other hand, the ratio of snowfall amount to the total precipitation is basically due to surface air temperature. Thus, we investigated the both factors, focusing on regional difference of the long-term changes.

Results showed that snowfall has drastically changed over the Sea of Japan side of Japan around late 1980's. Concurrent with the drastic change in snowfall, surface air temperature has dramatically increased. However, the drastic changes in snowfall was unclear over the some regions, which was modulated by the total precipitation changes. The regionality of long-term changes in snowfall will be discussed.

P-1109-08

Analysis of freezing rain occurrence over Eastern Canada using regional climate model simulations

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Winter storms can lead to many types of precipitation at the surface when the temperature is around 0°C. Freezing rain is the most damaging precipitation type produced during these storms. Its occurrence is associated with favourable synoptic conditions leading to a temperature inversion associated with temperatures >0°C aloft and subfreezing temperature near the surface. The overall goal of this study is to investigate the changes in the occurrence of freezing rain with our changing climate using regional climate model outputs. In particular, a study of the occurrence of freezing rain is conducted with climate simulations produced by the Canadian Regional Climate Model 5 (CRCM5) over Eastern Canada. This is achieved using existing empirical techniques commonly used to solve for the various winter precipitation types produced during storms. These techniques are based on the vertical temperature structure that affects strongly the type of precipitation reaching the surface. The results show that the model resolution impacts the vertical temperature structure. This suggests that the model resolution will impact the production of freezing rain by the model. Hence, the differences in the freezing rain occurrence diagnosed at different model resolutions are summarized. Overall, this study started addressing how well regional climate models can account of winter precipitation types to assess how their occurrences will evolve in our changing climate.

1110 - Observing the changing ocean climate

ORAL PRESENTATIONS

K-1110-01

Climate and Ocean: past, current and future changes and variability - a challenge for observations, models and assessment

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The ocean covers more than 70 % of the surface of our planet and plays a key role in supporting life on earth. It hosts the most diverse and important ecosystems, and contributes to global and regional elemental cycling. The ocean regulates our climate, and through climate, habitats are shaped that allowed humans to thrive and develop our societies. The marine system provides us with natural resources such as food, materials, substances, and energy. Furthermore, the oceans and the regional seas are essential for international trade, recreational and cultural activities.

A growing world population with increasing levels of affluence has had a noticeable impact on the environment causing 'global change'. In the area of climate in particular increasing levels of greenhouse gas emissions have altered the planetary heat balanced and caused changes in both global and regional climate.

The Intergovernmental Panel for Climate Change (IPCC) most recent assessment reminds us that: "The ocean's heat capacity is about 1,000 times larger than that of the atmosphere, and the oceans net heat uptake since 1960 is around 20 times greater than that of the atmosphere." About 90% of this extra heat has been stored in the ocean. The ocean plays a crucial role in climate change, in particular in variations on seasonal to decadal time scales. One example is sea level: the addition of heat and freshwater flux from the melting glaciers and ice sheets have cause the sea level to rise. The latest IPCC gives a best estimate rate for 1961 to 2003 as 1.8 ± 0.5 mm yr-1. However, the regional differences are large and the interplay between natural climate and ocean variability and change remains a challenge for assessments.

Finally the IPCC addresses the adequacy of ocean observing systems: "Many ocean observations are poorly sampled in space and time, and regional distributions often are quite heterogeneous. Furthermore, the observational records only cover a relatively short period of time (e.g., the 1950s to the present). Many of the observed changes have significant decadal variability associated with them, and in some cases decadal variability and/or poor sampling may prevent detection of long-term trends. When time series of oceanic parameters are considered, linear trends are often computed in order to quantify the observed long-term changes; however, this does not imply that the original signal is best represented by a linear increase in time." Thus this provides an opportunity for the global ocean observing community to rise to the challenge and deliver a fit-for-purpose more integrated, more cost effective and more sustained ocean observing system.

K-1110-02

How do we observe and model the changing ocean physics, biogeochemistry, and ecosystems?

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The oceans play a crucial role as a climate regulator, and changing ocean physics, biogeochemistry, and biology have direct impact on human well-being through hazards and ecosystem services changes.

Long-term, globally-coordinated, and high-quality sustained ocean observations are required to understand and model the role of the ocean in the earth's climate, to monitor ocean change, and to provide initial conditions to predict the evolution of climate on scales including seasonal, decadal, and centennial. Building on national efforts, these observations are internationally coordinated through the Global Ocean Observing System and the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology, building on the processes of a common Framework for Ocean Observing devised and adopted by the ocean observing community.

Observations and models combine to provide the best possible estimates of the present and future state of the ocean. These observations and forecasts inform decision-making about coastal protection, the marine economy, long-term changes in patterns of drought and flood, and the human consequences linked to climate change. Our confidence in the observations and models has increased over time, even as some key critical knowledge gaps remain.

O-1110-01

Pacific western boundary currents and their roles in climate

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Pacific Ocean western boundary currents and the interlinked equatorial Pacific circulation system were among the first to be explored by pioneering oceanographers. The widely accepted but poorly quantified importance of these currents - in processes such as the El Niño-Southern Oscillation, Pacific Decadal Oscillation and Indonesian Throughflow - has triggered renewed interest, with ongoing efforts seeking to understand the heat and mass balances of the equatorial Pacific, and possible changes associated with greenhouse-induced climate change. Only a concerted international effort through WCRP/CLIVAR will close the observational, theoretical and technical gaps currently limiting a robust answer to these elusive questions. This work will present a review of the boundary current characteristics, variations and their effects on local and remote climate, as well as their future projections.

O-1110-02

Preliminary results from the international South Atlantic Meridional Overturning Circulation (SAMOC) Initiative

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Within the MOC, the South Atlantic Ocean plays a key role as a nexus for water masses formed elsewhere and en-route to remote regions of the global ocean. Because of this important interbasin exchanges, the South Atlantic Ocean is the only major ocean basin that transports heat from the pole towards the equator. However, the South Atlantic is not merely a passive conduit for remotely formed water masses. Indeed, within this basin water masses are significantly altered by local air-sea interactions and diapycnal/isopycnal fluxes, particularly in regions of intense mesoscale activity and steep topography. These contributions have been shown to have a crucial role in the strength of the MOC in paleoceanographic and modelling studies.

The monitoring of the North Atlantic portion of the MOC has been ongoing for a decade now through the RAPID/MOCHA/WBTS program as well as other national and international initiatives. They all provide a scope for understanding the MOC variability in that region. Given the complex, multibasin nature of the MOC, achieving a more complete understanding of its behaviour and changes requires a more comprehensive observing system, one that extends across neighbouring ocean basins as the one we are developing for the South Atlantic within the CLIVAR SAMOC initiative.

In this presentation, we will discuss the preliminary results on estimates of the daily MOC strength at 35°S during a ~20 month long pilot array of mooring as well as model outputs and Argo data. The MOC variability show to be as large as that at 26N, with both eastern and western boundary flows contributing equally to the variance.

The full array was re-established in the fall of 2013 in collaboration with France, Brazil, Argentina and South Africa.

O-1110-03

Exceptional 20th-Century slowdown in Atlantic Ocean overturning circulation

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Possible changes in Atlantic meridional overturning circulation (AMOC) provide a key source of uncertainty regarding future climate change. Maps of temperature trends over the twentieth century show a conspicuous region of cooling in the northern Atlantic. Here we present multiple lines of evidence suggesting that this cooling may be due to a reduction in the AMOC over the twentieth century and particularly after 1970. Since 1990 the AMOC seems to have partly recovered. This time evolution is

consistently suggested by an AMOC index based on sea surface temperatures, by the hemispheric temperature difference, by coral-based proxies and by oceanic measurements. We discuss a possible contribution of the melting of the Greenland Ice Sheet to the slowdown. Using a multi-proxy temperature reconstruction for the AMOC index suggests that the AMOC weakness after 1975 is an unprecedented event in the past millennium (p>0.99). Further melting of Greenland in the coming decades could contribute to further weakening of the AMOC.

Reference: Rahmstorf et al, Exceptional twentieth-century slowdown in Atlantic Ocean overturning circulation, Nature Climate Change (in the press)

O-1110-04

Variability of the Meridional Overturning Circulation observed since 1993 across the A25-OVIDE section in the North Atlantic subpolar gyre, and its impact on the CO2 physical pump

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The meridional overturning circulation (MOC) transports heat from the subtropics to high latitudes and hence plays an important role in the Earth's climate. A region crucial for the MOC is the northern North Atlantic and the adjacent Nordic Seas, where waters transported northwards in the MOC upper limb progressively cool, gain density and eventually sink into the southward flowing lower limb. Here we will discuss the variability of the subpolar gyre circulation, the MOC and heat transport as quantified from a joint analysis of hydrographic and velocity data from eight repeats of the Greenland to Portugal OVIDE section (1997-2014), satellite altimetry and ARGO float measurements. For each repeat of the OVIDE section, the full-depth absolute circulation and transports were assessed using an inverse model constrained by ship-mounted Acoustic Doppler Current Profiler data and by an overall mass balance. The obtained circulation patterns revealed remarkable transport changes in the whole water column and evidenced large variations (up to 50% of the lowest value) in the magnitude of the MOC computed in density coordinates (MOCσ). The extent and timescales of the MOCσ variability in 1993-2014 were then evaluated using a monthly MOCσ index built upon altimetry and ARGO data at the OVIDE section location. The MOCσ index, validated by the good agreement with the estimates from repeat hydrographic surveys, shows a large variability on monthly to decadal time scales, with an inter-annual variability from less than 15 Sv to about 25 Sv (1 Sv = 1,000,000 m3s-1). The heat transport estimated from the repeated hydrographic OVIDE sections varies between 0.29 and 0.70 ± 0.05 PW and is linearly related to the MOCσ intensity.

The uptake of atmospheric carbon dioxide in the subpolar North Atlantic Ocean declined rapidly between 1990 and 2006. This reduction in CO2 uptake was related to warming at the sea surface, which—according to model simulations—coincided with a reduction in the Atlantic MOC. Here, we use the observed oceanic transport of volume, heat and carbon dioxide to track the CO2 uptake in the subtropical and subpolar regions of the North Atlantic Ocean over the past two decades. We separate anthropogenic carbon—derived from human activities—from natural carbon by assuming that the latter corresponds to a pre-industrial atmosphere, whereas the remaining is anthropogenic. We find that the uptake of anthropogenic carbon dioxide occurred almost exclusively in the subtropical gyre. In contrast, natural carbon dioxide uptake—which results from natural Earth system processes—dominated in the subpolar gyre. We attribute the weakening of contemporary carbon dioxide uptake between 1997 and 2006 in the subpolar North Atlantic to a reduction in the natural component. We show that the slowdown of the MOC was largely responsible for the reduction in carbon uptake, through a reduction of oceanic heat loss to the atmosphere, and for the concomitant decline in anthropogenic carbon dioxide storage in subpolar waters. To understand the mechanisms controlling the variability of the transport of anthropogenic carbon (Tcant) across the subpolar gyre, we decomposed it according to the net, the diapycnal and the isopycnal circulation. The diapycnal component is found to be the main driver of the Tcant variability. From this analysis, we propose a simplified estimator for the variability of Tcant based on the intensity of the MOCσ and on the difference of anthropogenic carbon dioxide concentration between the upper and lower limb of the MOCσ (ΔCant). This estimator shows a good consistency with the diapycnal component of Tcant, and helps to disentangle the effect of the variability of both the circulation and the Cant increase on the Tcant variability. We find that ΔCant keeps increasing over the past decade, and it is very likely that the continuous Cant increase in the water masses will cause an increase in Tcant across the subpolar North Atlantic Ocean at long timescale. Nevertheless, at the timescale analyzed here (1997-2010), the MOCσ controls the Tcant variability, blurring any Tcant trend.

O-1110-05

Oxygen Minimum Zone (OMZ) dynamics in the context of the ocean deoxygenation: the case off Peru from the AMOP «Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific» project

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Oxygen Minimum Zones (OMZs), defined as suboxic (O2<20 µmol/L) subsurface layer and mainly associated with Eastern Boundary Upwelling Systems (EBUS), would contract and expand during cold and warming periods, respectively. In the current context of the ocean deoxygenation, OMZs are known to play a key-role on the evolution of climate (greenhouse gases) and on the ecosystems and fisheries (nitrogen loss, respiratory barrier, sulfidic events) at both local and global scales. The objective of the AMOP project ("Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific") is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru. The central hypothesis is that the physical and biogeochemical O2 contribution to the OMZ maintaining and variability depends on the characteristics of the different OMZ layers, where the oxycline behaves as an engine of an intense but intermittent biogeochemical and ecosystem activity. The project is focused in one of the most intense and shallow OMZs associated with the most productive upwelling system (10 % of the world fisheries), the Peruvian OMZ. The trans-disciplinary approach is based on a cruise that took place in January-February 2014 off Peru and that consisted in 8 fixed stations (~54 h) on 3 transects at 7°S, 12°S and 14°S with the RV Atalante. The cruise also benefited from experimental development (instrumentation, sensors: argo-floats experiments; drifting lines; a trimaran dedicated to ocean-atmosphere exchanges; nanomolar O2 measurements). AMOP has also led to the deployment of the first long term (2013-2014) subsurface mooring off Peru providing unprecedented information of the OMZ variability at diurnal to intraseasonal timescales, and invaluable data for the validation of a high resolution regional ocean-atmosphere-biogeochemistry coupled modeling platform under development within the project. This French-Peruvian-German project involving 5 other countries (~90

participants) is viewed as one of the main pilot projects of the SOLAS Mid Term Strategy Initiative on OMZ-EBUS. In this presentation, preliminary results of the project will be presented both on observations and modeling, illustrating current challenges for the investigation of OMZ dynamics in Eastern Boundary current systems.

1110-POSTER PRESENTATIONS

P-1110-01

Recent changes and trends of the upwelling intensity in the Canary Current Upwelling System

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A summary of current knowledge for the quantification of the upwelling intensity from wind and SST is provided on the Canary Current Upwelling System (8°N-43°N) from 1982 to 2011. Statistical analysis of trends and seasonal changes of the upwelling activity are carried out in this work. Linear trends in upwelling intensity are estimated from both atmospheric forcing (wind stress) and thermal oceanic response (SST), both derived from satellite data, with a particular focus on the Cap Ghir of the moroccan area (30.5 °N).The results indicate different spatial trends in the upwelling favorable winds and an apparent increasing coastal warming associated with intensification of winds at the regional scale off Northwest Africa is found.

P-1110-02

Long term marine time-series expose underlying climate-driven changes in South America during the last 40 years

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Climate Change is creating a dynamic of continuous changes in ecosystems. Generally, the expected consequences of these changes are global; however, the occurrence of extreme events and specific environmental problems are usually local or regional phenomenon. One of the keys to uncover climate-driven changes are the long term time-series of observations. While there are a number of long-term biological time-series on land, there are relatively few in marine environments. This is highlighted by the fact that the Intergovernmental Panel on Climate Change (IPCC) noted 28586 significant biological changes in terrestrial systems, but only 85 from marine and freshwater systems. The present research deals with this gap in the state of the art, focusing in an area which holds scarce to null long-term research on ocean observation and climate driven changes: the South Atlantic Ocean. From the results of the analysis of up to 40 years of oceanographic physicochemical variables measured at the Bahia Blanca Estuary (Dissolved Oxygen, pH, Chlorophyll, Phaeopigments, Temperature, Salinity, NH4, Particulate Organic Matter, NO2, NO3, Phosphorous, etc.) unknown underlying trends were uncovered. In order to test the variables trend throughout several time-scales, the continuous wavelet transform (CWT) was used to divide the continuous-time function into wavelets. Moreover, the use of Cross Wavelet Correlation (CWC) allowed to light the relationship between the variables throughout different time-scales. After that, a correlation analysis which linked the ocean observations to biological documented changes was assessed. As result, novel hypotheses were raised in the field of phytoplankton and zooplankton assemblages climate-driven control, crustaceans catches and fisheries recruitment. For instance:

- "climate-driven variations in ocean Temperature, pH, DO and Salinity can restrict the growth of the phytoplankton assemblages, leading to other factors (i.e., grazing) the size control of the cells"
- "low interannual variability of water temperature and water salinity favours higher fishing yields and vice versa»

Undoubtedly, these findings will strengthen the theory which propose climate-driven changes at marine coastal ecosystems as a consequence of global climate change and will be of high relevance for the international dialogue on "anthropogenic vs. climate-induced changes" over the oceanic ecosystems.

P-1110-03

Past and future seasonal changes in Sea Surface Temperature in the Western English Channel as derived from satellite data and CMIP5 multimodel ensemble

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Seasonal changes in Sea Surface Temperature (SST) in the Western English Channel are estimated for the last decades from high-resolution satellite data, obtained by concatenating Ifremer AVHRRSST, OSTIA and ODYSSEA data over 1986-2013. Coastal seas, well separated from offshore waters by intense frontal structures, present colder SST by about 1°C in the English Channel to 2°C in the Iroise Sea in summer. A significant warming trend, concentrated in the autumn season, is highlighted. It is stronger offshore, with a SST annual mean increase of 0.32°C/decade, while it amounts to 0.23°C/decade in coastal waters, where a strong vertical mixing induced by tides and wind acts to reduce surface warming.

The performance of an ensemble of global climate models, participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5), in simulating recent seasonal changes of SST in the region is estimated. The median of CMIP5 models reproduces very well the observed SST mean seasonal cycle in offshore seas, but it less proficient in coastal waters due to model coarse resolution and absence of tidal forcing and related processes. In the Iroise Sea, the trend of the annual mean SST is relatively well simulated, albeit somewhat underestimated (0.20°/decade) and evenly distributed throughout the year.

The regional values of the annual mean SST as generated by the CMIP5 future scenarios simulations, range from 0.5°C (RCP2.6) to 2.5°C (RCP8.5) by year 2100, with a seasonal modulation leading to a more intense warming in summer than in winter. This increase in SST may strongly affect marine biomes, in particular phytoplancton and algae population density and phenology in the Western English Channel.

P-1110-04

Comparing coastal and open ocean sea level variability and trend from altimetric data

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Since 1993, altimetry has provided an unprecedented opportunity to study sea level variability with a quasi-global coverage. Satellite altimetry indicates that sea level has been rising fast in response to global warming, but with large regional variations. However, standard altimetric data do not allow to study sea level variability and rise close to the coast, where the socio-economic impacts of sea level rise are the greatest. Recently, along-track altimetric data have been reprocessed at LEGOS/CTOH using algorithms adapted to coastal regions to recover information in coastal zones (this reprocessed coastal product is referred to as the XTRACK dataset here).

In this study, we first intercalibrate the along-track Topex-Poséidon, Jason-1 and Jason-2 XTRACK dataset to that distributed by AVISO to have consistent sea level data in the open ocean. Then, sea level trends are computed with the XTRACK dataset to analyse how sea level rise varies as a function of the distance to the coast. Spectral analyses are performed to assess the frequency bands for which

coastal sea level variability and open ocean variability differ.

Analyses are performed over two regions (West coast of Africa and southwest Pacific). They will be extended to the global ocean to provide a map of sea level trends over the 1993-2012 period for the coastal zones of the global ocean.

P-1110-05

Ocean regulation of atmospheric carbon dioxide : timing of atmosphere-ocean reorganization, and CO2 outgassing during last deglaciation

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During the last deglaciation, centennial to millennial scale large climate changes occurred with a climate decoupling between the North and South poles called the bipolar seesaw. These events, expression of the complex interaction between the ocean, the atmosphere and the cryosphere, are not well understood yet. Associated with these events, CO2 outgassing from the ocean to the atmosphere occurred. These increases in atmospheric CO2, preceding the Earth's global temperature increase, have been an important factor of the deglaciation. The Southern Ocean plays a key role in the global climate. Intermediate and bottom waters formation occurs within the Southern Ocean and it is the region where the deeper ocean and the atmosphere are connected due to low density gradient and wind driven upwelling. We present the climatic behavior of the different Southern Ocean sectors during these climatic events, with a precise time scale. Thanks to the complementary archives and skills of Lund University and IPSL researchers, we combine the terrestrial records from the few islands present, in this mainly oceanic hemisphere, with oceanic high resolution records, using volcanic tephra to obtain a robust chronology for the marine records chronology and inconsequence a common 14C age scale. This multi-proxies approach allows reconstructing robust quantitative records of temperature and wind intensity evolution. Sediment core records from the South-East Pacific sector of the Southern Ocean indicate that both temperature increase and intensification of the Southern Ocean upwelling in this area are coeval in this area as well as, within dating uncertainty of the records, with the temperature increase over the Antarctic and atmospheric CO2 increase. In the Indian sector, a terrestrial record indicates a possible delay between the break in the increase of Antarctic temperature (Antarctic cold reversal within the deglaciation) and westerly wind belt shift. In the meanwhile, ocean records indicate that the sea surface temperature increase and the intensification of the Southern Ocean upwelling preceded the decrease or shift of the Antarctic circumpolar current. Such well-dated high resolution records will allow studying leads and lags between the climatic records of different North and South latitudes and thus establish the link between Southern Ocean and North Atlantic circulation changes. The space and time mapping of climatic changes will be compared to climate model experiments to disentangle the role of the different atmospheric and oceanic climate mechanisms of the bipolar seesaw. It is a necessary step to improve climate models that indicate a different response to fresh water discharge experiments designed to reproduce these rapid climatic events with a bipolar seesaw signature. Indeed the different models, used for future climate simulations, indicate different responses in the different sectors (Atlantic, Indian and Pacific) of the Southern Ocean for these experiments.

P-1110-06

Interannual variability of upper ocean stratification in Bay of Bengal: observational and modeling aspects

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The annual cycle and interannual variability of stratification in Bay of Bengal (BoB) are studied using both observations and Global Ocean Data Assimilation System (GODAS) analysis during 2003-2012. Annual cycle of stratification and SST evolves coherently (correlation coefficient is 0.85) highlighting its role on modulating air-sea interaction over this climatologically important region. Spatial distribution of stratification shows strong seasonality in ARGO observations, whereas it is highly underestimated in GODAS with highest discrepancies during fall and spring. The annual cycle of SSS in GODAS is out of phase with observations implying possible potential feedbacks. During La Niña years, SSS drop in fall and winter and are lesser than those reported during El Niño years. All these features are misrepresented in GODAS. As stratification modulates air-sea interaction over BoB especially during El Niño and La Niña years, such misrepresentation of ocean stratification may lead to improper thermocline-SST coupling in the models. The mean stratification and its interannual variability in GODAS are weaker than observed even though interannual variability in fresh water flux (P-E) is higher in GODAS. Detailed analysis of GODAS with in-situ observations reveals that upper ocean current shear (vertical) is overestimated in GODAS leading to unrealistically strong mixing which is primarily responsible for the deeper penetration of surface warm and freshwater resulting weaker stratification. As GODAS is used to initialize the ocean model of the Coupled Forecasting System for seasonal prediction of Asian monsoon, proper representation of stratification is essential. This study advocates the need of accurate representation of mixing in GODAS for improved summer monsoon forecast.

P-1110-07

Methane distributions and sea-to-air fluxes in the South China Sea and the West Philippines Sea

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We collected 700 water samples in the South China Sea (SCS) and 300 water samples in the West Philippines Sea (WPS), during 8 cruises from August 2003 to July 2007 in order to determine methane (CH4) distributions from surface to depths of 4250 m. The surface CH4 concentrations were above atmospheric equilibrium, both in the SCS and the WPS, with an average concentration of 4.5±3.6 and 3.0±1.2 nM, respectively. The sea-to-air fluxes were computed, showing that the SCS emits CH4 at a rate of 8.6 µmol m-2 d-1 and the WPS at a rate of 4.9 µmol m-2 d-1. In the SCS, the CH4 emissions were higher over the continental shelf (11.0 µmol m-2 d-1) than over the deep ocean (6.1 µmol m-2 d-1), owing to higher productivity and closer coupling with the sediments in the continental shelf. The SCS emited 30.1*10^6 mol d-1 CH4 to the atmosphere and exported 1.88*10^6 mol d-1 CH4 to the WPS during the wet season.

Both the concentrations of CH4 and chlorophyll a were higher in the 200m surface layer of the WPS, however, not correlated unlike recent reports suggesting the occurrence of CH4 production in surface oxic waters directly related to phytoplankton activity. CH4 concentrations generally decrease with depth below the euphotic zone but remain constant below 1,000 m, both in the SCS and the WPS. Some high CH4 values were observed at mid-depths in the SCS, and were most likely attributed to the anoxic generation of CH4 or the release of CH4 from sediments, gas hydrates or gas seepage.

1111 - Climate variability, change and vulnerability in the Pacific, Indian and Southern Oceans

ORAL PRESENTATIONS

O-1111-01

Why should coral reefs care about ocean acidification: general consensus, misconceptions and future research priorities

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Ocean acidification (OA) is one of the main threats for marine habitats, likely causing changes in biodiversity and ecosystem functions within this century. Ocean acidification might affect various physiological parameters at different stages of the animal life history, from their reproduction to larval phases and adult growth. Coral reefs, harboring a large part of the world's ocean biodiversity, will be the most affected by OA, as reef calcification and dissolution rates are related to seawater carbonate chemistry. Studies show a decline in net calcification rates as a result of decreasing pH and carbonate ion concentrations, and increasing dissolution rates of carbonate skeletons. This alarming general consensus has convinced the scientific community to deeply investigate marine ecosystems face to climate change, becoming among the top global ocean research priorities. After more than a decade studying OA responses of single species, mostly acclimated for short-time periods in laboratory conditions to projected acidified levels, it is time to progress our knowledge by better projecting ecological impacts of future climate change scenarios.

Recent findings show that some calcifiers do not seem to be affected by OA. Not only were their responses highly species-specific but varied among experiments. These divergent results have clearly shown that our actual knowledge on biological responses to OA and the physiological mechanisms involved are extremely limited and that some assumptions we have used so far might be inaccurate. In addition to these gaps of knowledge, all the data collected so far are single species responses to artificial conditions. Only few studies have scaled-up single species responses to the ecosystem scale. In our study, we aim at deciphering past misconceptions on the effects of OA, and promoting challenging research priorities in the field. This includes: i) to simultaneously test OA with other global environmental alterations, such as warming and eutrophication, which will likely exacerbate the organism's sensitivity to OA; ii) to perform experiments in natural conditions, over longer periods, to guarantee at least a complete acclimation of organisms to natural variations. This requires a rapid implementation of in situ experimental systems able to change and to maintain suitable altered conditions; iii) to investigate keystone species/habitats potential abilities to adapt fast enough to environmental changes in order to guarantee vital ecosystem functions in the future. The best way to do that is through the use of sites naturally enriched in CO2 which have successfully been used as natural laboratories to study natural response of ecosystems to OA.

O-1111-02

Bangladesh's coastal vulnerability under climate change

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In Bangladesh, the Ganges, Brahmaputra, and Meghna Rivers come together to form the largest river delta in the world. This low-lying region of the Bay of Bengal is one of the most densely populated countries in the world and is prone to monsoonal flooding, potentially aggravated by an intense annual cyclonic activity. In this context, sea-level rise, along with tectonic, sediment load and groundwater extraction induced land uplift/subsidence, significantly exacerbate the Bangladesh's coastal vulnerability. Here we present the goals and first results of a Belmont Forum/IGFA-funded project, BanD-AID (http://Belmont-SeaLevel.org) that addresses the causes and consequences of coastal vulnerability of Bangladesh, The project's outcome will establish an advanced observation system based on contemporary space geodetic sensors to quantify (1) causes of sea-level rise and land motion and establish their robust vertical datum link, and (2) human interactions that governs coastal vulnerability and resilience in Bangladesh. We present the first results such as the apparent sea level rise at the Bangladesh coast gained by combining space geodetic observations, including satellite altimetry, GRACE and GPS/InSAR, together with in-situ tidal and river gauges, and different reconstructed sea-level approaches. This unique combination of different satellite techniques and in-situ information offers the possibility to better quantify the major contributions to the relative sea-level rise at the Bangladesh delta, towards addressing its coastal vulnerability and future sustainability.

O-1111-03

Coastal vulnerability to climate change-induced sea-level rise may be increased by land motion and human factors

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Sea-level rise has been recognized as a major source of coastal vulnerability. Several areas, including low-lying Pacific islands and low lying countries such as Kiribati, Tuvalu, Marshall Islands and Bangladesh have been identified as being highly vulnerable to the effects of sea-level rise. While the major global source of sea-level rise is climate change, several other local factors can have as strong or stronger an effect than climate-based sea-level rise on coastal vulnerability.

We will present several case studies illustrating situations where increased coastal vulnerability is not solely attributed to climate change. We describe several other factors that can enhance the relative sea-level rise, such as natural factors like tectonic motions, erosion, sediment loading and local sea-level variability, and human factors like poorly designed development. Illustrating these factors using examples from Kiribati, Vanuatu, New Caledonia and Bangladesh, we emphasize that although climate related sea-level rise is a global issue, it can be locally combined with several other factors, modulating its value and impact. Studies of each individual case at the local scale are mandatory for adequate prediction and mitigation in the future.

O-1111-04

Influence of climate changes on mangrove ability to fix and store CO2

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Mangroves are forested ecosystems developing in the intertidal zone of tropical and subtropical coastlines. They cover up to 140,000 km² worldwide, and extend from 30°N to 38°S (1). They are amongst the most productive ecosystems in the world (2). Furthermore, they have been suggested to be enhancers of heterotrophic secondary production and offshore fisheries. In addition, it is well recognized that tropical mangrove ecosystems provide a high abundance of food, shelter, and breeding and nursery habitats for a diverse community of terrestrial, aquatic and aerial organisms, including many endangered species (3). At a larger scale, the high net primary productivity of mangroves and low decomposition rates results in global atmospheric CO2 sinks (4). In addition, mangroves are crucially important ecologically and economically, supporting a wide variety of ecosystem services (5). For example, mangroves stabilize the shoreline and serve as barriers against erosion. One of the most dramatic examples of the efficiency of this biological system as protection from catastrophic climatic events was demonstrated in 2004, when a large-scale tsunami devastate most coastal areas, but mangrove forested shorelines were significantly less affected (6). The annual economic value of mangroves, including products and services has been estimated to be US$ 200,000-900,000 ha-1 (7). Mangrove ecosystems have been decreasing dramatically worldwide, mainly due to habitat destruction. Once mangroves covered more than 200,000 km2 worldwide (8). However, human population growth and urbanization of coastal areas, expansion of industrial activities, and exploration and exploitation of natural resources have resulted in a current decrease in mangrove area of 1 to 2% per year. This declining rate is equivalent or even higher than that of other threatened ecosystems, such as coral reefs or primary rainforests (9). Mangrove ecosystems also are also threatened by climate change. However, the responses of mangrove ecosystems to climate changes are not well understood (10). Relative sea-level rise may be the greatest threat to mangroves because most mangrove sediment surface elevations are not keeping pace with sea-level rise (11). Additionally, the increases of temperature and atmospheric CO2 concentrations may also modify their functioning and distribution. Reduced mangrove area and health will increase the threat to human safety and shoreline development from coastal hazards, such as erosion, cyclonic events, and tsunamis (12). Mangrove habitat loss also may reduce coastal water quality, biodiversity, and fish and crustacean breeding and nursery habitats. Such ecological deterioration may have direct and indirect adverse effect on adjacent coastal habitats, and may eliminate a major resource for human communities that rely on mangroves for numerous products and services. Mangrove destruction also has the potential to release large quantities of stored carbon, which can have dramatic global implications (13). A synthesis of the current knowledge will be proposed, and our project of mangrove monitoring in the Indo-pacific area will be presented.

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O-1111-05

Evolution of dengue epidemics in the south pacific in the present and the future

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Dengue fever is the most important mosquito-borne viral disease, with 390 million people being infected each year and 2.5 billion people living in areas at risk of dengue worldwide. The rapid global spatial spread over the past 40 years is likely to be due to recent socio-economic changes such as global population growth and uncontrolled urbanisation but these factors need to be associated with suitable climatic conditions before dengue fever can establish itself in a given country, for it is transmitted by a number of mosquito species, mainly Aedes aegypti, whose life cycle is influenced by temperature, rainfall and humidity. In the following contribution, we focus on the South Pacific region, a vast, oceanic region where dengue epidemics are recurrent, aiming at disentangling socio-economic factors from climate factors.

We first analyse an original dengue database covering the 1971-2009 period across the South Pacific. In the Pacific region, dengue epidemics occurred every 3 to 6 years, with each epidemic wave caused by the regional circulation of 1 of the 4 dengue virus serotypes, with very limited serotype co-circulation. There are no apparent spatial propagation patterns in the region, and countries such as French Polynesia and New Caledonia are the most regularly affected. There is a weak anti-correlation between the major El Niño climate variability and the annual number of countries experiencing an epidemic, suggesting a link between climate and dengue epidemics. However, while the South Pacific has experienced a weak + 0.5°C trend in temperature, there is no detectable overall/regional long-term trend in the evolution of the number of affected countries for the past 40 years. However, local trends exist: New Caledonia is experiencing a positive trend whereas dengue epidemic frequency is decreasing in some smaller islands. We then analyse dengue epidemic profiles per country (endemic, regular epidemics, or sporadic epidemics). We identify variables linked to the different profiles by fitting a statistical model based on variables characterizing the socio-economic situation (e.g. GDP) or climate (e.g. temperature) in each country. These statistical models are able to reproduce the major epidemic profiles. Assuming the socio-economic variables to remain constant over time, we project these models for the next 100 years using models of the IPCC-AR5 under RCP8.5.

Finally, we focus on the case of New Caledonia where very high quality data allows a more quantitative analysis. At present, dengue epidemics there occur approximately every 6 years. Using spatial statistical modelling, we show that the primary variables explaining the spatial distribution of incidence rates are the mean temperature and a variable highly correlated with people's way of life. Using this model, we show that by the end the 21st century, with temperature increasing by approximately 3°C as projected by 6 IPCC-AR5 models in New Caledonia, mean incidence rates will be multiplied by two, with areas currently at low risk of dengue fever being highly exposed in the future. In terms of dengue epidemics recurrences, we also build a temporally dynamic model at weekly time

scales allowing the detection of the beginning and length of dengue epidemics. One key variable is the number of days where temperature exceeds 32 °C. As this number will increase substantially over the next 100 years in the IPCC-AR5 models, we show that the proportion of dengue epidemic years will rise from 17 % at present to 100 % in the RCP8.5 scenario and 66 % in the RCP4.5 scenario, with the duration of dengue epidemics substantially increasing compared to the present day. Implications for the future of dengue virus circulation in the South Pacific are discussed on the basis of our results

1111-POSTER PRESENTATIONS

P-1111-01

Mass mortality events in atoll lagoons: present environmental control and increased future vulnerability with climate change

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Several geomorphologically closed atolls of the Pacific Ocean have experienced in recent decades mass benthic and pelagic lagoonal life mortalities, that are due to unusual calm weather conditions lasting for several weeks. These events, although poorlyknown and characterized, pose a major threat for resource sustainability for islanders, and need to be taken into account for long-term resource management. A sample of eleven mortality events on eight atolls from the central South Pacific occurring between 1993 and 2012 were revisited to estimate the environmental thresholds required to trigger such events. We investigated thresholds and spatial patterns of sea surface temperature, significant wave height and wind stress satellite data. Then, using these thresholds, spatial maps of present-day potential risk are produced for the central South Pacific region. The highest risk zone lies north of the Tuamotu Archipelago in French Polynesia. To assess future risks in a climate change era, a regional climate model is used to downscale the projected future climate and to estimate the potential change in risk by the end of the 21st century. This process highlights a relative risk increase of up to 60% for the eastern Tuamotu atolls/ However, caution is required given the limited number of case-studies available to train the analysis and identify thresholds. This study suggests that long-term monitoring of the biophysical conditions of the lagoons at risk is needed to precisely identify the physical thresholds and better understand the biological processes involved in these rare, but consequential, mass mortality events.

P-1111-02

Mesopelagic heterotrophic N2 fixation related to organic matter composition in the Solomon and Bismarck Seas (Southwest Pacific)

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The oceans play a key role in absorbing carbon dioxide (CO2) emitted by human activities. This absorbing power depends largely on the activity of microalgae, which take up CO2 using nutrients and sunlight. The availability of nutrients is thus essential for maintaining life in the oceans and balancing global CO2 levels. In open ocean areas nitrogen is mainly provided through nitrogen fixation, a process performed by specific microorganisms called diazotrophs. Primary production in the oceans is strongly limited by the availability of fixed nitrogen. In open ocean nutrient-impoverished areas, which make up ~50% of the global ocean surface, nitrogen is mainly provided through the process of biological atmospheric nitrogen (N2) fixation. N2 fixation is carried out by the so termed diazotrophs, marine microorganisms that may belong to the cyanobacteria, bacteria or archaea. For many years, autotrophic diazotrophs were thought to be the most abundant diazotrophs in the ocean. Autotrophic diazotrophs need light to fix carbon dioxide via photosynthesis, and therefore are constrained to the sunlit layer of the ocean, which is generally less than 100 m deep. Recent investigations have revealed that heterotrophic diazotrophs, which cannot photosynthesize, are present in greater abundance than autotrophic diazotrophs in the world's oceans. Heterotrophic diazotrophs are not constrained by the availability of light and therefore are able to live in the dark ocean, the largest and less studied habitat on Earth. This discovery significantly expands the boundaries where N2 fixation was though to be possible and theoretically increases the inputs of fixed nitrogen to the ocean, which remain unaccounted for. The diazotrophs inhabiting mesopelagic dark waters are heterotrophic and depend on organic matter for their nutrition. In this habitat, these microorganisms can live in association with oxygen minimum zones or local oxygen deficit microzones like organic particles. However, the relationship of heterotrophic diazotrophic activity and diversity with organic matter is unknown. We investigated N2 fixation along two transects in the Bismarck and Solomon Seas (Southwest Pacific, Transects 1 and 2 respectively). In Transect 1, transparent exopolymer particles (TEP) where higher and oxygen concentrations lower than in Transect 2. The presence of N- and P-containing dissolved organic matter (DOM) compounds was also higher in Transect 1 than in Transect 2, as revealed by Fourier transform ion cyclotron mass spectrometry. N2 fixation rates (0.09-1 nmol N L-1 d-1) were higher in Transect 1 than in Transect 2, and correlated positively with TEP and negatively with oxygen, reflecting the dependence of mesopelagic heterotrophic diazotroph activity on organic matter. The scores of the multivariate ordination of DOM samples (principal coordinate analysis) were negatively correlated with bacterial abundances and positively correlated with N2 fixation rates. We interpret these results as an active bacterial exploitation of the DOM pool and its use to sustain diazotrophic activity. Phylogenetic analyses of the nifH gene detected γ-, δ-, α- and β-proteobacteria (Cluster I), Cluster III and Cluster IV. The relative importance of anaerobic Cluster III phylotypes in our clone library (26% of sequences), suggests that N2 fixation was partially supported by diazotrophs with a particle-attached lifestyle. Custom-designed quantitative PCR primer-probe sets were designed for three selected phylotypes. The abundances of a phylotype close to Cluster III ranged from undetectable to 1000 nifH gene copies L-1. Altogether, our results provide new insights into the mysterious ecology of heterotrophic diazotrophs and suggest that in situ organic matter sustains their N2 fixation activity. The input of fixed N2 by these organisms is significant and potentially contributes significantly to nutrient replenishment and primary production in the SW Pacific.

P-1111-03

Autonomous observations with Bio-Argo floats in the Southern Ocean

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The Southern Ocean (SO) is the most remote and the least understood of the world's oceans, although it plays a crucial role in past and present climate state and changes. It is unique in being the only zonally unbounded ocean. For this reason, it is the major link by which water properties are exchanged among the other oceans. Moreover, the SO is a major source of natural CO2 due to the upwelling of CO2-rich deep waters and a major sink of anthropogenic CO2 due to the formation of intermediate and bottom waters. The SO also largely contributes to supply nutrients from the deep ocean to the upper water layer everywhere in the world ocean. For all these reasons, the SO plays a critical role in the control of the Earth's climate. In turn it is very sensitive to climate variability. Given its critical

role, changes in the SO have global ramifications. In fact, such changes are already under way. But at present, the SO remains particularly under-explored. The SO extends over a vast area of the Earth's surface and it is located far away from the other continents and most of the research facilities. Extreme weather conditions and significant sea-ice coverage prevail over most of the year. This results in a scarcity of oceanographic data that limits our ability to understand key climatic-relevant processes and document ongoing changes.

The SOCLIM (Southern Ocean and Climate) project intends to implement a cutting-edge approach that will qualitatively and quantitatively improve the observation of the SO via pioneering in situ data acquisition with deployment of instrumented profilers and moorings.

Ten new-generation Bio-Argo floats were launched in water off South of Africa in the Antarctic Circumpolar Current from December 2014 to January 2015 and they are now entering the Indian sector of the SO. These floats are equipped with sensors that measure salinity, temperature, chlorophyll-a, color dissolved organic matter, backscattering at 700nm, transmission at 650nm, oxygen, nitrate and light attenuation at different wavelengths. They are collecting data in the Sub-Antarctic and Antarctic zones south east of Africa and around the Kerguelen Plateau. We will present the first data gathered during the austral summer and fall 2015. They will provide first insights in the dynamics of the termination of phytoplankton blooms in different environments and contribute to quantify the biological pump of CO2 in the SO. We will also present the plan for the deployment of an instrumented mooring in the region of Kerguelen to be deployed in 2016.

P-1111-04

Carbon production and export are fuelled by dinitrogen fixation and dissolved organic nitrogen in the South-western Pacific Ocean: results from the VAHINE mesocosms experiment

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The oligotrophic ocean represents 80 % of the global surface ocean. Its role on CO2 sequestration has long been considered to be low, but this view is currently challenged by new studies highlighting alternative pathways for carbon export to the deep ocean. In these systems, carbon production is limited due to nitrogen (N) scarcity but dinitrogen (N2) fixation and dissolved organic nitrogen (DON) would represent significant nitrogen (N) sources for the ecosystem. Here we deployed in New Caledonia large in situ mesocosms in order to investigate (1) the contribution of N2 fixation and DON use to primary production (PP) and particle export and (2) the fate of the freshly produced particulate organic N (PON) i.e. whether it is preferentially accumulated and recycled in the water column or exported out of the system. The mesocosms were fertilized with phosphate (P) in order to prevent P-limitation and promote N2 fixation. The diazotrophic community was dominated by diatoms-diazotrophs associations (DDAs) during the first part of the experiment for 10 days (P1) followed by the unicellular N2-fixing cyanobacteria UCYN-C the 9 last days (P2) of the experiment. N2 fixation rates averaged 9.8±4.0 nM d-1 and 27.7±8.6 nM d-1 during P1 and P2, respectively. NO3- concentrations (<40 nM) in the mesocosms were a negligible source of N indicating that N2 fixation was the main driver of new production all along the experiment. The contribution of N2 fixation to PP was not significantly different during P1 (9.0±3.3 %) and P2 (12.6±6.1 %). However, the e-ratio that quantifies the efficiency of a system to export particulate organic carbon (POCexport) compared to PP (e-ratio = POCexport/PP) was significantly higher ($p<0.05$) during P2 (39.7±24.9 %) than during P1 (23.9±20.2 %) indicating that the production sustained by UCYN-C was more efficient at promoting C export than the production sustained by DDAs. During P1, PON was stable and the total amount of N provided by N2 fixation (0.10±0.02 µM) was not significantly different from the total amount of PON exported (0.10±0.04 µM), suggesting a rapid and probably direct export of the recently fixed N2 by the DDAs. During P2, both PON concentrations and PON export increased in the mesocosms by a factor 1.5-2. Unlike in P1, this PON production was not totally explained by the new N provided by N2 fixation. The use of DON, which concentrations decreased significantly from 5.3±0.5 µM to 4.4±0.5 µM, appeared to be the missing N source. The DON consumption of about 0.9 µM during P2 is even higher than the total amount of new N brought by N2 fixation (about 0.25 µM) during the same period. These results suggest that while DDAs mainly rely on N2 fixation for their N requirements, both N2 fixation and DON can be significant N-sources for carbon production and export following UCYN-C blooms in New Caledonia and by extension in the N-limited Ocean where similar events are likely to occur. This study confirms that in the South West Pacific, N2 fixation is a biogeochemically relevant process able to provide sufficient new N to drive new carbon production and export. These results are particularly important in the context of increasing temperatures that will probably increase the diazotrophic activity in the future ocean.

P-1111-05

The role of dinitrogen fixation on carbon export in the South Pacific: results from the OUTPACE project (Oligotrophy to Ul-Tra-oligotrophy south PACific Experiment)

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The additional CO2 in the atmosphere, mainly resulting from fossil fuel emissions linked with human activities (anthropogenic CO2), is the main cause of global warming. The ocean has acted as a major sink of anthropogenic CO2 preventing a greater accumulation in the atmosphere and therefore a greater increase in the earth temperature. Although the biological pump provides the main explanation for the vertical gradient of carbon in the ocean, it was thought to be in an equilibrium state with an associated near-zero net exchange of CO2 with the atmosphere. Climate alterations are beginning to disrupt this equilibrium and the expected modification of the biological pump will probably considerably influence oceanic carbon sequestration (and therefore global warming) over a decadal time scale.

The overall goal of the OUTPACE (Oligotrophy to UlTra-oligotrophy PACific Experiment) project is to obtain a better representation of the influence of nitrogen fixation on the biological carbon pump in the South Western Pacific Ocean. The international OUTPACE cruise took place between February 18 and April 2, 2015, involved 30 scientists onboard, and covered around 5 000 km in the South Western Pacific Ocean from the North of New Caledonia to Tahiti.

The very first results are discussed in the context of global climate change and, more particularly, considering the role of the ocean in carbon sequestration through biological processes.

P-1111-06

The 3-dimensional potential vorticity structure and meridional overturning circulation of the Southern Ocean revealed using ARGO floats and data from instrumented elephant seals

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The meridional overturning circulation (MOC) of the Southern Ocean is a fundamental component of the climate system. The MOC exhibits first order control over the heat and CO2 budgets of the globe, forming the Earth's

large CO2 sink and mediating the exchange of heat, salt and chemical constituents southward and between ocean basins. Understanding the MOC is vital for understanding the climate system and predicting its future states.

To date, the vast majority of studies interpret the Southern Ocean MOC through a quasi 2-dimensional framework known as the Transformed Eulerian Mean (TEM). The TEM framework, developed for the study of the large scale atmospheric circulation, generally relies on zonal or streamwise averages. However, the Southern Ocean circulation is not 2-dimensional. Phenomena such as meso-scale turbulence, forced topographic meanders and mixing processes are highly localised due to the interaction between the Southern Ocean currents and large scale bathymetry. These local dynamics effect not only the regional, but the global potential vorticity structure of the Southern Ocean. It has been hypothesised that these local dynamics might have a strong influence on the MOC. We will present the results of a systemic program to study the MOC as a 3-dimensional system. Employing hydrographic profiles obtained from ARGO floats, cruises and instrumented elephant seals we develope maps of the 3-diemensional potential vorticity, geostrophic velocity and the associated fluxes due to stationary meanders. Using approximate force balances, we will use these maps to investigate the local overturning in the upper 2000m. Finally, we will discuss the implications for the large scale overturning.

P-1111-07

The O2C3 Project :Observing Pacific island societies facing climate change. Methodological, epistemological, ethical, and political implications

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Pacific island societies bear the historical hallmark of vulnerability, mobility and resilience. They have displayed adaptive capacities on the long run as far as livelihood, social institutions and political organization are concerned. The current intensification of global and climate changes could jeopardize these polities as well as pushing them to elaborate innovative solutions to face these dramatic trends. Current research programs carried out by IRD social scientists with colleagues from other institutions on changing livelihoods, health, coastal and marine governance and the value of place and land give clues about the individual and collective agency developed by Pacific islanders to deal with the risks and uncertainties inherent in this unstable situation. Against these emerging and serious challenges, there is a growing consensus about the need to think more broadly and Oceania-wide by sharing information, establishing data bases, and participating in collaborative research on the human and societal dimensions of climate change. The joint Francophone Pacific and Anglophone Pacific project Oceania Observatory of Climate Change and Its Consequences (02C3) is an effort to replicate GOPS, the South Pacific Integrated Observatory for the Environment, Terrestrial and Marine Biodiversity in the Social Sciences and Humanities, to enhance cooperation and collaboration initially among scholars based in New Caledonia and Fiji (USP) but with the intention to promote immediate Oceania wide collaboration.

The focus of the O2C3 observatory would be on peoples' knowledge, norms and practices in an encompassing framework, including various registers of knowledge: local/traditional, administrative, scientific, statistical, legal, professional... This self-evident idea raises serious challenges as far as methods, epistemology, data management and ethics are concerned. Collecting legal texts and scientific articles dealing with the issue does not raise specific difficulty, aside from localizing and accessing sources and making relevant information available to all. Identifying mobility forms linked to climate change (climate and environmental refugees, let alone mining refugees) is also feasible. When it comes to local knowledge, practices and representations of environmental and climate changes, things become trickier. There is a need for developing an in-depth reflection (1) on pertinent disciplinary and trans-disciplinary concepts that could be mobilized in social sciences for collecting and analyzing these data and (2) on the methodological and ethical implications of this type of data production and maintenance.

The O2C3 project seeks to contribute to this effort by bringing together social scientists to cooperate on the human dimensions of climate change. The first step would be to develop a collective framework on the issue of producing, collecting, managing social data on climate change and how to make them available quickly to stakeholders and decision makers. The second step would be to establish an expanding network of social scientists and humanity scholars that will focus on Pacific Island Countries and Territories (PICTs) people's awareness of climate change causes and consequences, stake holder standpoints, and governments' policies and policy implementation on climate change. Third step, it will build and host a shared digital database of information relating to climate change that will be a useful resource for above-mentioned decision makers, academics and other stakeholders.

P-1111-08

Variability in subtropical-tropical cells drives oxygen levels in the tropical Pacific Ocean

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Previous studies found a negative trend in oxygen concentrations in tropical regions during the last decades. Employing a biogeochemical circulation model, we highlight the importance of wind driven ocean transport associated with the Subtropical-Tropical Cells (STCs) in setting the oxygen levels in the tropical ocean. The observed and simulated slowdown of the STCs by 30 percent from the 1960s to the 1990s caused a decrease in oxygen transport to the tropics. Transport of phosphate was similarly reduced, decreasing export production and respiration. The effects of physical transport and biological consumption partly compensate, damping oxygen interannual and decadal variability. Our results suggest that the observed residual oxygen trend in the tropical Pacific is mainly driven by changes in oxygen transport. Accordingly, the observed recent strengthening of the STCs leads us to expect a pause in the oxygen decrease or even an increase of tropical Pacific oxygen values in the near future.

P-1111-09

Impact of the initialization with different ocean reanalyses on forecast bias in seasonal hindcasts

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We analyze seasonal hindcasts performed with EC-Earth3 that are initialized from two different ocean reanalysis estimates (ECMWF-ORAS4 and MERCATOR-GLORYS2V1), with the goal to investigate the impact of the different ocean reanalysis on the model bias and the model forecast skill. The seasonal hindcasts are four months long, consist of 10 ensemble members and they are initialized every May and November between 1993 and 2009. We find that the forecast initialized with ORAS4 is globally more skillful than the one initialized with GLORYS, particularly in the tropics. To study how the SST bias development relates with skill, we focus on the Tropical Atlantic, and in particular in two specific regions: the Atlantic3 region (ATL3), and the Angola-Benguela Area (ABA), where most climate models exhibit strong systematic biases. In both sets of hindcasts, a strong warm surface temperature bias develops in less than one month in winter or summer in ABA, and a strong cold surface temperature bias develops in one month in winter in ATL3. The biases in ATL3 in the hindcasts initialized with GLORYS2V1 are particularly strong in 1997, 2001 and 2003, and are caused by subsurface temperature errors in GLORYS. Despite the warm surface temperature

biases in ABA, monthly mean netsurface fluxes errors are negative, indicating that errors in SST most likely have an oceanic origin; this is also corroborated by the presence of strong subsurface temperature biases. Errors in the upwelling of the water masses could be in turn related to wind stress errors. We further investigate this possibility by performing additional sensitivity experiments using fixed windstress over the upwelling regions.

P-1111-10

Ant invasions in the light of climate change: forecasting a major threat for island biodiversity and economy

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In the last four centuries, spread of exotic species have been steeply rising through human mediated transportation, and have been responsive for major changes to natural ecosystems as well as major consequences and damages to human activities with tremendous associated economic costs. This situation is especially exacerbated in island context, where biological invasions are considered as the main driver of change and threat for both biodiversity and human societies. In the same time, the whole biosphere is experiencing consequences of climate change. There is, now, a wide consensus that climate change will also contribute to exacerbate threats posed by invasive species to ecosystems and human societies. Scientists estimate that this will be especially true for ectotherm organisms, whose current distributions are limited by thermal barriers. But to date, these assumptions have not been widely tested or validated. Among ectotherm organisms, ants are recognised as major invasive organisms, according to their high contribution and dominance in ecosystems, high aggressiveness in context of invasion as well as economic losses related to their spread (decreased of agricultural production, damage to infrastructure, management expenses..). Then this insect group represents an ideal biological model to test current assumptions, especially in the context of fragile insular ecosystems which are considered as major biodiversity hotspots.

Here we present first results of a study, which aims at providing a better understanding of the patterns and processes behind ant invasions as well as the impacts they have on invaded communities and the projections that one can infer from these for the future as a consequence of global environmental change (under climate change driver).

To better understand the main determinants of the distribution of exotic ant species, we developped species distribution models (SDM) to predict suitable ranges for 20 major invasive ants across Pacific islands. We also explored the evolution of these patterns in the future. We modeled current distributions, based on bioclimatic parameters, soil characteristics and land cover. Future climatic data were sourced from the 5th IPCC assessment report, and it had been calibrated and statistically downscaled using the WorldClim data for 'current' conditions, in order to compare projections. Also, we used ordination analysis to define invasiveness potential and develop spatial projection of life history traits on dynamic invasive fronts, localized on distribution maps. Then, to better fit our predictions, we made a downscale to New Caledonia biodiversity hotspot, which is already affected by 16 ant species and at risk from the last 4 species. It provides us an unvaluable opportunity to validate in the field current occurrences, then field data have been use to recalibrate our prediction of the distribution. More answers are needed regarding future ant species assemblages, ecological determinants of the distribution dynamics of introduced ants: How climate is impacting life history traits that will facilitate invasiveness? How ant species assemblages get structured under the influence of life history traits or biotic interactions?

NB: Our project is involved in a current European Eranet Biodiversa funded project 2013-2016 "(FFII) Forecasting Future Invasions and their Impacts."-

P-1111-11

Climate change impacts on marine fisheries: assessing the catchment in Peninsular Malaysia

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Global climate change variations over the past 30 years have produced numerous impacts in the abundance and production performance of marine fish and fisheries worldwide. The consequences in terms of flooding of low-lying estuarine habitats due to over rainfall, fluctuation of temperature, dilution of water parameters, devastation of feeding and breeding habitats, salinity fluctuations and acidification of waters, high siltation in coastal area, changes in the sea water table and breeding triggers have raised serious concerns for the well-being of marine fisheries and their production. This study shows that the overall total catchment of marine fisheries was decreased 38% in 2009 compared to 1998 while considers the fishing gears and vessels number used in Peninsular Malaysia. Registered vessels number was increased up to 92% in 2009 compared to 1998 which eventually increased the total catchment volume of marine fisheries. In 2009, the catching efforts and performance was far low as per vessels compared to 1998. Analysis of climate change variables shows that temperature was decreased as rainfall was increased within the year from 1998 to 2009. However, it is still early to conclude that whether climate change variables could have unpleasant impacts on fish production in the tropical seas like Malaysia. In spite of that it is predicted that the prolong exists of monsoon and increases of rainfall in this area resulting the stresses and sometimes interfering on the habitat, reproductive cycle and their related ecosystems in this coastal marine environment in tropics.

P-1111-12

Inter-annual Variability of the Upper Ocean Temperature in the Tropical Western Indian Ocean

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Interannual variability of the upper ocean temperature in the tropical western Indian Ocean has been studied using a regional ocean model. The strongest SST variability occurs in the offshore region lying over high subsurface temperature variations located between 30 and 130 m. Such a region corresponds with strong variations in the thermocline depth. The lowest SST variations occur in the Tanzanian shelf waters and lie over the subsurface waters with the smallest temperature variations in the upper 200 m. Such smallest temperature variations match with weak variations in the thermocline depth. However, the region with the highest variability of the subsurface temperature is more explained by interannual variability related to strong thermocline variations. The thermocline variations can be associated with local Ekman pumping and/or remote influence from the large-scale climate modes. Anomalous local downwelling (upwelling) and downwelling (upwelling) Rossby waves generated during ENSO and IOD events lead to anomalies in the thermocline depth and hence in subsurface temperature. The strong variability in the offshore region is related to strong interannual variability in the thermocline associated with ENSO and the IOD.

P-1111-13

THOT (TaHitian Ocean Time series): a new kind of long-lasting deep-sea oceanographic station in the central South Pacific

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Through various physical, chemical and biological processes as well as their synergetic interactions, oceans play a key-role in the modulation of climate system, carbon cycle and marine ecosystems. In the central South Pacific, including the 47 % of the French maritime domain of French Polynesia, ocean dynamic plays a key-role in the El Niño Southern Oscillation (ENSO). ENSO is the dominant mode of interannual variability in the Pacific with strong effects at global scales. It also modulates the decadal oscillations of the Pacific Ocean and longer-term trends. Furthermore, being part of the South Pacific subtropical gyre, variability of the French Polynesia waters is representative of those in the subtropical gyres of the global ocean. To observe and characterize climate changes in this region, the deployment of long-lasting oceanographic survey stations is necessary to follow the evolution of oceanographic key parameters (e.g., temperature, salinity, oxygen, phytoplankton biomass). However, presently there is no deep-sea monitoring observatory in the central South Pacific.

The objective of the TaHitian Ocean Time-series (THOT) project is to set up a deep-sea oceanographic station to observe and improve the understanding of climate changes in the French Polynesia waters as representative of subtropical gyre and Pacific scales. This project will be part of existing international programs on climate and ocean observations (Bio-ARGO, CLIVAR). It will provide a synergy and complementarity to long-term observations for global ocean

Implementation of a mooring station, such as those already existing, is complex in French Polynesia due to its geographical, scientific, logistical and technological remote context. Thus the originality of THOT is to set up a long-lasting station to observe climate changes based on 1) a regular deployment of physical-biogeochemical profiling floats in the area of interest over the next two/three years; 2) then to deploy the next generation of biogeochemical profiling floats capable of horizontal displacement to replace in their initial position.

P-1111-14

Diazotrophic impacts on the biogeochemistry of the South Western Tropical Pacific and the implications of rising temperature and CO2

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The physical, chemical, biological, and biogeochemical characteristics of the south western tropical Pacific Ocean have been studied since the 1980's. The initial studies focused on the equatorial upwelling which crosses the Pacific and annually enriches surface seawaters. Primary productivity in this high-nutrient, low-chlorophyll (HNLC) region is limited by the availability of Fe and regulated by intense zooplankton grazing which provide forage for tuna fisheries. In contrast, in the Melanesian Archipelagoes, the upper layer of the tropical ocean (between 15 and 25°S) is characterized by stable thermal stratification and nutrient-depleted (DIN, DIP), oligotrophic water especially in austral summer. Expansive surface blooms in the region experience strong seasonal and El Nino/La Nina cycles. Thus, primary producers include a high abundance of organisms fixing atmospheric dinitrogen (diazotrophs) that inject new-nitrogen into the system, the diazotrophs (including the cyanobacterium Trichodesmium spp, diatom-diazotroph associations, and unicellular cyanobacteria, and heterotrophic bacteria). The new production sustained by diazotrophy and the transfer of this " new N" to the planktonic food web critically impacts regional and global carbon and nitrogen cycling. In coastal lagoons, cyanobacteria are a major component of the food web, and run-off from land drainage and pollutions from land may affect the coastal carbon cycle and lagoon equilibrium. Here we will present a comprehensive review of the biogeochemical investigations over the last 30 years and examine the predicted impacts of increasing sea surface temperatures and elevated atmospheric pCO2 (leading to ocean acidification) on the growth, abundance, and contributions of diazotrophs to carbon and nitrogen cycling in this region.

P-1111-15

Indian Ocean warming trends simulated by an OGCM

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Tropical Indian Ocean (TIO) SST shows a steady increasing trend over the last 50 years. Many recent studies suggests that this surface warming has significant influence on large scale summer monsoon circulation features. In this study we investigate he reasons behind the TIO warming using OGCM simulations. The surface heat flux changes alone cannot explain the surface warming pattern in TIO. Significant changes large scale surface circulation in TIO is simulated by the model. The surface circulation change in TIO closely corresponds to surface wind changes and associated geostrophic response in the ocean. We propose an air-sea coupled feedback mechanism to explain the increased warming rate of central and eastern TIO. Results of model sensitivity experiments controlling the surface forcing parameters confirms that, TIO warming pattern is highly modulated by oceanic processes.

1112 - The Arctic Climate system

ORAL PRESENTATIONS

K-1112-01

The Physical Basis of Arctic Change

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Research suggests that the Arctic responds to climate change earlier, and with greater intensity, than other components of the earth system, making it a useful barometer for the health of the global environment. Observed changes in the Arctic marine and cryosphere, including increased seasonality, rapid sea ice loss and accelerated melting of the Greenland ice sheet, are consistent with these ideas of 'Arctic amplification'. Such changes can produce substantial environmental and societal stress, with regional implications and potentially profound global impacts. The resulting challenges include accelerated coastal erosion, changing weather patterns and rising sea level. Arctic environmental change can also produce new opportunities, such as expanded resource extraction and shortened shipping routes. Accurate predictions of Arctic environmental change and its global impact are needed to inform the response to these challenges and support planning of future activity.

However, current predictions sometimes differ from observed Arctic change, motivating efforts to advance our understanding of the physical processes.

This presentation will provide an overview of our current understanding of some prominent changes in the Arctic ocean and cryosphere. A complex interplay between the physics of the atmosphere, cryosphere and ocean, with the potential for positive feedbacks (such as that between reduced ice cover, reduced albedo and increased absorption of solar radiation, known as the ice-albedo feedback) govern the observed response to climate change. This motivates efforts to establish integrated, interdisciplinary, international programs to advance understanding and, ultimately, improve predictive ability. Sustained, climate-scale Arctic observing represents a critical component of such efforts, and the state of such observing systems and their underlying technologies will thus be briefly reviewed here.

K-1112-02

Assessment of Arctic Feedbacks

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Radiative feedbacks in the Arctic play a key role in determining the energy and moisture budgets both at the surface and top of atmosphere which, in turn, influences the atmospheric and oceanic circulation. The Arctic has experienced dramatic declines in summer sea ice over the past decade which has triggered a series of interconnected responses in the surface energy budget and the atmospheric feedbacks. The Arctic has become warmer, wetter, and cloudier. All of these changes further modulate the radiative fluxes at the surface. Observations indicate that the most pronounced warming occurs during boreal winter, with an increase in Arctic mean temperature of roughly 1K. This warming is associated with a pronounced sea ice loss in boreal summer which increases the evaporation rates (i.e. moisture flux). The resulting increase in water vapor and cloud cover enhances the downward long wave flux at the surface, contributing to earlier melt onset and the delayed autumn freeze up. This study will summarize the importance of these relationships using multiple observational data sets and compare the observed feedback strengths to those simulated in coupled ocean-atmosphere models.

K-1112-03

Biological impacts of recent climate change in the Arctic

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The ecology of the Arctic is changing in response to shifts in the climate system. Although Arctic species are well adapted to seasonal and diurnal variability in physical conditions, many of the observed climate-driven changes are leading to fundamental shifts in the structure and diversity of biological processes. What happens in both the marine and terrestrial environments has both local and global implications. For example, the tundra is a huge biome extending across 30 degrees latitutde. Vegetation changes show a complex pattern at larger scales, but overall there has been a rapid increase in woody vegetation (shrubs, trees), changes in phenology and albedo as a consequence of earlier snowmelt, and changes in foodweb structure and trophic interactions. Freshwater ecosystems are facing similarly large changes, and the ability of rivers, lakes and wetlands to maintain adequate streamflows, water levels and water quality for ecosystem sustainability is poorly understood. In the marine environment, there is already compelling evidence of a shift towards an increasingly pelagic system in the absence of summer sea ice. In both terrestrial and marine ecoystems, extreme events (e.g. winter rain, fire, storm surges) can overturn long-term trends, but there are still insufficient observations to adequately predict the future. I will provide a brief overview of current understanding of how Arctic ecosystems are responding to climate change and variability, and the most important research needs identified during the 3rd International Conference on Arctic Research Planning (ICARP III).

O-1112-01

The Regional Arctic System Model (RASM) - A Tool to Advance Science and Reduce Prediction Uncertainties of Arctic Climate Change

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Some of the largest changes due to climate warming are expected in the Arctic. However, 21st century projections of the magnitude of these changes vary widely in the latest suite of global climate predictions. In addition, several studies point to strong sensitivity of climate projections to multi-parameter space, varying within physically acceptable bounds. Such variations and sensitivities are the source of large uncertainties and limited skill in reconstructions of the past and present Arctic System, and in projections of the future state of this region.

We introduce a new tool for regional climate modelling, the Regional Arctic System Model (RASM), and demonstrate its advanced capability in simulating some critical physical processes and feedbacks, which significantly improve model representation of observed seasonal to decadal variability and trends in the sea ice cover.

RASM is a limited-area, fully coupled ice-ocean-atmosphere-land model that uses the Community Earth System Model (CESM) framework. It includes the Weather Research and Forecasting (WRF) model, the LANL Parallel Ocean Program (POP) and Community Ice Model (CICE) and the Variable Infiltration Capacity (VIC) land hydrology model. The ocean and sea ice models used in RASM are regionally configured versions of those used in CESM, while WRF replaces the Community Atmospheric Model (CAM). RASM has recently been upgraded to CICE Version 5.0 (CICE5.0) with (i) the new prognostic salinity thermodynamic model to represent sea ice growth and melt, (ii) a new anisotropic rheology to capture anisotropic sea ice dynamics at the multi-floe scale (of order 2-10km) and (iii) a form drag scheme to more accurately approximate ice-ocean and ice-atmosphere stresses. In addition, a streamflow routing (RVIC) model was recently implemented in RASM to transport the freshwater flux from the land surface to the Arctic Ocean. The model domain is configured at an eddy-permitting resolution of 1/12° (or ~9km) for the ice-ocean and 50 km for the atmosphere-land model components. It covers the entire Northern Hemisphere marine cryosphere, terrestrial drainage to the Arctic Ocean and its major inflow and outflow pathways, with optimal extension into the North Pacific / Atlantic to model the passage of cyclones into the Arctic. All RASM components are coupled at high frequency (i.e. 20-minute intervals) to allow realistic representation of inertial interactions among the model components.

Model results are presented from both fully coupled and a subset of RASM, where the atmospheric and land components are replaced with prescribed realistic atmospheric reanalysis data for 1948-2009. Seleceted physical processes and resulting feedbacks will be discussed to emphasize the need for high model resultion and fine-tuning of many present parameterizations of sub-grid physical processes when changing model spatial resolution. We also investigate sensitivity of simulated sea ice states to scale dependence of model parameters controlling ice dynamics, thermodynamics and coupling with the atmosphere and ocean. Finally, we show that sea ice extent commonly used to evaluate the model skill is not a sufficient model constraint as the modeled sea ice thickness distribution and volume can vary significantly while ice extent remains unchanged.

O-1112-02

IPCC AR5: Projections of Arctic Change

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The climate is changing, which is particularly visible in the Arctic sea ice state. To plan the access to shipping routes, resource extraction, etc. several groups with different

interests would like to know the future development of Arctic sea ice coverage.

Climate scenario simulations with global coupled climate models, contributing to the coupled model intercomparison project phase 5 (CMIP5), are used to exploit possible scenarios for the sea ice distribution under climate change during the coming decades. Their results are also discussed in the IPCC assessment report no. 5 (AR5). More than 30 models take part in the CMIP5 experiments and together they estimate a very large uncertainty range for Arctic sea ice. CMIP5 models simulate the global climate change and their individual strengths differ regionally. Several studies show that if a limited number of CMIP5 models are chosen with respect to their regional strengths, the range of uncertainty decreases considerably for selected variables.

Within the projects ACCESS (Arctic Climate Change, Economics and Society) and ICE-ARC (Ice, Climate, Economics - Arctic Research on Change) we compare satellite sea ice concentration observations with simulated sea ice concentration of 34 CMIP5 models. The skill of the models varies within the region in the Arctic, the time period of the satellite observation used and the satellite data processing. Thus, we analyse two different satellite derived products over individual regions, which have been discussed as potential sites for resource extractions, as well as the whole Arctic for two different time periods. From this, we select the best four CMIP5 models with regard to the misfit between model and observations. Although the models agree on the general future reduction on sea ice area, they differ in the magnitude of the sea ice decrease and thus the timing of when the Arctic becomes 'ice-free'.

The sea ice coverage correlates well with the near surface air temperature in summer and with the position of warm Atlantic water during winter. These correlations exist in the chosen models but with strong differences. For example, the position of the warm Atlantic water entering the Arctic via the Fram Strait and the Barents Sea Opening varies considerably in the four chosen models. Therefore, one reason for the differences in future sea ice estimates from different models is the simulated change of the atmospheric and oceanic northward heat transport into the Arctic.

Different sea ice projections between climate models can be understood not only being due to differences of the sea ice model component, but the model realisation of oceanic and atmospheric northward heat transport.

1112-POSTER PRESENTATIONS

P-1112-01

Reconstruction of the Greenland ice sheet surface mass balance over 1900-2014 with the help of the regional climate MAR model

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With the aim of studying the recent Greenland ice sheet Surface Mass Balance (SMB) rates with respect to the last century, we have forced the regional climate MAR model with ERA-Interim (1979-2014), ERA-40 (1958-2001), NCEP1 (1948-2014), NCEP2 (1979-2014), 20CR (1880-2012) and ERA-20C (1900-2010) reanalysis. While all of these forcing products are reanalyses, MAR simulates significant differences in SMB over the common period. A temperature correction of +1°C (resp. -1°C) had notably to be applied to the MAR boundary conditions given that ERA-20C (resp. 20CR) is ~1° colder (resp. warmer) over Greenland than ERA-Interim data over 1980-2010.

Discrepancies in simulated SMB is particularly high in regions where SMB measurements are missing suggesting that uncertainties in the current SMB reconstruction are high and observations are still needed before performing future projections. Comparisons with SMB measurements (along K-Transect), ice cores and satellite derived melt extent allows to select the best reanalysis forced data set.

All of these simulations show that i) the period 1961-1990 usually chosen as reference for SMB and ice dynamics (stable ice sheet) over Greenland is a period when the SMB was abnormally high in respect to the last 120 years; ii) SMB has been significantly decreasing after this reference period. Both ERA-20C and 20CR forced simulations suggest a precipitation increase over the last century but only the ERA-20C forced simulation suggests that SMB during the 1920-1930 warm period over Greenland is comparable with the SMB of the 2000's.

1113 - Climate Extremes: Patterns, Mechanisms and Impacts

ORAL PRESENTATIONS

O-1113-01

The timing of anthropogenic emergence in climate extremes

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Many extreme events can be attributed to anthropogenic climate change whilst others can not. This has motivated us to study the time of an anthropogenic emergence (TAE) of six indices representing temperature and precipitation extremes. We used multiple historical runs and RCP8.5 projections from six CMIP5 models. We define a quasi-natural variability for each of these indices at gridbox level and for sub-continental regions and the globe as a whole. We determine when an anthropogenic emergence occurs by comparing index distributions across moving windows with the quasi-natural variability. We also investigated how TAE compared for mean temperature and precipitation with extremes. We found earlier emergence of extreme temperatures in equatorial regions compared to other parts of the world and some seasonal variability in TAE. Spatial aggregation reduces variability in mean and extreme temperature and precipitation leading to earlier TAE values. Using limited observational datasets, the same TAE methodology was applied and signs of emergence found. Finally, using the CMIP5 models, we show the regions of the world where anthropogenic signals can already be detected in our temperature and precipitation indices to aid in the study of attribution of extreme events to climate change.

O-1113-02

Extreme heat waves with the Heat Wave Magnitude Index and their occurrence in the future

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Heat waves are defined as prolonged periods of extremely hot weather and their intensity, duration, and frequencies are expected to increase in the future under climate change.

Recently, a new Heat Wave Magnitude Index (HWMI) was developed that, by taking into account both heat wave duration and intensity, enables the quantification of the magnitude of heat waves across different time periods and

regions of the world.

Here we first apply the HWMI to grade the observed heat waves occurred in Europe since 1950: in fact, although the worst event in the last decades occurred in Russia in 2010 (the strongest recorded globally in recent decades exceeding in amplitude and spatial extent the previous hottest European summer in 2003), many other heat waves, documented in literature and in newspapers, occurred in different European regions in the past decades.

Subsequently, we apply the HWMI to the predictions from several regional climate models (RCM) from the COordinated Regional climate Downscaling Experiment (CORDEX). RCMs have been used to downscale CMIP5 Global Circulation Models under different Representative Concentration Pathway (RCP), namely RCP4.5 and RCP8.5. We focus on two regions, Africa and Europe, for which a large ensemble of models' results is available.

Results show that, by the end of this century, under the most severe emission scenario, events with magnitude even greater than the one in Russia in the summer of 2010 will become more frequent and are projected to occur as often as every 10 years for regions such as southern Europe and central Africa.

O-1113-03

The Role of Teleconnection Patterns in Wave Climate and Storms Distribution: The SW Spanish and Wales Coasts Examples

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Tele-connection patterns such as the North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) are influenced by climate change, as models predict a weakening of the overturning circulation that may affect both regional and global climate, sea level and extreme waves. Occurrence and distribution of storms are important variables in the incidence of coastal erosion, deterioration and/or complete destruction of ecosystems. This work presents the characterization of wave climate and energy, coastal storms and their recurrence intervals, related to several regional cycles in Cadiz (SW Spanish Atlantic coast), Tenby and Swansea (S Wales, UK). At the former site, wave records include 22 years of data covering the period between 1987 and 2012. Storm characterization was carried out using the Storm Power Index and five classes were obtained, from class I (weak events) to V (extreme events). Storm occurrence probability was 96% for class I (i.e. almost one event per year) to 3% for class V. The return period for class V was 25 years and ranged from 6 to 8 years for classes III and IV storms, e.g. significant and severe events. Classes I and II showed a period of recurrence ranging from 1 to 3 years. Approximately 40% of the change in monthly wave data and storminess indices was related to several teleconnection patterns, being the Arctic Oscillation (AO), with 21.45%, and the North Atlantic Oscillation (NAO), with 19.65%, the most important drivers of change.

O-1113-04

Timescales of Change: Unraveling East Africa's Climate Paradox

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East Africa is currently facing something of a climate paradox. Over roughly the past 15 years, the region has been experiencing an increased frequency of drought, particularly during the «long rains» season from March-May. In a seeming contradiction, there is a general consensus among climate change projections that the region of East Africa will become wetter as a result of anthropogenic climate change by the end of the current century. One possible explanation of this discrepency is that the climate models are not properly responding to increasing greenhouse gases and their influence on East African climate: The future climate of East Africa may in fact become drier, not wetter. Another possibility is that the recent rainfall decline is associated with processes in the climate system operating on shorter time scales than long-term climate change. In this case, the recent rainfall decline may be masking longer-term climate change. A third possibility is that there is an interaction of processes operating on these different time scales.

This paper will review recent and ongoing research that is helping to explain the recent variations in East African climate. A combination of observational and climate model experiments indicate that the recent rainfall decline in East Africa has been associated with decadal-scale variations of the climate system, specifically in the Pacific Ocean. Evidence is presented that the rainfall decline in East Africa was manifest as an abrupt shift towards drier conditions that occurred in 1998-99 when the Pacific Decadal Oscillation (PDO) shifted from its warm to cold phase. This shift in the PDO was associated with a colling of eastern equatorial Pacific while the western Pacific has remained anomalously warm. Observational evidence indicates that the recent rainfall decline in East Africa was part of a near-global scale shift in seasonal rainfall patterns, with similar shifts observed previously over the past century. Results from climate model experiments, using only observed sea surface temperatures in the tropical Pacific as forcing, indicate the models are able to reproduce the recent drying in East Africa and the associated shift in global precipitation patterns. However, observations also indicate that the western Pacific warm pool region has continued to warm over the past several decades, an increase which almost certainly contains an anthropogenic component. Current work is investigating whether this combination of «natural» decadal variations and anthropogenic change, particularly in sea surface temperatures in the Pacific warm pool region, led to an exacerbation of recent East African droughts (we note that the devastating drought in 2010-11 was likely the most severe of the past 50 years). Understanding the physical processes associated with climate model projected increases in East African rainfall and how realistic they are in light of what is known about the behavior of the current climate system remains a critical next step in fully unraveling the East African climate paradox.

O-1113-05

Physical insights on future European summer heat waves and record-breaking temperatures

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Recent summer heat waves had strong socio-economic impacts in different parts of Europe. This highlights the need for improved understanding of key processes and feedbacks. We focus on the detection of an anthropogenic signal on record-breaking summer temperature using historical and 21st century simulations from a set of CMIP5 climate models. Results show that simulated and observed record evolutions follow the stationary climate theoretical record rate until the 1980s. They then diverge from the expected value, with an increase of the number of warm records and a decrease of the cold ones. These changes are shown to accentuate over the 21st century. The influence of internal variability based on control simulations is used to estimate an anthropogenic signal emergence time around 2030.

We then focus on a set of case studies of future heat waves. We analyze a high spatial resolution simulation (from 1950 up to 2100) of the ALADIN regional atmospheric model driven by the CNRM-CM5 model. Based on warm spell duration indices, we select a few intense events that occur in the second part of the 21st century. Heat waves are generally associated with quasi-stationary anticyclonic circulation anomalies that produce clear skies and warm air advection. They are often associated to anomalously dry land surface conditions. For each case study, we perform ALADIN sensitivity experiments by perturbing either the prescribed large-scale circulation and/or the initial soil moisture content. We then infer the dominant mechanisms and the feedbacks operating to amplify or mitigate the heat waves. We also perform a worst-case scenario where we try to generate an extreme heat wave in order to assess the associated temperature rise and its possible saturation due to negative feedback.

O-1113-06

Global future changes of precipitation extremes

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Precipitation extremes have a strong impact on ecosystems and societies especially in exposed and vulnerable areas. In a climate change context, where exposure and vulnerability are also expected to change, it is essential to achieve a better understanding and an improved characterisation of these events. By analysing the latest global climate model simulations from the Coupled Model Intercomparison Project Phase 5 and by using an innovative statistical approach, seasonal changes in daily precipitation extremes under the high emission (RCP8.5) and the mid-range mitigation emission (RCP4.5) scenarios are investigated. Two future time periods (2020-2059, 2060-2099) are compared with the historical time period 1966-2005 and the results presented in terms of very high risk events. Furthermore, global models are evaluated w.r.t. precipitation extremes by using the available (high-resolution) gridded observations during the selected time period of the historical run. At the European scale, complex changes in the tail behaviour are also assessed. Results show that in the historical period a reliable characterisation of daily extreme precipitation cannot be achieved for large areas of the world, where an estimation of the return levels cannot be obtained. This is the case, for instance, during boreal winter for a belt elongated over the subtropics and tropics of the Northern Hemisphere and the oceanic areas west of the three continents of the Southern Hemisphere. In the Euro-Mediterranean area, northern Eurasia, and North America, the simulations show lower intermodel variability and higher correlation with the observations in boreal winter. Conversely, for Australia, southern Asia, and the Middle East, all seasons are characterised by larger intermodel variability and lower correlation with the observations. Concerning the future projections, the main findings point to an intensification (more pronounced at the end of the century under the high-emission scenario RCP8.5) of precipitation extremes almost everywhere in the world and in all seasons. However, a lack of reliability and consistency affects the subtropics/tropics. The zonal means of the identified changes clearly show more pronounced increases over the high latitudes of both hemispheres in all seasons, with the exception of the Northern Hemisphere in the mid-century boreal summer, associated with larger intermodel variability. Over the Southern Hemisphere, a sharp decrease in the estimated positive changes from the high to the middle latitudes is evident in all seasons followed by (with the exception of the austral winter) a strong increase towards the low latitudes. Stronger hemispheric differences are also estimated over the high latitudes for RCP8.5 at the second half of the century that are most prominent in summer and autumn. At the regional level, models show a better agreement on the projected increase of return levels over land, although large variability affects the estimated seasonal changes over specific areas (e.g., eastern Asia in summer).

O-1113-07

Weakened Flow, Persistent Circulation and Prolonged Heat Waves in Boreal Summer

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Changes in atmospheric circulation can strongly alter the frequency and/or magnitude of high-impact extreme weather events. The Northern Hemisphere mid-latitudes have seen significant changes in the large-scale summer circulation over the last decades and this might have contributed to more prolonged heat waves (1-3). The zonal mean zonal wind (or "jet") has weakened by about 5% over 1979-2014, likely driven by the much more rapid warming in the Arctic as compared to the rest of the Hemisphere. In conjunction with the summer jet, the kinetic energy associated with transient synoptic-scale weather systems (the Eddy Kinetic Energy, or EKE) has seen a significant weakening as well. The observed decline in EKE is more pronounced in relative terms than that of the jet (by about 10% over 1979-2014), which is consistent with theoretical arguments and climate model simulations. Transient eddies are both forced by the jet via vertical shear but can also accelerate it via the eddy-driven jet (4, 5). The observed summertime weakening of both jet and EKE is also a robust signal in future projections of CMIP5 climate models (5, 6). At the same time, for some wave numbers, we have seen an increased occurrence-frequency of high-amplitude quasi-stationary waves during recent boreal summers. We argue that this increase in frequency is associated with a recent cluster of resonance events which can create such high-amplitude waves.

The reduction in amplitude of fast-moving transient waves (as captured by EKE) and the more-frequent occurrence of high-amplitude quasi-stationary waves both favor more persistent weather conditions. It has been demonstrated that high-amplitude quasi-stationary waves in the atmosphere are statistically associated with extreme weather at the surface (7, 8). Especially regions at the western boundary of the continents show the strongest association between surface extremes and high-amplitude upper-level waves. In contrast, strong transient wave activity, i.e. large EKE, is linked to moderate surface temperatures and vice versa (3). Over most continental regions affected by storm tracks, there is a significant negative correlation between monthly EKE and surface temperature. Thus, the hottest summers are associated with extremely low EKE, while mild summers are associated with more pronounced EKE. Again the western boundaries of the continents are especially sensitive since these regions are most directly influenced by the storm tracks.

In conclusion, boreal summer circulation has seen pronounced changes over the last decades, trends which seem to have amplified since the onset of rapid Arctic Amplification around 2000. Especially the reduction in EKE, but also in zonal mean flow, have created conditions favorable for the buildup of heat and drought over the continents. Moreover, a cluster of resonance events is observed since 2000, which has increased the occurrence-frequency of high-amplitude quasi-stationary waves with wavenumbers close to 7. Thus, this generally implies a weakening of transient synoptic eddy activity and more-frequent states of quasi-stationary flow. These observed changes in large-scale flow point towards more persistent flow patterns and therefore more extreme surface weather. This is also consistent with the pronounced increase in heat extremes in Europe and other mid-latitude regions (9, 10).

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O-1113-08

Climate Model Simulation of Present and Future Extreme Events in Latin America and the Caribbean: What Spatial Resolution is Required?

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Latin America and the Caribbean are regions presently at grave risk to a variety of extreme climate events. These include flooding rains, damaging winds, drought, heat waves, and in high elevation mountainous regions, excessive snowfalls. The causes of these events are numerous. For example, flooding rains and damaging winds are often associated with tropical cyclones, but also can occur, either separately or in tandem, due to smaller, more localized storms. Similarly, heat waves and droughts can be large scale or localized, and frequently occur together (as excessive drying can lead to enhanced heating, while enhanced heating in turn promotes additional drying). Even in the tropics, extreme snow and ice events can have severe consequences due to avalanches, and also on water resources. Understanding and modeling the climate controls behind these extreme events requires consideration of a range of time and space scales. A common strategy is to use a global climate model (GCM) to simulate the large-scale (~100 km) daily atmospheric controls on extreme events. A limited area, high resolution regional climate model (RCM) is then employed to dynamically downscale the results, so as to better incorporate the influence of topography and, secondarily, the nature of the land cover. But what resolution is required to provide the necessary results, i.e., minimize biases due to improper resolution? In conjunction with our partners from participating Latin American and Caribbean nations, we have made an extensive series of simulations, both region-wide and for individual countries, using the WRF regional climate model to downscale output from a variety of GCMs, as well as Reanalyses (as a proxy for observations). The simulations driven by the Reanalyses are used for robust model verification against actual weather station observations. The simulations driven by GCMs are designed to provide projections of future climate, including importantly how the nature and number of extreme events may change through coming decades. Our results suggest that for proper simulation of both mean climate, and importantly extreme events, a spatial resolution of 4 km is required in regions of complex mountainous topography. A somewhat coarser resolution of 12 km is adequate in regions without much topographic relief, and where differing land covers account for most of the spatial heterogeneity.

O-1113-09

Should we expect more extreme rainfall from Atlantic tropical cyclones as a response to global warming?

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Daily precipitation extremes increase in intensity over many regions of the globe in simulations of a warming climate, including the tropics where observational constraints suggest that this sensitivity could be higher than expectations for the extratropics and from the Clausius-Clapeyron (CC) relationship (e.g. O'Gorman 2012). Here, the focus is on heavy precipitation related to Atlantic tropical cyclones (TCs). The objective is to investigate whether the sensitivity to global warming of TC rainfall is mainly controlled by the atmospheric water holding capacity, following the CC relationship, or could be even higher due to a dynamical cyclone amplification associated with an increased release of latent heat in the atmosphere. This amplification may lead to rates of change reaching twice the CC rate (Trenberth 2007). Our investigation is based on TRMM satellite precipitation observations and atmospheric ERA-Interim reanalysis in association with the IBTracs observed TC dataset on the one hand, and on coupled ocean-atmosphere simulations performed with a stretched version of the CNRM-CM5 global climate model on the other hand. For the CNRM-CM5 simulation an objective TC-tracking has been performed.A water budget analysis has been conducted along the cyclone tracks for both observation and model. It was found that moisture convergence is the dominant contribution to TC rainfall, as expected from previous case studies. Results also show that our climate model captures quite well the water budget derived from ERA-Interim, although the latter shows a systematic underestimation of TC rainfall, as compared with TRMM, possibly due to an underestimation of TC winds. Moreover, the analysis of our climate scenario suggests that the increase of spatially aggregated TC mean rainfall follows the CC relationship, while super CC rates are only reached in the very inner core of the TCs.

O-1113-10

Temperature and precipitation extreme compound events in Southeastern South America and the associated atmospheric circulation

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Compound events consist of the simultaneous or successive occurrence of two or more extreme events, the combination of extreme events with conditions that amplify the impact of the events, or the combination of events that are not individually extreme but can lead to extreme impacts when occurring together (IPCC, 2012). In this paper we analyse the joint occurrence of extreme temperature and heavy precipitation events (simultaneous or lagged by one day) in southern South America during 1961-2000.

The study is based on a comprehensive dataset of daily precipitation and daily minimum and maximum temperature observed at meteorological stations of the region and compiled during the CLARIS LPB project. Four different extreme temperature events were defined: warm nights (days) correspond to days with minimum (maximum) temperature exceeding the 90th percentile of the daily distribution; cold nights (days) are days with minimum (maximum) temperature below the 10th percentile. Heavy precipitation events are events with daily rainfall above the 75th percentile of the empirical distribution of rainy days. A compound event is defined when one of the above temperature extremes occurs simultaneously with, preceded or followed by a heavy precipitation event.

The existence of a significant statistical relation between these extremes could help to better characterize the uncertainties associated with projections of extreme precipitation events for a future warmer climate. Results show that the probability of occurrence of an intense precipitation increases during or after a warm night, but decreases during a cold night, compared to the expected likelihood of occurrence of this type of events in the absence of a relation between temperature and precipitation extremes. Warm days are usually associated to the occurrence of heavy precipitation events on the same day or the day before, but they rarely occur afterwards. On the contrary, cold days happen more often after an intense rain.

In order to characterize the atmospheric circulation during the occurrence of a compound event, we use a synoptic classification developed by Barrucand et al (2014) and based on daily mean fields of geopotential height at 500hPa from the NCEP2 reanalysis. The associated circulation during a compound event of warm nights or warm days and heavy precipitation shows a trough over the Pacific Ocean and a cold front over the continent that lead to warm and wet air advected to the east of the region of study. Cold days and heavy precipitation events in the southwestern part of the domain of study are usually characterised by a positive anomaly of geopotential height at the southern part of the continent associated with an eastern anomaly over the region.

1113-POSTER PRESENTATIONS

P-1113-01

Capability of CORDEX RCMs in simulating extreme rainfall events over South Africa

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In South Africa, extreme rainfall events often lead to widespread destruction, damage infrastructure, displace communities, strain water management and even destroy lives. Past studies have shown that reliable predictions of extreme rainfall events from regional climate models (RCMs) could help reduce the impact of these events. The present study evaluates the ability of nine RCMs in simulating extreme rainfall events over South Africa, focusing on the Western Cape (WC) and east coast region (EC). This study defines an extreme rainfall over a location as rainfall that is equal or above the 95th percentile of the rainfall distribution at that location, and defines widespread extreme rainfall events (WEREs) over an area as events during which more than 50% of the grid-points in the area experience extreme rainfall. The 95th percentile threshold values were calculated over 11 years (1989-2008) of South Africa's daily rainfall data from nine RCMS which participated in the Coordinated Regional Climate Downscaling Experiment (CORDEX). The simulations were compared to two observation datasets (TRMM and GPCP), and to ERAINT rainfall data to understand whether these RCMs improve on the results from ERAINT. A self organizing map (SOM) was used to characterize WEREs identified in all the datasets into archetypal groups, and ERAINT data is used to describe the underlying circulations for each archetypal rainfall pattern. The number of WEREs mapped to each rainfall pattern for each dataset allows us to get an idea of whether certain RCMs are more likely to simulate certain rainfall patterns.

The results show that RCA35, REMO and WRF seem to be the best at simulating the 95th percentile threshold values over the whole of South Africa. However, it was found that CCLM seems to do the best over the WC and PRECIS does the best over the EC. Downscaling ERAINT with CCLM produces fewer WEREs, whereas downscaling ERAINT with PRECIS produces a higher number of WEREs simulated over both areas (WC an EC). The SOMs identifies five major patterns of WERE over areas. The first pattern (TRW) links WERE in WC or EC with tropical activities, producing a tropical temperate through that is truncated at the coast. The second pattern links WERE in WC or EC with mid-latitude rainfall activities(MLW). The third pattern produces an isolated WERE over each area (ISW). The forth pattern, which is unique to WC, links WERE in WC with rainfall activities over the Agulhas current. The fifth pattern, which is unique to EC, links WEREs in EC with both tropical and mid-latitude rainfall activities, hence producing TTTs. PRECIS has the tendency to overestimate the frequency of TRW WEREs over both the EC and WC whereas, WRF only shows this tendency over the EC. ARPEGE simulates more WEREs associated with ISW over the EC region and over the WC WRF and CRCM5 underestimate the frequencies of these events. Over the EC the frequency of WEREs associated with mid-latitude rainfall activity seems to be simulated reasonably well by the RCMs whereas over the WC most of the RCMs overestimate the frequency of these types of WEREs.

P-1113-02

The potential risk of climate change and extreme climatic events on coastal cities of Nigeria

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This study examines the potential risk of climate change and extreme climatic events on coastal cities of Nigeria. The study applied satellites data, Remote sensing and Geographical Information System (GIS) methodologies to assess the environmental and societal implications and the risk of climatic events such as flooding, coastal erosion and seas surface rise on coastal cities of Nigeria. The risk of climate variability and extreme weather events cannot be overemphasized on urban settlements that occupy millions of people in Nigeria. It is obvious from the report of Nigerian National Population Commission (NPC, 2006) that a large percentage of Nigeria's urban population lives in coastal cities. Previous studies have reported that Climate change has been affecting and will continue to affect almost, if not all, the sectors of the urban economy including the most sensitive ones such as water and health sectors. Such impacts and the risk of climatic event are now obvious in many coastal cities of Nigeria. The impacts of climate change and urban risk may be felt also by a wide spectrum of socio-economic variables like human health, transport, energy, industry and other service sectors in the coastal cities. Increases in population growth rates in the coastal cities of Nigeria, combined with a likelihood of a 1m sea-level rise, could create high risk on tourism-oriented economies, ecology, and other societal implications. Though, the report of IPCC, (2007) has shown that there are some uncertainties about the nature and magnitude of risk and vulnerability to climatic changes, it is necessary to make some assumptions about risk of changes in climate in order to assess potential such risk on coastal urban settlements of Nigeria. Thus, the general objectives of this study has been to assess the spatiotemporal risk of climatic event; map out a composite of scenarios for climate change impacts; to examine the risk of climatic extreme events on coastal cities of Nigeria; and their implications on physical, economic and social environments. This study holds the benefit for better understanding of a need to have a coastal zone management plan to address the possible coastal cities risk indicated in this study.

P-1113-03

The Climate Expectancy : a resolute parametrical approach to redefine the climate

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1) The 30-year average, a largely outdated concept :

Since the climatic break (or powerful acceleration) that happened throughout the world in the late 70s, temperatures are following a steep slope. Considering the whole set of GCM simulations (see IPCC AR5), this trend is not going to slow down, to speak gently. So, we can no longer ignore that the mathematical operation of averaging applies not only on values but also on time, when used on a chronological series.

If we don't renew the definition of climate normality, we will be using the 30-year average of 1981-2010 (i.e. the 1996 expectancy) until 2021, when the 30-year average of 1991-2020 is to be calculated and released. What was tolerable in times of slow and weak fluctuations is becomming unacceptable in a situation where a strong trend is at work (from +0.3°C to +0.5°C per decade in France since the climatic break, for instance).

The link with climate extremes is obvious. An extreme is qualified by its distance to normality. If we define the normality better, we define better what is away from it.

2) Redefining the climate :

The World Meteorological Organization (WMO) classical definition of the climate can be written : observation time series = 30-year average + anomaly time series

The proposition is to refine the 3 terms of the equation by an homogenization of the observed meteorological datas, followed by a separation between the random part of the series (replacing the anomaly) and the organized part which is, in fact, the climate expectancy. The underlying idea is to consider that a 'real' anomaly in a time series should be what is totally unexpected, and so, what is part of a random series.

3) Organizationnal analysis :

The purpose is the separation of the long-term organizations (trend, cycles...) from the short-term ones (persistance...). Considering the long-term organizations, we can write :

Par(t) = (a*t+b)+Amp1*sin(2Πt/P1+Phas1)+Amp2*sin(...)+...+ParWLTO(t)

where Par(t) is the homogenized series and WLTO means Without LongTerm Organization.

The short-term organization is treated in an auto-regressive process :

ParWLTO(t) = A1.ParWLTO(t-1)+...+Akmax.ParWLTO(t-kmax)+ParWSTO(t)

where Ai are the auto-regression coefficients and kmax is the (maximum) horizon of significant persistance. WSTO means Without long term and ShortTerm Organization.

We can now easily deduce the expression of the climate expectancy ClimPar(t) :

ClimPar(t) = Par(t)-ParWSTO(t)

On this expression, it is easy to figure out that we can have a different value of the climate expectancy on each observed data till the last one. The compatibility with the classical WMO definition is achieved simply by centering ParWSTO(t).

The randomness of the ParWSTO(t) series can be verified with multiple statistical tests like the runs tests. It happens that the separation between organized and random parts is excellent. We experienced this with 30-year to 60-year long daily datas of maximum and minimum temperatures, located in the central region of France called Limousin.

Because the ParWSTO(t) series is a random series (or very close to), it can be regenerated by a random number generator. The shape of the random distribution is adjusted dynamically and parametrically to the observed one by analysing the organization of the variance, skewness and kurtosis of ParWSTO(t).

The upgrade of the determination of climate extremes is the result of the whole process which can be summarized as a separation between organized and random variability.

4) Biding farewell to the 30-year average ...

On one side, the 30-year average is an easily explained notion, which needs only simple calculations and is universal. To abandon it will be indeed a difficult human and social process. On the other side the climate expectancy is a quite open concept, delicate to understand at first sight and that can lead to long and uneasy calculations. However its integration into the toolbox of climatologists has to be started soon because of the strengh and the inertia of the global warming phenomenon. Its usability at very different scales of time (from hourly to centenial datas at the least) should facilitate a rapid consensus.

P-1113-04

Climate change and extreme weather events in Mediterranean Sea: studies with WRF atmospheric model

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Extreme weather events are becoming more frequent the last years. This fact along with its relation to the possible climate change, are two major issues of scientific study. In this work, WRF-ARW atmospheric model is used to simulate extreme weather conditions in Mediterranean Sea, focusing in the Greek peninsula. Sensitivity tests with different model configurations will be presented, as well as evaluation of the results against in-situ observations. The results show good agreement with observations and prove to be a very useful tool for studying, forecasting and trying to limit down the consequences of such events.

P-1113-05

Extreme Rainfall Events in Asia: Projected Changes and Uncertainties

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Extreme precipitation (and drought) are one of the main concern for society and environment, because they can lead to severe flood (and lack of water supply). In warmer environment, atmospheric moisture is expected to increase, and could thus create more favorable conditions to trigger extreme rainfall. However, the change in dynamics can also play a major role in the change of distribution of precipitation. The modification of the land-sea thermal gradient, the vertical structure of the atmosphere, or the latent heat released by the precipitation, can all impact the large scale circulation, and thus the rainfall distribution.

In this study, focussed on the East Asia region, we analyzed the results from two high resolution models (HiRAM-C192 and HadGEM3-GC2), and from the CMIP5 ensemble, to investigate the projected change in extreme rainfall events (either extreme precipitation or long drought). The role of the SST is also investigate. HadGEM3-GC2 is fully coupled with ORCA025, while HiRAM-C192 is forced by prescribed SST. The SST forcing for this model is determined by a cluster analysis from the CMIP5 projection. Three main patterns of SST are used, providing three different projections for this model. We also emphasize the correlation with the dynamics to explain the internannual variability of the extremes events.

In both CMIP5 ensemble and high resolution models the signal of extreme precipitation strongly increase during the summer. On the other hand, the signal on the drought spell is not clear. HadGEM3-GC2 show a decrease during winter of East Asia, while the three HiRAM runs show an increase during this same season. It could be due to a difference of sea-land contrast. The East Asia 200 hPa Jet intensity impacts significantly the variability of extremes precipitation, while the winter 850hPa winds show a strong correlation with the dought over East Asia. The results on CMIP5 ensemble also show a significant impact of the change in vertical motion (with a tendency to slow down), that could act as a counterbalance to increase of atmospheric moisture. But large uncertainties remain between different models, and impact strongly the confidence on the extreme projection.

P-1113-06

Climate change impacts on social well-being of fishers' communities in the Bangladesh Sundarbans

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Social well-being concept has garnered much interest in recent years as a multi-dimentional, holistic approach to understand and measure progress and problems. Though the concept of social well-being has operationalized across different disciplines, there are very few studies using this concept to show how climate change is affecting well-being of fishing communities. To fill this knowledge gap, this study employs social well-being approach to study the impacts of climate change on the livelihoods of mangrove fishers' communities in the Bangladesh Sundarbans. Qualitative data collection tools were employed; a semi-structured questionnaire was used to collect the empirical data from four fishing communities. Given that, in recent past two consecutive cyclones- Sidr (hit Bangladesh coast on 15th November, 2007), and Aila (struck Bangladesh coast 25th May, 2009) affected a major part of the Sundarbans mangrove ecosystem with great devastation. In addition, the region faces other environmental degradations such as saline water intrusion, occasional droughts as well as degraded resources base of the forest. Thus, ongoing environmental changes in the Sundarbans and its effects on the communities provide a suitable setting to study the impacts on climate changes on the well-being of the residing population. Following the WeD framework of wellbeing, social well-being has three dimensions, material, subjective and relational that together constitutes human welfare. Cyclones Sidr and Aila caused loss of different 'material' values for the fishing communities in several ways. Rising tidal waves, associated with cyclones washed away productive assets, housing, and standing crops in the field, employment opportunities in alternative occupations were also severely squeezed, that altogether rendered in income loss of the communities. Immediate aftermath of cyclone Aila, most fishers took shelters in makeshift built on embankments that severely degraded their standard of living. Increased salinization after cyclone struck caused acute crisis of drinking water and loss of biodiversity that reduced overall environmental quality of region. Many fishers expressed their shocks, fears after seeing that rising water washing away their belongings before their eye. Living in constant economic hardship, depending on external supports for survival for longer period, school drop out and increased child labour undermined fishers' aspirations and confidence for a secured future. In case of relational values, 'social cohesion' of fishers' communities traditionally served as buffer during the period of crisis. However, individual competition to receive relief at the cost of others' interest negatively affected the community bonding and dispelled social capital to certain extend. The

responses from the government mostly gave emphasis on of materialistic rehabilitation of the affected communities. Following this new understandings through social well-being lens, the present study submits for a more holistic, more responsive policy making in Bangladesh by taking consideration into multiple dimensions of human welfare that are affected by climate change impacts.

P-1113-07

Characterization of extreme rain events and assessment of Regional Climate Models in Morocco

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At a global scale, more than half of the costliest disasters are weather related and our planet is facing more devastating extreme events mainly those related to rain. In Morocco, the floods between the 21st and the 25th November 2014 in the south of the country had caused the death of 32 people. In Casablanca, the flood of the 29th-30th November 2010 had caused enormous human and material losses. In the province of Settat, the flood of the 23th and 24th December 2001 have caused the death of eight people and flooded several industrial units and Douars in the region, adding to many other tragedies in the flood areas. Also in Ourika, the floods of the 17th August 1995 had caused more than 230 deaths, 500 missing, 200 damaged cars and other property damage. Thus, there is a real need for understanding and anticipating weather extreme events mainly those related to intense rains, that may leads the way in risk assessment and development of mitigation strategies.

The aim of this work is to characterize the frequency and the trends of rain extreme events and to assess simulations of regional climate models for these extreme events in the watersheds of Tensift and Bouregreg (Morocco), during the last decades. First, the work analyzes the observed trends in daily rainfall time series, than it identifies rare, very rare and exceptional rain events, using percentile-sampling thresholds, and studies the trends of their frequencies. Finally it evaluates an ensemble of regional climate models from the European project ENSEMBLES, with regard to the found trends in order to recognize models that best describe observed rain regime, in the studied catchments.

P-1113-08

Relationship between the Tropical South Atlantic SST and drought over West Africa from CORDEX

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Droughts in West Africa are not only an environmental problem but also a social and economic concern. However, droughts research has not obtained the necessary attention in West Africa. Moreover, the dynamics of West African drought are not fully understood and among the studies that have considered droughts of West Africa, only a few have considered the link between Tropical South Atlantic (TSA) Sea Surface Temperature (SST) and drought over West Africa. In this study, we look at how CORDEX models represent the relationship between the TSA SST and drought, precipitation and temperature over West Africa. Studies on drought done over West Africa used only precipitation in Standardised Precipitation Index (SPI) to measure drought index. The use of precipitation alone is inadequate to give information about drought as evapotranspiration has a direct influence on drought. We recognize that evapotranspiration is an important process of water loss. Here, we use the Standardised Precipitation Evapotranspiration Index (SPEI) where evapotranspiration is included in the calculation of the drought index.

P-1113-09

Drought Hazard Analysis over India and Its Impact on Climate Using Applying Multivariate Technique for Composite Indicators

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Drought being complex and least understood disaster affects multidimensional parameters of social and economic structure of society. It is said to be hydro-meteorological disaster having prolonged period of below average precipitation causing drought whose severity is largely determined by the amount of rainfall. The objective of this study to carryout drought hazard analysis in India with a combination of drought indices in geospatial environment using meteorological drought hazard analysis has been carried out effectively by the generation of Drought Hazard Index (DHI). Meteorological drought hazard analysis was performed by analyzing rainfall and its distribution pattern and drought occurrences. The current study of this research is to develop a composite index capturing spatial variations of drought hazard by taking into account the spatial and temporal occurrence of meteorological drought and to map the drought hazard in India. The present research involves generation of drought hazard index formed by compilation of individual indicators based on meteorological parameters into single index which is further used for the analysis of namely meteorological drought hazard in the country India. The study uses Climate Precipitation Center (CPC) rainfall time series at 10 x10 km grid for south west monsoon season (June-September) for 12 years 2001-2012 shown in Figure 1. DHI proposed in this study is a major initiative towards generating hazard indices for disasters with the composite index approach. DHI has fairly well represented the drought hazard pattern in the country by capturing the spatial variations in drought hazard across India. The DHI has thus effectively captured the spatial variations in drought hazard across India. The spatial patterns of drought hazard are reasonable and justify the strength of the index. The procedure for generating DHI can be further improved by adding more number of indicators. The strengths of the methodology are using a composite index method, analysis in spatial perspective, inclusion of a wide range of inputs and covering a large geographic area. Indicators selection and weights generation are the possible areas for further work.

P-1113-10

Determining climate indicators to assess the impact of extreme weather events on road accidents in Hungary

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The Special Report of IPCC on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2011) concluded that there is evidence from observations gathered since 1950 of change in some extremes. A set of climate indices are used in several projects on climate change as prevailing indicators of changes in extremes.

The main focus of the presentation is preparing climate indicators to impact and vulnerability assessment of roads accidents, as critical infrastructure, within extreme weather events in wintertime periods based on existing dataset of the National Adaptation Geographical Information System (NAGIS) in Hungary. The daily grid for period 1961-2010 in 0.1° spatial resolution for several basic meteorological variables and climate indicators were created in CARPATCLIM (Climate of Carpathian Region) project is integrated to the NAGIS system for the territory of Hungary. The common used methods and software in the CARPATCLIM project was the method MASH (Multiple Analysis of Series for Homogenization; Szentimrey) for homogenization, quality control, completion of the observed daily data series; and the

method MISH (Meteorological Interpolation based on Surface Homogenized Data Basis; Szentimrey and Bihari) for gridding of homogenized daily data series. It is a relevant climate database for studying climate extremes and climate change in the region.

Different climate indicators are defined and quantified to mapping of exposure and sensitivity such as zero crossing days, precipitation amount in a specific period, ice days, snow cover, wind speed, cold/wet days, daily mean temperature < 25th percentile, and daily precipitation > 75th percentile for example. These climate indicators are the input values to impact studies that will be developed through the integration of the exposure and sensitivity mapping layers to the NAGIS system. Mapping of exposure will be based on measurement data and climate modelling results of Hungarian Meteorological Service (OMSZ), while the transport accident data recorded at the central body of disaster management will serve as a basis for sensitivity mapping. Among others these climate indicators will be used to assess the vulnerability due to climate change, which will foster the development of adaptation strategies and objective decision making.

P-1113-11

Changes in nature of extreme rainfall in southern Africa

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Extreme rainfall, usually expressed through local or regional weather events, is driven by synoptic-scale forcings as well as other factors like moisture availability, lapse rate etc. Rainfall and especially small-scale extreme rainfall associated with convection is poorly simulated by numerical models (general circulation models - GCMs) and regional climate models (RCMs). However, numerical models are able to simulate large-scale circulation states so in this study we characterize circulation states to investigate projected changes in extreme rainfall over Southern Africa.

Downscaled evaluation and projection data from two CORDEX regional models and four global models were examined and changes in the occurrence of rainfall and extreme rainfall investigated in three sub-regions over southern Africa. Synoptic states associated with extreme rainfall were identified in each region. Over teh evaluation period we find that the regional models performed adequately in capturing the general rainfall characteristics over the region but did not capture the characteristics of extreme rainfall well. However, synoptic states associated with rainfall and extreme rainfall were captured and characterized.

In the near-term (2036-2065) and far-term (2065-2099) under both RCP4.5 and RCP8.5, synoptic states that are associated with drier conditions are projected to increase, while synoptic states that enhance precipitation are projected to decrease over time. Furthermore, the synoptic states associated with extreme precipitation are projected to increase.

Given the current threat posed by extreme rainfall in the regions these results speak directly to the necessity to develop effective and implementable adaptation strategies to reduce the impact of extreme rainfall on vulnerable communities.

P-1113-12

Summer temperature extremes over Europe obtained from an ensemble of regional climate models

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European summer temperature extremes from simulations of six EURO-CORDEX regional climate models are analysed for the 20-year period, 1989-2008. The models were driven by ERA-Interim reanalysis at 50 and 12.5-km horizontal resolutions. Three categories of extreme temperature indices - absolute, percentile and duration - are derived from daily data. The results are compared with extreme temperature indices calculated from the gridded daily E-OBS data over Europe and for Croatia, where the indices are derived from daily observations at 20 Croatian meteorological stations. The ensemble spread is large, but the biases at 12.5-km simulations are smaller than at 50 km. When compared with validation data, model simulated temperatures and their percentiles are mostly overestimated over southern Europe and underestimated over northern Europe. Over Croatia, spatial distribution of indices at 12.5 km is closer to observed distribution than at the 50-km resolution.

P-1113-13

Standardized Precipitation Index (SPI) and Its Use to Assess Drought Occurrences in Cameroon over Recent Decades

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The standardized precipitation index (SPI) is computed and analyzed using 55 years of precipitation data recorded in 24 observation stations in Cameroon along with University of East Anglia Climate Research Unit (CRU) spatialized data. Four statistical distribution functions (gamma, exponential, Weibull, and lognormal) are first fitted to data accumulated for various time scales, and the appropriate functions are selected on the basis of the Anderson-Darling goodness-of-fit statistic. For short time scales (up to 6 months) and for stations above 10°N, the gamma distribution is the most frequent choice; below this belt, the Weibull distribution predominates. For longer than 6-month time scales, there are no consistent patterns of fitted distributions. After calculating the SPI in the usual way, operational drought thresholds that are based on an objective method are determined at each station. These thresholds are useful in drought-response decision making. From SPI time series, episodes of severe and extreme droughts are identified at many stations during the study period. Moderate/severe drought occurrences are intra-annual in short time scales and interannual for long time scales (greater than 9 months), usually spanning many years. The SPI calculated from CRU gridded precipitation shows similar results, with some discrepancies at longer scales. Thus, the spatialized dataset can be used to extend such studies to a larger region—especially data-scarce areas.

P-1113-14

Analysis of extreme temperature indices of long-term homogenised temperature series in South Africa

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Homogenized data reduces the risk of significantly biased results in historical climate trend analysis. This study utilises for the first time long-term homogenised maximum and minimum daily temperature data sets for South Africa, spanning from the period 1931 to 2014. Previous extreme temperature trend analyses for South Africa only covered periods from 1961, which makes the current analyses significant in terms of the period of analysis, but also the number of stations that could be utilised. Whereas previous studies covered the analyses of the time series of fewer than 30 stations, the combinations of data from different stations in single time series through homogenisation increased the number of time series to 36. The time series were analysed using the extreme temperature indices developed by the WMO-ETCCDI team, which makes it possible to compare the results to other analyses across the world. Examples of the index trends analysed are the annual number of cool days, annual number of warm days, Diurnal temperature range, annual maximum and minimum temperatures, warm and cold nights and annual maximum warm spells, amongst others. This analysis forms part of the ongoing study in historical temperature trends in South Africa from in-situ measurements, by the South African Weather Service.

P-1113-15

Characterizing and understanding the

Sahelian heat waves

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Large efforts are made to address the heat waves (HW) in developed countries because of their devastating impacts on human health. This interest increased after the intense event over Europe during summer 2003. However, HWs are still understudied over developing countries. This is particularly true in West Africa, and especially in the Sahel, where temperatures recurrently reach critical values, such as during the 2010 HW event. Understanding the Sahelian HWs and associated health risks constitute the main objective of ACASIS, a 4-year project funded by the French Agence Nationale de la Recherche.

Our work contributes to this project and aims at characterizing the Sahelian HWs and understanding the mechanisms associated with such extreme events.

There is no universal definition of a HW event, since it is highly dependent on the sector (human health, agriculture, transport...) and region of interest. In our case, we chose to define a HW as a period of at least 3 consecutive days of extremely high (90th percentile) daily heat index (Rome et al. 2015). This index combines temperature and relative humidity in order to determine the human-perceived equivalent temperature (Steadman, 1979).

Intrinsic properties of Sahelian HW are next analyzed from the Global Summary of the Day (GSOD) synoptic observations and ERA-interim and MERRA reanalyses over 1979-2012 during boreal spring seasons (April-May-June), the hottest period of the year in the Sahel. Reanalyses capture well the observed interannual variability and seasonal cycle at the regional scale, as well as the 1979-2012 increasing linear trend of springtime HW occurrences in Central and Western Sahel.

Reanalyses however overestimate the duration, spatial extent of HW, and underestimate their intensity. For both GSOD and reanalyses, we show that, over the last three decades, Sahelian HWs tend to become more frequent, last longer, cover larger areas and reach higher intensities. The mechanisms associated with HWs are analyzed to assess the respective roles of atmospheric dynamics, radiative and turbulent fluxes, in the establishment of such events.

P-1113-16

Changes in the occurrence of cold and heat waves in France toward the end of the century assessed using a stochastic model to downscale climate model simulated temperature

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As cold and heat waves have a major impact on society and economy, these events are widely studied in climate change simulations for different parts of the world. This study may be viewed as another of such studies, but its originality lies in the adopted methodology. The aim here is to assess changes in cold or heat wave frequency distribution in France at the station, or grid point level in order to avoid any smoothing of the time series which could alter the extremes. Thus 22 robust temperature time-series provided by Meteo-France in the framework of the national research agency project SECIF and designed as SQR (for Reference Daily time Series in French) are first used to estimate the distributions of cold or heat waves of different durations, from one single day to more than 15 consecutive days. Then a stochastic model for temperature (Parey et al. 2014), designed to correctly reproduce extreme values, is used to simulate 100 equivalent temperature time series with potentially more severe extremes, so that a distribution of such frequencies can be derived for each station. As the stochastic model simulates the random part of temperature, after removing the deterministic parts (seasonality and trends) of the mean and the standard deviation, these 100 simulations are also used to reconstruct 100 time-series from each climate model simulation for different periods and greenhouse gas emission scenarios. The climate model biases are corrected by reconstructing the future seasonalities as the observed ones, to which the future changes given by the climate models are added (Smf = Smo + (Smf - Smp) ; Svf = Svo*Svmf/Svmp where subscripts o is for observation, f for future and p for present). Then, the full climate model non parametric trends in mean and standard deviation are considered. In this way, distributions of the cold or heat waves frequencies can also be obtained for climate model simulations and thus the significance of the changes can be more robustly assessed. The results obtained with two climate models (CNRM-CM5, IPSL-CM5A-MR), two RCP scenarios (RCP4.5 and RCP8.5) and two future periods, the first and second half of the 21st century will be presented.

Parey S., Hoang T.T.H, Dacunha-Castelle D.: Validation of a stochastic temperature generator focusing on extremes, and an example of use for climate change. Climate Research, Vol. 59: 61-75, 2014

P-1113-17

Study of Extreme Rainfall Events over Odisha using observation and simulation

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The state of Odisha lies in the eastern part of India with a broad coast line of around 480 km. The climate of state fully depends on the Indian summer monsoon and being the coastal state always the disaster due to hydro meteorological events like tropical cyclone, extreme rainfall events (ERE) and flood etc. are important to monitor and model for the real time mitigation and disaster management. In this study first the extreme rainfall analysis is being carried out using the rainfall data from multiple sources like the India Meteorological Department (IMD) daily gridded data, APHRODITE and Tropical Rainfall Measuring Mission (TRMM) data. Firstly the EREs defined with the criteria of a grid point receiving 10cm or more rainfall per 24hour, are counted over the continental part of Odisha state domain (18-22.5oN, 82-87oE) at the daily scale for the period 1951 to 2014. The inter annual variability in the number of ERE over the state are presented and which clearly shows there is an increasing trend in the ERE of about 0.23 events/year. Because there is a positive trend of the ERE in the second part the ERE distributions are being analyzed and clearly indicates there is increase in the ERE over the south, central and eastern part of Odisha while the trend is normal in the northern part. The possible impact of climate change is also quantified. To simulate the ERE the Mesoscale Meteorological Research Institute, Japan Non Hydrostatic Model (NHM) is calibrated for the Odisha region and about 10 such events are simulated and the model is well capable of simulating the EREs before 48-72 hours. Some sensitivity studies also carried out with the model for the optimized configuration of the model for the meso scale forecasting of the EREs over Odisha. This model configuration and the observational studycan be used for the investigation of the ERE mechanisms in particular over Odisha region and the medium range forecasts can be useful for different sectors like agriculture planning, water management, disaster management etc. for the state of Odisha

P-1113-18

Uses and limits of thermal indices: the case of Sahel

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Our main goal here is to analyse extreme heat waves

(HWs) in the Sahel (13°N–18°N; 16°W–30°E), using different thermal indices. In the ACASIS project funded by the French "Agence Nationale de la Recherche", HWs analyses are characterized for the first time during the hottest season in the Sahel, using the Global Summary of the Day (GSOD) synoptic observations during April–May–June 1973–2013. Such extreme high temperatures are usually defined by 3 criteria: 1/ Their low probability of occurrence: less than the 10% of the days. The use of absolute thresholds, associated with heat budget and physiological impacts, could be an alternative (Seneviratne et al., 2012). 2/ Their intensity, i.e. their amplitude in terms of standard deviations from the local climatology (Goubanova, 2007), or otherwise excesses over absolute intensity thresholds. 3/ Their severity: extreme events causing socio-economic or human losses, the notion of impact is thus of major importance for their definition (Beniston et al., 2007).

According to prior IPCC assessments (TAR, AR4 and SREX), it is very likely that increased maximum temperatures and enhanced probabilities of hot days occurrences will occur at the global scale. There is also medium confidence that warm spells/heat weave frequencies, lengths or intensities will increase in many regions (Cubasch et al., 2013). Because of its latitude, Sahel is especially concerned, with diurnal temperatures often exceeding 40°C in boreal spring and, to a lesser extent, autumn. AR4 concluded that global land-surface air temperature (LSAT) had increased over the instrumental period of record, with the warming rate approximately double that reported over the oceans since 1979. AR5 confirms previous estimates: Global LSAT increased: 0.1005°C ± 0.01925°C per decade over 1901–2012 period while the rise reaches 0.262°C ± 0.05°C per decade over 1979–2012 time period, according to the observations of CRUTEM4.1.1.0, GHCNv3.2.0, GISS and Berkeley dataset average (Hartman et al., 2013). Changes in the length of the spells are observed and they are likely to increase but this needs to be investigated further over Sahel where severe heat can have damaging consequences for societies.

For instance, in Niamey (Niger) in April 2010 whereas Tmax reaching 47°C (Ringard et al., 2015), increased morbidity and mortality rates were observed, especially among the elderly and young children. Moreover, in some places, HWs can be associated with increased rates of atmospheric pollution.

Terminology is large: a "hot spell" implies the hottest temperature during an extreme of temperature with a small duration (a few hours), small extension (around the station) and a high frequency; a "warm spell" should be less frequent and covers a larger area; a "heat wave" (HW) exceeds thresholds of temperature most frequently and covers at least a whole region (~ 500–1000 km²). These thresholds can be absolute (T° fixed locally) or relative, exceeding 5 °C as local standards for example for Expert Team on Climate Change Detection and Indices (ETCCDI, 2013). ACMAD (African Centre of Meteorological Applications for Development) classifies the extreme temperatures following five high-impact weather events; they broadcasts a mail alert when Tmax> 40°C. In ACASIS, Sahelian HW is defined (Rome et al. 2015) as a period of at least 3 consecutive days of extremely high (above the local 90th percentile) daily heat index. The Heat Index (HI) (Steadman 1979, 1994), combining temperature and relative humidity, appears as the most appropriate index, suitable for tropical climate, which takes into account the human-perceived equivalent temperature. The role of humidity is rather small in boreal spring across the Sahel, when high incoming solar radiation is combined with extremely dry soils, preventing cooling effect associated with latent heat flux. As for global scales, results show a clear warming trend over the last three decades, with a clear trend for HW events to become more frequent, last longer, cover larger areas and reach higher intensities (see also Oueslati et al. 2015). We then observe a decrease in cases of "Caution" HI and an increase in cases of "Danger" and "Extreme Danger" HI values.

P-1113-19

Future changes of extreme events of sea cooling in the Black Sea region in winter period of end of XXI century

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The study of climate change at the end of the XXI century with increasing human intervention around the world is important and necessary. In particular, it is argued that the unprecedented magnitude of the positive trend in surface air temperature, observed since the mid XX century, largely due to the concentration of greenhouse gases in the atmosphere associated with human activities. Moreover, this warming will continue in this century, and by the end of the century will be 2 – 5 °C. At the same time, the spatial resolution of global models, despite their continuous improvement remains insufficient to display a regional atmospheric circulation. The method of «dynamical downscaling» takes an additional argument in regions with underdeveloped network of meteorological stations and difficult terrain. In the current global climate models do not take into account the Crimean Mountains, the Caucasus Mountains height not exceeding 2 km, and the Black Sea is posed less than 10 points calculation area. In this study, we used input data of global model INMCM4, which is a joint in international project CMIP5. Experiment of downscaling was carried out for area Black-Caspian Sea region to further revised data, i.e. the transition from large-scale calculations of global fields to regional estimates to obtain regional climate characteristics (temperature, turbulent heat fluxes, etc.), directly with the influence of regional factors with a spatial resolution of 25 x 25 km. Thus, for the Black Sea region were calculated turbulent heat fluxes in winter 2071–2100 (scenario RCP8.5). By control period used a data set of observations for the period 1971–2000 years. In the Black Sea basin was selected region's largest winter heat fluxes from the sea surface, which is the north-western basin. This water area is interesting that in the selected area of river runoff about 80% of the total annual flow into the Black Sea. According to the scenario RCP8.5 average temperature in winter over the Black Sea basin will increase by 2 – 3 °C at the end of XXI century. The following integral characteristics of the north-western shelf of the Black Sea are in the area of the sea bounded by the 44 – 47° N and 28 – 34° E. In the future heat fluxes of winter periods will change as follows: sensible heat flux will decrease by 3%, and latent heat flux will increase by 22% compared to the control period. Also Bowen ratio was calculated for the average winter values that will decrease in the future to 0.34 although it was 0.43 in control period. This ratio was calculated in order to look at the share of sensible and latent heat in the total heat flux (sensible heat flux + latent heat flux = total heat flux) and look at their quantitative changes. Most interesting were the calculations of extreme events P = 95% (5% of winter days with the largest values of total heat flux of the winter period) and their change in the future period. Thus it appears that the total flux extreme heat rise by 15% compared with the control period, but it is interesting that the most extreme P = 99% (1% of winter days with the highest values of total heat flux of the winter period), which in the future will rise by 40%. It was also interesting to see the changes in the synoptic situation during extreme cooling P = 95% of north-western part of Black Sea in the winter, where a total heat flux used to build composites. Composite fields showed that after clustering atmospheric situation in Europe have been identified 2 main types (clusters). So the first type – a anticyclone on the Baltic sea, and the second type of synoptic situation – a cyclone in the district of the Caspian Sea. So in the future period the number of extreme events P = 95% in each cluster was approximately 50% to 50%. And compared to the control period, the number of events first type was little over 20% and second type almost 80% of all events P = 95%. That is, it can be concluded that the change not only the quantitative characteristics of extreme cooling, but also qualitative changes in the synoptic situation in Europe during extreme cooling of sea surface of Black Sea. The greatest danger in the future period(2071–2100) in Black Sea region are extreme events for P = 99%, while increasing total heat flux almost 40% compared to the control period and result in potential losses in fishing, oil (gas) industry, agriculture and the other in this region. Thus these results require further verification and analysis of possible risks in the future for the economy of the Black Sea region.

P-1113-20

Climatological analysis of trend of rainy days in Bangladesh using Mann Kendall Test

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The impact of climate change on rainy days has received a great deal of attention by scholars worldwide. Many studies have been conducted to illustrate that changes in annual rainy days is becoming evident on a global scale. Bangladesh is likely to be one of the most vulnerable countries in the world due to climate change. This study focuses on detecting the trend of rainy days for 13 Bangladesh Meteorological Department rain gauge stations using Mann Kendall test, which was run at 5% significance level during the period 1950-2009. Seasonal and yearly trend of rainy days (greater than 01 mm/day) are studied. Variation of three threshold rainy days named: Moderated Heavy (22-44 mm/day), Heavy (45-88 mm/day) and Very Heavy (greater than 88 mm/day) are also studied. The country is divided into two regions named: wet region and dry region. All the stations showed increasing trend of rainy days except in Srimongal. The trend of Dhaka, Cox's Bazar, Srimongal and Chittagong stations are not statistically significant. All the four seasons (winter, pre-monsoon, monsoon and post-monsoon) showed statistically significant increasing trends except post-monsoon. The country's averaged threshold rainy days also showed statistically significant increasing trend except Very Heavy rainy days. The yearly rainy days indicate statistically significant increasing trend. The yearly rainy days in the wet region (122 days) were higher than that of dry region (105 days). The wet (dry) region showed negative (positive) trend of rainy days during 1950-1979 whereas wet (dry) region showed positive (negative) trend of variation of rainy days during 1980-2009. The country's averaged rainy days showed negative trend during 1950-1979 and positive trend during 1980-2009. These changes indicate that the climate of Bangladesh is changing. The yearly averaged increase of rainy days was 0.35 days.

P-1113-21

Climate Change Signal in the 2012 Central U.S. Record (Flash) Drought

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The summer drought of 2012 in the central United States is instructive regarding one unique feature, that is, its rapid intensification during the early summer, evolving over a mere month from moderate to severe status. The timing of this drought's rapid intensification coincided with a subseasonal feature of widespread drying. The seasonal transition from June to July saw precipitation in the central U.S. decrease by about 25%, and this precipitation decrease is observed to have intensified since 1979. Such an intensification could enhance spring drought occurrences in the central U.S., where conditions evolved quickly from being abnormally dry to exceptionally dry, likely within a mere month from June to July. In this study, various atmospheric and land reanalysis datasets were analyzed to examine the trend calculated from 1979 to 2012 in the June-to-July seasonal transition. It was found that the change in precipitation deficit was accompanied by increased downward shortwave radiation flux and tropospheric subsidence, enhanced evaporative fraction, as well as an elevated planetary boundary layer height. The change in the tropospheric circulation encompassed an anomalous ridge over the western U.S. and a trough on either side; this wave-form circulation pattern is known to induce dry conditions in the central U.S. Such trends in the June-to-July seasonal shifts in precipitation, surface drying, and tropospheric circulation could have intensified and accelerated drought that took place in spring. The knowledge of the trends allows one to anticipate the evolution of spring onset of drought into the summer.

P-1113-22

Extreme North America Winter 2013-15: California drought and cold East Coast

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The ongoing California drought was initiated by an anomalous high-amplitude ridge system in the winter of 2013-2014. The anomalous ridge was investigated using reanalysis data and the Community Earth System Model (CESM). It was found that the ridge emerged from continual sources of Rossby wave energy in the western North Pacific starting in late summer and subsequently intensified into winter. The ridge generated a surge of wave energy downwind and deepened further the trough over the northeast U.S., forming a dipole. The dipole and associated circulation pattern is not linked directly with either El Niño-Southern Oscillation (ENSO) or Pacific Decadal Oscillation; instead, it is correlated with a type of ENSO precursor. Multi-model analysis using CMIP5 model outputs indicated that the connection between the dipole and ENSO precursor has become stronger since the 1970s, and this is attributed to increased greenhouse gas loading as simulated by the CESM. Therefore, there is a traceable anthropogenic warming footprint in the enormous intensity of the anomalous ridge during winter 2013-2014 and the associated drought. When projecting for the future, the large-member ensemble simulations of CESM indicated increases in fire counts and extreme drought occurrences, both of which are increasingly linked to the ENSO cycle.

Furthermore, the extent to which climate oscillations will modulate wildfire occurrences in the changing climate is examined. The consensus of climate model has projected a generally wetter climate for California towards the latter part of the 21st century, a scenario that seems to counter the projections of more fires in a wetter climate. Using CESM that directly outputted fire parameters, it is found that both the mean fire probability and annual precipitation in California are projected to increase slightly towards the end of the 21st century. However, the fluctuation in annual precipitation will amplify leading to a robust increase in the variation of vegetation and fire probability. The increased fluctuation of fire probability is associated with the amplified ENSO cycle at the 4-5 year frequency. This association suggests a potential for increasingly severe wildfires to occur more regularly in the future.

P-1113-23

Early and late winter cold spells over the Euro-Mediterranean region

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Temperature extremes have a strong impact on ecosystems, societies and economies; for instance in terms of impacts on agriculture, human health, energy consumption among others. Warm summer extremes and their impacts, i.e. summer heat waves, have extensively been investigated and characterised in several studies focusing on either recent past-current time or climate projections for the next decades. Less efforts have been, instead, devoted to cold spells occurring in the Euro-Mediterranean region, although also these extreme events can have significant impacts especially in a future warmer climate. Especially for the European south, sensitivity to cold weather is greater than the northern, cooler regions, while mortality is found to increase to a greater extent with a given fall in temperature in regions with warmer winters. This study aims at characterising future changes in the occurrence, intensity, and duration of cold spells and their spatial variability over the Euro-Mediterranean region. The focus is on early and late cold season events (December and March, respectively), especially conditional on the occurrence of a presiding warmer autumn (winter for the late season events). Mid- and late 21st century potential changes are investigated by using the recently released Euro-Cordex regional climate simulations both under the mid-range mitigation emission scenario RCP4.5 and the high emission scenario RCP8.5.

1114 - Global emissions and their implications for climate targets

ORAL PRESENTATIONS

K-1114-01

Short Lived Promise? Short-lived climate pollutants, cumulative carbon and emission metrics

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The relative priority given to reducing carbon dioxide emissions versus other forms of anthropogenic climate pollution, such as the Short Lived Climate Pollutants (SLCPs) methane and soot, could be a significant issue for many countries in the preparations for COP21. The decision to allow countries to adopt their own metrics to add up the role of different gases in their contributions to the overall emission reduction goal highlights the need for clarity on these issues. This talk will review the findings on cumulative carbon and emission metrics in the IPCC 5th Assessment, and present a new Policy Brief from the Oxford Martin School, with the same title, that discusses and elucidates these issues.

Any strategy to prevent dangerous anthropogenic interference in the climate system must limit cumulative emissions of the main long-lived climate pollutant, carbon dioxide (CO2). To limit the warming they cause to 2°C, for example, CO2 emissions must be limited to a cumulative budget of about one trillion tonnes of carbon, over half of which has already been released. That said, other climate drivers are likely to contribute to peak warming, and hence reduce the carbon budget consistent with 2°C of total anthropogenic warming. Current emissions of both CO2 and SLCPs also affect the rate and magnitude of climate change over the next few decades, although it is important to note that the climate benefits of reduced emissions on these short timescales could be comparable to, and hence potentially outweighed by, natural climate variability, particularly on regional scales.

Reductions in SLCP emissions could be achieved at relatively low cost and with substantial co-benefits but, I will argue, implementing these reductions immediately would have little impact on peak warming unless CO2 emissions are substantially reduced at the same time. Hence any decisions on policy priorities between CO2 and SLCPs, and any country's choice of emission metric to relate them, represents in essence a matter of intergenerational prioritisation: Advancing measures to reduce SLCP emissions could provide some climate benefit to the current generation through reduced warming over the next few decades, while immediate reductions in CO2 emissions also deliver a more substantial climate benefit to future generations.

Any emission trading system or climate policy that addresses emissions of several different greenhouse gases together in a single 'multi-gas basket' requires some form of metric to specify what a given amount of one greenhouse gas is 'worth' in terms of another. The choice of metric to compare the impact of emissions of methane and other SLCPs with the impact of CO2 depends on the timescale of interest. If the policy goal is to limit peak warming, it also depends on the ambition and success of future mitigation measures.

The standard '100-year Global Warming Potential' metric (GWP100) provides (despite its name) an approximate indication of the relative importance of emissions of different gases to the increase in global temperatures over the next 20 to 40 years. GWP100 is therefore a measure of impact on peak warming if and only if temperatures are expected to be approaching stabilization within 40 years, for which CO2 emissions need to approach zero on a comparable timescale.

As long as CO2 emissions continue to rise, policies that allow SLCP measures to be exchanged, traded or offset against CO2 emission reductions using GWP100 overvalue the impact of SLCP measures on peak warming and hence risk discouraging the CO2 emission reductions that are required to stabilize temperatures. Replacing GWP100 with a different metric would not solve this problem because any metric that is suitable for long-term impacts would be misleading for short-term impacts and vice versa. Using a metric that changes over time would help, but introduces greater complexity and uncertainty.

Rather than discussing a change of metric within a single 'multi-gas basket' framework, policymakers should focus instead on introducing additional instruments, safeguards or measures to ensure that cumulative emissions of CO2 are limited to an overall budget consistent with meeting the 2°C goal. A simple precaution would be to avoid trading or offsetting between CO2 and SLCP emission reductions until global CO2 emissions are falling fast enough to allow a robust and realistic assessment of the remaining time to peak warming.

O-1114-01

The changing face of global fossil fuel carbon dioxide emissions

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Global fossil fuel carbon dioxide emissions have been persistently increasing for the last 250 years. This increase is a primary driver of the atmospheric disequilibrium impacting and changing atmospheric, terrestrial, and oceanic systems.

The Carbon Dioxide Information Analysis Center (CDIAC) at Oak Ridge National Laboratory (ORNL), U.S.A., has been estimating fossil fuel carbon dioxide emissions for more than 20 years. These emission estimates are based on fuel statistics, carbon contents, and the fraction of fuel oxidized. This has resulted in an annual time series of emission estimates from the year 1751 to the present. Annual updates add another year to the time series as well as revising data in previous years. Over the years, this basic time series has been supplemented by mapping the emissions at one degree latitude by one degree longitude, describing the time series in terms of stable carbon isotopic (à13C) signature, parsing the time series from annual to monthly time steps, and describing the uncertainty of the global total FFCO2 emissions. Underway now is an uncertainty evaluation of the annual and monthly mapped emissions.

This time series reveals interesting trends when disaggregated by country, fuel type, and source. For example, the proportion of emissions from Kyoto Protocol Annex B and non-annex B countries has changed since Protocol signing to today. The role of coal in fueling global energy systems has changed from being the primary fuel to becoming secondary to liquid fuels to again becoming the primary fuel. The practice of flaring excess gas in oil fields, as a proportion of total energy production, has decreased by more than a factor of two since the year 1950. Release of carbon during cement production has increased by more than a factor of four since 1950 and now equates to about 5% of global carbon dioxide emissions from fossil fuel production.

The global fossil fuel carbon dioxide uncertainty analysis resulted in a 2σ range of 1.0 to 13%, which can be greatly simplified to 8.4% (2σ). This uncertainty in the magnitude of global fossil fuel carbon dioxide emissions has become an important component to our overall understanding of the global carbon cycle. The uncertainty in the magnitude of mapped fossil fuel carbon dioxide emissions will become a limitation to our understanding of local carbon cycles in the absence of detailed local inventories and observations.

The emission time series has been used by the Global Carbon Project in its annual evaluation of the global carbon budget. The budget is a high level check on the

understanding of carbon flows throughout the Earth system. Uncertainty propagation through the budget constrains our knowledge about the carbon system.

O-1114-02

Potential emissions of CO2 and methane from proven reserves of fossil fuels in the context of the global remaining carbon budget

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Scientists have argued that no more than one-third of proven recoverable fossil fuel reserves can be extracted and consumed by 2050 if we are to avoid exceeding the 2°C temperature target agreed to in Copenhagen (IEA 2012). The remaining carbon budget is ≤275 gigatonnes of carbon (GtC) (assuming a 66% probability of staying below 2°C; IPCC 2014), whereas recoverable fossil fuel reserves contain an estimated 733 GtC (based on BP 2014; IPCC 2014 cites reserves of 1.0-1.9 TtC). Global reserves are based on national assessments without reference to reserve ownership or productive capacity. The studies that do identify corporate owners are limited to investor-owned companies listed on major securities exchanges. We identify the largest seventy investor-owned and state-owned companies that possess the financial and technical capacity (and the ownership or production rights) to exploit and produce the majority of the world's recoverable reserves of oil, natural gas, and coal. We quantify the potential emissions of CO2 and methane for each entity's reserves, and compare the emissions to the global remaining carbon budget.

This presentation will report on recent estimates of the potential emissions of CO2 and methane from the proven reserves declared by the world's largest producers of oil, natural gas, and coal, focusing on the seventy companies and eight government-run industries that produced 63 percent of the world's fossil fuels from 1750 to 2010 (Heede 2014). Full production of these reserves (accounting for non-energy uses and flared and vented CO2) is estimated to result in emissions of 440 GtC of carbon dioxide — or 160 percent of the remaining 275 GtC carbon budget. Of the 440 GtC attributed, the 42 investor-owned oil, gas, and coal companies hold reserves with potential emissions of 44 GtC, whereas the 28 state-owned entities possess reserves of 210 GtC — equivalent to 16 percent and 76 percent of the remaining carbon budget, respectively. Government-run industries possess reserves of 185 GtC (16% of the remaining budget).

This analysis shows that 1) the profound risk to the future arises not so much from the proven reserves in the hands of publicly-traded corporations, but from their on-going exploration for and development of new fossil fuel resources, and 2) that while the investor-owned companies may be most vulnerable to investor and consumer pressure, effective action to control climate change must also include the state-owned companies and governments that hold the preponderance of reserves. This work will inform climate scientists, energy and emission scenario modelers, climate negotiators, national climate and energy policy leaders, and investors in fossil fuel companies with practical data on the potential consequences of fossil fuel reserves held by specific companies with the capacity, financial resources, and incentives to extract, refine, and market carbon fuels. These supra-national companies may play a critical role in delivering solutions to reduce net emissions from the fossil fuel sector.

O-1114-03

Net Carbon gain and loss in the world's tropical vegetation: New estimates for the 2012 – 2014 period

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Tropical forests store 471 Pg C, 55 % of global forest stocks, and emissions from land use and land cover change (LULCC) are the second largest anthropogenic source of carbon dioxide to the atmosphere. Despite the near convergence of emissions estimates for the tropics as a whole, estimates for individual regions are much more variable, particularly at national and subnational scales. Forest disturbance and successional processes determine the magnitude and distribution of sources and sinks of atmospheric carbon dioxide, which influence climate. Tracking terrestrial carbon fluxes and predicting how tropical forests will respond to continuous global change relies on accurate estimates of annual changes in the density and distribution of carbon stocks at local to global scales. Thus, determining the magnitude and distribution of sources and sinks at annual time steps with measurable uncertainty is of scientific and political importance. While significant progress has been made in the quantification of single-epoch carbon storage across large areas of the globe, robust assessments of aboveground carbon dynamics remain lacking. Existing evidence for tropical forests as a carbon sink is based on a limited number of repeated in situ measurements that have been scaled to characterize sequestration dynamics across large regions of the tropics. Advancing the work of Baccini et al. (2012), we combine wall-to-wall satellite image data, Light Detection and Ranging (LiDAR) measurements and field data to empirically examine aboveground biomass dynamics (i.e., gains and losses) and quantify net changes in carbon density (i.e., rates of carbon sequestration and emissions) at annual intervals for the period 2002 to 2014 using a hierarchical statistical model that segments annual time series measurements of carbon density according to piecewise linear trends. Thirteen years (2002-2014) of pantropical satellite data serve to provide direct, measurement-based evidence that the world's tropical forests are a net carbon source on the order of 420 Tg C yr -1. This net release of carbon consists of net losses of 548 Tg C yr-1 and net gains of 128 Tg C yr-1. The gains result from forest growth, afforestation and reforestation; losses result from natural disturbance processes as well as both anthropogenic reductions in forest area attributed to deforestation and in biomass density within forests resulting from degradation. While the changes are widely distributed throughout the tropics, the forests of tropical America account for 75 % of the net loss. Advantages of this new approach to emissions estimation over traditional methods that rely on emission factors (carbon density) and activity data (forest area change) include (1) providing spatially explicit, consistent and accurate estimates of net emissions from forest biomass change that eliminate the need for error prone land cover classifications or area change products, (2) accounting for gains and losses without the need to explicitly define or delineate forest degradation and (3) tracking of changes in net forest carbon emissions on an annual basis with quantified uncertainty that is suitable for use in national and international policy making on REDD+ and associated mitigation actions.

O-1114-04

Global methane budget and natural gas leakage based on long-term □13CH4 measurements and updated isotopic source signatures

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Methane (CH4) is a greenhouse gas (GHG) with the second largest global radiative forcing contribution after CO2. Its atmospheric abundance has increased by about 150% since the industrial revolution. Given the critical role of CH4 in global climate change, it is important to better understand its sources and sinks. Improving the estimates of individual source magnitudes - such as fossil fuels, agriculture, and other anthropogenic and natural sources - helps prioritizing CH4 emissions mitigation efforts

and modeling future climate change. Policy-makers rely strongly on accounting-based national and international emissions inventories to inform mitigation regulatory action. However, recent field studies indicate that emissions inventories may significantly underestimate fossil fuel CH4 emissions (those associated with extraction and use of natural gas, oil, and coal). In this work, atmospheric measurements from the National Oceanographic and Atmospheric Administration (NOAA) Global GHG Reference Network spanning the past three decades are used to derive long-term estimates of global CH4 emissions from fossil fuels and other sources in comparison with inventories and other estimates. Atmospheric measurements include global CH4 and the stable isotope 13CH4, which are used in a global box-model to constrain source magnitudes. First, probability distribution functions of the key model parameters are derived including literature isotopic source signatures, isotopic fractionation factors, atmospheric CH4 lifetime, and fossil fuel hydrocarbon gas compositions. Our isotopic source signature distributions are based on the largest literature survey to date, which suggests significant corrections compared to previous studies. Second, a Monte Carlo simulation of the box-model is performed to quantify confidence intervals of individual emissions sources. We find that attributing the majority of increased CH4 levels over the past three decades to microbial sources is consistent with 13CH4. The sum of CH4 emissions from the fossil fuel industry and geological seepage is significantly larger than previous estimates, which is compatible with pre-industrial isotopic ice core records. Third, recently published estimates of global CH4 emissions from oil and coal production are subtracted from our global fossil fuel CH4 results to quantify global CH4 leakage from the natural gas industry during extraction, processing, transport, and distribution of the fuel. Natural gas CH4 leakage as a fraction of total production has decreased steadily over the same period indicating industry efficiency improvements. The results highlight a major gap in our understanding of global CH4 emissions. This motivates increased collaboration efforts between the physical sciences and regulatory agencies to explain and reconcile the differences between atmospheric measurements and emissions inventories.

O-1114-05

Arctic Deposition of Black Carbon from Biomass Burning in Northern Eurasia from 2002 to 2012

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Black carbon (BC) in smoke plumes in Northern Eurasia can be transported and deposited on Arctic ice and accelerate ice melting during certain times of the year. Thus, we examined daily BC emissions from fires in this region at a 500 m x 500 m resolution from 2002 to 2012 and modeled the BC transport and deposition in the Arctic. Black carbon emissions were estimated based on MODIS land cover maps and detected burned areas, the Forest Inventory Survey of the Russian Federation, and biomass specific BC emission factors. Annual burned areas in Northern Eurasia varied considerably with an average of 260,000 km2 for the study period. Grassland dominates the total burned area (61%), followed by forest (27%). For grassland fires, about three-quarters of the area burned occurred in Central and Western Asia and about 17% in Russia. More than 90% of the forest burned area was in Russia. Annual BC emissions from Northern Eurasian fires varied enormously with an average of 0.85 Tg. In contrast to burned area, BC emissions from forest fires accounted for about two-thirds of the emissions, followed by grassland fires (15%). More than 90% of the BC emissions from forest fires occurred in Russia. Central and Western Asia is the major region for BC emissions from grassland fires (53%). Overall, Russia contributed 83% of the total BC emissions from fires in Northern Eurasia.

The transport and deposition of BC on Arctic ice from all the global sources was estimated using the LMDz-OR-INCA global chemistry-aerosol-climate model at the LSCE. Overall, about 55% of emitted BC was deposited on the Arctic ice. Biomass burning over Northern Eurasia was the dominant source (54%) of the BC deposition in the Arctic. Anthropogenic sources in Northern Eurasia accounted for 24% of BC deposition in the Arctic, while all sources from North America and southern Asia comprised the balance. Seasonally, biomass burning contributed 68% of the BC sources in the Arctic in the spring and 81% in the summer, while anthropogenic sources contributed 73% in the winter and 67% in the fall. About 49% of total BC deposition in the Arctic originated from Asia and only 5% was from Europe. Geographically, in Asia, Siberia was the major source (59%) for the BC deposition in the Arctic, followed by Kazakhstan (18%) and Mongolia (8%).

These results are critical to understanding the contribution of black carbon from biomass burning to accelerated melting of Arctic ice under future climate conditions.

1114-POSTER PRESENTATIONS

P-1114-01

Lagrangian modeling of global atmospheric methane (MAIOLICA II project)

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In the MAIOLICA II project, the Lagrangian particle dispersion model FLEXPART is used to simulate the global atmospheric CH4 over the 1990-2010 period. In this Lagrangian framework, 3 million particles are permanently transported based on wind fields from ERA-interim. The history of individual particles can be followed allowing for comprehensive analysis of transport pathways and timescales and to establish a link between sources (emissions) and receptors (measurement stations) in a straightforward manner, a prerequisite for source inversion problems. FLEXPART was extended to incorporate the methane loss by reaction with OH. CH4 mass is further lost by soil uptake and stratospheric loss reactions with prescribed Cl and O(1D) radicals.

Sources are separated into 245 different tracers, depending on source origin (anthropogenic, wetlands, rice, biomass burning, termites, wild animals, oceans, volcanoes), region of emission, and time since emission (5 age classes). The inversion approach applied is a fixed-lag Kalman smoother similar to that described in Bruhwiler et al. [2005].

Results from the FLEXPART global methane simulation and from the subsequent inversion will be presented.

Bruhwiler, L. M. P., A. M. Michalak, W. Peters, D. F. Baker, and P. Tans (2005), An improved Kalman Smoother for atmospheric inversions, Atmos Chem Phys, 5, 2691-2702

P-1114-02

Changes in the global methane budget since 2000

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Methane is the second anthropogenic greenhouse gas after carbon dioxide. Atmospheric methane has contributed 20% of the climate forcing by long-lived greenhouse gases since pre-industrial times but also influences the oxidizing capacity of the atmosphere. With a lifetime around 10 years in the atmosphere and a diversity of emission types, methane is an important target for climate change mitigation. Observations of atmospheric methane began in 1978, reached global coverage after 1983, and now include a large variety of in-situ and remote-sensed observations. After the loss of SCIAMACHY (2002-2012), two space missions are currently producing methane

weighted-columns, GOSAT (since 2009) and METOP-IASI (since 2007).

Although sources and sinks of methane are identified, large uncertainties remain in their spatio-temporal quantification. Here, we present a synthesis of methane emissions and sinks since 2000 using an integrated approach to combine: atmospheric measurements, chemistry-transport models, ecosystem models, emission inventories, and climate-chemistry models. The results of an ensemble of atmospheric inversions (top-down) and of process-based models (bottom-up) are presented and compared. Global and regional methane budgets and their changes are presented and discussed for the period 2000-2012. Possible scenarios are presented to explain the increase of atmospheric methane after 2006, after almost a decade of stagnation. Year-to-year changes are also analysed after 2006 in order to identify robust changes as opposed to still uncertain ones.

(6) Global Carbon project / methane is a group of scientists working to improve the global methane budget : P.Bousquet, M.Saunois, B.Poulter, P.Ciais, J.G.Canadell, E.J.Dlugokencky, A. Peregon, D. Bastviken, D. J. Beerling, P. Bergamaschi, D. R. Blake, G. Braisford, V. Brovkin, L. Bruhwiler, S. Castaldi, C. Covey, C. Crévoisier, C. Curry, S. N. Denisov, A. V. Eliseev, J. Etiope, C. Frankenberg, Y. Fukuyama, N. Gedney, M. Herrero, P. Hopcroft, S. Houweling, A. Ito, R. Jackson, F. Joos, T. Kleinen, C. D. Koven, P. B. Krummel, J.-F. Lamarque, Z. Lingxi, Z. Loh, J. Marshall, T. Machida, S. Maksyutov, K. McDonald, J. Melton, G. Maenhout, I. Morino, C. Le Quéré, V. Naik, P. I. Palmer, P. Patra, S. Peng, G. Peters, I. Pison, C. Prigent, R. G. Prinn, M. Ramonet, P. Raymond, M. Rigby, K. Saad, M. Saito, M.Santini, R.Schroeder, I.J.Simpson, R.Spahni, P.Steele, L.Taylor, H.Tian, Y.Tohjima, F. Tubiello, G. R. van der Werf, N. Viovy, A. Voulgarakis, W. Wagner, M. Weitz, D. J. Wilton, D. Worthy, D. Wunch, Y. Yoshida, T. Yokota.

P-1114-03

Fossil fuels ultimate recovery appraisal, clue to climate change modelling

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According to ICCP report, Climate Change 2013 (the Physical Science Basis), as shown by figure SPM.10 of Summary for Policymakers, temperature of the earth's surface at the end of the century would depend primarily on the cumulative quantity of CO2 from anthropogenic sources emitted since 1860. Because roughly 80 % of these emissions are produced by fossil fuels combustion, according to this modelling, fossil fuels ultimately recoverable quantities are the main drivers of climate change during this century and the followers.

Since production histories of fossil fuels are already long, it is now possible, as shown in this paper, to predict with a good approximation their quantities to be ultimately produced. This is done by statistical methods, using mainly the construction of creaming curves of technical reserves discoveries and Hubbert's production linearization.

These quantities are such that a temperature increase till the end of the century as high as described by RCP 8,5 and 6, is highly improbable even in a Business As Usual scenario. And staying below a 2 °C temperature increase from 1860 on remains obviously possible, provided that use of coal is now strongly restricted. This is the responsibility of the main coal consumers.

10 of them, China, the USA, India, Japan, South Africa, Russia, South Corea, Germany, Poland and Indonesia, consume nearly 90 % of the world's total coal production. As a result, these 10 countries also produce for the moment most of the world CO2 emissions. Therefore they are, according to ICCP modeling, the main drivers of climate change. They should definitely cooperate to undertake immediate and strong action.

Exploitations of bituminous shales, methane hydrates, or of coal by underground gasification are not considered here. They are for the moment highly hypothetical at a large scale. Nevertheless they should not be encouraged.

P-1114-04

Extending the relationship between global warming and cumulative carbon emissions to multi-millennial timescales

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Climate model simulations and theoretical arguments indicate an approximately linear relationship between cumulative carbon emissions and projected global mean temperature over the 21st century and beyond in a wide set of future carbon emissions scenarios. This Transient Climate Response to cumulative carbon Emissions (TCRE) is estimated to likely (> 66% likelihood) be in the range of 0.8-2.5°C/1000 Gt carbon. TCRE is defined for peak temperature and is nearly independent of the rate of carbon emissions. Any global temperature target therefore implies a limited carbon emissions budget. TCRE is a simple and useful policy framework and may play an important role in the post-Kyoto political negotiations for a new global agreement on future carbon emissions.

A recent modeling study (Frölicher et al. 2014) using carbon pulse experiments of a comprehensive global atmosphere-ocean general circulation model (AOGCM) finds that global mean temperature may continue to increase on multi-centennial timescales even after stopping carbon emissions. In other words, there may be a significant amount of warming expected from past carbon emissions. These results imply that the linear relationship between global warming and cumulative carbon emissions breaks down when the carbon emissions are tapering off. This is in contrast to a large body of studies suggesting that global mean surface temperature stays roughly constant for a couple of centuries at the value attained when carbon emissions are stopped. These earlier studies, however, use climate models of intermediate complexity, which simplify the complexities of many processes such as cloud feedbacks.

These results call for an extension of the TCRE concept. Here I use climate models of different complexities to show that the temperature response to cumulative carbon emissions can be characterized by three different timescales or phases and that the TCRE concept is only valid during the first phase, when emissions are steadily increasing. For longer time-scales, when emissions are tapering off, two new metrics will be introduced that better characterize the time-dependent temperature response to cumulative carbon emissions, namely the Peak Climate Response to cumulative carbon Emissions (PCRE) and the Equilibrium (multi-millennial) Climate Response to cumulative carbon Emissions (ECRE). I will explain why the PCRE is generally larger than the TCRE in the fully coupled AOGCMs and why the models of intermediate complexity as a class don't simulate an increase in global mean temperature after carbon emissions stoppage. The implications of these results for allowable carbon emissions required to remain below a specific global warming target will be discussed.

Frölicher, T. L., M. Winton, J. L. Sarmiento, 2014, Continued global warming after CO2 emissions stoppage, Nature Climate Change, 4, 40-44.

P-1114-05

Hydrological and biogeochemical constraints on terrestrial carbon cycle projections

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Terrestrial ecosystems are playing a crucial role in the climate system by absorbing about one third of the total anthropogenic emissions of CO2, thus providing a valuable ecosystem service to mankind. How this ecosystem service will evolve in the coming decades is still a subject of debate. This evolution depends on the response of biogeochemical cycles and ecosystems to a changing climate with more frequent and severe extreme events in some regions as well as to increased CO2 concentrations. Earth System Models which are explicitly represent the

ecosystem behavior such as the exchange of carbon and water with the atmosphere are used to study the future evolution of the land and ocean carbon cycle sinks. However, the estimates of these carbon fluxes are clearly subject to significant uncertainties. Observationally-based constraints on these simulated fluxes should therefore facilitate reduce uncertainties in future terrestrial carbon cycle projections performed for AR5 (CMIP5).

Gross Primary Production (GPP) is the total amount of carbon that is taken up by plants during photosynthesis and it is one of the main components of the land carbon cycle and driver of the carbon uptake by land. We show that over many regions models simulating high present-day GPP and Evapotranspiration (ET) tend to simulate higher increase in future GPP. Using these emergent relationships combined with present-day estimates of ET and GPP we constrain future changes in GPP. We find that the inter-model spread in future GPP is reduced by at least 50% while the increase in future GPP in northern latitudes is higher than previously thought. Our results for future changes in Water Use Efficiency (WUE), a highly significant determinant of primary production of terrestrial ecosystems, show similar behavior. Applying the observational constraints on the future land sink (NBP) reveals higher than previously thought decrease in the land sink. The inter-model spread in the land sink is reduced by more than 30% and in most of the constrained ensembles the terrestrial biosphere is even turned into a net carbon source by the end of the century. Our findings therefore have several implications on the future productivity of ecosystems and the atmospheric CO2 concentrations.

P-1114-06

Air Pollution Emissions and Potential for Co-Benefits in Megacities of South Asia

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The South Asian region is highly and densely populated and includes 5 megacities (each with population more than 10 million) and hundreds of large and medium size cities. Megacities in South Asia are namely - Delhi, Mumbai and Kolkata (India), Dhaka (Bangladesh) and Karachi (Pakistan). Constantly increasing energy-intensive urban activities in burgeoning cities areas are responsible for a large share in the unacceptably high emissions of those air pollutants, which are responsible for poor air quality, adverse health effects and also climate change. High levels of Air pollution in South Asia came into highlight by the South Asian haze called Atmospheric Brown Cloud (ABC). The annual premature deaths due to ABC were estimated equal to 100,000s in the South Asian region. Whereas, recent estimates of the burden in India show approximately 1.04 million premature deaths and 31.4 million disability-adjusted life years (DALYs) to be attributable to household air pollution (HAP) resulting from solid cooking fuels. Numerous policy measures and technological interventions are being tried in India and other countries to curb the air pollution. However, there is a growing interest in adopting those measures which can reduce air pollution emissions resulting in not only air quality improvement and health benefits but also in climate change related co-benefits.

This presentation would provide an analysis of the urban pollution emissions and potential for health and climate change related co-benefits in South Asian megacities. Most of the South Asian countries are in the stage of developing or emerging economies, and India is the fasted growing economy among them. Given the increasing trend of energy use and emissions in South Asian cities, present study is a step to make governments and people aware of the extent and intensity of ambient as well as indoor air pollution problem. The analysis presented in this study is expected to help initiate appropriate policy measures and suitable action plans to limit air pollution emissions and adopt ways based on co-benefits approach that can promote the sustainable development - especially in South Asia.

P-1114-07

Cumulative carbon emissions modulated by policy options for limiting warming to below 1.5 and 2°C

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Cumulative emissions of carbon dioxide, or so-called carbon budgets, have recently received increasing attention in the climate policy arena. Not only are they part of the headline statements of the most recent assessment of the Intergovernmental Panel on Climate Change (IPCC), they have also been proposed as guidance for long-term emission reduction goals within the international climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). For example, directly following from the concept of a carbon budget is that as soon as 2055 to 2070, global net emissions of CO2 will have to be phased-out to zero in order to stay below 2°C warming with a likely chance.

A thorough understanding of the interplay between policy choices and the amount of carbon emissions compatible with specific temperature limits gains therefore in importance, in particular because the amount of future carbon emissions compatible with limiting warming to below the 1.5 or 2°C thresholds is vanishing quickly with time. Mitigation costs are related to the size of the carbon budget and can increase significantly with a delay of strong decarbonisation, as weaker reduction ambition early on comes with the necessity of much stronger reduction rates later.

We provide key insights that link the theoretical concept of carbon budgets to a real-world context, by quantifying policy-relevant emission-scenario aspects that increase or decrease cumulative carbon emissions compatible with limiting warming to below specific temperature limits, like 1.5 or 2°C relative to preindustrial. To achieve this, we explore dimensions not previously assessed by the IPCC.

First, we show that the choice of methodology to derive compatible carbon emissions from integrated multi-gas emission scenarios plays a non-negligible role. Both the influence of non-CO2 forcing variations and the timescales of the Earth system response lead to lower compatible carbon emissions when derived from low instead of high emission scenarios. Second, as non-CO2 forcing has the potential to modulate carbon budgets, we assess the potential influence of the mitigation of so-called short-lived climate pollutants (SLCP, like methane, soot, or hydrofluorocarbons) on the size of compatible carbon emissions. We show how, due to technological linkages between the sources of CO2 and some SLCPS, the potential impacts can vary strongly across species. Third, we explore how socio-economic developments and technological policy choices can influence the size and cost of a carbon budget for meeting a specific temperature goal by, often inadvertently, influencing the proportion of CO2 to non-CO2 forcing. Finally, by using multi-gas characteristics of a large set of emission scenario as well as theoretical phase-out pathways we explore the implications for the timing of global net zero carbon emissions.

P-1114-08

Speciation of anthropogenic VOC emissions from observations in contrasted urban environments: a basis for emission inventory evaluation and the definition of CMIP (Coupled Model Intercomparison Project) historical emission inventory

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Having accurate trace species emission estimates is critical in the development of basic scientific knowledge and to assess atmospheric chemistry, air quality, and climatic conditions at present and in the future. In addition, detailed emissions data are also required at high resolution for the design of feasible controls aimed at reducing emissions of pollutants, and for the evaluation of the efficiency of

the implemented policies. Therefore, concerted efforts in emission inventory development are necessary to improve the quality of the emission estimates and to be able to reproduce air quality conditions in models. In this context, the CMIP project was established to provide a basic support for the IPCC future report (AR6). The CMIP Panel has requested further improvements on the emissions data by using observations, as well as on the emissions spatial and temporal resolution. Among others, a high priority is given to the development of anthropogenic hydrocarbon and particle speciation.

Non-Methane Volatile Organic Compounds (NMVOCs), emitted from various sources, are of particular interest since they affect urban air quality and regional climate change by contributing to the formation of tropospheric ozone, PAN and Secondary Organic Aerosols. According to Shindell et al. (2012), NMVOC reductions could help slow the near-term rate of climate change because of their influence on short-lived climate forcers (e.g., ozone, methane, aerosols). Thus, reducing NMVOC emissions provides regional to global benefits to air quality and climate (Fry et al. 2014). Some studies have shown that the NMVOC composition depends on the regional characteristics, even among the northern mid-latitude megacities (Borbon et al., 2013). These discrepancies may be more important if we consider the UNFCC Non-Annex 1 countries.

Here, we propose to make an assessment of the spatial and temporal variability of the composition of NMVOC anthropogenic emissions from recent and decadal observations in urban areas in order to define more accurate and representative NMVOC emission sources profiles. The main objectives are: (1) the establishment of NMVOC emission sources profiles from in-situ observations or by near field measurements, (2) the analysis of seasonal and interannual variability of NMVOC emissions composition, and (3) the evaluation of the anthropogenic emission inventories.

This work is based on the most recent results of several long-term (air quality networks) and intensive measurement campaigns (MEGAPOLI - Paris, 2009, CalNex,) in post-industrialized regions (northern mid-latitude cities) and in the Eastern Mediterranean Basin within the TRANSEMED initiative. According to the ACCMIP and RCPs inventories, the total anthropogenic emissions of NMVOCs in the MEA region were constantly increasing reaching ~15 Tg in 2010 whereas in USA and Europe, the NMVOCs emissions were decreasing reaching ~10 Tg in 2010 (ECCAD database). A very detailed and unique multipollutant database was generated in a city of the Middle East, Beirut, with a focus on the organic carbon, and in Istanbul. Since, the current NMVOC speciation applied in models needs updating, source profiles were determined with field measurements close to the main potential emitters (Salameh et al. 2014).

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P-1114-09

Black Carbon emission and its climate implication in Pakistan

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Black carbon (BC) is a product of incomplete combustion (burning that gives off smoke). It is the solid, mostly pure carbon component of soot that is capable of absorbing light at all wavelengths. Black carbon emissions in South Asia are primarily derived from four sectors: residential, industrial, transportation, and biomass burning (field burning, cook stove burning). The residential sector represents the largest single source of black carbon emissions in South Asia. The transportation and industrial sectors are also significant contributors (US EPA 2012). Black carbon deposited on snow and ice darkens the surface and decreases reflectivity, thereby increasing absorption and accelerating melting. Kopacz et al., (2011) reported the role of BC in Himalaya glacier melting and change of radiative forcing in the region due to BC.

Emission inventories and analyses of aerosol samples indicate that more than half of the black carbon emitted in South Asia comes from the burning of biofuels, especially in traditional cook stoves. Shahid et al., (2015) reported that burning of different wood species for cooking emits 22% BC of the total amount of biomass burned. Other large sources include burning of coal (for example in brick kilns), exhaust from diesel vehicles and generators, waste burning, and forest fires. Many sources of black carbon also co-emit other substances that are less light-absorbing, or that scatter light, including brown carbon, organic carbon, and sulfate. Emissions from diesel trucks have a higher percentage of pure black carbon than emissions from open fires. The overall effect of BC in any region will therefore be a result of local / regional / global emission, climate and geography. For example, in the Himalayas BC can amplify the effects of enhanced global warming while, in addition, causing surface dimming which can reduce crop productivity. There have been efforts to build emission inventories in Pakistan, however, this has been sporadic and specific. Three local efforts, one in 1990, another in 1994 and the latest in 2009 have all focused on greenhouse gases (GHG), and BC carbon was ignored. In global and regional emission inventories scarce information is available for Pakistan. In this study BC emissions have been estimated from different sectors using Atmospheric Brown Cloud emission inventory manual with emphasis of biomass burning for cooking and field burning (crop Residue). Unfortunately no sector specific emission factors are available. Thus we used emission factors that have been already published and closely related to Pakistan environment. During the year 2013-14, 16.923 x 106 Hectare area was cultivated for crop production, and 116 x 106 tonnes of crops were produced which inturn produced 40 x 106 tonnes of dry mass that was burnt in field. Thus single source of crop residue buring emits about 24 mega tonnes of BC along with other pollutants. Based of this data emission maps will be generated for gridded emissions over Pakistan.

These are the preliminary results,work is going on and hopefully will be able to finish till June.

P-1114-10

National and regional contributions to global climate change

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According to the "Brazilian Proposal" from 1997 the industrialized countries should reduce emissions proportional to their contribution to temperature increase. The emissions of Greenhouse Gases (GHG) and Short-Lived Climate Forcers (SLCFs) have changed dramatically over the last decade with large regional differences, suggesting that previous estimates are outdated. In this work we update earlier estimates of the contributions to global mean temperature change from countries and regions, and perform deeper analysis of various scientific and policy related choices. Which time period should be accounted for when calculating the countries' contributions? We show the importance of the start year, end year, and evaluation year on countries' contributions. Another choice is which forcing components that should be included in the analysis. First we consider only CO2 from fossil fuels and then we explore how the results are affected when all Kyoto gases and CO2 from land use change are included, and then non-Kyoto gases together with SLCFs. Time series of emissions of GHGs, aerosols and its precursors for countries/regions are constructed and a simple climate model is used to calculate the temperature response. Another policy choice is for which stage in the emission chain the contributions should be calculated (extraction, production (territorial), consumption). Finally, we will discuss how the historical responsibilities of countries/regions can be seen in relation to attribution to extreme events based on work in the EU-project EUCLEIA.

P-1114-11

Biogenic CH4 and N2O emissions overwhelm land CO2 sink: implications for climate change mitigation

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The stabilization of greenhouse gas (GHG) concentrations in the atmosphere requires reducing net anthropogenic GHG emissions and increasing the capacity of carbon sinks in the biosphere. Although global terrestrial CO2 uptake partially mitigates global warming, its contribution may be offset or even overturned by the increasing biogenic emissions of methane (CH4) and nitrous oxide (N2O). Of particular importance to climate change mitigation policies is the ability to evaluate the net balance of these three GHGs in the terrestrial biosphere. Here we synthesized multiple estimates of CO2, CH4 and N2O from various studies to investigate the net biogenic GHG budget (NBGB) on global and regional scales. Based on 22 bottom-up studies using terrestrial biosphere models, empirical and inventory-based approaches and 7 top-down studies using atmospheric inverse models, we conclude that global terrestrial ecosystems had a net positive NBGB, indicating net greenhouse gas release to the atmosphere. After subtracting pre-industrial GHG emissions from land ecosystems, we found the global land uptake of anthropogenic CO2 (-7.7 to -9.2 Pg CO2 eq/yr) was offset by 129% to 147% due to anthropogenically-caused emissions of CH4 and N2O. Among them, agricultural CH4 and N2O emissions (7.0 to 8.0 Pg CO2 eq/yr) play the most important role, offsetting 85% - 103% of the global land sink of anthropogenic CO2. It is clear that biogenic CH4 and N2O emissions had overwhelmed the global land CO2 sink, contributing to a net climate warming effect of all the GHG exchanged to or from the land biosphere. Our results indicate that effective agricultural management strategies are very much needed to alleviate biogenic GHG emissions, while sustaining food and bioenergy production.

P-1114-12

Emissions metrics and evaluating methane-emitting natural gas as a bridge fuel

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Climate change mitigation is a multi-gas problem. Mitigation policies that focus on CO2 reductions alone may result in increased emissions of other gases such as CH4, leading to overshoots of climate policy goals. For example, policies aimed at reducing CO2 emissions may encourage a transition from coal to natural gas electricity, enabled by increased production of unconventional gas, but could also lead to higher CH4 emissions due to leakage in the natural gas supply chain. Therefore, it is important to consider multiple gases in making emissions reduction commitments and in evaluating technology options to meet these goals. Here we present an approach to evaluating policies and technologies based on their multi-gas emissions.

Evaluating technology options on a common scale, or setting a national target for overall GHG emissions reductions, requires some means of comparing different gases on a common scale. This comparison is challenging because of the dissimilar removal dynamics of different GHGs. Emissions equivalency metrics are a commonly used approach, and the global warming potential (GWP) is the most prevalent metric. The GWP converts masses of non-CO2 GHG emissions to a CO2-equivalent value based on a time-integrated radiative forcing comparison over a fixed horizon of 100 years, leading to a conversion factor that is constant over time. This static approach can lead to significant overshoots of climate policy goals, such as radiative forcing stabilization targets, because it doesn't take into account how close in time emissions occur relative to an intended stabilization year.

Here we present an alternative set of dynamic emissions equivalency metrics that evaluate emissions impacts relative to an intended radiative forcing stabilization level [1]. Our approach results in a lower impact value on shorter-lived greenhouse gases, like CH4, early on, but increases this value as emissions approach an intended stabilization time. The metrics are relatively independent of the future emissions and energy consumption scenario to be followed, and therefore can be used to evaluate policies and technologies despite the inherent uncertainty about the future. Applying the metrics to set emissions reduction targets and evaluate technologies results in substantially lower overshoots of climate policy targets than the GWP. Furthermore the metrics points to methane mitigation timelines that can allow for greater energy consumption while meeting climate policy goals [2].

How might dynamic metrics be used in setting policy targets? We will discuss a specific example by examining the US Environmental Protection Agency's Clean Power Plan target of 30% reduction in power sector CO2 emissions by the year 2030 (from 2005 levels). This policy incentivizes a shift to natural-gas based electricity generation, and could result in significant increases in power sector CH4-emissions. Applying the time-sensitive metrics mentioned above, overall GHG reductions (counting both CO2 and CH4) may only reach 10-20% by 2030, instead of the targeted 30%, without additional methane regulation. However, as shown by applying the proposed dynamic metrics, reduction rates of 11-13% per year would allow the 30% by 2030 GHG reduction target to be met [3]. As demonstrated by this US example, capturing the full climate benefit of coal-to-gas technology transitions requires substantial CH4 mitigation to complement CO2-focused climate policy frameworks. The alignment of CO2 abatement and CH4 leakage reduction goals is an important problem that needs to be addressed as nations globally prepare policy proposals for the 2015 United Nations Climate Change Conference in Paris (COP21. The method proposed here provides an approach to setting coupled CO2 and CH4 reduction targets, and evaluating mitigation technologies.

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P-1114-13

A global estimate of carbon stored in the world's mountain grasslands and shrublands, and the implications for climate policy

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Carbon market and climate finance schemes (e.g. the CDM, REDD+ and the Green Climate Fund) are being investigated for their ability to achieve enhanced sustainability outcomes in terrestrial forests, lowland grasslands and marine ecosystems, all which store large amounts of carbon (C). To date however climate policy discourse has largely overlooked the conservation of existing C stored in mountain grasslands andshrublands. These ecosystems provide critical ecological goods and services to humanity yet are increasingly at risk from anthropogenic stressors including agricultural intensification, mining and climate change. The absence of a global estimate for these C stocks is likely to be one reason for their exclusion from climate change policy discussions, both on a political and scientific basis. This represents a missed opportunity in two respects: firstly, by conserving and restoring existing C stocks the impacts of climate change can be lessened; and secondly, carbon finance and climate finance might provide financial support to address the aforementioned stressors. Here we use spatial analysis and estimate there to be between 60.5 Pg C and 82.8 Pg of C contained within biomass and soils of the world's mountain grasslands and shrublands. To put this in perspective, globally tropical Savannas andgrasslands, temperate forests and tropical peatlands are estimated to contain 326–330 Pg C, 159–292 PgC and 88.6 Pg C respectively. Our review of existing empirical studies and of United Nations FrameworkConvention on Climate Change (UNFCCC) national greenhouse accounts suggests that this C is not reliably accounted for in international carbon budgets. Our estimate is the first to provide a global point of reference, useful in developing future research and in climate policy discussions. We conclude by briefly discussing how climate finance might be leveraged to support the sustainable management of these C stocks, and in so doing uphold the other important socio-economic benefits provided to humanity.

P-1114-14

Global and China's admissible emissions pathways under various warming targets

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Using the adaptive control model with climate system, this paper projected and compared the global admissible emission pathways under various warming targets, namely, warming 2℃ above pre-industrial level, and the average level of 1850–1900, 1861–1880, 1961–1990, 1980–1999 and 1986–2005 that mentioned in IPCC-AR5 WGI report. Our study shows that the admissible emission is required to reduce by 20%, 35%, 50% and 62% until 2020, 2030, 2050 and 2100 respectively so as to limit the global warming within 2℃ above the preindustrial level. This indicates that the Copenhagen agreement is hard to achieve without some breakthrough in low-carbon energy technology since the global emission is ever-increasing. Corresponding to the RCP 4.5 and RCP 6.0 in IPCC AR5 report, the admissible emissions pathways for the 2℃ targets above the average level of 1850–1990 and 1861–1880 indicates that it can still rise until 2040–2045 following the historical trend and then reduce. Therefore, they are not effective targets to abate the emissions promptly. Moreover, taking 1961–1990, 1980–1999 and 1986–2005 as the base year means the admissible emission is far more than what is needed.

In view of the difficulty to achieve these targets, we further proposed three viable warming limit schemes after appraising the feasibility of the aforementioned targets, which are (1) warming 2.5℃ relative to pre-industrial level, (2) warming 1℃ relative to 1986–2005 and (3) 1.5℃ relative to 1850–1900. The first one is a mild reduction target, which requires the global emission to stop increasing immediately and starts to reduce since 2020 gradually, finally reach a level slightly less than that in 2005 by 2100. This target is in accordance with the current abatement commitments of major countries/regions. The second one is a moderate target, which indicates the global emission should decrease at once with a smooth dropping rate. It matches the average warming expectation of RCP 2.6 scenario in IPCC report and should be a reference for each country to make further commitment. The last one is a strong target, which requires the global emission to reduce immediately with the rate similar to its growth rate during 2000–2012, indicating greater efforts need to make.

Finally, the emission rights are analyzed with different principle of allocation. The sovereignty principle is to the benefit of developed countries such as United States, European Union and Japan; some populous countries like China and India are in favor of the egalitarianism principle; the developing countries will get more emission right under the principle of ability-to-pay. China will acquire about one fifth of global emissions under all the three principles, indicating the current emission level in China is compatible with its population and economy. But with all these principles, the admissible emission for China will shrink gradually under the three aforementioned warming targets and the emission gap between emission demand and supply will enlarge accordingly.

1115 - GHG Monitoring

ORAL PRESENTATIONS

K-1115-01

The GOSAT contribution to understanding global concentration distribution and regional fluxes of carbon dioxide and methane over its five-year operation period

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The Greenhouse gases Observing SATellite (GOSAT) has been operating for more than five-and-a-half years since January 2009. Over that period, the NIES GOSAT Project provided researchers and the general public with the retrieved column-averaged concentrations of carbon dioxide (XCO2) and methane (XCH4) (SWIR Level 2 data products), which helped ascertain the global distributions of the two global warming gases and their variability with time and space. Further, with those concentration data that filled gaps in the existing surface monitoring networks, the monthly estimates of regional sources and sinks of CO2 and CH4 (Level 4 data products) were produced with smaller uncertainties. Although there are some issues still left that need to be handled, such as region- and time-dependent biases and low retrieval success rates over the tropics, the GOSAT Project has contributed significantly to advancing the global carbon cycle studies through providing useful space-based GHG data. The Orbiting Carbon Observatory 2 (OCO-2) was launched successfully in July 2014, and now and finally, there are two CO2 monitoring platforms in space, as originally planned ten years ago. GOSAT is expected to operate and continue its observation for the next several years, even after its five-year nominal operation period ended in early 2014. Evaluating and inter-comparing data from the two platforms will yield valuable findings that can further advance the space-based GHG monitoring techniques. We will present the overview of the latest GOSAT data products and some of important research outcomes brought by the GOSAT Research Announcement researchers, and show our views on the future of space-based carbon cycle study by worldwide research collaboration.

O-1115-01

The Integrated Carbon Observation System (ICOS RI) – a European Research Infrastructure on greenhouse gases and the global carbon cycle

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Greenhouse gases contribute to radiative forcing and therefore their concentrations in the atmosphere influence climate of the Earth. The mission of ICOS RI is enabling research for understanding present state and predicting future behavior of the global carbon cycle and greenhouse gas emissions. ICOS RI does this by providing long-term observations through a distributed infrastructure with station networks designed to monitor GHG concentrations in the lower atmosphere and ocean as well as GHG exchange between terrestrial ecosystems or oceans and the atmosphere. By knowing the dynamics of GHG in the atmosphere and their fluxes, ICOS RI will provide independent data to improve and verify GHG emission inventories for international conventions.

This fusion of streams of (big) data from observational infrastructures with advanced earth system models is the next step in developing integrated knowledge on global carbon and greenhouse gas budgets. By using the complex model-data fusion systems currently under development, these observations will enable us to verify greenhouse gas fluxes on regional and national levels at unprecedented resolution in time and space.

O-1115-02

Potential of in-service aircraft based greenhouse gas observations within IAGOS for constraining regional carbon budgets

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Spatial and temporal variations of atmospheric greenhouse gas concentrations contain information about their sources and sinks as well as the exchange processes between the atmosphere and the surface of the earth. However, the potential use of these observations in inverse models for accurate estimation of surface fluxes is hindered by the fact that they are both insufficent and unevenly distributed. The use of passenger aircraft for obtaining information about atmospheric composition and physical and chemical processes is a relatively new concept. Within the recently established European Research Infrastructure IAGOS (In-service Aircraft for a Global Observing System), highly accurate and precise in-situ observation of greenhouse gases is foreseen in the near future. Detailed and continuous measurements are made during long distance flights by hi-tech instruments deployed on board, thus providing a view of the horizontal and vertical distribution of the measured trace gases on global scale and over long periods of time. The project IGAS (IAGOS for GMES Atmospheric Service) serves as a vital link between the data collected on board civil aircraft through IAGOS and the Copernicus atmosphere monitoring service (previously known as GMES) that utilizes these measurements for applications in the field of modeling, weather forecasting and air quality forecasting.

This study is focussed on assessing the impact of measurements from IAGOS on the constraint on the regional carbon budget and quantifying the reduction in uncertainty in the inverse source-sink estimates of CO2 and CH4, brought about by the use of this newly developed data stream. Anticipating the deployment of five GHG observing systems within IAGOS, the flight tracks from five in-service aircraft within MOZAIC (Measurement of OZone and water vapour by Alrbus in-service airCraft), a predecessor project of IAGOS, are used in an inversion system to assess the constraint on the carbon budget and quantify the potential for reduction in posterior flux uncertainties. These measurement locations and times are used to evaluate the impact of data from aircraft on the reduction of flux uncertainties compared to that based on the existing global observation network, and furthermore to identify areas where the addition of these measurements would be of greatest impact. We use the Jena Inversion System that employs the Global Atmospheric Tracer Model TM3 for atmospheric transport, focussing on the period 1996-2004. The vertical aircraft profiles are input into the inversion as two partial-column averages instead of point measurements, the lower partial column completely containing (and exceeding) the boundary layer. This is a novel approach, the advantage being that the error due to imperfect model representation of the boundary layer height and hence the vertical tracer transport near the surface can be diminished, which results in the reduction of the overall model-data mismatch error. The experimental design is such that in each simulation the existing measurement network is augmented by pseudo-observations from up to five simulated IAGOS aircraft. Uncertainty reduction from each of these simulations is compared to the uncertainty reduction from simulations employing only the existing observation network. We find that for both CO2 and CH4, the additional constraint on the carbon budget brought about by the use of IAGOS measurements is highest for the tropical regions, the magnitude of the change in uncertainty reduction being about 20 percent.

O-1115-03

Cost-effective guidelines for measurement of agricultural greenhouse gas emissions and removals

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As COP21 approaches, many non-Annex 1 countries are for the first time developing mitigation targets in the form of Intended Nationally Determined Contributions. Mitigation activities in the agriculture, forestry, and land use (AFOLU) sector are likely to be in developing countries because they provide up to 70% of the technical potential for AFOLU-based mitigation. However, decision-makers in these countries are currently limited by the lack of scientific information on emissions and mitigation potentials from the agricultural systems common in tropical developing countries.

For example, direct measurements of methane from livestock—perhaps the most significant agricultural GHG source in sub-Saharan Africa—are lacking. Measurements of soil carbon sinks from land rehabilitation and carbon storage in aboveground woody biomass are also notable gaps. The emission factors and models used in the absence of such data (IPCC Tier 1) rely on measurements largely from temperate, developed countries and their precision and accuracy in tropical developing countries is unknown.

Here we describe the SAMPLES measurement guidelines and data platform, two web-based resources for improving the availability of agricultural GHG information from tropical developing countries. Developed by scientists within the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS), the guidelines provide a critical assessment of various methods that can be used to quantify GHG emissions within a developing country context. As the cost of measurement is often a constraint, the guidelines compare the available methods for each GHG driver (e.g., land use change) and source (e.g., soil emission or biomass accumulation) in terms of cost and accuracy. They recommend methods that produce reliable, robust data considering factors common to developing country farming systems such as heterogeneity of farming systems and seasonality of feed supply and quality (e.g. for enteric methane emissions). The guidelines also emphasize informed sampling design in order to aggregate GHG measurements to larger scales without unnecessary replication of measurement.

The SAMPLES data platform is the first international, publicly accessible compilation of GHG flux and carbon stock change data from tropical developing countries. While it is currently houses data from CCAFS experiments in several countries, the data platform is open to contributions from agricultural emissions studies worldwide. The platform provides a resource for compilers of national inventories, designers of monitoring and verification systems and researchers to share and access data for developing Tier 2 emission factors and calibrating models.

These two new resources provide decision-makers and the global scientific community with a means of developing and sharing the information necessary to assess, monitor and verify the GHG impacts of agricultural policies and technologies.

O-1115-04

Reconstruction of super resolution oceanic pCO2 from remotely sensed data and multiresolution analysis: an application in the South Eastern Atlantic

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The knowledge of green house gases (GHG) fluxes at the air-sea interface at high resolution is crucial to accurately quantify the role of the ocean in the absorption and emission of GHGs. We present here a novel method to reconstruct maps of surface ocean partial pressure of CO2, pCO2, and air-sea CO2 fluxes at super resolution (4 km) using Sea Surface Temperature (SST) and Ocean Colour (OC) data at this resolution, and CarbonTracker CO2 fluxes data at low resolution (110 km). Inference of super-resolution of pCO2, and air-sea CO2 fluxes is performed using novel nonlinear signal processing methodologies that prove efficient in the context of oceanography. The theoretical background comes from the Microcanonical Multifractal Formalism which unlocks the geometrical determination of cascading properties of physical intensive variables. As a consequence, a multiresolution analysis performed on the signal of the so-called singularity exponents allows the correct and near optimal cross-scale inference of GHGs fluxes, as the inference suits the geometric realization of the cascade. We apply such a methodology to the study offshore of the Benguela upwelling system. The inferred representation of oceanic partial pressure of CO2 improves and enhances the description provided by CarbonTracker, capturing the small scale variability. The methodology is validated using in-situ measurements by means of statistical errors. Mean absolute and relative errors in the inferred values of pCO2 with respect to in-situ measurements are smaller than for CarbonTracker.The potential of the approach with other gases such as DMS is illustrated.

O-1115-05

Top down estimates of the European emissions of hydrofluorocarbons and comparison with bottom up inventories

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Hydrofluorocarbons are strong greenhouse gases included in the United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol.

Under the Protocol, Parties are required to submit to UNFCCC their annual emission inventories. Such emissions are normally assessed through "bottom-up" methods aggregating various local statistics. However, emissions measured by their accumulation in the atmosphere, can significantly disagree with reported bottom-up emissions.

Top-down emission estimates based on in situ long-term high frequency observations combined with inverse modelling have proved to be a powerful and important tool for the quantification of emissions and the verification of bottom-up inventories for many trace gases. Here we present regional (European) emission estimates of nine hydrofluorcarbons characterised by extremely high Glabal Warming Potentials (GWPs).

Emissions estimates are obtained through a combination of observations and models. For this study we used high frequency, long term observations conducted via gas chromatography-mass spectrometry in four WMO-GAW Global stations in Europe that are part of the AGAGE (Advanced Global Atmospheric Gases Experiment) network. The obtained data undergo a rigorous quality control, following the procedures adopted within AGAGE. FLEXPART 20-d backward trajectories and a Bayesian inversion method are then used in order to derive annual emissions from the European Geographic Domain, divided into eight macro-regions, strarting from 2001 onward.

Then, we compared our estimates with the bottom-up inventories submitted by the single countrie to the UNFCCC. Such comparison revealed not negligible discrepancies between the inversion results and the inventories, thus showing the effectiveness of this approch as a verification tool for declared emissions

The estimates provided by this analysis are relevant non only for constraining the atmospheric budget of these gases on a regional scale, but also also to improve the accuracy of their emissions quantification on a global scale.

O-1115-06

Observational Determination of Surface Radiative Forcing by CO2 and CH4

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Earth's background atmospheric CO2 and CH4 concentrations have been steadily rising due to anthropogenic emissions, and these increases since 1750 have implications for the radiative balance of the Earth's atmosphere. The physics governing how atmospheric CO2 and CH4, both well-mixed greenhouse gases (WMGHGs), influence atmospheric infrared energy balance, and thus climate, are well established, but the impact of recent atmospheric WMGHG trends on the surface energy balance has not been experimentally confirmed in the field.

Using infrared WMGHG absorption bands and controlling for atmospheric temperature and water vapor, spectra from the DOE ARM Program's Atmospheric Emitted Radiance Interferometers (AERI) yield the first direct observational evidence of the time-series of WMGHG surface radiative forcing directly attributable to recent increases in WMGHGs, in this case between 2000-2010. The time-series shows a secular trend of in the radiative forcing from both CO2 and CH4. This data record provides the first comprehensive observational evidence of upward trends in surface radiative forcing by WMGHGs, confirming theoretical predictions of the anthropogenic atmospheric greenhouse effect. These data support predictions of enhancements to the greenhouse effect from future WMGHG emissions.

1115-POSTER PRESENTATIONS

P-1115-01

Evolution of CO2 storage in karstic cavities by changes in climate in semiarid regions: Rull Cave (Alicante, Spain)

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The global carbon cycle in the Earth's surface-troposphere boundary depends on feedbacks among a number of sources and sink processes that operate on both short and long time scales. Soil and subsurface cavities in the vadose zone may contain large amounts of CO2 compared to the exterior air. CO2 concentrations in the vadose zone show significant seasonal and even daily variations, which involves the exchange of large amounts of this greenhouse gas with the lower troposphere. The main source of the CO2 contained in the caves is the organic production from

soil although the abiotic contribution can be important in warm seasons. CO2 from soil can be transported into the caves as a gas or dissolved in seepage waters and the final cave air CO2 concentration air is broadly the result of the mixing of background atmospheric CO2 with soil-produced CO2. Tourism can also increase CO2 concentrations in cave-air by an order of magnitude. The cavities CO2 outputs are mainly due to ventilation processes that depend on cave morphology, the number and configuration of cave openings, and microclimatic relationships with the exterior climate.

Our study has been carried out in the Rull cave during two annual cycles (November 2012 - January 2015). The karstic cavity is located in the northeastern sector of Alicante province, a semiarid region on the Spanish Mediterranean coast (30 km far from the coast line). Indoor trace gases (CO2 and 222Rn) showed that cave acts as both CO2 sink and source for the whole period, although some differences were found between the two registered cycles. For the first cycle (December 2012 - November 2013), average value of indoor T and RH were 15.9ºC and 97.2% respectively. Indoor T reached a maximum value of 16.6 ºC. CO2 mean concentration was 2054 ppm but this value varied from 463 ppm (minimum value, registered in January 2013) to 4065 ppm (August 2013). In 2014, indoor T and RH average values were 16.1ºC and 97.8% respectively but indoor T reached a maximum value of 17.9 ºC. Mean CO2 concentration was 1937 ppm but ranged from 565 ppm (February 2014) to 3731 ppm (August 2014). The gaseous recharge of the cavity occurs when the outdoors temperature is higher than the cave air temperature as consequence of the air density differences. For the second studied cycle (2014) the recharge of the cavity took place some days before than for the first cycle as outdoor temperature exceeded the temperature of the cavity slightly earlier than in 2013. This fact confirms that relationship between both temperatures is a key factor in the dynamics of this cavity. Furthermore, air cave CO2 changed for the both cycles and was closely related to rainfall since it contributes to biotic and abiotic processes. For the first cycle (2013) total annual rainfall was 471 mm, while it was 280 mm for 2014. Rainfall drop is mainly responsible of a lower CO2 concentration in the cavity for 2014 due to: (i) a lower organic production as consequence of reduction in soil moisture; (ii) a lower amount of seepage waters that finally reach the cavity containing dissolved CO2; (iii) when the soil-epikarst system suffers for a reduction in moisture (due to the scarce rainfalls) a major connection between the underground and the exterior environment is accomplished as consequence of an opening of the soil porous system and the fractures-fissures of the epikarst, which is responsable for a higher gaseous exchange.

The isotopic signal δ13C of CO2 is widely used as a proxy of the origin of the CO2. The light values of δ13CO2 inside the cavity point to an organic origin of the CO2. δ13CO2 average annual value for outdoor atmosphere, soil and cave are -10.1, -21.9 and -22.0 ‰ respectively. CO2 in soil was measured for the whole year in 2014. Maximum values (2948 ppm) occur while the cave is in gaseous recharging (April 2014) while the lowest concentration (735.5 ppm) is found in August 2014, when the soil production is buffered due to the high temperatures and scarce water.

Results highlight the narrow existing dependence between climate conditions and CO2 dynamics in the cave-soil-atmosphere system. The output of the CMIP5 multi-model ensemble, under the RRCP4.5 and RCP8.5 scenarios, predicts a relevant increase of temperature and a decrease in precipitation and relative humidity at the geographical coordinates of the cave surface throughout the current century. We are using this CMIP5 output to model the expected shift in season ventilation-recharge pattern and a potential reduction of the CO2 storage capacity in this semiarid region.

P-1115-02

The use of GHGs as tracers of the coupling/uncoupling between natural processes and human activities in a Mediterranean Delta system

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Delta ecosystems are important in many environmental aspects as they act like a buffer between terrestrial and marine ecosystems. Moreover, human activities control the basing hydrology and the overall watershed economy from the water in a resource perspective. Furthermore, the Delta environmental patchiness favors a high biodiversity standing on a delicate equilibrium.

The high sensibility of these ecosystems to small changes in environmental conditions, already under the pressure of human exploitation, might lead to abrupt changes on demographic dynamics of the inhabiting species, the migrant ones and the invasive ones. Under the threats of climate change, like reduced water discharge and the consequent salinization, increased temperature, increase in the incidence of droughts, etc., might amplify the effects of natural occurring cycles.

The detailed and continuous study of greenhouse gas emissions (GHGs) like CO2, CH4 and N2O as tracers of ecosystemic metabolic fluxes is a useful tool to discern the changes occurring along different temporal scales, from less than hours to years. Thus, they offer an excellent dataset to assess management, adaptation and mitigation policies on endangered deltas.

The Ebre River Delta is one of the largest wetland areas (over 300 Km2) in the North-Western Mediterranean region. This area presents a high diversity of ecosystems with rice fields, natural lagoons and marshes along the shoreline, conforming a highly patched landscape. Water management plays a relevant role in agricultural activity, birdlife habitat protection and GHGs sources and sinks.

A GHGs measurement station has been established at the Ebre River Delta Natural Park with the aim of studying climate interactions between land-surface and atmosphere by the Institut Català de Ciències del Clima (IC3) within the framework of the ClimaDat project (www.climadat.es, funded by Obra Social "la Caixa") and InGOS.

GHGs data obtained in this location provide thorough knowledge of the Ebro river delta and the coupling and uncoupling of human activities and natural cycles.

P-1115-03

A dedicated monitoring network for greenhouse gases: SNO ICOS-France

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Greenhouse gases (GHG) have been identified as the main actors of current climate change. Evolution of the atmospheric composition will drive our future climate and it is therefore essential to increase our knowledge of the global carbon cycle, to refine the carbon budget from global to regional and/or national scale and to precisely monitor the composition of the atmosphere.

Since the pioneer CO2 observation study conducted at Mauna Loa in the late fifties, atmospheric monitoring stations have been progressively deployed over most of the earth, mainly focusing on CO2 specie. Over the last decade a significant effort has been engaged to build real operational monitoring network including more monitored species (CO2, CH4, CO, N2O) and continuous recording (instead of flasks samples). In Europe, these efforts resulted in the foundation of the Integrated Carbon Observation System (ICOS) research infrastructure which is based on a harmonized and operational monitoring network including 16 countries.

As member and contributor to the ICOS infrastructure, France has a major role on the atmospheric component of the project through the GHG national network (SNO ICOS-France) and the atmospheric thematic center installed

at LSCE. The French monitoring network consists of 12 observation stations including ground stations and high tower equipped with several sampling levels.

We will present the French monitoring network for GHG:

- Network design and station location,
- station set up and specifications,
- instrumental set up and characteristics,
- data treatment and quality control.

We will also give some example of scientific results obtained from chosen observations within the French monitoring network (altitudinal gradients, characteristic synoptic events, trends and seasonal varibility on long term records).

P-1115-04

Methodological Discrepancies in Measuring Agricultural Greenhouse Gases for Precise Estimation of National Emissions

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The main agricultural greenhouse gases (GHGs) – nitrous oxide (N2O) and methane (CH4) –account for 10–12% of anthropogenic emissions globally, corresponding to ~ 60% and 50% of total anthropogenic emissions, respectively. Agricultural systems are highly diversified and complex, and that measured data covering all practices are very limited to estimate GHG emissions accurately at entity scales/system boudaries and thereby national levels, which is vital. This is to provide robust data for accounting, modeling, finding policy options and mitigation solutions with confidence, leading to achieve environmental sustainability and greater resilience in agricultural production. Special equipment, technical capacity and infrastructure required to measure actual GHG emissions from the source into the atmosphere are insufficient at global scales. These are associated with cost and complexity of methodologies as well as huge difficulty in measurement under field conditions. These result in large uncertainty due to sampling errors and the impact of soil, weather and other environmental variables including management-induced changes relative to background pools and fluxes.

Soil N2O emissions are extremely variable in time and space linking particularly to the practices that affect its fluxes in one soil alone or in association with climate/site-year more than in another. Accordingly, development/selection of existing but globally recognized methodology appropriate for a country should be chosen. It is to estimate changes in emissions accurately at the entity level but sufficiently generalizable for upscaling. There are several existing methods to measure N2O and CH4 emissions for example are: (i) intact soil cores under artificial environment without vegetation and simulated management practices, (ii) closed or open chamber measurements that are limited primarily by timing and frequency of gas samplings, (iii) automated chamber that represents the vegetation canopy and management practices inadequately, (iv) micrometeorological shows difficulty in differentiating the impact of land use and management practices at entity/boundary scales, and (v) isotope technique, which is very delicate and expensive.

Recently, tiered measuring approaches are proposed to capature both temporal and spatial variability of agricultural GHG fluxes including livestock and manure management systems coupling with the generation of ancillary data related to key variables in these systems. For precise estimation of national GHG emissions using practice-based scaling factors, a new hybrid approach i.e. coupling model with a measurement network of stratified monitoring sites with due consideration to key factors for example soil properties, land use type, nutrient and water management and climate influencing GHG emissions is likely to be most feasible and robust way forward to minimize uncertainty. Given the regulatory roles of the key influencing factors and variables, each measurement method has its advantages and disadvantages in providing the quantity of GHG emissions closer to reality. This paper illustrates the above issues to find a universally acceptable appropriate methodology to accurately measure and monitor GHGs from agricultural systems.

P-1115-05

A proposed open international standard for GHG emissions and offsets

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The diversity of carbon calculators, protocols and registries currently makes it difficult to publish, discover, assess, access, aggregate, analyze and share geospatial and statistical information about GHG emissions and offsets. In recent years, facing similar diversity, the hydrology, aviation meteorology, climatology and geology communities have all developed consistent international open geospatial standards (WaterML 2.0, WXXM, netCDF and GeoSciML) for encoding those four types of data. Those standards are based on a shared framework of geospatial and temporal standards that make maximum use of Internet and Web technologies. GHG markets, treaties, science, and taxation and regulator regimes all await an expansion of that standards framework to encompass GHG emissions and GHG offset projects. International standards for geospatially consistent digital characterization of GHG emissions and offsets would add rigor to GHG science and management analysis and transparency to GHG transactions and compliance. The standards would also increase the value of GHG data immeasurably by fully leveraging the computational and communication power of the Internet and Web.

Virtually all of the data involved in GHG measurement and management activities has geospatial and temporal elements. The not-for-profit standards organizations Open Geospatial Consortium (OGC) and World Wide Web Consortium (W3C) are already engaged together along with ISO with many other organizations in developing a unified platform of spatial environmental standards.

We propose that public and private sector climate organizations commit a very small fraction of their budgets to developing open international encoding and interface standards that would enable efficient and effective integration of GHG data. Much of what needs to be measured and communicated has already been captured in current GHG standards, registries, protocols and calculators. The next step is to agree on common conceptual models for this data, using something like UML (Universal Modeling Language) diagrams. There will probably need to be a separate data model for each greenhouse gas, though the models will share many features and borrow significantly from standards such as WaterML 2.0. The conceptual models would provide a basis for different but interoperable implementation standards for computing platforms such as XML, JSON and REST, or CSV.

Our talk, perhaps a keynote, would be focused on standards for encoding GHG data, but it wold also show how this proposed standard or set of standards is necessary for all types of environmental accounting. We would explain the methodology for developing such standards and explain why such standards are urgently needed as we enter «the environmental age».

P-1115-06

The French ICOS ecosystems stations : an overview

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The terrestrial biosphere interacts strongly with the climate, providing both positive and negative feedbacks due to biogeophysical and biogeochemical processes. To understand and predict the evolution of the climate, it is critical to understand both the contribution of vegetation to the greenhouse gases (GHG) budget and the response of the terrestrial biosphere to the changing climate.

The Integrated Carbon Observation System (ICOS), a new European monitoring network, offers a unique way of documenting and quantifying long term changes in the GHG balance of ecosystems. The ICOS research infrastructure includes atmospheric, ecosystem and marine station networks. The Ecosystem station network (ESN) of ICOS is based on a large number of monitoring stations that will be maintained for the next 20 years. The ESN uses a large set of standardised instruments to perform continuous and intensive measurements of meteorological and micrometeorological variables. A central part of this measurement set is the eddy covariance measurement, that allows a continuous monitoring of the flux exchanged between vegetation and atmosphere. All together these standardised observations allow a better understanding of the functioning of ecosystems in relation to climate and management practices.

ICOS Ecosystems France, the French part of ESN is a cooperation of three research institutes: INRA, CNRS and ANDRA. ICOS Ecosystems France is extensive and includes eight observation stations (4 Class 1, 4 Class 2). In addition seven associated stations also contribute to the network. The network samples a wide range of ecosystems (forest, crop and grassland), of management practices and climates (from cold mountain climate to tropical humid in Guyana, including wet oceanic and dry Mediterranean climate).

We will provide an overview of the stations and the measurement system (sensors and data flow). We will equally present the current status of the network, recent measurements and preliminary findings.

P-1115-07

Ground-based monitoring of greenhouse gases emissions over continental ecosystems: the ecosystem part of the ICOS European infrastructure

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Since the discovery in the early nineties of a missing terrestrial sink of carbon in the global carbon cycle (Tans et al. 1990), there was a tremendous effort of observation of the continental part of the carbon cycle.

The most recent estimate of its magnitude proposed by the Global Carbon Project reaches 10.6 GtC CO2±2.9 in 2014. The continental ecosystems contribute to attenuate the anthropogenic greenhouse gases enhancement by 29%.

This terrestrial sink is characterized by the large amplitude of its inter-annual variations and its ample uncertainty which makes it difficult to predict the future of the continental sink of carbon.

Inversion of atmospheric concentrations in greenhouse gases (GHG) and their temporal variations combined with atmospheric transport model allows characterizing the GHG exchanges at the continental surface at typical scale of 10 to 100 km.

Point measurements of the full GHG budget at half hourly resolution together with ancillary measurements on vegetation, management practices and soil permit to characterize the biogeochemical processes involved and their drivers. They are of utmost importance for understanding the GHG cycle and its sensitivity to environmental drivers on the long term.

Thus far, however, the inhomogeneity of methods, protocols and instruments used across ground observation networks have limited strongly our capacity to detect and observe the effects of environmental changes that are assumed to provoke changes in the GHG cycle. Indeed, the rate of pollutants deposition (Ozone, Nitrogen compounds), solar dimming, climate change and CO2 concentration enhancement not mentioning the secondary drivers are not monitored with sufficient accuracy and neither co-located in a sufficient number of stations for attributing clearly changes in the GHG budget of the main terrestrial ecosystems.

From this conclusion, the European research strategy implemented through the ESFRI roadmap was to build a new world class infrastructure having the capacity to coordinate and harmonise networks of ocean-, atmospheric- and ground-based stations equipped with identical instruments and operated according to the sale common protocols and standards, that is the ICOS infrastructure.

This communication will present the ICOS ecosystem network of stations and the Ecosystem Thematic Centre which collects and processes the measurements that are being operated across the station network. It will give few examples of the data obtained so far and show how they are being used for establishing robust GHG budgets of different ecosystems and their sensitivity to the environment, management practices and interaction.

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P-1115-08

A Multi-Model Regional Decomposition of CO2 Emissions: Socio-Economic Developments vs Energy Efficiency and Carbon Intensity Improvements

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This study explores the regional distribution of total CO2 emissions.

Kaya and Yokoburi (1997) decompose carbon dioxide emissions into 4 different components, namely Population, GDP per capita, Energy Efficiency and Carbon Intensity.

Ang (2004) shows that a difference in an aggregate indicator can be decomposed into the sum of the effects by differences in explaining factors and residual terms. Therefore changes of CO2 between time t and t-n is defined as the sum of the differences of each of the drivers and a residual term:

By making use of the Long Mean Divisia Index (LMDI) and the Refined Laspeyres Decomposition (RLD), the purpose of the paper is to quantitatively analyze how those components affect total CO2 emissions for different regions of the world, over time and across different socio-economic scenarios. In particular, socio-economic scenarios considered to perform this analysis are the 5 SSPs developed by National Center for Atmospheric Research (NCAR).

The reason of that is to determine the implications of each of the 4 drivers in evaluating the impacts of climate policies on global and regional economic systems and exploring the differences between short-term (2010-2030), medium-term (2010-2050) and long-run (2010-2100) effects.

By drawing data from the IIASA Database, this study considers 6 Integrated Assessment Models used to analyze climate mitigation and impact of different policies in regional economic systems, i.e. AIM-CGE, REMIND, MESSAGE, GCAM, IMAGE and WITCH and by making use of the Principal Component Analysis it evaluates their performances in explaining regional CO2 variations, and in which degree they differ.

The main findings of this study are the following:

REGIONAL VARIATIONS OF CO2 EMISSIONS:

- Index Decomposition Analysis, performed by utilizing

the LMDI method suggests a convergence and eventually divergence in total CO2 emissions over time for developing countries with respect to advanced economies. This is mainly due to more robust GDP per capita and Population growth rates relatively to those shown by the USA and Europe.

- However this is not the case of Latin America countries which thanks to a relative high rate of carbonization and less GDP per capita growth will show a minor average growth of total CO2 emissions with respect to that of the USA.

IMPACT OF EACH FACTOR IN EXPLAINING CO2 OVER TIME AND ACROSSSCENARIOS:

- GDP per capita and Population are shown to have a positive impact on total CO2emissions, in particular for developing regions. Energy Efficiency, in contrast, is the main determinant in dragging down total CO2 emissions variations across different economic scenarios. This is valid for all regions considered expect for Latin America countries in which decarbonization plays the biggest role.

- While the impact of Energy Efficiency is more stagnant over time, the pattern shown by the Carbon Intensity Effect suggests an increasing trend over the course of the years. Nevertheless the implications of such components differ from region to region and scenario considered.

PERFORMANCES OF INTEGRATED ASSESSMENT MODELS IN EVALUATING REGIONAL CO2 EMISSION VARIATIONS:

- Principal Component Analysis suggests that although the 6 models achieved a considerable degree of homogeneity, the main source of difference stems from the components of Primary Energy (i.e. Fossil, Biomass, Nuclear and Non Biomass Renewables), while showing a similar pattern for Carbon Intensity, Population and GDP per capita. In particular IMAGE and MESSAGE incorporate more optimistic assumptions on total CO2 variation in the short-term relatively to WITCH, GCAM, AIM and REMIND.

P-1115-09

Influence of Tropospheric and Stratospheric Air Pollution on Climate Change over the Indian Subcontinent

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India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. India is characterised by strong temperature variations in different seasons ranging from mean temperature of about 10°C in winter to about 32 °C in summer season. Monsoonal and other weather patterns in India can be wildly unstable, epochal droughts, floods, cyclones, and other natural disasters are sporadic, but have displaced or ended millions of human lives. Ongoing and future vegetative changes and current sea level rises and the attendant inundation of India's low-lying coastal areas are other impacts, current or predicted, that are attributable to global warming. Over the past two decades India has undergone rapid industrial and economic development with increasing emissions of gaseous pollutants. The main tropospheric pollutants (O3, NO2, CO, formaldehyde (HCHO) and SO2) and two major greenhouse gases (tropospheric O3 and methane (CH4)) and important parameters of aerosols, which play a key role in climate change and affecting on the overall well-being of subcontinent residents. In the light of considering these facts this paper aims to investigating possible impact of air pollutants on climate change over the subcontinent. Atmospheric aerosols can impact the local and regional radiation heat budget. Black carbon aerosols absorb incident solar radiation and heat the atmosphere more effectively than dust, sulfates, and organic carbons, which reflect more radiation and cool the atmosphere. The population 1.25 billion in India has led to a significant demand on natural resources. Biofuels such as wood fuel, dung, and crop waste are the primary contributors of aerosols in rural areas of India. Satellite derived column aerosol optical depth (AOD) is a cost effective way to monitor and study aerosols distribution and effects over a long time period. Aerosols have an impact on cloud formation process largely affecting monsoonal rainfall distribution over Indian subcontinent especially in the Ganga basin. Aerosols are found to be substantially increasing in the Ganga basin. Indo-Asian aerosols have impact on radiative forcing that cause negative forcing (cooling) at surface and positive effect (warming) at top of atmosphere.AOD is found to be increasing rapidly since 2000 in summer season that may cause adverse effect to the agricultural crops and also to the human health. Increased aerosol loading may likely affect the rainfall which is responsible for the observed drought conditions over the Indian subcontinent.Carbon monoxide is emitted into the atmosphere by biomass burning activities and by various other anthropogenic activities. The MOPITT CO retrievals at 850 hPa show large CO emission from the IG region. MOPITT CO distributions are able to capture at least part of the surface CO pollution, particularly where the sources are strongest in the Indian region. MOPITT CO daytime retrievals are able to provide significant information on the vertical transport of CO associated with the deep convective activities during the Asian Summer Monsoon and horizontal transport during the winter monsoon. The development of convective activity associated with the ASM leads to large scale vertical transport of the boundary layer CO from the Indian region into the upper troposphere. Ozone (O3) plays an important role in the global weather and climate even though the total atmospheric composition of ozone is less than that of other trace gases. The total ozone column (TOC) in the tropical atmosphere depends on both chemical and dynamical processes and has been studied extensively during the past few decades.TCO over the Indian subcontinent has a systematic and gradual variation, spatial as well as temporal. Higher amount of TCO in the northern latitudes and simultaneous lower TCO at near equatorial latitudes indicates depletion of ozone near the equator and accumulation at higher latitudes within the subcontinent. Winds at tropospheric and stratospheric heights may be just one of the principal factors of spatial variation of TCO that transports atmospheric constituents from one region to another. The Asian monsoon affects the chemical composition of the troposphere. In addition, changes in stratospheric ozone and atmospheric abundances of aerosols alter the energy balance of the climate system.

P-1115-10

A Roadmap for Monitoring GHG Emissions Reduction in Brazil

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The Brazilian government is developing and implementing a modular system to monitor, analyze and manage the greenhouse gases (GHG) emissions reductions achieved through the National Mitigation Plans (NMP) - SMMARE (in Portuguese: Sistema Modular de Monitoramento e Acompanhamento das Reduções das Emissões de Gases de Efeito Estufa).

Since the NMP are in different stages of implementation and are substantially different in terms of mitigation actions, each NMP will have a Monitoring Module (MM) that will be implemented in different points of time. All MM will be based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, taking into consideration relevant national circumstances.

CGEE (a non-profit organization with the mission of rendering Science, Technology and Innovation as Brazil's best allies for economic growth, competitiveness and well-being) has coordinated, under the supervision of the Environmental Ministry, a group of experts with wide experience on national GHG inventory planning, implementation and review, to develop each MM.

SMMARE was conceived during a one-year process with extensive and continuous dialogue with all the Ministries responsible for each NMP; and is being implemented based on 2 scenarios:

- Possible scenario: in which, based on the existing data and/or data that can be easily obtained, the monitoring of GHG emissions reduction could be done in the short-term at the national level;
- Ideal scenario: in which it would be necessary to improve the data collection in order to make the GHG emissions

reduction monitoring in a more disaggregated level (e.g. emissions reduction at the territorial-unit level, due to decrease in deforestation; emissions reduction at the plant level due to implementation of a specific technology; etc.).

Finally, SMMARE is designed to be a tool to help the international consultation analysis (ICA) process to be conducted under UNFCCC, with the aim to increase the transparency of mitigation actions and their effects.

An Example of a Monitoring Module – One of the NMP that have been implemented and is obtaining good results is the Action Plan for Protection and Control of Deforestation in the Amazon (PPCDAm), under the responsibility of the Ministry of Environment. Since its implementation in 2004, deforestation rates in the Amazon region have been decreasing (a 84% reduction in 2012). With the aim of monitoring the GHG emissions reduction associated with the actions implemented by the PPCDAm, a specific MM is being developed based on a generic spatially explicit modeling framework to estimate carbon emissions from deforestation developed by the Brazilian Institute for Space Research (INPE-EM). An indicator for monitoring the GHG emissions reduction achieved by PPCDAm will be tons of CO2 reduced per hectare of avoid deforested areas. Preliminary results indicated that the total potential CO2 emission reduction from PPCDAm could be around 580 million tones by 2020, with an average value of 200 tones of biomass per hectare.

P-1115-11

Greenhouse gas emissions from energy consumption and mitigation of a mining project in Padcal, Benguet Province, Philippines

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The mining industry is one of the most economically important sectors in our society particularly for developing countries. It is a major foreign exchange earner and provides employment opportunities to thousands of people. However, the industry is viewed as among the primary causes of environmental degradation. One of the potential adverse impacts of mining operation is greenhouse gas emission that contributes to global warming and climate change. To minimize the impacts, accurate assessment of greenhouse gas emitting activities is necessary not only to identify them but more importantly to find ways to minimize if not totally avoid their adverse consequences.

A study was conducted to determine the amount of GHG emissions of a mining project focusing on its energy consumption. Using 2014 as base year, the study showed that under Scope 1, the fuel used for both mobile and stationary sources amounted to a total of 5,081,995.10 liters of diesel and 8,317.00 liters of gasoline. The total fuel usage has an equivalent amount of 14,021.09 Mg of CO2e. While under Scope 2, the company consumed a total of 280,142.01 megawatts of electricity in its mine and milling operations including those of ancillary services and staff housing needs. The amount of electricity consumed has an equivalent of 238,400.85 Mg of CO2e emissions.

To sum it up, the company's GHG emissions from energy usage yielded a total of 252,421.94 Mg of CO2e. This would mean that the project has to mitigate their CO2 emissions. One of the easiest and economical ways of sequestering carbon is through plantation maintenance and establishment in which the company has intensively done since then. A Pinus kesiya plantation has an average sequestration rate of 12.7 Mg C ha-1 year-1 or 46.57 Mg CO2 ha-1 year-1 based on studies conducted from different age classes. P. kesiya is a common and most dominant species in the Cordillera Region. Hence, to offset the company's current emissions, it would need a minimum of 5,420.3 hectares of pure Pinus kesiya and mixed P. kesiya plantations to maintain per year. This could also be supported by other mitigating measures to compensate emissions from other sources.

P-1115-12

Interannual variability of atmospheric CO2 and CH4 in Western Europe

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The space-time variations of trace gases in the atmosphere reflect the distribution of surface emissions, mixed by horizontal and vertical atmospheric transport. By using atmospheric tracers or/and models to quantify the intensity of the mixing, surface emissions can be resolved from the atmospheric measurements. The objective of our study is to characterize the CO2 and CH4 variations observed over Europe. We have analyzed the CO2 and CH4 molar fractions gradients between the continental stations in Western Europe and the Atlantic Ocean. The marine selected data from Mace-Head, Ireland, was used as a reference to define Atlantic Ocean background conditions. Long term (> 10 years) time series of DCO2 and DCH4 were calculated from Shauinsland, Plateau Rosa and Puy de Dôme. New monitoring stations set up in France provide a more detailed view of the gradients for the most recent years. The signals are characterized by a high year-to-year variability (up to 6 µmol.mol-1 for CO2), with a strong correlation between most of the stations. The latest winter (2013-2014) shows relatively low gradients at all sites, similarly to 2007-2008 winter season. Both winters correspond to a warm anomaly, associated to stronger Westerlies. Stronger advection and vertical mixing due to higher Westerlies seems to be the main reason for the low gradients observed in 2008 and 2014. However the interannual variability of the climate in Western Europe, also induce variations in trace gases exchange with terrestrial ecosystems and fossil fuel emissions. The objective of our analysis will be to discriminate between the contributions of atmospheric transport and surface emissions in the observed variability of DCO2 and DCH4 over Europe.

P-1115-13

Recovery, recycling and destruction of F-gases in Georgia

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Introduction of a sustainable system for recovery, disposal and destruction of contaminated artificial refrigerants, which are F-Gases with very high GWP (Global Warming Potential), is a direct contribution to the reduction of emissions of GHG into the atmosphere especially for developing countries.

Refrigerating, Air-conditioning and Heat pump (HRAC) sector is only consumer of industrial GHGs in Georgia. These substances have been widely introduced as alternatives to ODS (Ozone Depleting Substances) refrigerants during the last twenty years since Georgia ratified the Montreal Protocol on Substances that Deplete the Ozone Layer. By this reason annual consumption of the industrial GHGs has grown up sharply and reached two hundred thousand metric tons now. Therefore the Introduction of an effective monitoring system together with recovery, disposal and destruction of F-gas refrigerants is urgent issue today in the country.

This study gives feasibility assessment of such system for Georgia taking into account the experience of the Georgian Refrigerant Recovery & Recycling Centre in recovering, recycling or destruction of the ODS.

In order to make the feasibility assessment the preconditions for generating unwanted refrigerants bank were studied.

Based on the gathered and analyzed data the recommendations were formulated for designing a sustainable monitoring system of new and used GHG refrigerant in the country. The recommendations include introduction of measures to support the sustainability looking at available F-gases waste that can be collected through two Recovery & Recycling centers operating in the country in cooperation with service companies, importers, car dismantling and metal scrapping companies in longer run with future waste disposal deploying in-country generated sources of finance.

This is very urgent issue because like in other developing countries there are no technical facilities of destruction of F-gases waste in Georgia. So the collected unwanted GHG refrigerants have to be saved for trans-boundary transportation where they can be safely destroyed. Financial mechanism for sustainable system of F-gases waste permanent collection and destruction has been studied and shown that several methods for accumulation of funds inside the country can be acceptable for Georgia.

P-1115-14

Transferring concern with climate mitigation to Institutional Sustainability: A case study applying carbon accounting as a tool for resource management in a desert environment

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As a result of climate change and the potential risk of global warming, an emerging interest across academic institutions to develop a comprehensive inventory of greenhouse gas emissions is on the rise. Higher education institutions are often faced with the challenge to develop a process that will accurately assess the campus' resource consumption in a timely, economical, and informative manner. This type of assessment is not typical and relies heavily on the availability of data and institutional capacity to carry such exercise accurately and report the findings, benchmark against peer institutions and establish the institutional mechanisms to sustain this type of data intensive work. In response to the previous principals and faced with a number of environmental challenges in a desert environment, the American University in Cairo (AUC) recently completed the first phase of carbon accounting and issued a Carbon Footprint Report which highlights the strategies adopted by the sustainability team to reduce energy consumption on campus. The report measured the University's carbon footprint, which is the annual total of carbon dioxide (CO2) and other significant greenhouse gases emitted into the atmosphere as a result of daily activities and campus operations. AUC was the first higher education institution in the Middle East and North Africa to conduct such a comprehensive study of its own impact on climate change. As part of its ongoing efforts to maintain and improve its operational sustainability, AUC has witnessed a one-third reduction in overall energy consumption on the New Cairo campus over the past two years, decreasing the cost of utilities by 35%, thanks to an energy-saving plan designed and implemented by the University's sustainability team. This proposal presents the method, challenges, strengths and areas of improvement of the method used and outlines the present strategies developed to manage the campus resources as a result of this exercise. It also presents the efforts taken to institutionalize the method so it becomes campus culture and to transition the work from research to a daily practice.

P-1115-15

Assessing the role of megacities on atmospheric CO2: results for Paris from the CO2-MegaParis project, France

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On average, atmospheric CO2 increases in the atmosphere at a rate of about 2 parts per million (ppm) per year, due to the accumulation of about half of the anthropogenic CO2 emissions in the atmosphere (mostly from the combustion of fossil fuels), while the other half is being re-absorbed by the ocean and the continental biosphere. Today, more than 70% of global fossil-fuel CO2 emissions come from punctual sources such as megacities. Paris is the third megacity in Europe and it emits about 15% of the total French emissions, while it covers only less than 2% of the national territory. Currently, most of the estimates of urban CO2 emissions are given by bottom-up CO2 emissions inventories, which rely on activity proxies and benchmarked emission factors. The associated uncertainties can be as high as several tenths of percents, especially when it comes to discriminate the CO2 urban emissions by emission sectors. Therefore, there is an urgent need for developing new methods to better Monitoring, Reporting and Veryfying (MRV) CO2 emissions from megacities, dedicated to provide robust results to policy makers for taking efficient decisions and actions in matter of controling CO2 anthropogenic emissions and mitigating climate change. Since 2009, the CO2-Megaparis project aims to quantify CO2 emissions from Paris using top-down approaches based on a synergy between atmospheric observations and modeling. For the first time, a mini-network of 3 greenhouse gases (GHG) monitoring stations was developed by LSCE in Paris agglomeration within the infrastructure of the regional air quality monitoring agency, AIRPARIF, completing 2 other GHG stations from the ICOS European greenhouse monitoring network. One of our urban station was located on top of the Eiffel tower above Paris megacity. The analysis of one year of data showed that Paris CO2 emissions lead to a mean increase of the atmospheric CO2 concentration in the mid-afternoon of 2 to 3 ppm, and is strongly season, windspeed and wind direction dependent: the CO2 urban plume is characterized by a very large spatio-temporal variability and can reach about 60 ppm at low windspeeds on top of the Eiffel tower. In addition, analysis of correlations between CO2, CO and 14C02 were carried out from field measurements and allowed an independent assessment of the inventories emission sectors. Furthermore, direct modeling of CO2 at a very fine resolution (2x2 km2, 1h) was performed and matched well with the observations. Last but not least, inverse modeling efforts at the same resolution allowed a significant improvment of the regional inventory from Airparif. Finally, a campaign conducted during springtime and based on lidar facilities revealed that due to the effect of the urban heat island, the boundary layer height (that can be seen on the first degree as the man dilution factor of CO2 emissions in the atmosphere), is 10 to 40% time higher in Paris than in surrounding rural areas: this is an important result that supports the implementation of urban canopy models in future fine scale urban CO2 modeling framework. A synthesis of the different results will be presented, as well as an attempt of defining the strengths and weaknesses of the atmospheric approach to quantify urban CO2 emissions. Contributions from sister studies (MultiCO2 - IPSL, Le CO2 parisien - Ville de Paris 2030, CarboCount-City - KIC Climat...) will also be mentionned.

ORAL PRESENTATIONS

K-1116-01

Observational constraints on biogeochemical feedbacks

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Tremendous efforts are underway to use a wider range of observations to inform model projections. Efforts range from enhanced coordination of repeat observations, the collection of quality controlled data in public databases, the development of new data interpolation methods, and extensive model-data comparison efforts. This presentation will provide an overview of efforts by the carbon cycle research community to constrain, using a range of observations, our quantitative understanding of how the carbon cycle works. It will use the trends and variability observed during 1959-2014 in a range of observations to examine how the land and ocean carbon sinks have responded to changes in increasing atmospheric CO2 and climate change and variability at the global and regional level, and comment on the qualities and limitations of models to project changes in the 21st century and beyond. This presentation will be based on the 'Global Carbon Budget' annual update by the Global Carbon Project. It includes an assessment of the annual change in land and ocean carbon sinks from three ocean data products, seven ocean models, eight dynamic global vegetation models, three atmospheric inversions, plus indirect constraints from CO2 emissions and measured atmospheric CO2 growth rate. The presentation will also include additional data and model analysis from the marine environment and discuss the marine biogeochemical feedbacks related to ocean deoxygenation and to the response of marine ecosystems to climate change and ocean acidification.

K-1116-02

Projecting the carbon-climate feedback from thawing permafrost

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The loss of carbon from ecosystems as they adjust to a warmer climate may act to amplify climate change. Permafrost-affected ecosystems may be particularly vulnerable to such carbon losses because of the huge amounts of organic carbon that have been preserved in frozen soils, which may thaw and decompose more rapidly as a result of climate warming. In the IPCC fifth assessment report, the models of the Earth system that were used to estimate the magnitude of these terresrial carbon-climate feedback processes did not include key representation of the CO2 and CH4 release from permafrost thaw. Recent progress has been made to synthesize observations of permafrost carbon dynamics and develop the representation of these processes in global carbon cycle models, to better estimate the amount and timing of greenhouse gas emissions from permafrost. I will discuss a variety of approaches to project the feedback from warming permafrost, from highly simplified and data-constrained soil models to detailed ecosystem models that include vegetation-permafrost-nutrient interactions. Such approaches suggest that the carbon-climate feedback from permafrost is an important process on the 50-300 year timescale, and that the magnitude of ecosystem carbon losses is highly sensitive to the future trajectory of fossil fuel emissions, with much larger losses under high emission scenarios such as RCP8.5 than on mitigated emissions pathways such as the RCP4.5 scenario.

K-1116-03

Biogeochemical feedbacks to climate change: Insights into soil moisture controls on soil heterotrophic respiration

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Soils contain the largest C terrestrial pool and even small changes in soil organic C (SOC) can have a significant impact on the atmospheric CO2 concentration. The C cycle feedback to climate will largely depend, in magnitude and timing, on the response of soil C to climate changes. However, there is still considerable uncertainty regarding such effects.

While the effect of temperature on soil C mineralization has been the subject of much work and considerable debate, much less attention has been paid to the effect of changes in water regime, another predicted component of climate change. However, soil moisture has a key role in regulating soil respiration. Here, we synthesise work regarding the relation between soil moisture and soil C dynamics, focusing on the underlying mechanisms, on the interaction with soil properties and other components of global changes, and discuss how mechanisms and the complexity of soils can be integrated into models.

The effect of soil moisture is complex to predict because, unlike that of temperature, it is strongly dependent on soil characteristics. Soil moisture effect on heterotrophic respiration is represented in most current carbon cycle models by empirical functions, which are often based on limited experimental data. We performed a data-driven analysis of soil moisture respiration relations and showed how these are consistently affected by soil properties such as clay content, organic C content, bulk density. We developed empirical models including the effects of soil texture, soil organic carbon and bulk density which improve the functions currently used in different soil biogeochemical models.

Partially responsible for the present state of knowledge may be the idea that, in biogeochemical models, time- and spatially averaged or approximate relationship of microbial activity with moisture is sufficient to reliably predict C fluxes. But soil microorganisms live in a complex 3-D framework of mineral and organic particles defining pores of various sizes, more or less inter-connected, which result in a variety of microhabitats. Most promising perspectives in this area are based on mechanistic approaches, where theoretical linkages between substrate and gas diffusivity in soil pores and heterotrophic respiration are explored in different soil matrices. A new generation of biogeochemical models is based on an explicit representation of soil architecture at a fine scale, which provides in-depth mechanistic understanding, and should help to define relevant descriptors of soil characteristics to improve how larger scale models account for the effects of soil moisture.

The complex interplay between biological, biogeochemical and physical processes is apparent when considering the variability of soil C storage upon a widely used cropping practice: not tillage, where soil moisture also regulates the flows of C between soil litter and mineral layers. The interactions between soil moisture and other components

of global change, i.e. land use, cropping practices, temperature, will also result in biogeochemical feedbacks to climate change.

O-1116-01

Positive future climate feedback due to changes in oceanic DMS emissions

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The global ocean is the largest natural source of dimethylsulphide (DMS) gas to the atmosphere. DMS is produced by phytoplankton and is released to the surface ocean if cells are degraded. Once it enters the atmosphere, it might contribute to the nucleation particles important for cloud formation, which then effect the Earth's radiation budget and climate. Future global warming and ocean acidification is projected to alter marine DMS production and emission. However the none of the models assessed in the last IPCC report includes the DMS-climate feedback.

Recent study indicated that under high CO2 emissions future, the oceanic DMS emission is projected to decrease by 12 to 24% by the end of this century, potentially leading to an equilibrium temperature response of 0.1K to 0.76K.

Here, for the first time using a fully interactive Earth system model including a microphysical aerosol module with sulfur chemistry, we perform simulations on future climate projection with coupled DMS feedback. Under the highest pH sensitivity, our simulation shows that projected DMS production and emission decrease relative to the preindustrial state by 50% and 36%, respectively toward the end of the 21st century under the RCP8.5 emissions scenario. The largest emission reduction is simulated in the Southern Ocean. On contrast, emissions at polar latitudes increase owing to the sea ice retreat. This large change in marine sulfur emisson leads to an additional global warming of 0.3K relative to the reference simulation without DMS-climate feedback at the end of the 21st century. Both simulations also produce similar trajectories in atmospheric CO2 concentration, consistent with little change in the cumulative oceanic and terrestrial carbon sinks.

O-1116-02

How much carbon dioxide and methane will be released from thawing permafrost soils?

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High northern latitudes are predicted to warm rapidly during the 21st century. The tundra, boreal forests and peatlands found in these regions are recognised to contain substantial stores of organic matter. Permafrost soils are particularly important in this context, storing as much carbon as all the rest of the world's soils put together, and more than twice as much carbon as the atmosphere. The IPCC AR5 report emphasises that there is high confidence that warming in the Arctic and Boreal will lead to a reduction in permafrost extent. However, while some estimates suggest that the potential for carbon release from thawing permafrost soil could be the single most important climate-carbon cycle feedback, the AR5 report also emphasises that there is low confidence in predicting rates of soil carbon loss, and also whether the carbon will be released mainly as carbon dioxide or the more powerful greenhouse gas, methane. Importantly, the permafrost feedback is not currently included in the models evaluated in the IPCC CMIP programme, and thus a potentially critical feedback is missing.

This presentation will focus on how recent studies, making detailed in situ observations, and running manipulative field and laboratory experiments, have improved understanding of the permafrost feedback. In particular, the presentation will: 1) explain the role of different high-latitude plant communities, including understudied groups such as mosses, in both controlling rates of thaw and potentially mitigating against some of the expected carbon release, 2) outline the important role radiocarbon dating has played in detecting the contribution of the decomposition of old, previously-frozen organic matter to rates of carbon release following permafrost thaw, and 3) discuss the potential for substantial amounts of permafrost carbon to be released in the form of methane.

Research has shown that in boreal forest, thick moss layers may insulate soils to such an extent that disturbances (e.g. fire) may be required before warming promotes deep permafrost thaw. Therefore, tundra and peatland ecosystems may thaw more rapidly due to wetter conditions or reduced thickness of insulating moss layers. Overall, it appears that there is indeed considerable potential for increased carbon dioxide production from thawing permafrost, especially from highly organic soils, and where soils are not permanently waterlogged post thaw. The latter issue requires a fuller consideration of water flow paths within permafrost landscapes. Given the potential for large soil carbon losses, it may be unlikely that these could be fully compensated for by increased plant growth, at least in tundra ecosystems where plant biomass is low. There does though remain the potential for increased soil carbon inputs from plants to reduce rates of soil carbon losses. On the other hand, rates of methane production from thawing permafrost may not be as high as first predicted. Rather, the direct effect of climate warming on rates of methanogenesis associated with the decomposition of contemporary carbon inputs in northern wetlands, is likely to be more important.

The permafrost feedback remains potentially one of the most important carbon cycle feedbacks to climate change, but requires considerable further study. Improving understanding of the proportion of previously-frozen organic matter that will decompose aerobically following thaw, and the extent to which nutrient release from thawing permafrost can increase plant growth and soil carbon inputs, should be considered as key ongoing research priorities.

O-1116-03

Biomass burning in northern sub-Saharan Africa and associated changes in environmental and climate variables

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One of the most vulnerable tropical regions of the world is the northern sub-Saharan African (NSSA) region, which is bounded on the north and south by the Sahara and the Equator, respectively, and stretching East-West across Africa. This is so because of the highly active

environmental and meteorological processes associated with its unique location and human activities. Over the years, this region has suffered frequent severe droughts that have caused tremendous hardship and loss of life to millions of its inhabitants due to the rapid depletion of the regional water resources. On the other hand, the NSSA region shows one of the highest biomass-burning rates per unit land area among all regions of the world. Because of the high concentration and frequency of fires in this region, with the associated abundance of heat release and gaseous and particulate smoke emissions, biomass-burning activity is believed to be one of the drivers of the regional carbon and energy cycles, with serious implications for the water cycle and climate. This extensive biomass-burning phenomenon contributes to environmental change, whose effects on the regional climate variability can be significant, with far-reaching implications for societal adaptation. An interdisciplinary research effort sponsored by the United States National Aeronautics and Space Administration (NASA) is presently being focused on the NSSA region, to better understand possible connections between the intense biomass burning observed from satellite year after year across the region and the water cycle, through associated changes in certain essential climate variables (ECVs) including land-cover, albedo, soil moisture, evapotranspiration, and atmospheric composition, which can drive changes in additional ECVs such as atmospheric water vapor and wind patterns, precipitation, surface runoff, and groundwater recharge. A combination of remote sensing and modeling approaches is being utilized to investigate these multiple processes to establish possible links between them. We are finding appreciable relationships between biomass burning and many of the above-listed ECVs. In this presentation, we will discuss interesting results as well as the path toward improved understanding of the interrelationships and feedbacks between the water cycle components and the environmental change dynamics due to biomass burning and related processes in the NSSA region.

1116-POSTER PRESENTATIONS

P-1116-01

The biggest terrestrial tipping point or a potential carbon sink? 124 experts weigh in on the permafrost carbon feedback

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Arctic tundra and boreal forest contain approximately half of all terrestrial organic carbon. As the permafrost region warms, more of this immense carbon pool will be exposed to decomposition, combustion, and hydrologic export. This permafrost carbon feedback has been described as the largest terrestrial feedback to climate change as well as one of the most likely to occur; however, it is not included in current emissions negotiations and estimates of its strength vary by a factor of thirty. Models predict that some portion of this release will be offset by increased Arctic and boreal biomass, but the lack of robust estimates of net carbon balance increases the risk of further overshooting international emissions targets with serious societal and environmental consequences. Because precise empirical or model-based assessments of the critical factors driving carbon balance are unlikely in the near future, we collected expert judgments from 124 permafrost-region scientists of the response of high-latitude carbon balance to four warming scenarios. Experts provided quantitative estimates of CO2 and CH4 release, change in biomass, wildfire CO2 emissions, and hydrologic carbon flux by 2040, 2100, and 2300. Results suggest that, contrary to current model projections, total permafrost-region biomass could decrease due to water stress and disturbance. Assessments indicate that end-of-the-century organic carbon release from Arctic rivers and collapsing coastlines could increase by 75% while carbon emissions from wildfire could increase four-fold. For the business as usual scenario (RCP 8.5), experts hypothesized that the permafrost zone could emit 14 to 40% of the carbon necessary to push the climate system beyond the 2C threshold by the end of the century (140 to 240 Gt CO2 equivalent) with cumulative net emissions reaching 320 to 510 Gt by 2300. However, because lower warming scenarios resulted in less carbon release from soils and more carbon uptake by Arctic and boreal biomass, results suggest that 65 to 85% of permafrost carbon release can still be avoided if human emissions are rapidly reduced.

P-1116-02

Constraining the strength of the terrestrial CO2 fertilization effect in Earth system models

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The response of the global carbon cycle to future atmospheric emissions of carbon dioxide (CO2) is paramount to projecting the future atmospheric CO2 concentrations and the resulting climate change. Yet, the current generation of Earth system models (ESMs) show widely varying responses of the global carbon cycle to future increases in anthropogenic CO2 emissions. A large fraction of the differences in response of the ESMs is due to the land carbon cycle. The response of the ocean carbon cycle, to changes in atmospheric CO2 and changing climate, is much more consistent across ESMs. Over land, the strength of the CO2 fertilization effect is biggest source of uncertainty that contributes to the large differences in response of the land carbon cycle. Here, using results from the three generations of the Canadian Earth System Model (CanESM1, CanESM2, CanESM 4.2) it is shown that the net land carbon uptake over the historical period and the amplitude of the annual cycle of the atmospheric CO2 concentration may be used together to constrain the strength of the terrestrial CO2 fertilization effect. Uncertainty exists in land use change emissions over the historical period, and thus the estimate of historical land carbon uptake, and monthly global atmospheric CO2 data go back only to the 1980s. These limitations imply that both the net land carbon uptake over the historical period and the amplitude of the annual cycle of the atmospheric CO2 concentration provide not-too-strong, but still meaningful, constraints on the strength of the CO2 fertilization effect of the land carbon cycle.

P-1116-03

What you see is not what you get: the permafrost carbon feedback in the context of climate stabilization and reversibility

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Permafrost soils contain large amounts of relatively inert soil carbon, a proportion of which is projected to thaw and become vulnerable to decomposition under future climate change. This paper utilises a series of idealised scenarios – where the surface temperatures are increased, stabilised and reduced – to highlight the implications of the timescale of response of the permafrost carbon to changes in climate and the potential for (ir)reversible loss of carbon. Patterns of warming are based on the HadGEM2-ES climate model. Uncertainty ranges in permafrost carbon loss are estimated using a simple model that accounts for uncertainties in the distribution of soil carbon, its lability and different plausible decomposition mechanisms. Under scenarios of steadily increasing temperature only a proportion of the carbon vulnerable to decomposition is emitted at any given time, because of a time lag in decomposition. The proportion of vulnerable carbon released at any given level of warming depends on the rate of past warming. Faster transient warming causes less of the vulnerable carbon to be emitted than a slower increase. In a scenario where the global warming reaches 2.6 K over a period of 70 years only about 30 % of the 70 – 230 Gt C vulnerable to decomposition has been emitted. However, if temperatures are stabilised, then the majority of the remaining vulnerable carbon will be emitted over the next 200 years causing an eventual additional temperature increase of 0.1–0.6 K. If the permafrost is allowed to recover (by reducing temperatures) causing the vulnerable carbon to refreeze some of the permafrost carbon loss can be avoided depending on the peak warming and the rate of subsequent cooling. The contribution of permafrost

carbon needs to be included when assessing targets for stabilisation and developing policies designed to avoid dangerous climate change.

P-1116-04

Is Ocean really a source to atmospheric CO2 during cyclones in the Arabian Sea ?

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The enhanced biological production, and associated regeneration, leads to higher pCO2 in the sea water compared to atmosphere and ocean becomes a source of atmospheric CO2 (Sarma et al., 2008) during such events. Cyclone induced productivity intensify this source. Byju et al., (2011) reported that Phyan associated net CO2 flux to the atmosphere was 0.123 Tg C. We have employed a coupled 3-D bio-physical model, ocean general circulation model ROMS with an ecosystem model, to study whether Ocean is really a source to atmospheric CO2 during cyclones in the Arabian Sea. It is observed that the storm has a significant effect on the thermocline and mixed layer depth which in-turn enhance sea surface chlorophyll concentration. Model generated sea surface chlorophyll concentration during several extreme events is validated using satellite derived ocean colour data which also shows higher concentrations of chlorophyll in the storm influenced region. The high concentration of chlorophyll appeared as a bloom over an area of approximately 150 km in diameter along the storm passage. It is observed that thermocline shoaled up after the storm passed and this shoaling of the thermocline caused entrainment of nutrients in upper 50 meters which triggers high biological productivity. The 50 meter vertically integrated primary production during three different cyclones (Cyclone 01A, Tropical storm 05A and Tropical Storm PHYAN) was estimated in terms of carbon using the model along the track of the cyclone/storm. The net sequestration of carbon due to the above mentioned cyclones are 0.125 Tg C, 0.16 Tg C and 0.125 Tg C, respectively. Our study, in conjuction with Byju et al., suggest that ocean is not a source of CO2 to the atmosphere during cyclones but more such study is required to ascertain whether the ocean acts as a sink during such events.

P-1116-05

The great climate change and the fuzzy C sink: how irrigation can change soil carbonates dynamics

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There are two types of carbonates in soils: lithogenic or primary carbonates, and pedogenic or secondary carbonates. The formation of the later depends on the availability of bicarbonates (HCO3-) and cations in the soil solution. When bicarbonates present in the solution are the result of the dissolution of CO2 from soil respiration, the formation of pedogenic carbonates can be considered a net CO2 sink. Carbonates dynamics in soil are however complicated to depict because in addition to the sources of carbonates (which can include pre-existing carbonates, bicarbonates dissolved in incoming water and the soil atmosphere) and cations, the conditions for precipitation and/or dissolution and leaching are continuously changing. From a global perspective, these conditions can be considered at steady state in a given place when relatively long periods of time (f.e. one year) are considered, and local climate and soil conditions do not change.

However, when the annual soil water balance changes, alterations in soil carbonate concentrations can be expected in a short period of time because of the solubility of carbonate minerals. In this context, human-induced changes, such as the implementation of irrigation, can accelerate the dissolution and precipitation cycles of soil carbonates. In addition, irrigation stimulates the soil biological activity and biotic CO2 generation and also irrigation water can be an external source of cations and bicarbonates. For this reason, studying the evolution of carbonates in dryland agricultural soils converted to irrigation can help to understand the extent of this change in terms of carbonates dynamics. The complexity of these biogeochemical interactions makes modelling a useful and interesting tool.

The purpose of this work was to evaluate the variations of carbonate concentrations in the topsoil of a semi-arid Mediterranean agricultural soil after the implementation of irrigation. Two adjacent plots were selected for this study; one under dryland conditions with wheat since at least 50 years and another under irrigation conditions with corn for 7 consecutive years. The plots were located in the same soil unit (Calcic Cambisol) in Funes (Navarra, Spain). Numerical simulations of carbonates concentration, dissolution and precipitation were performed with PHREEQC for the evaluation of the geochemical interactions between the soil, the soil solution and irrigation water, for a simple model based in the monthly water balance and the observed concentrations in the soil solution and irrigation water. In addition, a sensitive analysis was developed in order to investigate the potential impact of the type of crop, salt concentrations in the irrigation water and partial CO2 pressure due to soil respiration. Finally, for the validation of the model, samples of the irrigated and non-irrigated plots were analyzed for their carbonate content and isotopic composition (δ13C).

Simulated values were consistent with the observed values of carbonates concentrations and isotopic signature of the soil samples. The simulation results also suggested that the amount of new precipitated carbonates and the amount of carbonates leached varies with the salt concentration in the irrigation water, the partial CO2 pressure and the type of crop. The most sensitive parameter was the partial CO2 pressure of the soil solution. The modelling results showed annual values of carbonates-C leaching around hundreds of kg/ha in the studied area under irrigation.

This study showed that in a relatively short period of time (seven years) the differences observed in the inorganic C budget of the agricultural soil studied could be significant in relation to the total soil C budged. Irrigation could therefore have an important effect in soil fractions of carbonate-rich soils and this should be taken into consideration in regional-scale studies.

P-1116-06

The long-term effect of short-lived species through the climate-carbon feedback

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This work aims to quantify and discuss the impact of short-lived species on the carbon-cycle and through the climate-carbon feedback. It proceeds in three steps. First, we isolate the climate-carbon feedback and its contribution to the currently observed, human-driven, change in atmospheric carbon dioxide. Second, we attribute this feedback to its various anthropogenic causes following the concentration-based attribution of radiative forcing provided by the IPCC. To do so, we updated the compact Earth system model OSCAR to its version 2.2, and we use it combined with attribution algorithms developed to answer the Brazilian Proposal (Trudinger and Enting, 2005; doi: 10.1007/s10584-005-6012-2).

In the first step, the model is used as a carbon-cycle model in which the sensitivity of the ocean and land modules were calibrated on complex three-dimensional models used in CMIP5 (Arora et al., 2013; doi:10.1175/JCLI-D-12-00494.1). Using three historical drivers: (1) anthropogenic CO2 emissions from fossil-fuel burning, (2) land-use and land-cover changes, and (3) reconstructed climate, the historical change in atmospheric CO2 is shown to be satisfactorily reproduced by the model. This change in atmospheric CO2 is then attributed to the three drivers. As best guesses, we find that the observed 2008 burden increase of 107 ppm is attributed at 56% to fossil-fuel emissions, at 28% to land-use activities, and at 16% to climate change.

In the second step, we expand the model with a climate module whose global and local responses to radiative forcing are also calibrated on CMIP5 outputs (Geoffroy et al., 2013; doi:10.1175/JCLI-D-12-00195.1). Using

the radiative forcing timeseries produced for the fifth IPCC report (Myhre et al., 2013), we repeat the previous experiment, albeit this time the contribution of «climate change» is further broken-down into contributions by the various primary and secondary radiatively active species: CO2, non-CO2 greenhouse gases, ozone or aerosols. Of the 17 ppm (= 16% of 107 ppm) previously attributed to climate change, we estimate 79% are caused by non-CO2 greenhouse gases, -57% by short-lived species (ozone and aerosols), and the complementary 78% by CO2 itself.

The overall negative figure from short-lived species is explained by the dominance (among the various effects of the these species) of the cooling effect of aerosols. Over the historical period, we show that this cooling avoided a reduction in the carbon sinks efficiency that would have been seen if only CO2 and non-CO2 greenhouses gases had been emitted. To complete this analysis, we make a third experiment with a slightly altered model designed to keep track of past changes in the carbon-climate system. This «book-keeping» approach shows that past emissions of short-lived species still have an impact on present-day atmospheric CO2, and thus on present-day climate. For instance, we estimate that sulfur emissions from the 1980s have an impact of about -2 ppm over the 107 ppm observed in 2008.

To conclude, this study quantifies one of the indirect biogeochemical effect of aerosols (and ozone), as first introduced by Mahowald (2011; doi:10.1126/science.1207374). It provides an emission-based analysis of the causes of the change in CO2 atmospheric concentration (and thus of its radiative forcing), similarly to what was done for CH4 or O3 in the last IPCC report (Myhre et al., 2013). The emission-based approach complements the «traditional» concentration-based one, since it has the interest of providing a diagnosis of the anthropogenic drivers of climate change that is one step closer to the political decision, albeit at the cost of an increased uncertainty as we will also show.

P-1116-07

Response of Soil Carbon Storage to Temperature and Carbon Input Variability in Earth System Models

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Soil comprises the largest terrestrial carbon pool, containing more than double the carbon currently in the atmosphere and triple that in vegetation. Soil organic matter (SOM) is particularly vulnerable to environmental change, with potential carbon-climate and carbon-concentration feedbacks resulting from soil warming, CO2 fertilization, nitrogen (N) enrichment, and precipitation. These changes are expected to influence SOM decomposition and stabilization processes, thereby threatening the soil's capacity to serve as a carbon (C) sink. Earth system models (ESMs) currently use linear kinetics to represent soil C dynamics, and therefore lack explicit representation of the non-linear biotic and abiotic mechanisms that govern soil processes. As such, ESMs exhibit high uncertainty in their simulated current and future soil C storage. Recent studies have shown that explicit representation of microbial and mineral interactions improve estimates of current global C stocks and better capture spatial heterogeneity. These microbe-enabled SOM models also better represent non-linear responses to changes in soil temperature and C inputs (e.g., priming of old SOM in response to increased soil C inputs) that have been observed in many field and laboratory experiments.

Although recent work has explored the feasibility of incorporating microbial and mineral mechanisms into SOM models within ESMs, most of these models lack explicit representation of nutrient cycling (nitrogen and phosphorus) and seasonal variability (temperature, C inputs, and moisture). Omitting nitrogen cycling significantly affects simulated global priming responses to elevated CO2 concentrations, as nitrogen availability plays an important role in dictating microbial activity in nutrient-constrained environments. Thus far, microbe-enabled SOM models within ESMs have also largely ignored the effect of temporal forcing on soil C dynamics, representing seasonal and diurnal temperature, C and N inputs, and moisture with annual averages. These simplified model input assumptions, however, omit the seasonal and inter-annual fluctuations that microbial communities undergo in response to environmental conditions, greatly affecting the prediction of soil C equilibria and dynamics in ESMs. For example, a significant amount of soil respiration can occur during winter, while soils sampled in the summer (with different microbial composition) do not show respiration at winter temperatures. Leaf litter (primarily in the fall) and root exudates (throughout the growing season) support different microbial strategies depending on the type and duration of inputs. Global environmental change will affect the seasonality of these processes, which cannot be resolved by annual averages.

In this study we demonstrate that the frequency at which the system is resolved matters, i.e., that the seasonality and magnitude of temperature, and C and N inputs greatly impact the magnitude and sign of model response to climate change. We incorporate a trait-based, microbial-mineral, SOM model into the vertically-resolved Community Land Model (CLM4.5) of the Community Earth System Model (CESM) and present simulated current and future global C stocks that result from including seasonal forcing. We explicitly represent microbial diversity and physiology in our SOM model, allowing microbes with distinct temperature and C input optima to dominate decomposition at different times of the year when forced with seasonal temperature and C inputs from CLM4.5. We show that this temporal variability plays an important role in the diverse responses attained at sites with similar mean annual temperatures, but very different seasonality. The results of our vertically-resolved model also show that surface and deep soils' distinct diurnal and seasonal temperature fluctuations greatly affect their respective C storage capacity and vulnerability to global warming. We compare our model to the conventional SOM model within the CESM and to global observations from the Harmonized World Soil Database, and discuss improvements in estimating global and regional C storage and their response to anthropogenic climate change.

P-1116-08

Spatial distribution of atmospheric variability of greenhouse gases measured at the IC3 climatic stations

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Changes in the atmospheric greenhouse gases (GHGs) content results as a combinationof natural and anthropogenic factors. Understanding the GHGs composition, theiratmospheric variability and its effect on climate change is necessary for mitigation andadaptation strategies. Indeed, GHGs variability is strongly related to the climaticconditions and closely dependent on the latitude.

In the framework of the ClimaDat project funded by Fundació Obra Social "la Caixa".researchers at the Catalan Institute of Climate Sciences (IC3) have established anetwork of eight climatic stations across Spain performing continuous high-precisionobservations of CH4, CO2, N2O concentrations together with meteorological variables.The climatic stations are located in protected and remote areas within Spanish NaturalParks with middle latitudes ranging between 33N and 41N (Ebre River Delta, Xurès, Valderejo, Gredos, Grazalema, Segura, El Estrecho and El Hierro).

Analysis of the atmospheric variability of GHGs concentration is performed at eachstation of the ClimaDat network. The study of the influence of the atmosphericcirculation on GHGs observations is carried out by a source characterization of the airmasses and their pathways using experimental meteorological data, daily backtrajectories and cluster analysis. The observed GHGs concentrations at differentlatitudes and under different climatic conditions are analyzed and presented in thisstudy.

P-1116-09

Multidecadal variability of subsurface oxygenation off the Central Peruvian Coast since the nineteenth century

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Subsurface and benthic biogeochemical conditions over the upper Peruvian continental margin are characterized by oxygen deficiency in the bottom waters, strong fluxes of settling organic matter and reducing conditions in the surface sediments. Previous work has shown a multidecadal cooling trend in the surface waters off Central Peru, and an increase of export productivity, particularly since the 1960's to the present, suggesting an intensification of coastal upwelling. The present study aims to reconstruct the coeval variation of subsurface oxygenation and benthic paleo-redox conditions for the last two centuries, based on laminated sedimentary records of benthic foraminiferal assemblages and redox-sensitive metals (Mo, Re, etc.) in the upper margin off Callao (12°S) and Pisco (14°S). The period between the mid to the late nineteenth century, during which there was an enhanced ENSO activity and paleo-temperatures were higher, was characterized by the occurrence of massive diatom-rich sedimentation events and development of bottom anoxia. Afterwards, decadal variations marked the changes of the proxy records since the late nineteenth century to the mid-twentieth century. Finally for the late twentieth century until the early 2000's, redox-sensitive metal records and benthic foraminiferal assemblages exhibited a trend towards less reducing conditions. This period also featured an increase of organic matter sedimentation and a declining trend of siliceous sedimentation. Our findings suggest that pelagic-benthic fluxes, vertical mixing and/or subsurface ventilation are important factors that modulate the subsurface oxygenation and benthic redox conditions in the Peruvian upwelling system.

P-1116-10

Contribution of Carbon, Nitrogen and Climate Interactions to Terrestrial Carbon Uptake

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There is compelling evidence showing that terrestrial biosphere has acted as a net carbon (C) sink in recent decades. However there is a large uncertainty regarding the magnitude and location of the C sink, predominantly due to large uncertainties associated with C emissions from land use change and our limited understanding of processes affecting plant C sequestration, such as CO2 fertilization effect, impact of changing climate conditions on plant and soil respirations and the interaction of N dynamics with carbon and climate change. This presentation focuses on understanding and assessing the interactions between the C cycle, N cycle and climate and how they might impact terrestrial C sources and sinks in the context of changing global environment (particularly, increasing atmospheric CO2 concentrations ([CO2]), climate change, N deposition and land use change) by using a global terrestrial C-N cycle model in the modeling framework of the Integrated Science Assessment Model (ISAM). The ISAM model to be used here has been calibrated based on in situ data (Ameriflux and LBA field campaign). The model is also evaluated with two sets of global GPP data, MODIS and FLUXNETMTE. Analysis on the results of this study suggests that responses of available N in terrestrial ecosystems to global environmental changes might have not significantly affected the net global amount of terrestrial C uptake over the last three decades, but these N responses have a strong influence on the spatial and temporal distribution of predicted C sequestration as are the influences of global environmental changes.

P-1116-11

Are soil organic carbon and its decomposers sensitive to a temperature increase? New insights from long term bare fallows and consequences for the terrestrial carbon biogeochemical cycle

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The IPCC projects a temperature increase of 0.3-4.8°C at the global scale by the year 2100 as well as longer and more frequent extreme events such as heat waves (IPCC, 2014). The impact of a temperature increase and of extreme events on the dynamics of stable soil organic carbon (SOC) and its decomposers remains a major source of uncertainty in predicting future changes in atmospheric CO2 levels.

Long-term bare fallow experiments in which plants and organic amendments were excluded for at least 25 years represent a unique research platform to examine this issue as with increasing duration of the treatment, the proportion of stable SOC increases. This study employs soils from four experiments situated at Askov (Denmark), Ultuna (Sweden) and Grignon and Versailles (France). We used archived soils sampled at the start of the experiments and after 25, 49, 53 and 79 years of bare fallow, respectively, when the soils had become enriched in stable SOC. The samples were incubated at constant soil moisture and at four different temperatures (4, 12, 20 and 35 °C). The evolution of total CO2 and of 13CO2 from the incubated soils was monitored for more than one year. At the end of the incubation, SOC decomposers were determined thanks to next generation sequencing techniques.

The results indicated a higher temperature sensitivity of SOC in soils enriched in stable carbon. However, we observed no relationship between the duration of the bare-fallow treatment and the temperature sensitivity of SOC. Interestingly, the quality (as determined by 13CO2) of the mineralized SOC depended on the incubation temperature. Our results provided strong evidence for a general relationship between temperature sensitivity and SOC stability upon which significant improvements in predictive models could be based.

This study also showed that soil microbial richness and equitability were both enhanced in organic resource depleted soils. We observed a shift from copiotrophic to oligotrophic microorganisms, indicating a radical change of ecological niches with carbon depletion and temperature increase. Surprisingly, the more diverse soil microbial communities linked to stable soil organic carbon were more sensitive to a temperature increase than less diverse communities linked to more labile organic carbon compounds. It provided evidence that biodiversity is not the only factor of functional stability and that functional stability might be a combination of biotic and abiotic soil characteristics.

P-1116-12

Seasonal and inter-annual variability in wetland methane emissions simulated by CLM4Me□ and CAM-Chem and comparisons to observations of concentrations

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Understanding the temporal and spatial variation of

wetland methane emissions is essential to the estimation of the global methane budget. We examine the seasonal and inter-annual variability in wetland methane emissions simulated in the Community Land Model (CLM4Me¢). Methane emissions from both the Carbon-Nitrogen (CN, i.e. CLM4.0) and the Biogeochemistry (BGC, i.e. CLM4.5) versions of the CLM are evaluated. We further conduct simulations of the transport and removal of methane using the Community Atmosphere Model (CAM-chem) model using CLM4Me¢ methane emissions from both CN and BGC along with other methane sources and compare model simulated atmospheric methane concentration with observations. In addition, we simulate the atmospheric concentrations based on the TransCom wetland and rice paddy emissions from a different terrestrial ecosystem model VISIT. Our analysis suggests CN wetland methane emissions are higher in tropics and lower in high latitudes than BGC. In CN, methane emissions decrease from 1993 to 2004 while this trend does not appear in the BGC version. In the CN versions, methane emission variations follow satellite-derived inundation wetlands closely. However, they are dissimilar in BGC due to its different carbon cycle. CAM-chem model simulations with CLM4Me¢ methane emissions suggest that both prescribed anthropogenic and predicted wetlands methane emissions contribute substantially to seasonal and inter-annual variability in atmospheric methane concentration. It also suggests that different spatial patterns of wetland emissions can have significant impacts on N-S atmospheric CH4 concentration gradients and growth rates. This study suggests that large uncertainties still exist in terms of spatial patterns and magnitude of global wetland methane budgets, and that substantial uncertainty comes from the carbon model underlying the methane flux modules.

P-1116-13

Effects of multiple global environmental changes and fire on soil greenhouse gas emissions: feedbacks to climate change

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Global environmental changes are expected to alter ecosystem carbon and nitrogen cycling, but the combined effects of multiple simultaneous environmental changes are poorly understood. Furthermore, little is known about the combined effects of chronic global environmental changes and ecological disturbances on ecosystem functioning. In particular, these combined effects on soil emissions of greenhouse gases might be critical as they could accelerate climate change.

We assessed the responses of soil nitrous oxide (N2O) production, an important greenhouse gas, to elevated CO2, warming, increased precipitation, and enhanced nitrogen deposition, as well as their interactions, in an annual grassland as part of the Jasper Ridge Global Change Experiment (CA, USA). In addition, we took advantage of an accidental, low-severity wildfire that burned part of this long-term global change experiment to investigate the interactive effects of a fire disturbance and chronic global environmental changes on soil N2O emissions. We examined the responses of soil N2O emissions, as well as the responses of the two main microbial processes contributing to soil N2O production - nitrification and denitrification - and of their main drivers.

We found that elevated precipitation increased soil N2O emissions, especially in combination with added nitrogen and warming. Furthermore, we show that the fire disturbance greatly increased soil N2O emissions over a three-year period, and that elevated CO2 and enhanced nitrogen supply amplified fire effects on soil N2O emissions: emissions increased by a factor of two with fire alone and by a factor of six under the combined influence of fire, elevated CO2 and nitrogen. We then provide evidence that these responses were caused by increased microbial denitrification, resulting from increased soil moisture and soil carbon and nitrogen availability.

Our results indicate that the combined effects of multiple simultaneous environmental changes and fire can exceed their effects in isolation, thereby creating unexpected feedbacks to soil greenhouse gas emissions. In our data and across the literature, single-factor responses tended to overestimate interactive responses, except when global change was combined with disturbance by fire, in which case interactive effects were large. Thus, for chronic global environmental changes, higher order interactions dampened responses of N2O emissions to multiple global environmental changes, but interactions were strongly positive when global change was combined with disturbance.

These findings highlight the need to further explore the impacts of ecological disturbances on ecosystem functioning in the context of global change to see how much these combined impacts might play critical roles in shaping ecosystem processes that in turn feed back to climate change.

P-1116-14

Changing environmental controls affect the strength of the permafrost carbon feedback

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As the global climate warms the Arctic is experiencing rapid increases in temperature causing permafrost (perennially frozen ground) to thaw and thereby exposing large quantities of previously frozen organic matter to microbial decomposition. High latitude ecosystems store almost twice as much carbon in soils and permafrost than what is currently contained in the atmosphere. Warmer temperatures in the Arctic will not only increase carbon emissions from previously frozen organic matter in the permafrost zone but also indirectly affect the carbon cycle through changes in regional and local hydrology. As permafrost degrades due to warming, soil drying will occur in upland ecosystems as a result of increased natural drainage as the water table moves further down. On the contrary, low lying areas can turn into anoxic environments as the topography and the underlying permafrost layer prevent runoff. These changes in soil surface hydrology and oxygen availability in permafrost ecosystems have broad impacts on the amount and form (carbon dioxide or methane) of carbon release from newly thawed permafrost and have the potential to further increase the permafrost carbon feedback. In order to successfully include the permafrost carbon feedback into models relevant to IPCC reports it is important to provide data sets that serve as constraints for complex models assessing the carbon-climate feedback from high latitude soils.

We have compiled a database of 26 incubation studies with soils from active layer and permafrost from across the entire permafrost zone to quantify a) the effect size of

increasing temperatures and b) the changes from aerobic to anaerobic environmental soil conditions on carbon release from permafrost. Results from two different meta-analyses show that a 10°C increase in temperature increased carbon release by a factor of two in the three most important permafrost ecosystems (boreal forest, peatland and tundra). Under aerobic incubation conditions, soils released on average 3.4 times more carbon than under anaerobic conditions which was consistent for all three ecosystems as well as for soils with different organic carbon concentrations. While the lack of oxygen in anaerobic incubations reduced the amount of total carbon release it increased the amount of the more potent greenhouse gas methane. Even if accounting for the higher global warming potential of methane one unit of soil released more than twice as much carbon under aerobic incubation conditions than under anaerobic conditions.

This pan-arctic synthesis shows that carbon release from newly thawed organic matter in high latitude ecosystems is highly affected by increasing temperatures but that changes in soil moisture and oxygen availability have an even larger impact on carbon release. The permafrost carbon feedback is stronger in an aerobic environment as the faster decomposition offsets the higher heat trapping capacity of methane occurring under anaerobic conditions over a 100-year timescale.

P-1116-15

Topography and geochemistry influence methane response to permafrost thaw

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Arctic wetlands are currently net sources of atmospheric CH4. CH4 emissions in Arctic tundra vary widely in space and time, with proximate controls—substrate availability, competition for substrate among decomposition processes, CH4 oxidation, and CH4 transport—dependent on local climate, soil, hydrology, and biology. These complex controls and high spatial and temporal variability make it difficult to characterize current CH4 processes and predict their responses to climate change. We investigated these processes in Arctic polygon tundra, across a permafrost thaw gradient from low-centered (intact) polygons to flat- and high-centered (degraded) polygons. We asked: (1) how do CH4 production and consumption vary with permafrost thaw and microtopographic feature, and (2) how do subsurface CH4 processes relate to surface CH4 and CO2 fluxes? We made measurements in 3 microtopographic features (polygon centers, rims, and troughs) across the permafrost thaw gradient. Measurements included surface CH4 and CO2 fluxes, concentrations and stable isotope compositions of CH4 and DIC at 3 depths in the soil profile, and soil moisture and temperature. We found clear patterns in CH4 processes with permafrost degradation, as well as polygon feature and month. More degraded sites had lower CH4 emissions, a different primary methanogenic pathway, and greater CH4 oxidation than intact permafrost sites, to a greater degree than soil moisture or temperature could explain. Surface CH4 flux decreased from 190 nmol m-2 s-1 in intact polygons to 9 nmol m-2 s-1 in degraded polygons. Stable isotope signatures of CH4 and DIC showed that acetate cleavage dominated CH4 production in low-centered polygons, while CO2 reduction was the primary pathway in degraded polygons. We see evidence that distinct patterns of water flow and geochemistry between intact and degraded polygons contribute to these observations, through transport of redox-active species among high-centered polygon features. These findings suggest that future Arctic tundra CH4 emissions will depend not only on profile-scale changes in soil moisture and inundation, but also on the effect of warming on larger-scale geomorphic, geochemical, and hydrologic factors. Wetland drainage due to ice wedge degradation may reduce CH4 emissions across the landscape, even in inundated inter-polygon troughs.

P-1116-16

Feedbacks between climate change and the terrestrial biosphere

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Land ecosystems are absorbing ~25% of anthropogenic CO2 emissions but emit a range of other greenhouse-gases and indirectly regulate their concentrations in the atmosphere through the emission of chemically active compounds. Terrestrial greenhouse-gas emission rates and the energy exchange between the land surface and the atmosphere are sensitive to climate and atmospheric CO2 and thus represent a feedback to anthropogenic climate change. Recent research using coupled Earth System Models has demonstrated that land-based feedbacks may amplify climate change through positive feedbacks that have previously not been accounted for. Here, we present a comprehensive compilation of feedback strength estimates from individual land-mediated forcing agents (CO2, CH4, N2O, albedo, etc.) and their interactions based on observational data and Earth system modeling. Today, the dominant negative feedback arising from the CO2-stimulated land C sink compensates smaller positive feedbacks from non-CO2 forcing agents. Under a future business-as-usual scenario, these positive feedbacks exert an increasingly strong additional warming. Anthropogenic land use change and inputs of reactive nitrogen by atmospheric deposition and fertilizers act to further shift the balance of feedbacks towards more positive values. This may be mitigated by protection of forest ecosystems and a more efficient use of mineral fertilizers in agriculture.

P-1116-17

Modeling high-Arctic permafrost thawing impact on greenhouse gas exchange in Northeast Greenland

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Frozen organic carbon stored in northern permafrost soils may become vulnerable due to the rapid warming of the Arctic. The loss of carbon through the emissions of CO2 and CH4 may imply a critical warming potential, resulting in positive feedbacks to global climate change. However, positive and negative feedback dynamics associated with thawing permafrost and ecosystem biogeochemistry on a landscape scale is still unclear. Here, we combine two contrasting modeling techniques to model the high-Arctic ecosystems in Northeast Greenland. Firstly, the Coup (Coupled Heat and Mass Transfer Model for soil-plant-atmosphere system) model is validated with three years' measurements of active layer depth and soil carbon content. Secondly, to account for the transient impacts of climate change to potential vegetation dynamics, we employ the leaf area index, projective cover fraction and climatic forcing produced by a regional Earth system model (RCA-GUESS), which simulates climate as well as vegetation dynamics, as the driving data to the Coup model to project future active layer depth and greenhouse gas exchange. Comparing to the Coup model driven with static vegetation properties of the validation period, we are able to quantify the effects of vegetation dynamics on the magnitude and timing of active layer depth, and ecosystem greenhouse gas exchange in the high-Arctic subject to the scenarios in different representative concentration pathways (RCP2.6, 4.5 and 8.5) as simulated with the regional Earth system model.

P-1116-18

Effects of nitrogen deposition on photosynthesis of an alpine meadow ecosystem in Eastern Qinghai-Tibetan Plateau

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Responses of leaf and canopy photosynthesis to global change play an important role in global carbon cycling. Due to human activities, especially the burning of fossil fuels, the extensive use of farmland ecosystem nitrogen and continuous development of animal husbandry, the nitrogen input level into ecosystem increases significantly. However, the effects of increasing atmospheric nitrogen deposition on leaf and canopy photosynthesis of grassland ecosystems in Qinghai–Tibetan Plateau are unclear. In this study, we measured leaf nitrogen content, photosynthesis, and leaf area index in an alpine meadow ecosystem in Eastern Qinghai–Tibetan Plateau, based on a multi–form N addition experiment. Maximum rates of carboxylation (Vcmax) and electron transport (Jmax) were calculated from A–Ci curves measured with an LI–6400 portable photosynthesis system. The results showed that leaf nitrogen content in Stipa aliena growing with a high–level nitrogen input (40 kg N ha−1 yr−1) increased by 6.2% and 9.7 % in 2012 and 2013. Vcmax and Jmax at 25oC increased by 46.5% and 39.8% in 2012, 37.9% and 25.4% in 2013, respectively. Meanwhile, leaf area index of the alpine meadow ecosystem also had an increase of 45.0% in 2012 and 21.9% in 2013. Positive effects of nitrogen addition on leaf nitrogen content, leaf photosynthetic capacity, and canopy leaf area undoubtedly resulted in an increase in gross primary production of the alpine meadow ecosystem.

P-1116-19

Carbon Cycle Response to Artificial Atmospheric Carbon Dioxide Removal

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Artificial removal of carbon dioxide from the atmosphere (CDR) is increasingly discussed as a complementary approach to CO2 emission reductions, particularly in the context of stringent climate targets. The efficiency of CDR is determined by the interplay between the natural carbon sinks on land and in the ocean and atmospheric CO2 levels. Only a few studies have explored the response of the global carbon cycle to CDR. Here, we use an Earth System model of intermediate complexity – the University of Victoria Earth System Climate Model (UVic ESCM) – to explore the response of the carbon cycle to atmospheric CO2 removal under a range of idealized scenarios, which differ in the total amount and rate of negative emissions, and the initial state of the system. We perform two sets of model simulations: one where a drop in atmospheric CO2 to a target level and maintenance at that level is prescribed (P), and one where an equivalent amount of negative CO2 emissions is prescribed over a given period of time, with atmospheric CO2 left to evolve freely thereafter (E).

Results indicate that for both simulation sets, CO2 outgasses from the terrestrial biosphere and the ocean during the atmospheric CO2 removal phase. The amount of outgassing is sensitive to the experimental setup (P versus E simulations) and the rate and amount of CO2 removal. For P simulations we find that the lower the target atmospheric CO2 level, the larger the outgassing from natural sinks, and the larger the negative emissions required to maintain the target level. The efficiency of CDR – defined for P simulations as the cumulative negative emissions required to achieve a unit decrease in atmospheric CO2 – is independent of the rate of removal in the long–term, but increases significantly for scenarios with larger amounts of CDR.

1117 - Understanding decadal variations in the climate system and implications for the future

ORAL PRESENTATIONS

K-1117-01

Global and regional climate variability: a pause for thought

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Our experience of how climate changes depends on the interaction between externally driven changes, such as those due to greenhouse gases, aerosols and volcanic eruptions, and internal climate variations, both globally and locally. The recent slowdown in global temperature rise has dramatically highlighted these interactions and challenged the climate community to understand, explain and communicate the complex issues involved.

This talk will focus on some of the history of our understanding of climate variability, the links between changes in global temperature and regional climate, and the limits on the precision with which we can make climate projections. The concept of 'climate emergence' will also be discussed as a useful framework to help understand the role of climate variability and to help communicate the many plausible possibilities for how regional climate may change over the coming decades.

K-1117-02

Past and future European climate trends: uncertainty due to internal variability

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This talk will highlight the relative importance of internally generated versus externally forced climate trends over the past and next fifty years at local and regional scales over Europe. The assessment is based on a large ensemble of climate simulations performed with the CESM1 NCAR model that cover the 1920–2100 period. The ensemble contains a large number of integrations (30), each of which is subject to identical natural and anthropogenic radiative forcing but initialized from a slightly different atmospheric state. The large ensemble shows that natural climate variability superimposed upon forced climate change results in a large range of possible trends for surface air temperature and precipitation over the past and next fifty years. A variant of the flow–analogue approach is used to partition the temperature and precipitation changes due to internal variability into dynamical and thermodynamical components. Internal thermodynamical changes are shown to be more important in summer while dynamical ones are the dominant contributors in winter. Removing the unpredictable dynamical contribution results in a significant increase of the signal to noise ratio, particularly in winter. The thermodynamical changes are shown to be linked with the ocean, sea–ice and land surface conditions. While large ensembles are needed to fully characterize the forced response at global and regional scales, they also provide a robust estimation of the uncertainties due to internal variability that is needed to better characterize model structural differences. This is important for a wide range of stakeholders as the partial masking of human–induced climate change by internal multidecadal variability is an important consideration for policy and planning efforts.

O-1117-01

The Pacific decadal oscillation, revisited

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Since its identification in the late 1990's as the dominant pattern of North Pacific sea surface temperature (SST) variability, the Pacific decadal oscillation (PDO) has been connected both to other parts of the climate system and to impacts on natural resources and marine and terrestrial ecosystems. Variability associated with the PDO has often been confused iwth externally forced climate change including anthropogenic effects. Subsequent research, however, has found that the PDO is not a single physical mode of climate variability but instead largely represents the combination of three groups of processes: (1) changes in ocean surface heat fluxes and Ekman (wind-driven) transport related to the Aleutian low, due to both local, rapidly decorrelating, unpredictable weather "noise" and to remote forcing from interannual to decadal tropical variability (largely El Nino) via the "atmospheric bridge"; (2) ocean memory, or processes determining oceanic thermal inertia including "re-emergence" and oceanic Rossby waves, that act to integrate this forcing and thus generate added PDO variability on decadal time scales; and (3) decadal changes in the Kuroshio-Oyashio current system forced by the multi-year history of basin-wide Ekman pumping, manifested as SST anomalies along the subarctic front at about 40°N in the western Pacific ocean. Thus, the PDO represents the effects of different processes operating on different timescales, with few of its apparent impacts due to extratropical SST anomalies. This talk presents a synthesis of this current view of the PDO, and discusses corresponding implications for climate diagnosis, including of PDO climate impacts and predictability (both oceanographic and atmospheric); potential decadal «regime»-like behavior; simulations of the PDO in climate models; the interpretation of paleoclimate multicentennial reconstructions of the PDO; and its impacts on marine ecosystems. We conclude with some suggested "best practices" for future PDO diagnosis and forecasts including investigating the potential role of the PDO in the global temperature hiatus.

O-1117-02

Importance of Atlantic decadal variability for near-term assessment and predictability of western Amazon dry-season dry and wet events

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The drought of 2005 was a "1 in 100 years" event in western Amazon resulting in fire damage to over 300,000 hectares of rainforest in the Brazilian state of Acre and 22,000 hectares in the province of Coronel Portillo in Peru. In 2010 another severe drought resulted in the isolation of entire communities as the Negro River, a major northwestern Amazon tributary, registered its lowest water lever in over 100 years. The Amazon ecosystem is sensitive to repeated occurrence of droughts, which interferes with the forest's natural ability to recover from stress and undermine climate change mitigation efforts to reduce CO2 emissions from deforestation and forest degradation. Whether this apparent increase in drought severity and frequency is related to natural low-frequency modes of climate variability, to anthropogenic influence on climate, or to a combination of both is explored here.

A modest negative trend in dry-season precipitation is observed in western Amazon over the period 1935-2012, which along with a multi-decadal pattern of reduced moisture transport from the tropical Atlantic worked to enhance the severity of the recent droughts. Most of the western Amazon dry-season precipitation decadal variability is attributable to decadal fluctuations of the north-south gradient (NSG) in Atlantic sea surface temperature (SST). The observed western Amazon and NSG decadal co-variability is well reproduced in Global Climate Models (GCMs) pre-industrial control (PIC) and historical (HIST) experiments that were part of the Intergovernmental Panel on Climate Change fifth assessment report (IPCC-AR5). This suggests that unforced or natural climate variability, characteristic of the PIC simulations, determines the nature of this coupling, as the results from HIST simulations (forced with greenhouse gases (GHG) and natural and anthropogenic aerosols) are comparable in magnitude and spatial distribution. Decadal fluctuation in the NSG also determines shifts in the probability of repeated dry and wet events in western Amazon, as there is a 66% chance of 3 or more years of dry events per decade when NSG>0 compared to 19% when NSG<0. The HIST and PIC model simulations also reproduce the observed shifts in probability distribution of dry and wet events as a function of the NSG decadal phase, suggesting there is great potential for decadal predictability based on GCMs. Persistence of the current NSG positive phase may lead to continuing above normal frequencies of western Amazon dry-season droughts.

O-1117-03

Stochastic low-frequency variability in the eddying ocean: mid-latitude imprints, possible atmospheric impacts

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Laminar Ocean General Circulation Models (2° to 1° resolution) used in recent climate projections are being progressively replaced by turbulent ocean models (about 1/4° resolution) in the perspective of the next CMIP exercise. Atmospherically-forced ocean experiments show that this resolution increase improves the physical consistency of simulations, but also allows the ocean to spontaneously generate a substantial variability up to interannual-to-multidecadal timescales. Consistently with idealized studies, this low-frequency intrinsic variability (LFIV) is negligeable when mesoscale oceanic eddies are not explicitly resolved, and spontaneously emerges in the turbulent regime.

This non-linearly driven oceanic LFIV has a stochastic character, and a marked signature on the upper ocean temperatures in mid-latitude regions where air-sea fluxes are maximum in Nature. Seasonally-driven global eddying ocean simulations exhibit the strong, large-scale imprints of this stochastic LFIV on several climate-relevant oceanic indices: sea-surface height (SSH) and temperature (SST) in western boundary current systems and the Antarctic Circumpolar Current, Meridional Overturning Circulation (AMOC) throughout the Atlantic Ocean, etc.

How these low-frequency intrinsic variability modes are impacted, and may or not be paced, by the interannually-varying atmosphere is an important question about climate uncertainty. The ongoing OCCIPUT project aims at investigating these questions probabilistically through a 50-member ensemble of 1/4° global ocean/sea-ice 57-year hindcasts, driven by the same 1958-present atmospheric forcing. Present results demonstrate that initial state perturbations spontaneously grow, cascade toward long space and time scales and non-linearly saturate. The resulting ensemble spread describes the atmospherically-paced stochastic LFIV (uncertainty), with marked imprints on oceanic variables at large space and time scales both at the surface (SST, SSH) and below (AMOC, mode/intermediate/deep water mass properties and depths, etc).

This ensemble experiment will provide the first probabilistic description of the global ocean state and evolution over the last decades, and a measure of the actual constraint exerted by the atmosphere on low-frequency ocean variability. The imprint of this stochastic LFIV on the upper-ocean thermal fields and AMOC will then provide insights into how this eddy-driven low-frequency oceanic "noise" might ultimately impact the atmosphere and climate predictability in future coupled climate projections.

O-1117-04

Contribution of sulfate anthropogenic aerosols to the Euro-Mediterranean climate trends since 1980 using a regional coupled modelling approach

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Since the 1980s, sulfur emissions have considerably been reduced in industrialized countries, notably in Europe, thus leading to a decrease of sulfate aerosol concentration over the Euro-Mediterranean region. Meanwhile, an increase of incoming solar radiation reaching the surface, known as the brightening effect, has been observed over the same period but global and regional climate models still have trouble in reproducing the all-sky surface solar radiation trends and their consequences on climate.

In order to investigate the consequences of this aerosol trend on regional climate and its role in the observed changes during the last three decades, the present study introduces an original approach, through the use of a fully coupled regional climate system model (CNRM-RCSM). The latter includes the different components of the regional climate system, namely the atmosphere (with ALADIN-Climate), the ocean (with NEMOMED8), the land surface (with ISBA) and the rivers (with TRIP). This approach enables us to take into account the high-frequency feedback of the sea surface temperature (SST) on the atmosphere, as well as the river-ocean-atmosphere feedback. Aerosols are included in ALADIN-Climate through monthly interannual climatologies, coming from a combination of satellite-derived and model-simulated products, and considered as the best possible relevant estimation of the atmospheric aerosol content for the five most relevant species (sea salt, desert dust, sulfates, black and organic carbon aerosols). Simulations using the lateral boundary forcing of the ERA-INTERIM reanalysis have been carried out over the period 1980-2012 with and without the trend in sulfate aerosols.The scattering of the incoming solar radiation by sulfate aerosols leads to important changes in the Euro-Mediterranean climate. Comparisons between both simulations and homogenized surface observations reveal that our model is able to reproduce the all-sky surface shortwave radiation trends only when the aerosol trend is included. This improvement is particularly visible in regions where aerosols have been strongly reduced (i.e., Central Europe, Po Valley). Aerosol changes explain 81 ± 16 per cent of the simulated brightening over the 1980-2012 period, while the direct effect has been found to be the main cause of the simulated brightening.

As a result of this brightening effect, when including the aerosol decrease, the surface temperature trend is higher and closer to homogenized surface observations, indicating that aerosols explain 23 ± 5 per cent of the observed warming between 1980 and 2012. The use of an atmosphere-ocean coupled model enables us to show that Mediterranean sea surface temperature changes are also better reproduced using the aerosol trend. Air-sea fluxes have consequently been modified by this evolution in the sulfate aerosol content, as well as river flow.

Overall, our results demonstrate the importance of changes in aerosol loads for the understanding of regional climate variability.

O-1117-05

Volcanic Forcing: new initiatives to establish its impacts on climates of the Southern Hemisphere

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In the northern hemisphere (NH), 1816 is well known as 'the year without a summer'. But what happened in the southern hemisphere (SH) in 1816, or for that matter following other major tropical or SH volcanic eruptions? Whilst recent work has taken on an increasingly global focus on volcanic forcing as a driving mechanism influencing climate, the emphasis has largely been on the NH where most of the world's landmass and people have been impacted by large scale volcanic eruptions. To this end, the SH continues to remain in the shadows; hence our initiative to investigate: a) past impacts of major volcanic eruptions on SH climate and environment/society, and b) to model the climatic impacts of such eruptions on specific SH landmasses such as southern Africa, South America, Australia and New Zealand.

Several numerically based studies and experiments have confirmed global mean temperature declines during years immediately following major volcanic eruptions, and in particular, this correlation seems to be driven by considerably cooler than normal summers which more than compensate for warm winter anomalies over the NH (e.g. Briffa et al., 1998; Fischer et al., 2007; Miller et al., 2012). Such work has additionally been supported with longer-term tree ring density and frost ring data for North America and Europe, demonstrating a clear environmental response and signature to such events (e.g. D'Arrigo and Jacoby, 1999; Breitenmoser et al., 2012). Recent modeling approaches have demonstrated the association between high northern latitude volcanic eruptions and the dispersion of aerosols, which remain mostly confined north of 30°N (Oman et al., 2006), and the connection to Arctic/sub-Arctic ice growth development and consequent sea-ice/ocean feedbacks causing hemispheric cooling (Miller et al., 2012). Thus, much is known and much has been learnt from volcanic forcing events on NH climates and environments, but to what extent are these patterns mirrored in the SH?

Given the scarcity of SH instrumental records covering the Tambora and other major historical period volcanic events, little is known about their impact in southerly latitudes. Here we triangulate evidence from a variety of proxies including historical documentary sources, and tree ring and speleothem data, to demonstrate that major tropical or SH volcanic eruptions are usually followed by extreme climate events across much of the SH. For instance, in southern Africa, such events may be followed by exceptionally hot summers and severe winters (with unusually early and/or late frosts and heavy snowfall events) (Grab and Nash, 2010). Whilst this temporally mirrors austral winters and summers in the NH (which are warmer and cooler respectively), the cooling anomalies are seasonally reversed between the hemispheres. In addition, data thus far suggest that one to two years following such a major eruption has [have] a very high probability of experiencing very wet [floods] or very dry [drought] conditions, but that the relationship is not linear owing to other climate drivers such as ENSO cycles. This work is ongoing and seeks further evidence to substantiate these new findings.

Finally, we present our current and future aims to model the climatic impacts (all major climate parameters) of major volcanic eruptions across various spatial and temporal scales in the SH using the Variable-Resolution Earth System Model (VRESM) and its atmospheric component the Conformal Cubic Atmospheric Model (CCAM) (see Engelbrecht et al., 2011). The models will be integrated to simulate volcanic events ranging in size from Toba to Pinatubo (or smaller), and will test the associations between geographic location (longitude/latitude) and event magnitude to establish spatial, temporal and type/magnitude of climatic impacts in the SH.

P-1117-01

Calibration and Validation of Summer Monsoon Rainfall over Bangladesh Using PRECIS Model

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A regional climate model named PRECIS is employed in generating rainfall scenarios for SAARC region. PRECIS generated rainfall scenario is calibrated with ground-based observed rainfall during 1961-1990 in Bangladesh. Through calibration regression coefficients such as slope and constant are obtained at 27 observational sites over Bangladesh. The regression coefficients are utilized in validation of PRECIS generated rainfall during 2000 to 2006. Better performance of PRECIS through validation encourages employing it in rainfall forecasting for Bangladesh. In this work rainfall forecast for Bangladesh is performed experimentally for 2009. The monsoon rainfall is projected surplus 0.29 mm/day or 2.03% in 2009 and it will be surplus 0.44 mm/day or 14.02% in post-monsoon. It will deficit 0.11 mm/day (2.08%) and 0.01 mm/day (1.44%) in pre-monsoon and dry season respectively. Through the analysis of monsoon rainfall in Bangladesh this work discloses that PRECIS simulated rainfall is not directly useful in application purposes. Without calibration with ground-truth data model outputs are very risky in providing long-term rainfall prediction. However, after performing calibration excellent result is obtained in estimating rainfall in Bangladesh with R2 is 0.94 and correlation is 0.97. The encouraging results of this work can be taken as the starting point of SMRC to do more realistic research on long-term rainfall forecasting. The monsoon rainfall forecasting approach using down scaling of regional climate model outputs is very new in Bangladesh and also in SMRC. This persuades result suggests extending the work for other SAARC countries in a consecutive research project. Model run with other ensembles and with high horizontal resolution are also under consideration with the improvement of computational facilities in the Centre. After completion of the calibration and validation of PRECIS for SAARC region, the projected rainfall is supposed to be posted through SMRC website (www.saarc-smrc.org) which is now available only for Bangladesh. Completion of such type of job is really necessary for SAARC region where SMRC can play important role as a regional meteorological research centre.

P-1117-02

Crops response to climate variability and societal implications on rural dwellers of Nigeria

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This study examines impacts of climate variability on the yield of eight major crops in the guinea ecological of Nigeria, using both quantitative and qualitative methods. The Guinea ecological zone represents a rich agricultural area for Nigeria, sometime call "the food basket zone of the country". Several studies have been show that variability of rainfall has significant implication not only on the differences in the types of crops cultivated but also the rate of yield of such crops. Majority of these studies were based on assessment of two to four crops. Thus, the present study apply GIS techniques to examine the climate variability and its implications on the eight crops (Cassava, yam, Maize, sorghum, Groundnut, Cowpea, Cocoyam and Melon), majorly cultivated in the area. Rainfall, temperature and the crops yield dataset from 1982 to 2012 were used in the analysis. A year is divided into two growing seasons. These seasons are: early growing season (April-June) and late growing season (July- October) with regard to seasonal differences and the crops yields. The results show that during the past decades the yields of these crops were associated with climate variability, which vary differently in the year with high rainfall than the year with low rainfall. The study found out that the crops yield have been dominated by reduction in the number of rain days during the middle of the rainy season and there is evidence of a significant change in the crop yield as climate varied. The study concluded by recommending the need to encourage rain fed agriculture and agricultural research to improve crop yields.

P-1117-03

Diatoms evidence for past two centuries major changes in seasonal sea surface conditions prior the instrumental period in the southern Gulf of California

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Studies on laminated marine sediments have enabled to exploit annual to subseasonal information of oceanic and climatic conditions of the past, and particularly in the Gulf of California where there are excellent laminated records, underlying anoxic basins. These studies, however, are based on resin-embedded thin sections and present only qualitative snapshots of the past environments. Any of them have compared high resolution records with instrumental data, in order to reconstruct the environmental conditions and document the variability on interannual to decadal timescales beyond the instrumental period.

Here, we describe environmental conditions in the eastern part of Carmen Basin in the southern Gulf of California, over the past two centuries using diatom census counts in the DIPALV-C33 marine sediment box core. Diatom census counts show progressive changes since AD 1850, marked by persistent warm stratified and nutrient limited water conditions on the Gulf eastern sector. In parallel, inferred environmental conditions provide evidence for reduced seasonal upwelling during the last century and limiting primary productivity, concurrent with increase of storm/hurricane frequency. We propose that these multi-decadal sea surface variations are mainly governed by synoptic and regional wind fields in relation to the position and intensity of the atmospheric low and high-pressure trough around the Gulf of California. However, both ENSO and PDO variability patterns in the last century cannot explain the regional trend observed in this study, probably due to the effect of local processes on the response of our biological proxies.

P-1117-04

Mechanisms relating the MJO to intraseasonal variability of the surface climate in the Americas

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This study uses the NCEP's Climate Forecast System Reanalysis (CFSR) to revisit the dynamical mechanisms associated with the Madden-Julian Oscillation (MJO) that affect the surface climate over the Americas. During the boreal cold season, North America sees a notable eastward propagation in temperature anomalies through the MJO evolution. Despite the smaller land area, temperature effects in South America during the austral cold season appear clearer than in North America and more appropriately connected to MJO convection. This is especially true over subtropical portions of the continent. These structures are related to the MJO enhanced tropical convection that can induce anomalous upper-tropospheric cyclonic circulation on the leading edge of the MJO enhanced convection and anomalous anti-cyclonic circulations trailing the convection. During each hemisphere's winter season, and connected with these patterns, enhanced direct circulations favor changes in the subtropical and polar jet streams. Intra-seasonal changes in the divergent circulation in upper levels modulate the Rossby Wave Source centers around 30-45° latitude and the propagation of Rossby waves, as noted in the wave activity fluxes, into the extratropics inducing near-surface

temperature and precipitation anomalies.

During the corresponding summer seasons, the diagnostics show that precipitation patterns are more directly connected to the convection anomalies rather than the circulation anomalies. The Americas see enhanced precipitation in the monsoon regions when the large scale upper tropospheric divergence associated with the MJO convection passes over the western hemisphere. Similarly, suppressed precipitation in these regions is observed when the large scale upper tropospheric convergence passes over the continents.

P-1117-05

Climate Change Studies over Western-ghat Region using Remote Sensing & GIS Modelling

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Western ghat region is one of the major mountain system in the Indian sdunbcontinent, extending in the western part of Indian from Kerala in South till Maharastra in north and the total area is about 160,000 Sq. km. The western ghat is of important from different point of view starting from the flora and fauna to medicin al plant to the rich region of river systems and the orography is most important for its role in the Rainfall during Monsoon and other seasons. In the study the remote sensing data from different soiurces like MODIS, TRMM, IRS and the multi-source observations from reanalysis products like NCEP, ERA-40, JMA and the high resolution observations like IMD are being used to study the climate change and quantified in terms of the different climate parameters mainly temperature, rainfall, humidity etc. The IRS and Landsat data are being analtysed in the GIS Modelling frame work to see the signature in the Land Use and Land Cover Change detaection at high resolution over the mountain region. Finally the spatio-temporal analysis of the climate change are presented. Various algorithm and visualisation to understand the climate change over the mountain region are developed and presented in a very user friendly way which can be easily used by the users of different sectors for the better understanding of the climate change.

P-1117-06

Temperature impact on Non-Communicatble Diseases in Africa – a Blind Spot in Research

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The mean temperature in northwest rural Burkina Faso, in the Nouna Health and Demographic Surveillance System (HDSS) region, is projected to increase under different climate change scenarios by the end of the 21st Century[1]. The Nouna HDSS consists of approximately 100,000 people, and is one of several International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) sites that collect health and demographic data across populations in low-and-middle income countries. As life expectancy increases in Burkina Faso and people live for longer with chronic and degenerative diseases, non-communicable disease will play a greater role in contributing to the burden of disease. This study assesses the impact of 18 years of temperature exposure on non-communicable disease years of life lost, an indicator of premature mortality, in the Nouna HDSS population.

Preliminary analysis used all-cause mortality data from the Nouna HDSS, to conduct a survival analysis and calculate the outcome variable, years of life lost, for 12,769 deaths between 1993-2000. A time-series regression analysis using the generalized additive model, adjusted for time-trends and seasonality was used to study the impact of mean temperature on all-cause mortality. Results indicate that a 1°C increase in temperature was associated with a 1.024 relative risk increase (p value=0.029) in all-cause mortality per 1°C increase in mean temperature above 30°C (1 day lag). We will present an extended 18-year cause-specific time-series analysis on the impact of mean, maximum and minimum temperature on non-communicable disease years of life lost, including the lagged effects.

As life expectancy at the Nouna HDSS increases, the burden on non-communicable disease is likely to increase with higher temperatures. Targeted preventive measures are required to alleviate this burden.

[1] David M Hondula, Joacim Rocklöv, and Osman A Sankoh, "Past, Present, and Future Climate at Select INDEPTH Member Health and Demographic Surveillance Systems in Africa and Asia," Global Health Action 5, no. 0 (November 23, 2012), doi:10.3402/gha.v5i0.19083.

P-1117-07

Farmers' perceptions of climatic trend in Allada plateau in southern Benin

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Although several studies show an increase in agricultural production in West Africa in connection with the improvement in rainfall, farmers perceive otherwise. This study highlights the differences between farmers' perceptions of changes in precipitation and their impacts on agricultural production and scientific observations in the Guinea region where two rainy seasons coexist. For this purpose, it compared precipitation data (from 1951 to 2010) and potential yields of corn (from 1970 to 2010), simulated by SARRA-H model, to farmers' perceptions of changes in precipitation collected from 201 farm managers spread over 67 villages in Southern Benin. The study clearly shows that farmers do not make any distinctions between the long rainy season and short rainy season in terms of changes in rainfall and agronomic impacts. On the contrary, climate analysis results, and agronomic simulations reveal that the long rainy season and short one are not affected in the same way by atmospheric forcing. Consequently, these two rainy seasons have opposite agronomic trends. Since 1970, the long rainy season has a rainfall deficit coupled with a poor temporal distribution of rainfall and a shortening in its duration which led to a sharp drop in potential crop yields. Conversely, since the late 1980s, the short rainy season rainfall recorded a surge which causes a sharp increase in agricultural yields. This pessimistic perceptions of farmers on the evolution of rainfall in both rainy seasons influences their choice of management of the farming calendar of the short rainy season, worsening food insecurity in the study area.

P-1117-08

On the characteristics of climate change in Scandinavia and its association with the Northern Atlantic Oscillation (NAO) and sea ice

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We analyzed some characteristics of climate change over Scandinavia using CRU data (1901- 2012), and both temperature and precipitation exhibit well-documented positive trends. However, the spatial variability of the trends is large with some areas showing high significance (northern Norway and Sweden) and others none at all (central Finland). The scenarios simulated by NorESM and ECHAM6 models exhibit continued warming and increased rainfall in the 21st century over Scandinavia. Given the

well-known zero-lag relationships between the NAO and both temperature and precipitation, responses of sea ice to external forcing and its potential influence on the NAO are of interest. The summer sea ice, fall-early winter NAO relationship suggests that in a warming climate, and under continued decreasing sea ice conditions, the tendency will be towards more positive NAO conditions leading to a wetter, warmer Scandinavia and potentially drier conditions in central-southern Europe. Initial modeling experiments appear to support such speculation (e.g., Folland et al., 2009) but more research is needed.

P-1117-09

Dengue, Weather and Urbanization in Brazil

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Since two decades, the population affected by dengue disease is exponentially increasing and dengue is now affecting more than 100 million people in the world. It ranks behind malaria as the second most important vector-borne disease in the world and the first one in Latin America. Despite the important economic and social cost of the uncontrollable growth of the disease, little economic analysis has been devoted to it. In addition to weather, socio-economic factors such as urbanization and sanitary systems play an important role in the proliferationof dengue. In this paper, I measure the impact of weather and urbanization factors on dengue incidence in Brazilian states durin gthe 1992-2012 period, since Brazil is the most affected country in Latin America. I find a positive and statistically significant effect of different weather factors (temperature, vapour pressure, temperature anomalies) and urbanization factors (population density and urbanization rate). I find also statistically significant support for a negative impact of education and wealth on dengue proliferation.

P-1117-10

Evaluation of Climate Change Effects on the Growing Season in Butana Region and North Kordofan, Sudan

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This study applied remote sensing to evaluate the effects of climate changes on growing season in different agro-ecological zones, in North Kordofan and Butana region, Sudan, for the period 2001-2011. NDVI data were used for the NDVI time series and phenological analysis. Within the semidesert zone in Butana region, the trend for the starting date of the growing season was stable, while that for the end of the season indicated a shift to an earlier date, resulting in shorter growing season (av. 80 days). Minimum NDVI value was 0.13 in 2011 and maximum value was 0.16 in 2010, indicating an increasing trend. In North Kordofan, however, the average length of the growing season was 69 days and the minimum and maximum NDVI (production) value was 0.12 in 2011 and 0.32 in 2009, respectively, indicating a decreasing trend. Within the arid zone in Butana region, the trend for the end of the growing season indicated a shift towards a later date, resulting in more number of days (av. 81 days). Minimum and maximum NDVI (production) value was 0.27 in 2009 and 0.45 in 2003, respectively, indicating a decreasing trend. In North Kordofan, the shortest length of the season was 59 days in 2005 and the longest was 116 days in 2009, reflecting a considerable increase in the length of the growing season. The minimum and maximum NDVI value was 0.23 in 2011 and 0.39 in 2002, respectively, with an average of 0.31, indicating a decreasing trend. Within the semiarid zone in Butana region, the length of the growing season and the NDVI value showed a trend of increase, whereas in North Kordofan, they showed a decreasing trend.

P-1117-11

Climatic trend in Nepal Himalaya since early 17th century as reconstructed from the ring-width chronologies of multiple tree species

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Climate change in Nepal is more pronounced compared to other countries or regions. Centrally located in the Himalayan range, its average annual increase in temperature is 0.06 °C since late 1970s while the precipitation pattern is much erratic. Even within the country, the warming trend is double in the high mountains than that in its foothills or lowland Tarai conjoint to Gangetc plain. The future projection of the trend is deemed necessary; however, available meteorological data is too short for this purpose. Taking advantage of Nepal's rich tree diversity distributed in diverse topography of varied aspect and high elevation range, we carried out dendro-climatological study in 15 different sites of Nepal Himalaya from east to west that included eight protected areas of the high mountains. The objective of the study was to reconstruct the past climate of Nepal Himalaya. For the purpose, over 1400 tree core samples collected from major tree species, viz. Abies spectabilis, Abies pindrow, Betula utilis, Juniperus recurva, Larix grifithiana, Picea smithiana, Tsuga dumosa were analyzed following standard dendrochronological techniques. A positive correlation was observed among the chronologies of different species within and between different sites indicating some common climatic factors limiting the growth of these trees, and this gave us the basis for climate reconstruction.

Response function analysis revealed that pre-monsoon temperature (March-May) had an indirect relationship with growth of most of the species while such positive relation with precipitation of pre-monsoon to monsoon (March-July) depended also on the site condition. In some treeline sites, winter climate had significant influence for the growth in subsequent growing period of the some of these species. The seasonal correlation analysis with climate data for 1899-2012 revealed a significant indirect relationship between the ring width and spring temperature ($r = -0.56$) and positive correlation with spring precipitation ($r > 0.50$). The temporal stability of correlation model was tested by dividing the annual time series data into two equal halves as early and late period and found significant with correlation $r = -0.51$ and -0.62, respectively. The stability of the models led to the reconstruction of March-May average temperature for the past 373 years (AD 1640 to 2012).

We used a simple linear regression model for temperature reconstruction. The validation of the reconstruction model was assessed with validation statistics such as reduction of error (RE) and coefficient of efficiency (CE) using split sample procedure i.e., by dividing the calibration period into two equal sub-periods. The model was further validated through spatial correlation with gridded temperature data. This temperature reconstruction identified several periods of warming and cooling, however, it did not show the significant pattern of cooling during the Little Ice Age except few cold episodes. Similarly the reconstructed precipitation for 311 years (AD 1702-2013) showed several high events and low events of precipitation. High precipitation events were seen in AD 1721-1740, 1751-1765, 1819-1830, 1882-1888 and 1912-1922. On the other hand low precipitation event was in AD 1741-1720, 1741-1750, 1780-1788, 1800-1818 and 1922-1975.

The correlation of spring temperature with Sea Surface Temperature (SST) index of different region of the equatorial Pacific viz., NINO1.2, NINO3, NINO3.4 and NINO4 and extended multivariate ENSO Index (MEI) was carried out. It presented a significant negative correlations with monsoon and post monsoons seasons. These negative relationships suggest that warm (cool) spring season over the western Nepal Himalaya region are associated with cool (warm) SSTs in the following seasons. Furthermore spatial correlation of spring temperature with Sea Surface Temperature showed similar negative correlation in the equatorial belt of the Pacific Ocean. The relationship showed the climate of western Nepal has linkages with spatio-temporal climatic variability at a global scale.

P-1117-12

Temperature effects of the large volcanic eruption events during the past 100 years over China

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Based on the meteorological temperature data and the records of volcano events, the temporal and spatial temperature characteristics after the different types of large volcanoes which were classified by the geographic latitudes were identified in China five climatic regions, and the effects of the large volcanic events on regional temperature were analyzed. The results showed that there were significant differences between the temperature variation during winter years and the summer years after different large volcanic eruptions, northeast region was warmer in winter year after the large volcanic eruptions at the middle and high latitudes, other regions mainly appeared temperature decrease, northeast and northwest regions which were sensitive to climatic change was cooler. In addition, there was an obvious secondary cooling process during the summer year and in some regions during the winter year, the change of cooling even more obvious than the first cooling process. At the same time, the impact of large volcanic eruptions was different in five climate regions, regional temperature variation related to latitude after large volcanic eruptions at equatorial and high latitudes, but this variation related to longitude after volcanic eruptions at low and middle latitudes.

P-1117-13

A Study of Multi-decadal Global Sea Surface Temperature Variability Based on CMIP5 and Reanalysis Data

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The analysis of long-term changes in the distribution (mean, variance and extremes) of climate variables is essential for a full understanding of climate change and its impacts. The majority of climate change studies have focused on changes in the mean climate, therefore underestimating how changes in climate variability may impact biological and food systems. Observed and projected long-term changes in climate variability still lacks investigation.

Noticing this, we explore the patterns of sea surface temperature variability by looking at the observed sea surface temperature data record from 1854 to 2014. We investigate the global yearly and monthly sea surface temperature variability changes. For example, annual mean sea surface temperature and intra-annual variability (measured by the standard deviation and range). We also investigate the global and regional decadal changes in sea surface temperature variability, for example, using normalized probability density functions for different periods of anomalies in the data set.

In addition to the analysis of observational data, we assess how sea surface temperature variability may change in the future using model projections. We analyse the model projections by targeting the RCP8.5 (business-as-usual emission scenario) and the RCP4.5 (mitigation scenario) from the Coupled Model Intercomparison Project Phase 5 (CMIP5). This allows us to verify whether mitigation has an impact on projected changes in climate variability.

Comprehending the changes in climate variability is important for our society. Revealing the potential patterns of sea surface temperature variability can help us better understand the climate variability.

P-1117-14

Correlation between Polar motion and climate variables during 1962-2013

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Polar motion is a significant Earth orientation parameter, but our understanding of its relation to climate forcing remains highly uncertain. In this study, the relationships between the polar motion excitation and climate variatbles are examined. High correlations are found between the excitation and annual mean climate variables, such as air temperature, atmospheric pressure, zonal wind at various atmospheric pressure levels, especially at 1000 hPa level. High correlation coefficients between the excitation and climate variables are found for the regions of the Arctic, Antarctic and Indian Ocean, with the center values exceeding 0.72. Two abrupt changes in polar motion excitation time series are detected and the accompanied changes of climate variables are also studied. Since the polar motion can be accurately measured by satellite, the accurately determined polar motion can be used as an indicator for monitoring and understanding the global climate change.

P-1117-15

Climate change vulnerability of fishery-dependant coastal communities in Bangladesh

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Being situated in a deltaic geographic setting, Bangladesh is considered as one of the most climate-vulnerable countries on earth. The country frequently faces different climate change related events such cyclones, rising tidal floods, erosion and inundation, saline water intrusion which are further compounded by degraded natural resources base. In contrast to other climate vulnerable communities, very few research have conducted in Bangladesh on vulnerability of fishery-based livelihoods to climate change impacts. Based on a fieldwork with four fishing communities in Patuakhali region of south-west coastal Bangladesh, the present study assessed vulnerability of fishery-based livelihoods to climatic change and variability. Bottom - up research approach was adopted in the study and participants' information was collected through 70 individual interviews and 5 focus group discussions. The result revealed multi-faceted vulnerabilities across different scales that impinge on the livelihoods of already resources-poor fishers' community in coastal Bangladesh. In line with global evidences, the level of vulnerabilities differs among the communities and across households within a community. Being dependent on climate sensitive fisheries resources, fishers' vulnerability further depend on their level of exposure, and adaptive capacity. For instance, fishers' level of exposure varied depending on areas of their fishing. Fishers with limited asset base usually do fishing in rivers and estuaries thus less exposed to extreme events, however when disaster stuck in their living places they are more vulnerable due to limited adaptive capacity. The case is reverse in case of better off fishers. They go for sea fishing thus more exposed to extreme events; however has better adaptive capacity due to strong financial capabilities. In both cases, fishers reported an increase of climate change-induced extreme events such as storm surge, strong wind, higher wave and stronger current during fishing operation that often cause loss in physical capitals and subsequent financial hardship. Loss of fishers' lives is also common as a deadly consequence during fishing in sea. A number of internal and external factors regulate adaptive capacity of fishing communities in the study areas. Adaptive capacity of fishers often undermine by different internal factors such inappropriate fishing vessels, lack of modern fishing appliances, inadequate and poor infrastructure of cyclone shelter, complexities and non-availability of scheduled credit during crises period, exploiting relationship between fishers and fish entrepreneur (money lender) lack of alternatives livelihood opportunity etc. To illustrate, with absence of state loan facility, fishers often have to take loan from moneylender at higher interest rate that create long term debt bondage with fish entrepreneur that weaken fishers' adaptive capacity. A number of external factors such as lack of security during deep sea fishing, also make fishers' lives more vulnerable by influencing their financial and social capabilities. For instance, increased risk of piracy in the bay causes financial loss of fishers in the form of ransom pay, bodily harm including death as well as loss of fishing gears and craft. In the above-mentioned, the present study submits

that to make climate resilient fishing communities in Bangladesh, it is important to address no-climate related external factors, along with climate change related factors for a more holistic adaptation policy.

P-1117-16

Assessment of Regional Climate Models over Côte d'Ivoire and Analysis of Future Projec-tions over West Africa

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The ability of six Regional Climate Models (RCMs) used in AMMA-ENSEMBLES project is assessed over six meteorological stations in Côte d'Ivoire. The ensemble mean of the models is also used for the prediction of climate change over West Africa. The study focused on two periods: the period 1995-2005, the present-day simulations, is used to evaluate the skills of the models over the country and the years 2010-2013, for assessment of the future climate change scenario used. The results show that the skills of the models vary from one station to another and from one season to another. None of the models considered, presents an excellent performance over the entire country and in all the seasons. Generally, the ensemble mean of all the models presents better results when compared with the observation. These results suggest that the choice of any model for study over the country may depend on the focus of interest: intensity or variability of the rain and also on area of interest. The projection for 2020-2040, future climate change over West Africa shows that the Sahel exhibits a tendency to be drier while wetter Guinean coast is observed.

P-1117-17

Recent Observations and Experiences of Glaciers response to Intrinsic Climatic Variability: the Himalayan Inquest

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The earth's climate has undergone a many phases of both long and short term fluctuations in the past; more so during the late Quaternary period. However, the recent climatic fluctuation has become a bone of contention among scientist for as to what causes these changes; to be precise, through the human actions. Therefore, the understanding the varying role of natural and human actions needs to be precisely quantified for a better understating and impact thereof. The Himalayan environ, with one of the sensitive parameters in the form of ice and glaciers, provides an indispensable laboratory for evaluating and understanding climate variability through these fluctuations in space over a longer temporal scale. Many climate scientists agree on the warming trend of climate past few decades. There are no concrete studies on regional climatic variability especially at the higher altitudes. As a layman we understand that climate changes regionally, based on latitude, altitude, aspect, and land-cover and so on. Lack of climatic data in the Himalayan region limits us to assess just this sensitive key in the form of glaciers on a longer time scale, given the understating that response time is very large. Now the question arises, how much do we know about the changing climate in the Himalayas? We present here the land surface temperature (LST, MODIS) data of the higher altitudes and behavior of glaciers for past one decade in the Himalaya and an assessment among the point source data and grid based data analyzed. Point source data of Bhojbhas has taken from the Automatic Weather Station (AWS), Snow and Avalanche Study Establishment (SASE). The grid source data are satellite based Land Surface Temperature (LST) temperature data obtained from Moderate Resolution Imaging Spectroradiometer (MODIS).A strong relationship emerges between satellite based and ground based data, a useful indicator if considered, especially in case of high altitude and a complex climate system like the Himalaya. The analysis of data are provides a very strong and positive correlation (0.887), which means 89 percent of SASE data, is explained by the MODIS data, which is very encouraging. The coefficient of determination is 0.7870; therefore, about 78.7% of the variation in the SASE data is explained by MODIS data. The root mean square error (standard deviation of regression) is 2.4569, which is very close also provides a better fit. All the stations values are represented on the simple line; and a simple linear trend lines have been drawn on temporal framework. The daily data trend of all the station does not show significant results in a simple regress line (2000-2013). But the yearly trend line data shows variability as; Harsil (0.241); Bhaironghati (0.157); Bhojbhas (0.158); Kalapani (0.208), Rudugaira (0.104), Raktavarn (0.0103) and Chaturangi (0.134) which is highly significant. There is a high variability in the elements but is not reflected as such in the study area during the last thirteen years. Trend lines show downward dip, meaning that there has been, without any doubt, temperature has dropped during 2000-2013. It is but true that temperature is a highly variable component in the high altitudes and may vary on the hourly and daily basis. But the thirteen years of data for five different stations portray a declining trend. Behavior of minimum and maximum temperature variability is not similar, each at varied nature in different stations. Given that we have not been able to assess precipitation characteristics for the same duration for these stations, it is highly speculative to assume that declining trend line may, on a longer temporal scale, would uphold the Himalayan glacier beyond the limit of imagination. Indeed the last 100 years glacier responses with differential rate due to their different geomorphological, geographical, climatic conditions and especially the response time. Same types of results are observed in Western Himalaya, particularly in case of Gangotri glacier, which is retreating with an alarming rate until. Although since 2001 rate of retreat has been slow down and particularly 2007 onwards there are no significant changes in glacier snout. Interestingly terrestrial records are showing that two of its tributary glaciers as Rakatavarn and Chaturangi glacier are showing positive change in their mass and terminus position since 1994. It propounds the complexity of glacier responses even within same geographical and climatic conditions, which means behavior of glacier is identical in nature, with self strength of mind.

P-1117-18

Simulations of Future Climatological Conditions in Central Asia CORDEX Region 8 by Using RegCM4.3.5

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In this work, projected future changes in mean surface air temperature and precipitation climatology, inter-annual and seasonal variability and climatic aridity/humidity conditions for the period 2010-2100 over the large Central Asia region with respect to present climate (from 1970 to 2000) were simulated based on the RCP4.5 and RCP8.5 emission scenarios. Regional Climate Model (RegCM4.3.5) of the International Centre for Theoretical Physics (ICTP) was used for projections of future and present climate conditions. HadGEM2 global climate model of the Met Office Hadley Centre and MPI-ESM-MR global climate model of the Max Planck Institute for Meteorology were downscaled to 50 km for the CORDEX Region 8. We investigated the seasonal time-scale performance of RegCM4.3.5 in reproducing observed climatology over the domain of Central Asia by using 2 different global climate model outputs. For the future climatology of the domain, the regional model predicts relatively high warming in the warm season and northern part of the domain at cold season with a decrease in precipitation almost all part of the domain. The results of our study show that surface temperatures in the region will increase from 1 ◦C up to

more than 7 ◦C on average according to the emission scenarios during the period 2010–2100 with respect to past period 1970–2000. Therefore, the projected warming and decrease in precipitation and also resultant or associated increased aridity and more frequent and severe drought events very likely adversely affect the ecological and socio-economic systems of this region, which is already characterised with mostly arid and semi-arid climate and ecosystems.

P-1117-19

Spring temperatures in the far-western Nepal Himalaya since AD 1640 reconstructed from Picea smithiana tree-ring widths

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The Nepal Himalaya has heated rapidly over the last four decades (more than twice the mean global rate), with this warming being even more pronounced in higher elevations. Unfortunately, because climate records in most of the country does not go extend prior to AD 1980, these short records make it more difficult to gauge the rate and (potential causes) of recent changes or enact long-term plans for resource management in the Nepal Himalaya under changing climate.

We conducted dendroclimatic study in order to extend the temperature record in western Nepal Himalaya beyond the instrumental period. For this, we developed a new, 422-year long tree-ring width chronology (spanning AD 1591-2012) from Picea smithiana (Wall.) Boiss in Khaptad National Park, which is located in the far-western Nepalese Himalaya. Seasonal correlation analysis revealed significant indirect relationship with spring temperature (March-May) and lead to the reconstruction of March-May average temperature for the past 373 years (AD 1640-2012). The reconstruction was found significant based on validation statistics commonly used in tree-ring based climate reconstruction. Furthermore, it was validated through spatial correlation with gridded temperature data. This temperature reconstruction identified several periods of warming and cooling. The reconstruction did not show the significant pattern of cooling during the Little Ice Age but there were few cold episodes recorded. However, the reconstructed temperature revealed the recent warming for last three decades as recorded in the stations. Wavelet analysis revealed high frequency variability (2-7 years) of spring temperature in western Nepal Himalaya for last four centuries, which can be linked to global climate system, El-Nino Southern Oscillation (ENSO). Significant negative correlations were found between the spring temperature in western Nepal and temperatures of monsoon and post monsoon seasons over the equatorial Pacific Ocean. This showed western Nepal Himalaya has linkages with climatic variability in a global scale.

This multi-centennial reconstruction of temperature in western Nepal Himalaya would serve as a basis for Ministry of Environment, Science and Technology to develop climate change adaptation strategies, including the National Adaptation Program of Actions and Local Adaptation Plans of Action. Future climate modeling shall also possible with this long available estimated temperature record for west Nepal.

P-1117-20

Drought monitoring with root zone soil moisture derived from ASCAT satellite data over the East Asian region

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Several studies showed that semi-arid regions of Asia are vulnerable to climate change induced drought (Alimullah Miyan , 2014). While drought has often occurred over the East Asia, we have little understanding of drought at a large scale in that region. Accordingly, there is a need to establish an appropriate drought monitoring and prediction system. There are different types of drought such as agricultural drought or hydrological drought (Rhee et al., 2010). The factors that influence drought are interconnected through land-atmosphere interactions. One of the major factors is soil moisture, which can be effectively used to monitor agricultural drought. The surface soil moisture information from ASCAT satellite data is employed to provide root zone soil moisture for drought monitoring. This approach suggests several merits, when compared to the MODIS Vegetation Index-based indicators or precipitation-based indices often applied to drought monitoring. First, it is difficult to characterize the dynamics of soil dryness with the vegetation indices such as leaf-area-index (LAI) or normalized difference vegetation index (NDVI), as some vegetation species well grow up in dry soils. Secondly, it is difficult to monitor the deep soil that is actually important for predicting the agricultural productivity solely with the precipitation indices, because it is still unknown whether precipitation will infiltrate into the soils, evapotranspirate, or run off.

For these reasons, root zone soil moisture is considered a key indicator for agricultural drought monitoring due to its direct relationship with agricultural productivity and its climatic implication over the land (Lee, 2014). In this study, we use an exponential filter to infer root zone soil moisture from the satellite-retrieved surface soil moisture dynamics. The spatial distribution of soil moisture profiles over this region is evaluated with other datasets such as SMOS and ECMWF data. The 1D soil moisture profile is validated with newly obtained in-situ observations (e.g. precipitation, soil moisture) from the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI) research program under the frame of The Global Energy and Water Cycle Experiment (GEWEX). The role of soil moisture on the East Asian monsoon circulation is also assessed.

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P-1117-21

Global warming and cause-and-effect relations in solar cycles 20-23

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Since the early works by Bernard Vonnegut and Edward Ney that related cosmic radiation to the weather a lot of controversial results were discussed. Thereby we have studied solar activity and interplanetary space conditions, which can have an influence on galactic cosmic ray (CR) and on global temperature. In this connection the solar wind and interplanetary magnetic field parameters and cosmic ray variations have been compared with geomagnetic activity represented by the equatorial Dst index from the beginning 1965 to the end of 2012. The important drivers in interplanetary medium which have effect on cosmic rays as CMEs (coronal mass ejections) and CIRs (corotating interaction regions) undergo very strong changes during their propagation to the Earth. Because of this CMEs, coronal holes and the solar spot numbers (SSN) do not adequately reflect peculiarities concerned with the solar wind arrival to 1 AU. Therefore, the geomagnetic indices have some inestimable advantage as continuous series other the irregular solar wind measurements. We have compared the yearly average variations of Dst index and the solar wind parameters with cosmic ray data from Moscow, Climax, and Haleakala neutron monitors during the solar cycles 20-23. The descending phases of these

solar cycles (CSs) had the long-lasting solar wind high speed streams occurred frequently and were the primary contributors to the recurrent Dst variations. They also had effects on cosmic rays variations. We show that during the 11-year solar cycles 20-23, the IMF B, global temperature and Dst variations were correlated with the cosmic ray count rate. We demonstrate that the detrended annual means of global surface air temperature in 1965-2012 show the maxima during CRs and Dst index minima. It proves that CRs play essential role in climate change and main part of climate variations can be explained by mechanism of action CRs modulated by the solar activity on the state of lower atmosphere and meteorological parameters. Following this we have to seek for another ways of looking for global warming reason, first of all, as a man impact on climate.

P-1117-22

Solar wind effects on climate change

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Climate change in connection with evolution of Dst index and cosmic rays (CR) variations is analyzed. We considered Dst index evolution from the point of view of solar variability, cosmic rays and climate during SCs 20-23. It is shown that together with other solar and interplanetary parameters the long-term variations of the Dst-index can be used for studies of this kind of solar-terrestrial relationship. During the descending phases of these solar cycles the long-lasting solar wind high speed streams occurred frequently and were the primary contributors to the recurrent Dst variations and had effects on cosmic rays variations. We have studied conditions in interplanetary space, which can have an influence on galactic cosmic rays (CRs) and climate change. We show that long-term cosmic ray count rate variations in SCs 20-23 were modulated by solar activity and by the B of IMF which are correlated with Dst variations. On the long-term scale, the correlation CRs count rate in term of the B of IMF and Dst index is much higher than the correlation between solar spot numbers.

P-1117-23

Local climate assessments in data scarce mountain areas; for example Kullu district, Himachal Pradesh, India

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High-mountain regions like the Himalayas and their adjacent downstream areas are often highly affected by climatic changes, climate variability and/or related extremes. As a result of cascading effects of rising air temperatures, melting glaciers, thawing permafrost - as well as anthropogenic water usage or changes in forest and agro-biodiversity - vulnerability of people's livelihood has broaden and increased. However, climate impacts assessments on physical and societal systems are often limited due to the scarcity of reliable long-term observations, particularly in remote high mountain regions, which additionally also hampers robustness of future projections. Since livelihoods in remote high-mountain regions are particularly vulnerable to climate related impacts, and have typically only low adaptive capacities, studies assessing climate variability pattern of the past and for the future are an important basis for sound impact assessments, and as such for preparing and planning adequate adaptation measures. Key for such studies and measures are climatic baselines.

Within the Indian Himalayas Climate Adaptation Programme (IHCAP) integrated vulnerability and hazard and risk assessments are on the way for the Kullu district in Himachal Pradesh, India, for the sake of supporting adaptation planning there. Related to these studies, the present work aims to provide an approach and according results for climatological baseline generation for regions without respective observations available or accessible. Here, we use observational gridded data sets (CRU, GPCP, TRMM, IMD, Berkeley) and Reanalyses (ERA-i, MERRA, NCEP/NCAR-R1, CR20) to provide spatially and temporally continuous data. For the grid boxes covering the area of interest, the time series for temperature and precipitation are analysed and possible trends and variations are assessed for the time window 1981-2010, as well as the entire time line of the respective gridded dataset. Preliminary analyses reveal that the 2m air temperatures have slightly increased over time, whereas the 500 hPa temperatures do not portray this trend clearly. Seasonal analysis for the same time window for the 500 hPa temperatures show a clear positive linear trend for winter (DJF), whereas there is no clear linear trend visible for spring (MAM), summer (JJA) and autumn (SON) temperatures. Precipitation amounts seem to have significantly decreased in MAM and JJA for the period 1981-2010.

As gridded datasets are prone to inhomogeneities, an 'ensemble' of observational and reanalysis datasets are analysed and possible uncertainties are discussed. In conclusion it is important to state that global observational datasets and reanalysis are not a surrogate for ground and upper air in-situ measurements and allow only a very coarse estimation of air temperature and precipitation trends. Nevertheless, it often remains the only option for local studies.

P-1117-24

Spatial pattern of recent rainfall trends in Serbia (1961-2009)

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This study examines a spatial pattern of annual, seasonal and monthly rainfall trends in Serbia. The study used data from 63 weather stations between the period of 1961-2009. The rainfall series was examined by applying the nonparametric method of the Mann-Kendall test and Sen's method to determine the significance and magnitude of the trends. Significant trends have not been detected for the whole country at an annual scale. Seasonal trends at the confidence level of 97.5 %, however, indicate a slight decrease in winter (5 stations out of 63) and spring (7 stations out of 63) precipitation and an increase in autumn precipitation (10 stations out of 63). Results for monthly rainfall trends also generally showed a nonsignificant trend with the exception of a negative trend in May (6 stations out of 63) and positive trend for October (9 stations out of 63). Calculated global autocorrelation statistics (Moran's I) indicate a random spatial pattern of rainfall trends on annual, seasonal and monthly timescales with exceptions for March, June and November. Overall, results suggest that only weak, mostly nonsignificant trends are present in Serbia in the period 1961-2009. To obtain spatial pattern of rainfall trends web mapping techniques are used applying recently developed package plotGoogleMaps.

P-1117-25

Evaluation of regional climate models in the context of AGRHYMET

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The AGRHYMET regional Center is a specialized institution of the Permanent Interstates Committee Drought Control in the Sahel (CILSS) composed presently of thirteen member states. It has the objective to contribute to achieve food security for agroclimatological and hydrological applications with emphasis on rural and natural resource management. It contributes to achieve food security for increasing agricultural production in the CILSS member states by providing training and information to stakeholders and partners. For these missions some innovative projects have been initiated in the recent years to help countries to achieve the Millennium Development Goals (MDG) throughout their ability to analyse the climate change impacts. In this regard AGRHYMET has just initiated a climate modelling activities to examine the present and future climate for identifying the climate related risks in the main sectors and provide information for decision-makers. In the Sahel, food security is highly reliant on rainfed agriculture, and thus the intra-seasonal variability of rainfall including the onset dates, the cessation dates, the length of the rainy season remain an

important factors to investigate. The aim of this work is to provide improved knowledge and evidence on current and probable future climate conditions, for use by decision makers in the region. It will also enhance the capabilities of the above mentioned characteristics of the rainy from regional climate simulations. Some approaches are then used in the region through the regional seasonal outlook forum (PRESAO) to determine a suitable planting date aiming to minimize the water stress in the growing period and then optimizing the staple crop yields in the Sahelian and the guinean cost countries The exercise is focusing to analyse the divergence of regional climate models in the CORDEX experiment on intra-seasonal variability of daily rainfall as well as the likely occurrence of long dry and/or wet spells during the critical growth of the dominant crop varieties sown by West African farmers.. The project outputs will contribute to significantly lower uncertainties by developing better and more tailored climate change knowledge to inform the user communities on climate related risks, as well as enhance their resilience to food insecurity and other climate related disasters.

P-1117-26

Effects of Drastic climatic variability in Pakistan

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Weather and climate have very important socio-economic impacts. Climate of Pakistan have become unpredictable. This study describes the effects of intense flooding during 2010 and severe drought since December 2013 in Pakistan. Because of rapidly growing population and industrialization in Pakistan, the waste material is getting into the atmosphere and contaminating it and producing greenhouse gases. In late July 2010, heavy monsoon rains in Pakistan increased the water level in Indus River which caused heavy flooding in southern Pakistan. During the wet spel from 27 to 30 July Risalpur, Islamabad, Peshawar, Lahore, and Rawalpindi received rainfal of 415 mm, 394 mm, 333 mm, 288 mm, and 219 mm respectively. More than one fifth of Pakistan land was under water and 20 milion people were affected and there was a large-scale destruction of property, livelihood, and infrastructure. On the contrary, currently most of the areas of southern Pakistan (i.e. Tharparkar district) are facing a severe drought since December 2013. More than 120 malnourished children have died and about 175,000 families have been affected and some of them have been forced to leave their homes and move to barrage areas. There is a need to explore the causes of climatic variability and sophisticated methods of weather forecasting so that damages can be minimized to a greater extent.

P-1117-27

Climate Variability and Waterborne Diseases: Case of Typhoid Fever and Enteric Viral Hepatitis in Meknes city, Morocco

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Background: In spite of all efforts deployed by health officers to control the waterborne diseases, Meknes stills the most severely affected province in Morocco. Various factors may explain this trend, including climatological and environmental ones.

Therefore, this study was carried in Meknes province and aims to understand the impact of climatological factors on typhoid fever and enteric viral hepatitis temporal variability, and to highlight the relation between climatological and environmental factors in this case, over the period 2004-2013.

Methods: Due to non-normal distribution of our input data, Spearman correlation was used. In order to point out the relevant periods of the year where the infection by Salmonella typhi and hepatitis viruses A & E, was strongly correlated to climate conditions, namely air temperature and rainfall, a new statistical approach was used, Partial Least Squares.

Results: The results reveal a temporal periodicity of typhoid and enteric viral hepatitis recorded cases, and the presence of significant positive correlation between the studied factors and the cases.

Partial Least Squares regression showed two relevant periods where the number of typhoid and viral hepatitis recorded cases increased, in coincidence with rise of air temperature and decrease of rainfall. The first period started from the end of March to the beginning of June, while the second one extended from the beginning of August to the end of October.

In fact, need of water for irrigation is more required during these two periods which are characterized by water scarcity. The wastewater reuse in irrigation is a common practice during the hot season, what may explain this typhoid and enteric viral hepatitis temporal variability.

Conclusion: This study identified some of climatological and environmental determinants of waterborne diseases in Meknes Province which currently exhibits the highest incidence in Morocco. This knowledge can be used to design intervention measures to reduce and control the said diseases in this area.

P-1117-28

Evaluation of model simulation of the Southeast Asia climate under the Southeast Asia Regional Climate Downscaling (SEACLID)/CORDEX Southeast Asia project

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In the face of future climate change impacts, high-resolution climate projections are essential in developing appropriate adaptation measures. The Southeast Asia Regional Climate Downscaling/CORDEX Southeast Asia (SEACLID/CORDEX-SEA) project aims to generate these projections through a collaborative effort in regional climate downscaling. However, before downscaling global climate projections, a regional climate model is first evaluated to determine its performance in simulating the climate over the SEA region. In this study, simulations using the 4th version of the International Centre for Theoretical Physics (ICTP) Regional Climate Model system (RegCM4) have been conducted over the SEA domain (80°E-145°E; 15°S-40°N) at 36 km spatial resolution for the period of 1989-2008 using the ECMWF ERA Interim data as boundary condition. Comparisons of model temperature and rainfall with observed data show areas where the regional model tends to enhance (or reduce) biases from the boundary forcing. For example, there is a consistent cold bias over the Tibetan plateau and Indochina, especially during the boreal winter. However, the seasonal cycles are generally well-represented in the model. The correlation between model and observed data also tends to be high over the mainland Asia continent but low over the Maritime continent, which may either be due to the model or to uncertainties in the observation data used. Results also indicate relatively higher similarities for both seasonal and inter-annual variabilities in the temperature and rainfall extremes among the different model experiments performed over mainland Asia compared to the Maritime continent. These results emphasize the need to evaluate and appropriately configure the regional climate model, particularly for the SEA region.

P-1117-29

Atmospheric Systems and Thermical Comfort Index in Presidente Prudente (Brazil) in January-March 2014 period

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Since humanity's beginnings man has a concern with the phenomena that originate in the atmosphere. The city of Presidente Prudente is located in the western portion of the state of São Paulo, with a population estimated at 218,960 inhabitants (IBGE, 2013). The city is situated at an average altitude of 472m above sea level and has a great diversity of land use, because the neighborhoods are densely built. With regard to the climate, the city is located in a tropical climate system, a climate transition area, thus hurting the performance of most air systems present in South America. Thus, this research is to identify the performance of weather systems and its relation to the thermal comfort in the city of Presidente Prudente in the quarter January, February and March 2014. For this purpose, we applied initially to Rhythmic Analysis methodology developed by Monteiro (1971) and index calculations Thermal Comfort. Given this, it was found that the feeling of «great discomfort» prevailed during the three-month study, and in the second half of January and the first half of February this feeling was linked to the phenomenon Lock Atmospheric, which caused an increase of up to 5 ° C in temperature and made cities registrassem record highs. Moreover, the action of «atmospheric blocking» and the daytime heating caused the sensation of «maximum discomfort» was set up, which is active mainly in the afternoon.

P-1117-30

Analysis of the Effects of Climate Variability on Crop Yield in Imo State of Nigeria

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Agriculture is one of the sectors that are strongly affected by climate variability and change especially in developing countries of the world which Nigeria is among. Africa is considered the most vulnerable region in the world in terms of climate variations and change due to its physical and socio-economic characteristics. In Nigeria, it is well known that climate has varied in time and space and it will continue to vary in future. Many variations in rainfall particularly have occurred for the different climatic regions and individual locations in Nigeria. In the Southeast, Imo state for example, droughts have been relatively less persistent, while rainfall is observed to be increasing and temperature increases and reduces moderately over the years compared with other states in the Northern parts of the country. Many parts of Imo state in Southeastern Nigeria experience flood disasters following excessive rainfall which destroy their farmland and wash away their crops. One major issue with respect to climate variability involves its influence on crop yields. Some studies have shown that fluctuations in rainfall and temperature regimes are the atmospheric driving forces that are responsible for the changes in the climate systems of Imo state and other parts of the Southeastern Nigeria. The yield and quality of food crops is central to the wellbeing of humans and is directly affected by changes in climatic systems. Climate variability affects crop cultivation, uncertainties in the onset of the farming season due to changes in rainfall characteristics (early rain may not be sustained and crops planted at that instance may become smothered by heat waves) can lead to an unusual sequence of crop planting which results to poor harvest. Extreme weather events such as thunderstorms, heavy rainfall and extreme temperature also devastate farmlands and leads to poor yield of crops. Pest and crop diseases migrate in response to climatic variations and change. In the study, 15 years (1999-2013) climatic data (rainfall and temperature) generated from the archives of Nigeria Meteorological Agency (NIMET) and crop yield data on selected crops from Agricultural development program (ADP), Owerri, Imo state were examined . After data analysis, the result shows fluctuations in temperature and rainfall pattern in the state with negative effects on crop yield, which also affects humans socioeconomically. Based on this, it is suggested that farmers should adopt good farm management techniques in order to adapt to the prevailing climate variability.

P-1117-31

Climate variability and susceptibility to desertification in Maranhão State, Brazil

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Desertification is a serious global problem. Its impact is greater in developing countries, because it can increase hunger, malnutrition and rural exodus. This paper investigates the susceptibility to desertification in the State of Maranhão, the transition zone between Amazonia, inland Cerrado and the semi-arid Northeast Provinces of Brazil. For this purpose, we spatially interpolate data from 84 climatological stations in operation >20 years throughout the state, provided by the National Hydro-meteorological Network developed by National Water Agency. There is a marked contrast between humid and dry areas reflect the transition-zone between Amazonia and the semi-arid Northeast. Rainfall distribution is very unequal, followed by rapid water-loss via evapotranspiration after the end of the rainy season. Total rainfall varies from about 700.0 to 2784.0 mm/year, with highest rainfall in March (531.3 mm) and April (523.5 mm), whereas August is the driest month (17.1 mm), monthly and annual potential evapotranspiration varies from 20.6 - 302.2 mm/month and 276.0 - 2300.0 mm/year respectively, and annual water deficiency varies from 53.0 to 1421.0 mm/year. In the months of August and September we registered water deficiencies throughout the entire State. The highest rates of annual and monthly water surpluses are 1678.9 mm/year and 424.6 mm/month, respectively. 20.1% (66.854 km2) of the total area of the State of Maranhão, is susceptible to desertification, affecting an estimated 361 thousand inhabitants. Coincidentally, the counties with desertification risk are among the least developed and poorest of Maranhão State and of Brazil. Exposure is especially high in the indigenous population (55.2% of the State´s total indigenous population). Until recently, Maranhão was not included in Brazil´s map of desertification, and public awareness of desertification risks continues almost absent. Our results demand an increased public awareness, and call for the development and implementation of policy and management strategies designed to combat against and adapt to desertification risks, in order to avoid increased rural poverty, food insecurity and further rural exodus.

P-1117-32

Spatial and Temporal Variability of Precipitation over the Gandaki River Basin of Nepal Himalaya

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Landslides, floods, and droughts are recurring natural disasters in Nepal related to too much or too little water. The summer monsoon contributes more than 80% of annual rainfall, and rainfall spatial and inter-annual variation is very high. The Gandaki River, one of the three major rivers of Nepal and one of the major tributaries of the Ganges River, covers all agro-ecological zones in the central part of Nepal. Time series tests were applied for different agro-ecological zones of the Gandaki River Basin (GRB) for rainfall trends of four seasons (pre-monsoon, monsoon, post-monsoon and winter) from 1981 to 2012. The non-parametric Mann-Kendall and Sen's methods were used to determine the trends. Decadal anomalies relative to the long term average were analyzed using the APHRODITE precipitation product. Trends in number of rainy days and timing of the monsoon were also analyzed. We found that the post-monsoon, pre-monsoon and winter rainfalls are decreasing significantly in most of the zones but monsoon rainfall is increasing throughout the basin. In the hill region, the annual rainfall is increasing but the rainy days do not show any trend. There is a tendency of the late departure of monsoon from Nepal, indicating an increase in its duration. These seasonally

and topographically variable trends may have significant impacts for the agriculture and livestock smallholders that form the majority of the population in the GRB.

P-1117-33

Early warning of climate variability and change from seasonal forecasts

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Projections of future climate suggest that extreme events such as drought, floods, storms, cold spells, and heatwaves will all change their regional frequency of occurrence due to long term climate change. However, on planning timescales of months to years in advance, the timing and occurrence of extreme or unprecedented events is determined by climate variability. In particular, it depends on the superposition of climate variability and climate change. In order to advise on the risk of imminent extremes we therefore need climate predictions which accurately take into account current climate variability. This requires initialisation of the current state of the climate in the atmosphere, ocean, sea ice, and land surface as well as the changes in radiatively active greenhouse gases and aerosols.

Here we discuss near term climate predictions from the Met Office Hadley Centre out to seasonal lead times. We show evidence of predictability of the leading modes of climate variability in both the tropics (El Nino Southern Oscillation) and the extratropics (North Atlantic/Arctic Oscillation). We show how this can lead to predictability for regional climate extremes and discuss the prospects for improved warnings and adaptation to imminent extreme events.

P-1117-34

Ability of a high regional climate model to represent key climatic features over West Equatorial Africa

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Climate dynamics over West Equatorial Africa (WEA) is dominated by four prominent features. At lower level, two cells of westerlies (LLW) are discernible, controlled by different mechanisms. At middle level, African easterly jet prevails with a northern component (AEJ-N) discernible year round, and a southern cell discernible from September to February. The upper troposphere is dominated by the Tropical Easterly Jet (TEJ) which drivers over the region vary with season. Surface processes over WEA play a prominent role on the variability of the atmospheric dynamic over the region.

This underlines the complexity of atmospheric features over WEA, and the requirement of fine scale climate model for investigating locally driven atmospheric circulations. High resolution (25 Km) regional climate model HadRM3P was evaluated in its capacity to capture and model key dynamical features over WEA.

Results show the ability of HadAM3P to reproduce features related to the development of the two cells of LLW over WEA. HadAM3P do well in locating the core speed of the two cells of LLW and simulate well their annual variability. HadAM3P does a well job in simulating characteristics of AEJ-N and AEJ-S. The height of the core speed of the two components of AEJ is well simulated, together with their annual latitudinal migration. In upper troposphere, TEJ is well captured by HadRM3P.

However, some biases appear in the simulations. Investigation of the reasons behind these biases leads to highlight some mechanisms over the region. Exploration of the overestimation of the strength of LLW shows that HadRM3P overestimates surface temperature over the coastal region in WEA. This leads to overestimation of local vertical convergence of sensible heat flux from the surface, inducing a warm bias of diabatic heating. This promotes positive bias of vertical motion and in turn overestimation of LLW. This reveals the key role of surface condition over coastal region in WEA for the development of LLW.

Analysis show that during the main rainy season over WEA, from September to November, the prominent feature for the development of uplifts is diabatic heating release by condensation throughout the depth of the troposphere over WEA, rather than jet streak type circulation associated to the development of AEJ-S and AEJ-N.

P-1117-35

Stochastic Dynamical Cascade for Downscaling Precipitation signals over Complex topographies in the High Andes

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Global Climate Models (GCMs) suggest that rising concentrations of greenhouse gases will have significant implications for climate at global and regional scales. Less certain is the extent to which meteorological processes at individual sites will be affected. Downscaling climate techniques are used to bridge the spatial and temporal resolution gaps between what climate models are currently able to provide and what decision-makers require. Among the most important impacts of regional-scale prediction of climate change is to assess how food production will affect the food security. Regional scale precipitation and temperature simulations are crucial to understand how global warming will affect fresh water storage and the ability to grow agricultural crops. Precipitation and temperature downscaling improve the coarse resolution and poor local representation of global climate models and help decision-makers to assess the likely hydrological impacts of climate change, and it would also help crop modelers to generate more realistic climatic-change scenarios. Thus, a spatial downscaling method was developed based on the multiplicative random cascade disaggregation theory, considering a β-lognormal model describing the rainfall precipitation distribution and using the Mandelbrot-Kahane-Peyriere (MKP) function. The Multifractal downscaling technique, complemented by a heterogeneity filter, was applied to a 15 years (01/11/1998 - 03/31/2013) daily rainfall time series produced by the Weather Research and Forecasting model (WRF- 15 km grid spacing). A downscaled signal of approximately 1 km grid spacing was generated for a 220 km x 220 km region within the high plateau of the Andes. The model parameters were estimated from gauged daily rainfall data registered over 15 years from 18 weather stations. A detailed testing of the model was undertaken by comparing statistical characteristics of the spatial and temporal variability of rainfall between the rainfall fields obtained from the rain gauge network and those generated by the simulation model. The potential advantages of this methodology are discussed.

P-1117-36

Volcanic Eruptions, Carbonaceous Aerosols and ENSO Events

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El Niño/Southern Oscillation (ENSO) events are the dominant mode of variability in the global climate responsible for significant variations across the world including drought in Australia and Indonesia, floods in the Americas and a generally increased global temperature. An El Niño commences when the Trade Winds blowing across the Pacific Ocean relax, reduce in strength or even reverse. This is a major perturbation of the Walker Cell, the major zonal atmospheric circulation system over the tropical Pacific Ocean, and, as the literature, IPCC and the USA Climate Change Science Program suggest that

aerosols can affect the large-scale atmospheric circulation and hydrologic cycle I examine the relationship between certain volcanic eruptions and carbonaceous aerosol plumes and ENSO events and demonstrate a causal link exists between the eruptions, aerosols and ENSO which logically must be that the volcanic eruptions and aerosols trigger and then sustain ENSO events until the eruptions end and the aerosol plume dissipates enabling the climate system to recover to a non-ENSO state.

P-1117-37

Heating and cooling rate calculations for realistic volcanic ash clouds and applications to climate simulations

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The radiative effects of long-lived stratospheric volcanic sulphate aerosols have been widely studied, while the impacts of short-lived, but more strongly absorbing volcanic silicate particles have seen less attention. Silicate ash injected into the stratosphere by the 1982 eruptions of El Chichón volcano were estimated to have induced a net radiative heating rate of up to 20 K per day. This research involves the use of satellite measurements to determine important characteristics of dispersing volcanic ash clouds in order to develop new knowledge on the radiative effects of silicate ash on the atmosphere. Ten explosive volcanic eruptions (VEI ≥ 4), occurring over the last decade (2006-present), have been considered in this study. Hyperspectral infrared and satellite-based lidar remote sensing measurement techniques have been used to detect and quantify volcanic cloud heights, thicknesses, mass loadings and microphysical properties. These measurements are well suited to provide this size and compositional information. Finally, the new data has been used to provide some realistic estimates of the radiative impact of silicate ash on the atmosphere using a 1D radiative transfer model. The significance of the results and possible applications to climate simulations are discussed.

P-1117-38

Observed connections between temperature increase and the altitude of snowfall / snow pack in the Swiss Alps

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The consequences of global warming are particularly visible in mountain areas. The impact of changing temperatures on the snow to rain ratio is highly critical for alpine ecosystems as well as for winter tourism. Knowledge of the decrease in snow amount is still poor, due both to high interannual variability and to the frequent lack of data.

Here, we analyse snowfall and snow pack for up to 100 years at 140 stations, spanning elevations from 200 to 3500 m asl in Switzerland. Our method allows to assess the impact of changing temperatures on snowfall while minimizing the impact of variability in precipitation frequency and intensity.

Our results show the connection between the decrease in snowfall / snow pack and the increase in temperature. This decrease was stronger at locations with temperatures closer to the melting point. These locations depend both on elevation and season. The current frequency of snowfall for December, January and February are similar to those of the 1960s for November and March. These changes also result in a decrease in snowpack and in earlier snowmelt, particularly at higher elevation.

The transfer in altitude of snowfall affects the beginning and end of the ski seasons. Currently approximately every second precipitation day already consists of rain up to 1400 m asl in November and March.

The amount of snow available for water storage and runoff during the spring and summer months is declining, because more and more winter precipitation will directly contribute to runoff. Impacts can also be expected on the alpine vegetation, which will experience a shorter snow season and possibly be more exposed to late spring frost events, irrespective of variability or changes in precipitation.

P-1117-39

First signs of climate change in Lyon (France) according to Köppen and Hess-Brezowsky classifications

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The Greater Lyon (France) gathers human and environmental issues that can be affected by climate change by heat waves and intense precipitation. The objective of this study is to identify recent trends of climate change using the annual climate types from the Köppen-Geiger classification and the catalog situations of Hess-Brezowsky, to assess the dynamics and evolution of heat waves and heavy precipitation.

1. Annual climate types in Lyon since 1922

The Köppen-Geiger climate classification is the most used method to categorize the earth's climates. The methodology used is the one detailed in Kottek et al. (2006) and Rubel and Kottek (2010). Rainfall and temperature data are from the weather station of Lyon-Bron (Météo-France). The annual climate types is calculated, for each year (1922 - 2013), and analyzed by decades. All years are placed in the category of warm temperate climate, with the exception of 1940, 1945, 1956 and 1963 which have a snow climate. Regarding temperatures, two types are identified in Lyon since 1922: warm and hot summer. There has, since 1965, a strong increase of the years with hot summer at the expense of warm summer. Indeed, absent for the decade 1965-1975, the hot summers represent 30%, 40%, 80% and 70% for the following decades. Thus, the hot summer type is the majority since the 1995-2005 decade. An additional study on heat waves shows also an increase of the latter.

Concerning rainfall, the proportion of dry winters is constant with about 20% of the years of this type by decades. Fully humid and dry summer years have high variability for the decades before 1995, where they are since observed in the same proportions (40% each). This first study on rainfall is complemented by studying the evolution of the weather types causing rainfalls, using the Hess-Brezowsky classification.

2. Rainfall atmospheric patterns evolution since 1881

Greater Lyon floods are caused by rainfalls with different characteristics. Their natures (intensity, water height, duration) are known since 1988 thanks to the Lyon 30 rain gauges network. In addition, rain is measured daily, since 1881, using Lyon-Bron station. The second part of this study relates the different types of rainfall to atmospheric circulation, and highlights trends related to climate change.

A comparison of many atmospheric circulation type catalogs has been made, and the method of Hess-Brezowsky (Gestengarbe and Werner 1999, 2005) was chosen to identify the types of rainy weather and its evolution. Since 1881, most of the rainfalls occur with southerly (22%) and westerly (31%) circulations. However, most of extreme rainfalls in terms of intensity, water height or duration are due to southerly regimes, with 57 %; 47 % and 34 % respectively. Concerning the evolution of synoptic circulations since 1881, it is noticed a sharp and steady decrease of north-west and north regime, as well as north-east and north regimes, whereas southerly regimes have strongly increased, going from 20% of rainy weather in 1881 to about 45% in 2013. Regarding intense precipitation and focusing on the sub-types of circulation (Großwetterlagen GWL), it is noticed that the GWL «zonal Ridge across Central Europe» is the most frequent, with a strong increase since 1881, according to the Mann-Kendall trend test. This is the same results for the «cyclonic south-westerly» and «trough over western europe» GWLs that have strongly increased since 1881. According to these results, it can be expected an increase in hot summer and

an intensification of rainfall in the Greater Lyon.

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P-1117-40

Average Bias of Diurnal Precipitation Over Maritime-Continent

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Numerical simulation of diurnal precipitation over maritime-continent were inverstigated using WRFV3.5.1. The numerical model use input data from GFS and from GFS+RTGSST data then the average bias from both input data shows that the precipitation is bigger in the afternoon untill morning from 12 UTC until 00 UTC. In March, Most of the diurnal precipitation are on southern part of Indonesia, In June, most of the diurnal precipitation are almost around Indonesia, in September, most of the diurnal precipitation are on northern part of Indonesia and in December, most of the diurnal precipitation are around Indonesia, except south of Java. It's also revealed, that the diurnal precipitation over ocean is strongest in June rather than Land.

P-1117-41

Spatio-temporal characteristics of the recent rainfall recovery in West Africa

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Using daily (monthly) rainfall data from 167 (254) stations across West Africa with at least 80% data availabilityfor the 31-year period 1980-2010 and the gridded African Rainfall Climatology Version 2 (ARC2) for the period 1983-2010,linear trends in yearly and monthly rainfall totals were investigated. Measures of the Expert Team on Climate Change Detectionand Indices (ETCCDI) and two rainy season onset and retreat definitions were employed to assess the corresponding trendsin frequency and intensity of daily rainfall and changes to monsoon season length. A rotated Empirical Orthogonal Functionanalysis yielded two homogeneous rainfall regions, the Sahel and Guinea Coast, in terms of interannual to decadal rainfallvariability, and this led to analysis of station data and Standardised Precipitation Index for the two regions. Results showthat the majority of stations in the Sahel between the West Coast and 15◦ E shows a statistically significant positive rainfalltrend for annual totals. The August-October period exhibits the largest rainfall recovery in the Sahel and the date of theretreat of the rainy season significantly moved later into the year by 2 days per decade. The recovery is reflected both in morerainy days associated with longer wet spell duration and more extreme rainfall events. Trends along the Guinea Coast are weak and non-significant except for extreme rainfall related indices. This missing significance is partly related to the hiatusin rainfall increase in the 1990s, but also to the larger interannual rainfall variability. However, the tendency towards a moreintense second rainy season suggests a later withdrawal of rains from the West African subcontinent. ARC2 trends are broadlyconsistent where ground calibration was undertaken, but are dubious for Nigeria and Ghana, and especially for the Guinea, Jos and Cameroon Line highlands due to missing gauge data.

P-1117-42

Characteristics of Hydro-Climatic variables In Nigeria during episodes Of Sea Surface Temperature Anomalies in the Gulf of Guinea

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This study examined the characteristics of hydro-climatic variables in Nigeria at various Agro-ecological zones (Forest, Southern-Guinea-Savanna, Northern-Guinea-Savanna and Sudan-Savanna) during different episodes of sea surface temperature anomaly (SSTA) in the Gulf of Guinea (GOG) region. The study utilizes SSTA and continental climatic data spanning 40 years; and with the aid of advance statistical analysis to determine onset of rain, cessation of rain, duration of rain and frequency of occurrence of rain day using rainfall-potential-evapo-transpiration model. Results showed that SST is critical to climate monitoring at the local, regional and hemispheric scales. The result further display how to enhance optimal schedule of farm operations, proper adaptation and mitigation practices against extreme weather events arising from observed warming trends in both the SST and the near air surface temperature. Further recommendation is made for SSTA as a forecasting tool in the prediction of hydro-climatic variables that is essential for optimal agricultural practices.

P-1117-43

Studies on Climatic parameter influencing milk production in Cattle in South West Nigeria

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This study further advance the knowledge of climatic indices applicable to the mitigation strategies aimed at reducing the vulnerability of cattle milk production in south west Nigeria. It shows that milk production in the tropics is affected by environmental factors of which climate appears to be most critical. We adopted Cocheme and Franqiun (1967)'s model of 0.1PE<P<0.5PE lactation method. The experiment was a 2x2x3 factorial arrangement of two cattle breed, two locations and three seasons. Analysis of variance (ANOVA), correlation and regression was used to test the strength of relationship

between climatic parameters and milk yield. The result shows that sunshine duration and evaporation are the dominant climatic parameters affecting milk production irrespective of breed and location. Furthermore, milk production in the study area was highest during the dry season with mean value as (approximately 331 litres/cow/day). However, no significant interactive effect of cattle, breed, location and season on the lactation yield of cattle is observed in the study.

P-1117-44

Influences of climatic variability on coastal oceanography of benin

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In article are analyzed temporary ranks for average monthly air temperature at Cotonou station Kazhekhun(06 ° Nord, 002 ° 23 East) during 10 years (from 1975 to 1984) with every fifteen days discretization ofcounting in. For same the period are used average monthly temperatures of the ocean surfaces near the capital ofthe Republic of Benin, Cotonou. Authors calculated correlation coefficients for humidity of air; air temperature;sea surface water temperature. Research of interrelations between sea surface water temperature variations andsalinity changes on depth, allow to identify a mesolimnion zone; gives the chance to understand distinctionswithin a year, concerning lifting of deep waters (upwelling). Also authors carried out calculations of correlationcoefficients between monthly bioproduction of a pelagic species of fish (Sardinellamaderensis), as «the upwellingindicator», with air temperature. In addition in article are represented fields of sea water temperatures andthe salinity, received with use of SURFER program.

P-1117-45

Rectification of El Nino-Southern Oscillation into Climate Anomalies of Decadal and Longer Time Scales: Results from Forced Ocean GCM Experiments

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To better understand the causes of climate change in the tropical Pacific on the decadal and longer time scales, the rectification effect of ENSO events is delineated by contrasting the time-mean state of two forced ocean GCM experiments. In one of them, the long-term mean surface wind stress of 1950-2011 is applied, while in the other, the surface wind stress used is the long-term mean surface wind stress of 1950-2011 plus the interannual monthly anomalies over the period. Thus, the long-term means of the surface wind stress in the two runs are identical. The two experiments also use the same relaxation boundary conditions, that is, the SST is restored to the same prescribed values. The two runs, however, are found to yield significantly different mean climate for the tropical Pacific. The mean state of the run with interannual fluctuations in the surface winds is found to have a cooler warm pool, warmer thermocline water, and warmer eastern surface Pacific than the run without interannual fluctuations in the surface winds. The warming of the eastern Pacific has a pattern that resembles the observed decadal warming. In particular, the pattern features an off-equator maximum as the observed decadal warming. The spatial pattern of the time-mean upper-ocean temperature differences between the two experiments is shown to resemble that of the differences in the nonlinear dynamic heating, underscoring the role of the nonlinear ocean dynamics in the rectification. The study strengthens the suggestion that rectification of ENSO can be a viable mechanism for climate change of decadal and longer time scales.

P-1117-46

Sub-Saharan Africa Climate in CMIP5

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This paper examines the Sub-Saharan Africa climate in CMIP5. First we evaluate the historical simulations of continental and regional climatology with a focus on a core set of thirteen models. Second, we compare the CMIP5 climate projections with the historical simulations. We use both RCP 4.5 and RCP 8.5 model simulations. We evaluate the historical runs for a set of basic surface climate and hydrological variables and their extremes for the continent for the period 1979 - 2005. In addition, we conducted evaluations for selected regional climate processes relevant to the African climate, including the West African monsoon, the Greater Horn of Africa spring and fall bimodal rains, and the southern Africa warm season. For temperature and climate variables, we use ERA-I and NCEP reanalysis as proxy for observations. For precipitation, we use GPCP and CMAP. Models are able to reproduce the observed spatial patterns of basic climate and hydrological variables but with considerable differences across models and regions in the magnitude and sign of errors. The variability in surface air temperature compares reasonably well with observations. For West Africa precipitation, the north-south migration of the ITCZ is fairly well captured in 10 of the 13 models. However, while CMAP and GPCP place the area of maximum precipitation in August around 10°N, only a few of the models (3 out of 13) captured this feature. Results from a similar analysis for the Greater of Africa and for southern Africa are presented. The ability of the models to capture extreme events such as drought or flood events has also been investigated and the results presented.

Examining the projected changes in precipitation and temperature trends, we present the differences from the seasonal mean between the last 27 years of the 21st century (2073 - 2099) and the period spanning 1979 - 2005. For DJF southern Africa rainfall season, precipitation changes are significant for only four of the models. Two of these models exhibit a drying trend over southern Africa, one exhibit a wet trend, and one model shows dryness in the northeastern part of southern Africa and wetness in the south. For the MAM season, only the CSIRO and HADGEM2 show a reduction in rainfall across south central Africa. For the JAS season, MIROC exhibits a wet trend in West Africa, while CSIRO reduces precipitation there. Precipitation changes in all other models are not significant. For the OND season, CanESM2, CSIRO and HadGEM2 exhibit a wet trend over East Africa, though there are some differences in the location of the changes in intensity. None of the models depicts a significant dry trend over this region. For temperature, however, all the models project positive temperature changes across Africa. Finally, the dynamic patterns associated with the changes in precipitation and air temperature are presented.

P-1117-47

Changes induced by dust on West African Monsoon features

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The generation and transportation of dust from North Africa are thought to modulate the West African Monsoon (WAM) features. In this study we investigated the relationship between the Saharan Air Layer located above Atlantic Ocean (OSAL) and WAM features, including Monsoon flow, African Easterly Jet (AEJ), and Tropical Easterly Jet (TEJ) over West Africa using the RegCM4 regional model. Toward this purpose, we performed two sets of experiments from 2000-2010, one including dust and one without dust effect over the West African domain, encompassing the whole West Africa and a large part of the adjacent Atlantic Ocean. An Intercomparison of the two simulations show that dust load into the atmosphere has an effect on both the wind and temperature structure at different levels, inducing observed changes in WAM system during JJAS seasons. These changes lead to (1) a westward shift and slight strength of AEJ core over tropical Atlantic which is associated to (2) a weak TEJ and (3) lastly to West Africa monsoon penetration over land. Moreover despite the prescribed Sea Surface Temperature, correlations have been found between Aerosol Optical Depths in OSAL and wind, suggesting that mechanism relationship between dust and WAM features is well reproduced by RegCM4.

P-1117-48

Perceived Effects of Climate Change on Nomadic Practice of the Gujjar and Bakarwal Tribe in Kashmir Valley, India: A Socio-Demographic Analysis

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Despite the effects of climate change being evident at a global scale, its negative impact will severely affect those communities highly dependent on natural resources. Significant discussion has been focused on the possibility that climate change will displace large numbers of nomads from their nomadic way of life in the developing world, but few multivariate studies have addressed this issue. High Mountain areas in the arid environment are extremely sensitive indicators of sometimes only slight changes of precipitation and temperatures. Himalayas as the most vulnerable mountains for climate change has already been affected by climate change impacts. Climate change, however, is not the only consequence. Climate and environmental changes have deep impacts on the traditionally nomadic population, their economy and lifestyle. Thus it is justified to speak of both cultural and socio-economic vulnerabilities that characterise the present day development of India's mountain regions. Regional focus of this study is the Jammu and Kashmir mountain area in the north of India and its forelands. Although however, temperature and rainfall trends suggest an increase exposure of the Jammu and Kashmir Nomads to the environmental stresses. Thus, their adaptation strategies show a clear trend towards different forms of agro-pastoralism as a reaction to the climatic change and changing political and socio-economic pressures. This holds true especially for the so far under-researched mountain regions of Kashmir in the Himalayas.

The study examined perceived effects of climate change on grazing land, livestock performance and examined the coping strategies of the nomadic to climate change. Multistage sampling technique was used to select 140 respondents for the study. Data were analysed using percentages, frequencies, tables and Chi square statistical tools. The result of the study showed that 37.5% of the respondents were between the ages of 51-60 years with an average age of 49.8 years. The results revealed that 67.5% of the pastoralists strongly agreed that the pattern of rainfall in recent time affects pasture availability. Consequently 47.5% and 52.5% of them reported a decrease in milk production and increase in livestock's mortality rate respectively due to the effect of climate change. A significance relationship was established between factors of climate change and milk production of the herd (calculated $x2 = 52.00$, tabulated $x2=7.8147$. $p \leq 0.05$). It is therefore recommended that the pastoralists be trained in forage conservation techniques. They should also be encouraged to pool their resources to enjoy economics of scale by the extension workers. Grazing reserves should be developed by the government to fast track the disposition of the pastoralists to sedentary life. It was recommended that animal production/veterinary services should be stepped up, diversify their production to include crops and other sources of income generation and establish more gazing reserves.

P-1117-49

Summer precipitation in Ukraine - observations, modeling and controlling factors

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Summer atmospheric precipitation in Ukraine is studied via climatology, atmospheric circulation and simulation in operative and climate models. Climatology of summer precipitation in Ukraine is studied with special attention to recent decades' with growing number of extreme events contributed greatly to the present-day climate variability. Trends in total precipitation amounts and other indexes were obtained; showing difference between early and late season; trends in extreme parameters in threshold values are found statistically significant; they are used for regionalization of spatial changes.

Spatial inhomogeneity is found in precipitation indexes across Ukraine, greatest growth in the daily intensity of extreme precipitation occurred between 1990s and 2000s. Precipitation changes are analyzed against near-surface air temperatures (SAT) variability, showing great intraseasonal contrast, on the background of general seasonal warming. Early summer became much wetter in 2000s with numerous extreme events, and period from August till mid-Autumn is much drier causing greater frequency of droughts or heat waves in the last decades. In contrast, early period of global warming in 1970s-mid-1980s has been characterized by much drier climate in the early summer.

It is shown that it is convection intensification that resulted in significant growth in extreme precipitation and attendant events in 2000s and is contributed greatly to the present-day climate variability. In turn increased frequency of summer extreme events are attributed to larger-scale atmospheric circulation change that responsible for significant spatial in broader scale (also across Europe) and intraseasonal contrasts. Growth in extreme precipitation is detected in the latest decade due to deeper European trough with frequent cut-off lows, and its interaction with blocking high over the East Europe, and their greater time residence. The latter became strengthened in the late July-August, providing great weather contrast across Europe, causing rains and floods in the West and greater frequency of droughts in the East.

Ability of WRF ARW and NMM models to reproduce different scales' convection is assessed. Types of mesoscale fields responsible for extreme rainfall events due to the strong convection development are recognized within the larger-scale synoptic systems, threat potential is assessed to increase during the last decade. Transition between atmospheric scales can be used to assessing general threat of extreme precipitation.

Many uncertainties in climate models outputs are detected, not reproducing well observed growth in extreme precipitation in the recent decade as well as spatial variability. One of the main challenges facing the recent climate change is intensification of convective potential and summer showers on the background of further warming; many uncertainties exist in future climate projections. Our own model of the atmospheric circulation change is developed, and scenarios are built, on the basis smaller rate of near-surface warming and variable precipitation. Recommendations for sustainable development for national economy, mainly for agriculture are given.

P-1117-50

Instability intraseasonal of rainfall and its implications on agricultural activities in the middle of Benin Republic (West Africa)

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Until now rainfed agriculture is the main occupation of the people and is the basis of socio-economic development of rural areas of Benin (food security, monetary income). Furthermore inter-annual variability (which has already been the subject of several studies), it is necessary to understand the intra-seasonal rainfall perturbations which depend mainly cropping calendars in this region known for its agricultural potentials.

Daily rainfall amounts of 4 stations (Dassa-Zoumé, Savalou Savè and Bantè) for the period 1941 to 2010, obtained the National Direction of Meteorology (DNM) were used. Determining the beginning of the end and the length of the dry season was done according to the criteria Gueye and Sivakumar (1992) used by Sane et al. (2008). Similarly, the frequency analysis of the beginning, the end and the length of the seasons was made at the frequencies 8 years out of 10, 5 years out of 10 and 2 years out of 10 by calculating the cumulative frequency to better appreciate the risks. Moreover, years of rupture (in season length) were verified by Pettitt test at significance level $\alpha = 5$ %. Moreover, the frequency and magnitude of dry sequences (false start of the rains, drought pockets at the heart of seasons) and wet sequences (risk of flooding and water profusion) were analyzed (Zakari et al. 2012) to better characterize the qualities of the seasons.

On average, the first (large) rainy season lasts 120 days (3rd decade of March in the second decade of July-while the second (small) rainy season is longer than 70 days (3rd decade of August to October). this distribution allows two crop seasons per year (farmers cropping calendars are modeled on that distribution), although the

second is short and uncertain. But in reality, the region is characterized by a high occurrence of late start of the rains (between 15 and 30% for the great season, between 10 and 25 % for early season) and ends early (20 and 35% for the great season and 10 and 20 % for early season). It follows a significant trend towards shorter lengths of the seasons, making the crop seasons uncertain. in these episodes add the appearance of dry spells especially at the beginning at the end of the seasons that negatively affect agricultural activities. The degradation of the quality of rainy season has increased since the 1970s in keeping with the decline in seasonal and annual rainfall totals. It should be noted that the relative improvement of annual rainfall totals recorded since the 1990s has not induced an improvement in the quality of agricultural seasons in the region. So the years considered normal (average) or even surplus concerned with intra-seasonal volatility rain. In this context of quality degradation rainy seasons, the region has per moment of high rainfall sequences in the heart of the seasons, causing disastrous floods for crops and / or harvests.

It is therefore appropriate that agricultural promotion policies and strategies integrate these intra-seasonal rainfall fluctuations while taking into account the knowledge and logical farmers in order to define strategies for adapting agriculture to climate change in this region.

P-1117-51

Analysis of the West African Heat Waves and their Associated Dynamics Factors using Regional Climate Models Outputs

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Diagnostics combining Regional Climate Models Outputs and Station-based temperature Data from 1962 to 2013 indicate characteristics signals of heat waves over the West Africa. These heat waves can be associated with the occurrence of the record warm days during December, January and February (DJF) and the specific atmospheric circulation like Saharan heat low. Heat waves for various continental locations are shown to occur as isolated spatial and temporal events, and not as part of larger-scale systems over continental-size domains. An examination of the physical processes associated with heat waves showed mutually consistent climatic relationships, such that heat waves were associated with reduced rainfall and consequently reduced soil moisture content, evaporation, and increased insolation at the surface. These combined changes created the surface temperature increase intrinsic to the heat waves.

1118a - Attribution of extreme events: How are high impact extreme events changing and why ?

ORAL PRESENTATIONS

K-1118a-01

Are humans exacerbating climate and weather extremes?

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This talk will review some of the recent research on extremes, pointing to aspects of changes in extremes in which we have higher and lower levels of confidence. The body of evidence indicating a human contribution to observed climate change has continued to strengthen as indicated by the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). This continued development includes an accumulating body of evidence suggesting that temperature and precipitation extremes have both changed in response to human influences on the climate. The research on temperature extremes is well established, with recent work indicating that temperature extremes have continued to warm over land despite the recent global warming "hiatus", and that anthropogenic forcing has substantially increased the odds of extreme warm years and summers, both globally and regionally. The evidence on precipitation extremes is less well established, although there is increasingly strong evidence that human influence is detectable in observations at the largest scales that are resolvable in available international compilations of daily precipitation records. In contrast, assessments of historical and projected changes in droughts and storminess remain cautious, due to both data limitations and uncertainty in process understanding and modelling. Despite uncertainties and limitations in knowledge, observed and projected changes in the simple temperature and precipitation indicators in which we have greatest confidence provide ample evidence that adaptation is required now, and that further adaptation will be required in the future under all RCP forcing scenarios.

K-1118a-02

Detecting and attributing impacts of recent climate change on multiple systems worldwide – certainties, uncertainties and new research questions

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Due to rapidly growing scientific evidence, based on growing stocks of observations as well as on improved methodologies, it is widely accepted that recent climate change has triggered changes in numerous systems worldwide. Most cited examples concern hydrological systems, the cryosphere, and many biological systems in the ocean and on all continents. The recent IPCC assessment, which was based on an unprecedented trans-disciplinary community effort, found more widespread impacts than previous reports, covered a greater range of impacted system types but also identified regions and systems with insufficient research and monitoring effort. Updating the report, three key questions will be addressed: a) To which extent have human systems been impacted, either directly or through cascading impacts through natural systems? b) How much is known about impacts in poorly observed regions? c) To which extent can the impacts of anthropogenic climate change be distinguished from those of natural climate variability?

K-1118a-03

Attribution of extreme events : Taking attribution science to the limits

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Around the World recent heatwaves, floods and droughts have demonstrated the vulnerability of citizens to such extreme weather. However, scientifically robust information about the extent to which recent extreme weather events can be linked to climate variability and change is often lacking. There is therefore a clear need to develop better information on weather and climate risks as part of the development of climate services to enable citizens to better deal with the effects of climate change.

This paper describes recent progress in developing the

science needed to deliver such much needed reliable and timely information about weather and climate risks. It focuses on two important developments in particular.

An annual report published each September in the Bulletin of the American Meteorological Society seeks to explain extreme events of the previous year from a climate perspective. This report has demonstrated the capability to deliver assessments relatively quickly while also showing how the scientific capabilities to carry out such studies is developing rapidly with an increasing number of types of event being considered with larger geographical coverage.

One of the main international groups working to further the development of this science is the EUCLEIA project, a European funded project with eleven partners. EUCLEIA (European CLimate and weather Events: Interpretation and Attribution) is developing an attribution system to deliver reliable and user-relevant attribution assessments on a range of timescales; on a fast track basis in the immediate aftermath of extreme events, on a seasonal basis to stakeholder groups and annually to the annual attribution reports in the Bulletin of the American Meteorological Society.

We will illustrate the presentation with some of the main scientific highlights of this work while also exploring how such scientific information can be best developed and applied in future.

O-1118a-01

Attribution of record high daily temperatures in Australia in 2013

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There has been increasing scientific interest in understanding the climate factors associated with extreme weather and climate events. This has led to the series of special supplements in the Bulletin of the American Meteorological Society over the last three years on "Explaining Extreme Events from a Climate Perspective". A wide range of extreme events has been considered in the studies included in these supplements, ranging from heavy rainfall and drought events to record hot and cold seasons. However, there have been no studies so far on the attribution of record high daily temperatures at single sites.

The Australian summer of 2012-13 was the hottest summer averaged across Australia since reliable records began in 1910. Lewis and Karoly (2013) showed that human influences on climate have very likely increased the likelihood of extreme summer average temperature across Australia such as in 2012-13 by at least a factor of five. Here we present an analysis of the contribution of human-caused climate change to the frequency of events such as the record high daily temperatures that occurred across Australia on 7 January 2013 and in Sydney on 18 January 2013.

The recently launched citizen science distributed computing project weather@home ANZ (http://www.climateprediction.net/weatherathome/australia-new-zealand-heat-waves/) has generated very large ensembles of simulated regional daily weather data needed for the attribution of extreme events. By comparing the frequency of extreme daily temperatures in the model simulations for 2013 and for a counter-factual world without any human influences on the regional climate, we assess the role of human influences on the likelihood of these two cases of record high daily temperatures in Australia in 2013.

Lewis, S.C., and D. J. Karoly (2013) Anthropogenic contributions to Australia's record summer temperature of 2013. Geophys. Res. Lett., 40, 3705-3709. DOI: 10.1002/grl.50673

O-1118a-02

Human influence on climate in the 2014 Southern England winter floods and their impacts

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The whole winter of 2013/2014 was characterized by a near-continuous succession of westerly storms. Accumulated rainfall during January 2014 was the largest ever recorded for that month across much of southern England, including the Radcliffe Observatory record in Oxford that begins in 1767. Severe floods resulted, causing major disruption.

So far, quantifying any contribution from human influence on climate to such weather events and resulting floods has been difficult due to the large natural variability of winter precipitation in the North Atlantic and European regions. The emerging science of probabilistic event attribution however increasingly allows us to evaluate the extent to which human-induced climate change is affecting localised weather events. Under the project "EUropean CLimate and weather Events: Interpretation and Attribution" (EUCLEIA), an end-to-end attribution study is performed for the first time. An ensemble of 134,354 general circulation model simulations is run using the citizen science project weather@home. We find that the frequency of days in January in zonal flows increases jointly with increases in precipitation as a result of anthropogenic climate change. The best estimate of the change in risk of extreme (1-in-100-year in pre-industrial conditions) precipitation for January in southern England is an increase by 42%, but the uncertainty range includes no change or an increase by over 150% due to uncertainty in the pattern of anthropogenic warming. Further, we partition the impact of greenhouse gases to dynamic changes in atmospheric circulation and to thermodynamic increasing water loading, demonstrating that both mechanisms played a role. A hydrological model driven by the model-simulated precipitation gives similar increases in risk compared to precipitation for 30-day peak river flows for the Thames at Kingston. Given these river flows we estimate that anthropogenic climate change has placed an additional 3,500 properties in the Thames catchment (upstream of the tidal reach through London) at risk of flooding from rivers over a broad range of return-times. Our study provides for the first time an estimate of the scale of precipitation-related damages in a specific region due to the effects of anthropogenic changes in the composition of the atmosphere on climate.

O-1118a-03

Role of soil moisture vs. recent climate change for heat waves in western Russia

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Using the framework of event attribution, anthropogenic climate change was found to have a discernible influenceon the occurence-probability of heat waves, such as the one in Russia in 2010. Soil moisture, on the other hand, is an important physical driver for heat waves as its availability has a large influence on the partitioning of the available surface net radiation into latent and sensible heat flux. The presented study investigates the relative importance of both controls, soil moisture and increasing greenhouse gas concentrations, on heat waves in the region of the 2010 Russian heat wave. This is done with a large number of ensemble members from climate simulations with and without interactive soil moisture for both, the 2000s and the 1960s. The simualtions allow to determine the occurence-probability of heat waves with and without the soil moisture-temperature feedback and to compare

it to the warming caused by climate change. Thereby, we expect to see the largest effect on daytime maximum temperatures (TXx) and a smaller influence of soil moisture on the mean temperatures and cold extremes.

1118b - Attribution of extreme events: How are high impact extreme events changing and why ?

ORAL PRESENTATIONS

K-1118b-01

Framing Extreme Event Attribution from the Bottom up – an Enquiry into the Social Representations of key stakeholders, of the Press and of Climate Scientists

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Attribution of extreme weather events has recently generated a lot of interest simultaneously within the general public, the scientific community, and stakeholders affected by meteorological extremes. This interest calls for the need to explore the potential convergence of the current atttribution science with the desire and needs of stakeholders. Such an euiry contributes to the development of climate services aiming at quantifying the human responsibility for particular events.

Through interviews with climate scientists (internationally and within Germany), through the analysis of the press coverage of extreme meteorological events (heat wave in the Paris area, storm surges in the baltic sea), and through stakeholder (private sector, covernment services and local and regional government) focus groups, we analyze how social representations of the concepts associated with extreme event attribution are theorized. From the corpuses generated in the course of this enquiry, we build up a grounded, bottom-up, theorization of extreme weather event attribution. This bottom-up theorization allows for a framing of the potential climate services in a way that is attuned to the needs and expectations of the stakeholders.

From apparently simple formulations: "what is an extreme event?", "what makes it extreme?", "what is meant by attribution of extreme weather events?", "what do we want to attribute?", "what is a climate service?", we demonstrate the polysemy of these terms and propose ways to address the challenges associated with the juxtaposition of four highly loaded concepts: extreme - event - attribution - climate services.

O-1118b-01

Attribution of extreme climate events in coupled and uncoupled GCM experiments

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Extremes of weather and climate events at global and regional scales can have devastating effects on human society and the environment, and there is overwhelming evidence that these extreme events are changing. Interest in attributing the risk of these extreme events to anthropogenic climate change is increasing and understanding these past changes is critical for reliable projections of future changes. However, there is still no consensus about the best methodology for event attribution. A common approach relies on experiments in which the time periods of interest are simulated using an atmospheric general circulation model (AGCM) forced by prescribed sea surface temperatures (SSTs), with and without anthropogenic influences. A potential limitation of these experiments is the lack of explicit atmosphere-ocean coupling, and therefore a key question is whether the attribution statements derived from such studies are in fact robust. In this research, we have carried out climate model experiments to test attribution conclusions in a situation where the answer is known - a so called "perfect model" approach. The study involves comparing attribution conclusions derived from experiments with a coupled climate model (specifically an AGCM coupled to an ocean mixed layer model) with conclusions derived from parallel experiments with the same atmosphere model forced by SSTs taken from the coupled model experiments. We analyse and compare the changes in surface air temperature and precipitation in response to anthropogenic forcing in the coupled and uncoupled experiments, assessing both seasonal mean changes and extreme events. Our experimental design also allows comparison with observed changes. Our results demonstrate that whilst the AGCM method has some strengths, it also has significant limitations and may lead to erroneous attribution conclusions in some situations.

O-1118b-02

Unreliable climate predictions overestimate attributable risk of extreme climate events

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Climate predictions are increasingly being used to attribute single extreme climate events to anthropogenic factors by retrospective predictions. The reliability of the systems to predict extreme events might be an important aspect in such an assessment, yet limited hindcast periods which cover only a small number of extreme events in the past inhibit a robust evaluation. Using an idealized framework based on a synthetic forecast model this limitation is here circumvented. The framework allows to perform large number of predictions and to compute the fraction of attributable risk (FAR) on extreme events. Varying the forecast reliability shows that unreliable climate predictions are prone to overestimate the FAR due to ensemble overconfidence, which leads to unrealistically small probabilities for the event to occur without climate change. We show under which conditions forecast reliability becomes important an factor and give an outlook for future event attribution systems using climate predictions.

O-1118b-03

Investigating human influence on Southern France heavy precipitation events

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In spite of a relatively dry mean climate, the Mediterranean regions in Southern France use to experience heavy rainfalls over short durations - typically a few minutes to one day. If compared to the rest of mainland France, 10-yr return values of maximum daily precipitation are two to four times larger over this area. The 2014 fall season was particularly severe, with 11 events exceeding the 190mm/day threshold, flash floods and several fatalities.

The possible link between such events and anthropogenic climate change has not been specifically addressed so far. Several approaches might be proposed to deal with this issue, including the realisation of specific climate model experiments. Unlike many other studies, we only focus on past observations and investigate the significance of recent trends in such events. Trends are investigated in terms of magnitude, frequency, and extent of events. Some statistical challenges arise to properly account for spatial depencies among locations. While previous studies looked at trends locally or over a small neiborhood, here

we propose an aggregated diagnosis for the whole region (about 100 stations). The consistency of these trends with the change simulated by state of the art climate models is also discussed. Main results suggest that observationnally based estimates of the human influence on heavy precipitation events are still weakly constrained over such a limited area.

O-1118b-04

Attribution of the June-July 2013 heat wave in the southwestern United States

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A severe heat wave occurred in the southwestern United States (US) during June and July 2013. To investigate the effects of natural variability and anthropogenic climate change on this event, we generated large ensemble simulations of possible weather using the MIROC5A climate model forced by "historical external forcing agents, sea surface temperature (SST) observations and sea ice (SIC) observations" both with and without human influence. It was suggested that both the anthropogenic warming and an atmospheric circulation regime related to the natural variability of SST and SIC made the heat wave event more likely. On the other hand, no significant human influence was found in atmospheric circulation patterns. These results were robust for two different estimates of anthropogenic signals on SST and SIC.

O-1118b-05

Attributing regional effects of the 2014 Jordanian drought to external climate drivers

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Throughout 2014, the regions of Jordan, Israel, Lebanon and Syria have experienced a persistent draught with clear impacts on the local populations. In this study we look at how the probability of such a draught has changed under climate change, with a specific focus on the flow rate of the Litani river and the water level of Lake Tiberious (AKA the Sea of Galilee). Both of which hold major societal, political and religious importance. To perform the analysis we make use of distributed computing power to run thousands of modelled years of 2014 with slightly different initial conditions. We use an atmosphere only model (HadAM3p) with a nested 50 km regional model covering Africa and the Middle East. These data are downscaled to 1 km. Two separate experiments and simulations, 1. For all known climate forcings that are present in 2014, and 2. For a naturalised 2014 scenario where we assume humans never impacted the climate. For observations, we use station data obtained from the Jordanian Ministry of Water. Using a combination of these local station observations and model data we are able to make clear statements on the attribution of a 2014-like draught event to human causal factors.

O-1118b-06

Distinguishing natural and anthropogenic influences on extreme fire danger in Australia

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In the aftermath of the 2013 Blue Mountains wildfires in New South Wales, Australia, the scientific community was faced with the challenge of quantifying the event's link to different causal factors, including human-induced climate change. While there are a number of recorded attribution studies for temperature and precipitation-related events, no such study exists for fire weather.

This study investigates how the likelihood of extreme fire weather in south-east Australia has been changed due to the competing influences of human-induced climate change and modes of inter-annual climate variability. Our analysis benefits from the use of the recently launched weather@home Australia-New Zealand distributed computing citizen science project to generate very large ensembles of regional climate model simulations over Australia. The likelihood of extreme fire weather is examined for different phases of the El Niño Southern Oscillation under present climate conditions and climate conditions with no human influences.

1118-POSTER PRESENTATIONS

P-1118-01

Contribution of soil initial conditions for the occurrence of the 2003 and 2010 heat waves

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Dry soil moisture condition before both 2003 and 2010 heat wave over western Europe and Russia, respectively have been suggested to play an essential role on the occurrence of the event. In order estimated the impact of soil initial conditions on those two heat waves, we run two sets of seasonal hindcasts with the general circulation model EC-Earth2.3. The initialization of those hindcasts is done either using climatological or realistic land surface initialization in May, June, July and August using the ERA-Land re-analysis. Results show that the 2003 heat wave is predictable either with climatological or realistic land-surface initial condition and for all considered start dates. This feature clearly shows that the 2003 heat waves was predictable. Conversely, the 2010 heat wave is reproduced in May only if the land is realistically initialized, while in June the event is not predicted by none of the hindcasts. The present study will investigate the processes behind the occurrence of the two heat waves.

P-1118-02

Evaluation of Mechanisms of Extreme Temperatures over Europe and North America

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The 20th century reanalysis is used to investigate changes in the monthly frequency, location and intensity of temperature extreme events during the first half of the 20th century for North America and Europe. Using composite analysis the main synoptic weather patterns associated to the events are identified in the 20th Century Reanalysis and compared to those associated with events in the latter 20th century. An assessment of the capability of CMIP5 models to simulate these extreme events and their mechanisms is also performed by comparing the model patterns with those obtained from the 20C reanalysis.

P-1118-03

Attribution of Extreme Summers in Northern Europe

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The summer climate of northern Europe exhibits large variability from year to year and on longer timescales. In extreme summers the region experiences heat waves, droughts, or floods. This presentation will discuss the characteristics and drivers of variability in northern European summers with a particular focus on the summer of 2012, which was a record wet summer in northern Europe and was associated with widespread flooding, and the contrasting warm dry summer of 2013. The wet summer of 2012 was not an isolated event but rather one in a cluster of wet summers that have occurred more

frequently in the 21st century than in the last decades of the 20th century. Wet summers are associated with a southward position of the North Atlantic storm track and a negative phase of the Summer North Atlantic Oscillation, with the opposite pattern for dry summers. The magnitude of decadal variability in these features suggests a role for forcing from outside the dynamical atmosphere. Climate model experiments have been carried out to identify the drivers of variability and to attribute the factors that influenced the summers of 2012 and 2013 in particular. The results indicate that anthropogenic forcing, both through its direct impact, and through its impact on warming sea surface temperatures, has substantially increased the likelihood of hot summers in northern Europe. Establishing the impact on the likelihood of wet or dry summers is more complex. Evidence suggests that changes in North Atlantic Sea Surface Temperatures were an important factor in explaining the striking contrast between the summers of 2012 and 2013. The implications of these findings for future summers in northern Europe will be discussed.

P-1118-04

The extreme wet 2013/2014 winter season in Western Europe in a changing climate

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Southern UK and North Western France witnessed records of precipitation amounts during the winter of 2013/2014. How this specific extreme seasonal event is linked to climate change remains a difficult issue, due to the large inter-annual variability of precipitation amounts. Using observational records and the new EURO-CORDEX regional climate projections ensemble, we find that over the regions hit by the 2013/2014 event, recent trends in winter precipitation have increased. The estimates from observations are consistent with those from climate simulations. The non-significant change of the return period of the seasonal precipitation is found to be reduced.

We also address the issue whether precipitation amounts would have changed across past decades as a result from external changes than those of the regional atmospheric flow, we used the methodology of circulation analogues, computed from anomalies of sea level pressure over the North Atlantic region. Seasonal precipitations in the regions under study are well reproduced by flow analogues. We find that Southern U.K. precipitations occurring with analogue flows taken in the early part of the century are on average weaker than those taken from analogue flows from analogue flows in the past few decades.

P-1118-05

Climate change induced temporal variability of droughts in Ukraine – the role of North Atlantic Oscillation

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We used the multiscalar drought index – standardized precipitation evapotranspiration index – to investigate spatiotemporal droughts variability caused by the climate change. The index was calculated using the 0.5 degree grid data on the temperature and precipitation for Ukraine. The two periods with different trends of global temperature – 1951-1980 and 1981-2010 – were used to reveal a climate change impact.

The analysis revealed the periods with moistest and driest conditions. The moistest years were registered in the end of 1970s – start of 1980s. Moreover, both the number and intensity of droughts increase significantly since 1980, especially for the Southern Ukraine. During the 2006-2009, the most extreme and long drought was observed in the Odessa region. The analysis also showed that hydrological droughts begin with some delay from the meteorological ones, and have maximal duration.

We used CUSUM method in order to detect specific years, when the significant change points occurred in the time series of droughts. This method also detected the start of 1980s as the years of transition from the moist to the dry conditions.

The cross-wavelet transform was applied to reveal a connection between the droughts in Ukraine and teleconnection patterns in the North Atlantics. The analysis showed that the North Atlantic Oscillation (NAO) has a maximal effect on the droughts in Ukraine. The anti-phase relation is registered for the joint fluctuations with the periods 2-3 years and is most prominent in the Southern Ukraine. On the contrary, the NAO has a small impact on the Northern Ukraine. This fact can be explained by the orientation of main storm tracks for positive and negative phases of the NAO.

P-1118-06

Understanding the role of anthropogenic climate change behind changes in regional heatwaves

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Since 1950, heatwaves have been increasing in their intensity, frequency and duration over many global regions. This period of time includes the temperature "hiatus", where global average temperature did not significantly increase since 1998. This study makes use of a 21-member of a single GCM to determine whether changes in heatwaves over various global regions are a result of anthropogenic, and whether observed changes and discrete heatwave events could have occurred without human influence on the climate.

The 21-member ensemble of the Community Earth System (CESM) global climate model is a novel tool, in that it provides a considerable estimate of internal climate variability that is not readily obtainable from most other model ensembles. Each of the historical and future simulations has identical prescribed external forcings, the former of which is based on observations. However, they differ only slightly in their atmospheric initial conditions, commencing on 1st January 1950. The resulting simulations provide a unique sample of a large range of "possible" climates that are all equally plausible under the same external conditions and physical mechanisms of the model. This is distinctive from a multi-member model ensemble such as the 5th Phase of the Climate Model Intercomparison Project, where each participating model has a different physical set-up. Moreover, the version CESM employed in this study provides a 980-year control simulation, allowing for substantial research into climate conditions without influence from human activity.

Firstly, this study explores whether a hiatus occurred for regional heatwaves. Results show that for many global regions there is a large range in plausible heatwave trends during the ~15 year hiatus period, thus inhibiting the robustness of any one estimate, including that of observations. Next it is explored whether similar heatwave trends are possible without anthropogenic climate change. Similar to absolute changes heatwave intensity, frequency and duration, we conclude that the rate of change (i.e. trend magnitudes) in heatwaves since 1950 is primarily a result of human influence on the climate system.

Lastly, the fraction of attributable risk methodology (FAR) is employed to determine whether the likelihood of particular heatwave events have increased due to human influence on the climate. For all regions, it is very likely (>90% probability) that there has been a substantial increase in what is now considered the 1-in-20 year heatwave events. Moreover, for some regions, there is little evidence the current 1-in-20 year heatwave event would have occurred at all without anthropogenic activity. Such results highlight that there is already a signal in anthropogenic climate change in the extreme events we observe today.

P-1118-07

Scenarios for extreme climate characteristics

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State-of-the-art regional climate models (RCMs) are the best tools to provide detailed and quantitative information about future climate change at regional and local scales since it describes physical processes affecting regional climate features in detail. The results obtained from a regional climate model of around 10-25 km horizontal resolution are of good basis for local impact assessments instead of using low resolution global climate model outputs. However, model simulations have different sources and magnitude of uncertainties, the climate modelling community strives to deliver the projection results together with their uncertainties for impact studies. To assess uncertainty in the simplest way, at the Hungarian Meteorological Service two RCMs are run covering Central-Eastern Europe: REMO (25 km) adapted from Max Planck Institute for Meteorology and ALADIN-Climate (10 km) from Météo-France.

Local impact assessments are based mainly on daily minimum and maximum temperature (besides daily mean values). According to observational data, our local climate over Hungary is warming up more rapidly than the global temperature. The main question of our investigation is whether the record highs increase or the record lows decrease faster. Using observations we calculate how many record high daily maximum temperature and record low daily minimum temperature are set in each year over a grid point. Current record high to record low ratio is above one: it is around 3 to 1 in Hungary with an average of 3.6 in the last 5 years and 2.6 in the last 10 years. Relative increase of record highs to record lows is shown for the two locally-run RCMs from 1961 to 2100, however, the increasing ratio could eventuate that record lows could disappear in the whole country around the end of the 21st century.

We give results for the record high daily precipitation, as well. Compared to the theoretical stationary climate conditions, observations show only an intensification in the inter-annual variability of precipitation records in Hungary. The two models also do not expose robust results: only one model shows a clear increase in record high daily precipitation for the end of the 21st century.

1119a - Extreme hydrological events: Deciphering changes in hazard and risk at different time-scales

ORAL PRESENTATIONS

K-1119a-01

Review of Hydrological norms for Climate Change Resilient Hydraulic Infrastructures in Africa (RESIHYST-Africa): towards a regional programme

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In order to address the current and future water needs and to boost the economic growth of African countries, it is crucial to improve substantially the current rate of mobilization of renewable water resources which is less than 5%. Hydraulic infrastructures (Dams) with various sizes are needed to increase substantially the level of water storage. For road construction, urban water drainage and flood protection other types of hydraulic infrastructures are needed. In many African countries, guidelines and hydrological norms currently used by engineers and managers are obsolete.

In West Africa for example, particularly francophone countries, the hydrological norms for the design of hydraulic infrastructures currently used were established during 60-70s. These norms were established based on hydrological data collected from around 200 experimental basins in West and Central African countries for a period of 3 to 5 years during and following the International Hydrological Decade which led to the creation of the UNESCO International Hydrological Porgramme. In regard to the ecological and climate changes recorded within the region and the huge consequence on infrastructures safety and with the future climate change, there is an urgent need to review and adapt these norms for a resilient design of hydraulic infrastructures in the region. Within the framework of its International Hydrological Programme and on the request of countries through a resolution of IHP Africa national committees UNESCO has initiated a regional programme to address the issue of hydrological norms for the design of hydraulic infrastructures within the context of climate change with a focus for the first phase on West and Central Africa. The first phase of the programme will concern 26 countries from ECOWAS and ECCAS. Two experts working meetings have been held in Ouagadougou. Twelve baseline studies have been conducted in the following countries: Senegal, Niger, Ivory Coast, Guinea, Togo, Benin, Chad, Cameroon, Congo, CAR, DRC and Rwanda.

The regional programme will have the following components: i) Data and hydrological monitoring: new basins should be monitored in partnership with hydrological services and universities and all available climate and hydrological data capitalized; ii) Analysis, Methods and Modelling: Based on the available and collected new data, hydrological research will be conducted focusing on techniques, methods and hydrological modelling for a robust and adapted assessment of discharges taking into account non the stationarity; iii) Operational tools: proposition of new adapted hydrological tools (guidelines, softwares,..) and iv) Capacity building and promotion of the new tools: capacity building at various levels including technician, engineer, graduate and a wide dissemination of the new tools will be considered.

There is an urgent need to mobilze key stakeholders and donors for the funding of the programme which has been endorsed by ECCAS and ECOWAS.

K-1119a-02

Extreme seasonal hydrological events in the Amazon Basin

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The Amazon basin is the world's major hydrologicalsystem. Its watershed covers about 6,000,000 km2, almost 5% of all continental masses, andits average discharge is the greatest inthe world (±200,000m3/s). During the last decades, an intensification of extreme seasonal hydrological events (droughts and floods) has been reported in the Amazon region, producing strong impacts on humans and natural systems. In this contribution we propose a synthesis of the key aspects of the recent extremes droughts and floods in the Amazon basin from the Andean regions to the lowland rainforest, including their causes and main impacts. Our results are based on large-scale climate data and observed hydrological information coming from the whole Amazonian countries, in the context of the SO-HYBAM observatory. A trend towards an intensification of the hydrological cycle has been reported during the last decades. For instance, in the Peruvian Amazon, a significant discharge diminution trend ($p<0.01$) is noticed during the low-water season; indeed discharge decreased by 30% after the 1990s when comparing to the 1970-1989 period. However, no trend is observed during the high-water season but extreme floods have recently occurred (e.g. 1999, 2012). Extreme hydrological events have been frequently related to sea surface anomalies in the Pacific and Atlantic oceans. For instance, intense rainfall and subsequent floods have been associated with La Niña events (e.g. 1989, 1999, 2011 and

2012) or to warm conditions in the tropical South Atlantic, as observed in 2009. However the 2014 rainfall and flood anomalies have been related to warm conditions in the western Pacific-Indian Ocean and to exceptional positive anomalies in the Subtropical South Atlantic. Rainfall deficits and droughts have been attributed to El Niño events (e.g. 1998), or to warm conditions in the tropical north Atlantic (e.g. 2005) or to a combination of both oceanic features (e.g. 2010).

O-1119a-01

Evolution rain-vegetation-agricultural yields in the watershed of the Bouregreg (Morocco) from 1980 to 2009

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Bouregreg Watershed (central Northwest of Morocco) belongs to the agricultural area of Morocco. The agricultural area of the country is only 20% of its national territory, where a strong agricultural and pastoral attractiveness for wet areas like Bouregreg watershed. This watershed is subject to a Mediterranean semiarid climate. Precipitations that fall are estimated, on average, 400 mm per year. They are unevenly distributed over the basin. Thus, the altitude is causing a significant rainfall contrast between Northeast parts of the basin where rainfall rising to 760 mm per year and Southwest areas where they drop to less than 350 mm per year. In addition, climate dynamics of this space, since the 1970s, is marked by strong climate variability with a downward trend in rainfall. This is a major concern for the agricultural and pastoral production; especially that agriculture is mainly rainfed. The crop production system (natural or cultivated) is heavily influenced by the soil and climate conditions in Bouregreg watershed.

This study analyzes the interaction between changes in precipitation and dynamics of crop production from 1980 to 2009. It is a component of the SIGMED (project Spatial approach to the impact of agricultural activities in the Maghreb on sediment transport and water resources in large river basins). The study focuses on the impact of droughts and wet periods on crop production. To achieve this goal, a time series of comparative statistical analysis is first performed on Normalized Difference Vegetation Index (NDVI) of NOAA (National Oceanic and Atmospheric Administration) and MODIS (Moderate Resolution Imaging Spectroradiometer), made in space mesh of 8 km x 8 km, and rainfall series. In holding the large spatial variations in rainfall in the basin, the analysis is made by homogeneous climatic unit. Then, a special statistical analysis is performed on the dynamics of agricultural production, frequencies and intensities of agricultural drought. Droughts and their intensity are determined by linear regression of cereal production with a 95% confidence interval.

The analysis of the evolution of vegetation reveals significant interannual variation in plant activity (37% coefficient of variation), with a marked tendency to decline in the summer. A break in the dynamics of plant activity of the basin is observed in 1999: Reductions are 13% and plant activity maxima are before 1995. The largest areas are located downstream, in the center and south of the basin. The analysis of changes in rainfall also highlights an interannual variation of 30 to 40%, with deviations from the average, greater than 120 mm. Paradoxically, there is no annual downward trend in rainfall amounts in downstream, the center and the south of the basin, but in the northeast that is the wettest area of the basin. In addition, the observation of a significant decrease of vegetation in the summer is not correlated to changes in rainfall. For cons, the correlation between precipitation and vegetation change in wet period (growing season) is important. The analysis of the evolution of wheat (soft and hard) and barley agricultural droughts (the three grains representing ¾ of agricultural production of the basin) allows to notice a declining intra seasonal dynamic of rainfall amounts during wet periods. Agricultural drought is particularly great between 1990 and 2002. Analysis of drought frequency for all three cereals allows concluding that the period from 1980 to 2009 was marked by eleven important agricultural droughts. The intensities of droughts between 1990 and 2002 are between 60 and 80% for these cereals. Thus, the high productions of certain grains such as wheat are mainly related to the conquests of new lands. Yield reductions are offset by an extension of cultivation areas at the expense of forests and fallow land. In addition, the overall decline in plant activity in summer is related to increasing grazing pressure and thus to a rapid depletion of crop residues. This further leads to another pressure on forest vegetation and scrub.

O-1119a-02

Monitoring and seasonal forecasting of droughts in China

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Persistent hydrologic extreme events such as droughts have devastating impacts on the human and natural systems. Their occurrences are associated with anomalous atmospheric moisture transport which may be linked to variations of large-scale climate phenomena (e.g., ENSO), and their severities and durations are also influenced by land-atmosphere coupling that can enhance existing extremes. They may be further exacerbated by anthropogenic climate change and human water consumption. Improving our monitoring and forecasting capability of droughts, and facilitating adaptations through establishing climate service systems at regional to global scales, are among the grand challenges proposed by the WCRP, and are the core themes of the GEWEX/RHP. Focusing on the major river basins in China, I will show the quality of the latest satellite surface soil moisture retrievals produced by the European Space Agency Climate Change Initiative (ESA CCI) for drought monitoring, and the drought predictability and forecast skill based on North American Multi-Model Ensemble (NMME) climate forecast models.

As compared with in-situ observations at 312 stations in China and global reanalysis, the ESA CCI soil moisture products provide independent drought information over sparsely observed regions such as northwestern China, and the active microwave product with better vegetation penetration works the best in southern China. Although remote sensing products can only detect less than 60% of drought months over most in-situ stations, they capture the responses of inter-annual drought variations to ENSO at river basin scales quite well.

For drought forecasting using NMME models, the drought predictability is quantified by using a perfect model assumption. Drought predictability and forecast skill are positively correlated, but they vary depending on seasons, regions and forecast leads. Higher drought predictability is found over regimes where ENSO has more significant impact. For the ENSO-affected regimes, both drought predictability and forecast skill in ENSO years are higher than that in neutral years.

The outputs from NMME climate forecast models are bias corrected and downscaled to drive a hydrologic model to produce hydrologic drought (in terms of soil moisture or runoff anomaly) forecasts over river basins in China. Hydrologic hindcasts will be performed and evaluated against in-situ station observations and satellite products for a comprehensive analysis.

O-1119a-03

Trends in Precipitation Extremes over Mississippi and Yangtze River Basins in CMIP5 Models

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Both central-eastern portions of U.S. and China are prone to increasing flooding from Mississippi River and Yangtze River Basin respectively. This presentation contrasts historical and projected spatial-temporal distribution of extreme precipitation in these two large river basins using 31 CMIP5 models' historical and RCP8.5 experiments. Results show that 1) over both river basins, the heaviest rainfall events have increased in recent decades while the lightest precipitation reduced in frequency. Over Mississippi River Basin, both the lightest precipitation (<2.5

mm/day) and heaviest (>50 mm/day) would decrease in frequency notably after mid-2020s while intermediate events occur more frequently in future; whereas over the Yangtze River Basin, all categories of precipitation are projected to increase in frequency over the coming decades. 2) Although the consensus of CMIP5 models was able to reproduce well domain-time mean and even time-averaged spatial distribution of precipitation, they failed to simulate precipitation trends both in spatial distribution and time means. In a similar fashion, models captured well statistics of precipitation but they had difficulty in representing temporal variations of different precipitation intensity categories. 3) The well-documented 2nd half of the 20th century surface summer cooling over the two river basins showed different associations with precipitation trends with higher anti-correlation between them over the U.S. region, implying different processes contributing to the cooling mechanisms of the two river basins.

1119b - Extreme hydrological events: Deciphering changes in hazard and risk at different time-scales

ORAL PRESENTATIONS

K-1119b-01

Attribution of Hydrological Extreme Events and the Need for National Inventories of Loss and Damage

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The Report of Working Group I (Physical Science Basis) of the IPCC assessed the evidence for trends in hydro-meteorological extremes and the growing literature on the attribution of extreme weather events, in a probabilistic sense, to anthropogenic drivers. In a very small number of cases, these event attribution studies have been carried through to hydrological impacts, but this remains a new and emerging science.

The Report of Working Group II (Impacts of Climate Change) of the IPCC reported on numerous studies of the hydrological impacts of observed climate change, but because of the paucity of the literature on «end-to-end» attribution, stepped back from making strong statements attributing these impacts to anthropogenic influence. Owing to the multiple uses of the phrase «Climate Change» in the IPCC and UNFCCC, there is considerable scope for confusion on this point, so I will review these issues carefully. The central question is the attribution of harm: how strong is the evidence that past greenhouse gas emissions and other forms of anthropogenic influence on climate have caused actual harm through their impact on hydrological extreme events?

I will argue, perhaps controversially, that these specific issues have evolved in such a way that the IPCC, or any global review process, is no longer the appropriate venue for their assessment: quantifying harm involves value judgments and region-specific contextualising and confounding factors such that it is often impossible to make any useful generalisations. Instead, the role of bodies such as the IPCC should become the assessment and recommendation of methods and standards of evidence, while actual assessments are carried out at a regional or national level.

I will provide a general, non-specialist over-view of the science of Probabilistic Event Attribution, specifically focussing on its application to recent flood and drought events. I will explain how different ways of framing the attribution question can yield different-seeming conclusions even if confronted with the same evidence, requiring the broader community to engage with these issues and not simply rely upon «attribution specialists».

In the context of extreme hydrological events, I will then ask what kind of extreme event is likely to be most important in determining the overall level of climate change harm: is it those very extreme events that would have been «effectively impossible» (or, more accurately, just very, very unlikely) in the absence of climate change, or is is the much broader range of events that have simply been made somewhat more (or less) likely by climate change. I will argue it is often the second category that is overlooked in national climate impact assessments because the role of climate change is relatively subtle, yet because there are simply so many more of these events, their cumulative impact could be quite profound.

All this builds up to the conclusion that, if countries are to get serious about quantifying Loss and Damage from climate change -- and it remains very much a matter of debate whether they will -- then they have no option but to work towards national or shared regional attribution services to allow them to quantify the role of anthropogenic climate change in regional hydrology, accounting for location-specific factors. I will discuss what this might involve, and present some ideas on how to go forward.

O-1119b-01

Future changes in extreme streamflow over the Amazonian sub-basins

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The Amazon basin plays an important role in regulating the local and global climate since the discharge at its outlet contributes nearly 20% of global freshwater inputs (Callède et al., 2010). Streamflow changes have been characterized by more severe extreme values on the main stream for about forty years. At Óbidos, the last gauging station before the outlet, the high flows significantly increase by 13% over 1903-2011 and exceed 250,000 m^3/s almost every year since the late 60s (updated from Callède et al., 2004). The low flows are stable over the period 1903-2011 but significantly decrease by 16% over the last twenty years. The resulting increase in the annual amplitude of discharge during the last two decades is marked by severe droughts (2005 and 2010) and floods (2002, 2009, 2012 and 2014), mainly attributed to large-scale oceanic and atmospheric circulation changes (Espinoza et al., 2012, 2013, 2014). The populations living near the rivers whose activity is regulated by the present annual cycle of waters are particularly sensitive to these extreme streamflow events. During high floods, boat trips are dangerous and the mobility of the populations is reduced. Severe low flows make the boat trips longer and increase fish mortality. Thus, food prices increase and directly impact the local economy. Given these facts, it is crucial to estimate the future of the hydrological extremes in the Amazon basin in a future warmer climate (between +1.5 and +5.0°C by 2100). The model ORCHIDEE (ORganising Carbon and Hydrology In Dynamic EcosystEms), the land component of the IPSL global climate model (GCM), is able to accurately simulate the present-time streamflow in many stations over the Amazon basin (Guimberteau et al, 2012). ORCHIDEE is therefore used to provide discharge projections at sub-basin scale under future climate. Climate change scenarios over the Amazon basin were built with the delta downscaling method approach from up to eight AR4 GCMs based on three emission scenarios for two periods of the 21st century. For the middle of the century under a medium-emission scenario, no change is found in high flow on the main stem of the Amazon River, but the low flows decrease by 10%. Contrasting discharge variations are pointed out depending on the location in the basin. In the western upper part of the basin, which undergoes an annual persistent increase in precipitation (P), more flooding events are expected (high flows increase by 7%). By contrast, simulated P decreases during the dry seasons over the southern, eastern and northern parts of the basin lead to significant low-flow decrease, especially in the Xingu River, where it reaches -50%. In the north, the

low-flow decrease becomes higher toward the east. Finally, the southern sub-basins, that have low runoff coefficients, will become more responsive to P change (increase in streamflow elasticity to P by up to 35%) than the western sub-basins, experiencing high runoff coefficient and no change in streamflow elasticity to P.

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O-1119b-02

Fires in Amazon: Comparison between land use and palaeoclimatic changes

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Interpreting the geological record of Amazon biomass combustion requires comparing charcoal accumulation rates in various biomes at different time scales. Charcoal accumulation rates, a proxy for palaeofire records, were obtained in sediment cores from Amazon lakes surrounded by several vegetation types and froma reservoir in an intense land use change region. The records presented in this studywere obtained in the following areas i) a reservoir in Alta Floresta region (northern Mato Grosso State); ii) Lago do Saci (southern Pará State), a lake close to Alta Floresta and located at the southern border of Pará State; iii) a bog in an ecotone area in the Humaitá region (southern Amazonas State); iv) lakes in lateritic iron crust of the Carajás Hills (southeastern Pará State); v) Lago Comprido, a floodplain lake close to the Amazon River and surrounded by tropical rain forest (Monte Alegre, Pará State; vi) Lagoa da Pata in the Morro dos Seis Lagos alkaline complex (São Gabriel da Cachoeira, Amazonas State) and vii) Lago Caracaranã, a secluded lake in the northern Amazon cerrado (Roraima State). The highest charcoal accumulation rates were observed for modern records related to an intense change in land use at Alta Floresta, which had no precedent during the Holocene history of the Amazon. High charcoal accumulation rates that were observed in the Carajás region during low lake level phases in the Amazon in the mid-Holocene were comparable to those at the onset of the human settlement in Alta Floresta region. An increase in charcoal accumulation rate was observed in the late Holocene when the lake level was high, suggesting an interaction between climates and human presence. Low charcoal accumulation rates are typical of modern high rainfall environments, as observed in Lagoa da Pata where the environment is not susceptible to occurrences of wildfires even during relatively drier climatic phases. Low charcoal accumulation rates also exist in the relatively dry cerrado (savanna type) biome even during relatively dry phases in the Caracaranã region where the savanna-type vegetation biomass is lower and thus generates less charcoal particles than forest ecosystems. The timing of fires correlated well with the mid-Holocene dry climate phase in Brazil. These events may be related to changes in the high-resolution record of CO2 in ice cores from the last 11,000 years. These records indicate an increase in CO2 concentration of 25 p.p.m.v. that occurred between 7000 and 1000 years BP. Anomalies of 5 ppm in the CO2 concentration in the atmosphere identified at the Taylor Dome station may similarly be related to the high variability in forest fire occurrence in the Amazon region recorded by the high charcoal accumulation rates that can be associated principally with human activity during the late Holocene, especially considering from higher lake levels that indicate a wetter climate compared to the mid Holocene.

O-1119b-03

Intense storm activity during the Little Ice Age on the French Mediterranean coast

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Understanding long-term variability in the frequency of intense storm activity is important for assessing whether changes are controlled by climate evolution. Understanding this variability is also important for predicting present and future community vulnerability and economic loss. Our ability to make these assessments has been limited by the short (less than 50 years) instrument record of storm activity. Storm- induced deposits preserved in the sediments of coastal lagoons offer the opportunity to study the links between climatic conditions and storm activity on longer timescales. In this study, we present a record of these extreme climatic events that have occurred in the French Mediterrannean coast over the past 1500 years. The identification of these extreme events is based on the analysis of sediment cores from Gulf of Aigues-Mortes lagoons that contain a specific sedimentary and geochemical signature associated with intense storms.

Overwash deposits do not show any evidence of intense storm landfalls in the region for several hundred years prior to the late 17th century A.D. The apparent increase in intense storms around 250 years ago occurs during the latter half of the Little Ice Age, a time of lower continental surface temperatures. Comparison of the sediment record with palaeoclimate records indicates that this variability was probably modulated by atmospheric dynamics. The apparent increase of the superstorm activity during the latter half of the Little Ice Age was probably due to the thermal gradient increase leading to enhanced lower tropospheric baroclinicity over a large Central Atlantic/European domain and leading to a modification of the occurrence of extreme wind events along the French Mediterranean coast. A complete understanding of the relationship between climate fluctuations, storm activity, and the coastal response will be crucial to predicting the impacts of future climate change.

O-1119b-04

Characterization of drought and soil moisture in context of climate change : results and operational applications of ClimSec project in France

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Evolution of water resource is one of the main stakes of climate change in France. The ClimSec project (2008-2011) focused on the impact of the climate change on drought and soil moisture over France by using a high resolution climatological reanalysis since 1958 based from a Soil Vegetation Atmosphere Transfer model, the Safran/Isba/Modcou suite.

The high-resolution 1958-2008 Safran atmospheric reanalysis was used to force the Isba land surface scheme and the hydrogeological model Modcou. Meteorological droughts are characterized with the Standardized Precipitation Index (SPI) at time scales varying from 1 to 24 months. Similar standardizing methods were applied to soil moisture and streamflow for identifying multiscale agricultural droughts - through the Standardized Soil Wetness Index (SSWI) - and multiscale hydrological droughts, through the Standardized Flow Index (SFI). Based on a common threshold level for all indices, drought event statistics over the 50-yr period - number of events, duration, severity and magnitude - have been derived locally in order to highlight regional differences at multiple time scales and at multiple levels of the hydrological cycle (precipitation, soil moisture, streamflow). Results show a substantial variety of temporal drought patterns over the country that are highly dependent on both the variable and time scale considered. Independent spatio-temporal drought events have then been identified and described by combining local characteristics with the evolution of area under drought have finally been used to compare past severe drought events, from multi-year precipitation deficits (1989-1990) to short hot and dry periods (2003). Results show that the ranking of drought events depends highly on both the time scale and the variable considered. This multilevel and multiscale drought climatology served as a basis for assessing the impacts of climate change on droughts in France.

At the end of the project, the new drought indices were adapted for the operational hydrological monitoring and used for the qualification of drought event in real time, namely for the 2011 spring drought.

These indices were also calculated in future climate from the various regionalized climatic projections available over France. Three particular experiences in socioeconomic scenarios, climatic models and downscaling methods have been run to estimate the relative importance different uncertainties for drought evolution.

In the same time, a diagnosis on drought evolution can be established with a schedule much shorter and more intense for the agricultural drought linked to the deficit of soil wetness than for meteorological drought in relation with the precipitation. The climatic projections suggest that France could know at the end of the XXIth century a quasi-continuous drought with a strong intensity, totally unknown in the present climate.

O-1119b-05

Analysis hydrometeorological events of floods in the watershed Mono shared Benin-Togo (West Africa)

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The recurrence of extreme anomalies of precipitations involving of the floods or the droughts is a normal component of the natural variability of the climate. The harmful effects of the floods these last have strong incidences socio-economic and ecological and involved human losses of life and property damages. The vulnerability with these natural risks is high in West Africa and basin of Mono in particular, where the populations tend to occupy the most exposed zones more and more. The objective is to model the distribution of the risings entering to the dam Nangbeto thanks to hydrological model GR4J with the step of daily time to assess the risks of flood in the low valley of the river.

The data used cover the period 1961 to 2010. They is the daily outputs (m3.s-1), the evapotranspiration (mm/jour, calculated according to method FAO) and average precipitations on the basin (mm/day). The various methods of space interpolation of the rains were tested (linear, cubic, Thiessen, simple average). Model GR4J was useful with modeling of the risings upstream and the stopping of 1988 to 2010 to appreciate the effects of the dam.

The results show a marked variation in rainfall by increasing annual maximum daily followed by an increase in ETP. The rates recorded in output Nangbéto dam are equivalent to those recorded input, especially during floods, showing the weak regulatory role of the dam and the very limited capacity of the reservoir. The annual maximum incoming flow at the dam can be modeled by an extreme value distribution (GEV) Fréchet-type, while those measured at the outlet of the dam after a GEV law Weibull (bounded). The dominant runoff generation mechanism in the basin is the gradual rising waters associated with increased saturation of the soil, rather than isolated episodes of rainfall. The analysis of flood flows between 1988 and 2010 showed no increase in flood magnitude during this period. Finally the effectiveness of the model to reproduce GR4J flood flows has been tested showing that the observed floods are simulated during calibration. However, validation tests over several periods with different climatic characteristics show a degradation of performance criteria and the model as one moves away from the calibration period, showing the instability of the model parameters in the time. Under these conditions, the use of such a model to assess future risks future flooding is risky and it is necessary to consider alternative approaches.

1119-POSTER PRESENTATIONS

P-1119-01

Extreme rainfall analysis and water resources system sensitivity in Nigeria

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Climate change poses unique challenges to global socio-economic development and growth of the societies due to multiple shocks and stresses concurrently faced. This call for studies to estimate the potential impacts of climate change on the society. Extreme rainfall events today pose a serious threat to many populated and urbanized areas worldwide since anthropogenic climate change is now widely considered to have the potential not just to cause perturbations in the weather but also to create major discontinuities in many complex natural and human systems.

Hence, the need for an accurate estimate of frequency and distribution of extreme rainfall events can significantly aid policy planning in the area of land use planning and water resources system design that suits the harmonizing plan of their enormous physical structure and hydrological system. Quality precipitation information remains an indispensable requirement for warning systems, hydraulic structures design, risk assessment and hydrological modelling. Hence, reliable spatial information on precipitation distribution and pattern at finer climate information scale remains an important tool towards attaining a sustainable socio- economic development of a region, in the wave of climate change and variability.

In this study an attempt was made to address the potential effect of extreme rainfall events on the water resources system sensitivity in Nigeria, in the aftermath of observed current global change scenarios. These analysis entails fitting of statistical distribution of the monthly rainfall dataset (1960 - 2005) for the analysis of extreme events and generation of rainfall intensity-duration-frequency curves. Also, the threshold level was used to evaluate the extreme conditions. This is necessary in other to address potential climate change effect in terms extreme rainfall

occurrence and water resources system sensitivity in Nigeria.

P-1119-02

Groundwater induced flood estimation in extreme rainfall context; methodological approach applied to Somme basin (France)

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Climate change is expected to modify hydrological cycle, and extreme events would be more frequent. Increasing extreme precipitation (frequency and intensity) projected in northern Europe and continental Europe (IPCC WG2 AR5 chapter 21) would result in an increase of flood risk. In chalky basins located in northern France (Somme catchment) and the United Kingdom (Pang and Lambourn catchments), groundwater flooding, with return periods superior to 100 years has already occurred in winter 2000/20101. The estimation of groundwater contribution to flood peak under extreme rainfall context remains difficult because of a lack of appropriate methods and data. Nevertheless, this estimation is a decisive element for policy makers to assess and manage the flood risks.

In the Somme basin, a probabilistic approach to develop «extreme» climate scenarios based on cumulative rainfall return period of 1000 years and hydrodynamic modeling of the groundwater and rivers system were used. A statistical extreme value analysis using a long rainfall time series allowed defining rainfall events of return period of 1000 years. Correlative analysis rainfall–discharge of the Somme river at the watershed outlet (Abbeville station) performed with cumulative rainfall over n days show that the best correlation is obtained with a total of n=180 rainy days. In addition, estimating the river discharge of return period 1000 years was made by fitting a probability distribution for extreme events (GEV law)

Several scenarios were simulated with the hydrodynamic model of the Somme basin; they differ in the temporal distribution of daily rainfall over the period of 180 days, the groundwater level at the onset of the rainy millennial episode, and the value of base flow of the river at the start of the rainy millennial episode.

The results highlight the rainfall distribution importance on the maximum discharges and the influence of the water table and the base flow of the river at the onset of the rainy period. It is also clear that for such climatic events, the groundwater contribution to the Somme river discharge remains important, between 65% and 72% of the flow according to the scenarios.

P-1119-03

Paleoclimate reconstructions over eastern Andes of Perú and Bolivia based on stable isotopes □18O of speleothems

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During the last years, especial efforts on paleoclimate reconstructions have shown interest in the behavior of South American Monsoon System (SAMS) during the last 2 ky. Since there is considerable concern that the SAMS dynamics will be significantly affected by increasing greenhouse gas concentrations in the 21st century, there is an urgent need to improve document and understand the causes of Monsoon variations in response to natural forcing during the most recent past period. For instance, climate modeling studies and additional paleoclimate records of ocean and atmospheric conditions are needed to best define the relationships between SAMS rainfall and ocean– atmosphere variability during the late Holocene.

In this sense, we have developed stable isotopes (δ18O, δ13C) and trace elements time series (Ex: Mg/Ca, Sr/Ca) from calcite speleothems collected in the eastern Andes of Perú (Rioja – San Martin, ~6° S) and Bolivia (Torotoro – Potosí, ~18° S). These records allow us to reconstruct past changes in the SAMS and local hydrological conditions during the Holocene with special interest through most of the last two millennia. Our results evidence different modes of SAMS variability arriving from decadal (64 yrs) to millennial timescales (1500 yrs). Comparison between Andean records and other South American proxies records reveals spatial changes in rainfall distribution and SAMS intensity over different time periods. Such variations in SAMS suggest interactions of oceanic – atmospheric modes triggering teleconnections associated with hydroclimate conditions reconstructed in the SAMS region.

Moreover, it is worth noting that is necessary to develop more proxies record in the southern hemisphere and key areas of the SAMS for better understand the climate system. Additionally, it is also important to reproduce these changes by coupled ocean–atmosphere models in order to define and recognize better relationships and mechanism that could affect this system. These approaches would bring invaluable tools for define possible effects of climate change in SAMS and reduce population affected by extreme events in South America.

P-1119-04

Extreme events effects on dissolved inorganic and organic carbon yields and fluxes in the watersheds of tropical volcanic islands, examples from Guadeloupe (FWI)

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Organic matter is an important factor that cannot be neglected when considering global carbon cycle. New dataincluding organic matter geochemistry at the small watershed scale are needed to elaborate more constrainedcarbon cycle and climatic models. The objectives are to estimate the DOC and DIC yields exported from smalltropical watersheds and to give strong constraints on the carbon hydrodynamic of these systems. To answer thesequestions, we have studied the geochemistry of eleven small watersheds around Basse–Terre volcanic Island in theFrench West Indies during different hydrological regimes from 2006 to 2008 (i.e. low water level versus floods).We propose a complete set of carbon measurements, including DOC and DIC concentrations, 13C data, and lesscommonly, some spectroscopic indicators of the nature of organic matter. The DOC/DIC ratio varies between 0.07and 0.30 in low water level and between 0.25 and 1.97 during floods, indicating that organic matter is mainlyexported during flood events. On the light of the isotopic composition of DOC, ranging from 32.8 to 26.2hduring low water level and from 30.1 to 27.2hduring floods, we demonstrate that export of organic carbon ismainly controlled by perennial saprolite groundwaters, except for flood events during which rivers are also stronglyinfluenced by soil erosion. The mean annual yields ranged from 2.5 to 5.7 t km 2 year 1 for the DOC and from4.8 to 19.6 t km 2 year 1 for the DIC and exhibit a non–linear relationship with slopes of watersheds. The flashfloods explain around 60% of the annual DOC flux and between 25 and 45% of the DIC flux, highlighting theimportant role of these extreme meteorological events on global carbon export in small tropical volcanic islands.From a carbon mass balance point of view the exports of dissolved carbon from small volcanic islands are importantand should be included in global organic carbon budgets.

P-1119-05

Modeling the 2013 Typhoon Haiyan storm surge: Effect of wave coupling, offshore winds, and tidal level

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Super Typhoon Haiyan, with wind speeds exceeding 300 km h-1 generated a storm surge in San Pedro Bay reaching heights of more than 6m in Tacloban City. Severe winds and storm surge heights caused catastrophic structural damage and casualties. Delft Dashboard (DDB), an open-source standalone Matlab based graphical user interface, was used to develop a coupled flow and wave storm surge model to understand the Typhoon Haiyan storm surge development and propagation. Model results corroborated by field observations showed that as the storm center entered Leyte Gulf, strong northerly winds prevailing on the northern part of San Pedro Bay caused sea level to recede by 1-2m. This was followed by the development of the surge off the towns of Palo and Tanauan. This surge then propagated northwards to Tacloban and Basey as the winds shifted to the north when the storm center made landfall. Various idealized simulations were also designed to determine the effect of wave coupling, offshore winds, and tidal phase, with results highlighting importance of physical processes such as wave dissipation, wind-forced flow, and non-linear tide and surge interactions.

P-1119-06

Future trends of South American droughts: comparison between the reference period 1961-1990, and the RCM-CORDEX projections in the period 2071-2100

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1 Introduction

The relationship between positive precipitation anomalies and the warm phase of ENSO phenomenon (El Niño - Southern Oscillation) has been broadly documented in the southern South America (Grimm and Tedeschi, 2009; Grimm, Barros, and Doyle, 2000). Nonetheless, the tropical region of the continent faces drought conditions when El Niño is turned on (Poveda and Salazar, 2004; Marengo, 2004; Fu et al., 2001). Another studies have shown the broad spreading of positive trends in temperature time series, and the negative trend of precipitation time series in some areas of Amazonian basin (Aguilar et al., 2005; Haylock et al., 2006). These positive trends for temperature, and erratic trends for precipitation, are consistent with the climate models projections (Marengo et al., 2009; Urrutia and Vuille, 2009; Cook and Vizy, 2008).

Given the scenario described above, some questions arise about what will happen with South American droughts. Li et al. (2008) showed that, according to the Standardized Precipitation Index (SPI), the Amazon region has been undergone to recurrent drought conditions since 1970s, which were particularly strong during the great drought of 2005 (Zeng et al., 2008). However, it seems that periods of drought in southern South America will be reduced because the spatial re-arrangement of precipitation. The objectives of this project are computing the Dry Spells Length (DSL) for different intensities of drought; as well as, computing trends and future changes on South American droughts using data from Regional Climate Models (RCM).

2 Methodology and Results

2.1 Data

Precipitation's time series from Delaware University database (Matsuura and Willmott 2012a; Matsuura and Willmott 2012b) were used in order to compute the climate model's bias from observed data. The future trends of droughts were estimated using RCM from CORDEX project (Coordinated Regional Climate Downscaling Experiment). The RCM were developed by SMHI (Swedish Meteorological and Hydrological Institute) under the RCP 4.5 and 8.5 (Representative Concentration Pathways). The spatial resolution of the models is about 50 km close to the terrestrial equator.

2.2 Drought definition

The SPI was chosen in the present work as drought's metric (Agnew, 2000). The SPI is among the most widely used drought index because its versatility, since it only uses precipitation data. The SPI could be computed using several temporal scales (e. g. 3, 6, 9 or 12 months). The more negative is the SPI, the more intense are the drought periods.

From the SPI, the depiction of the droughts was done in the reference time window 1961-1990 (also, 1961-1990 was the reference time window to compute the SPI), and in the projected future by the RCM (time window 2071-2100). The droughts were characterized using DSL with a minimal length of two months, together with several levels of drought intensities (through SPI values of 0, -0.5, -1.0, -1.5 and -2.0).

The dry spell length (DSL) time series were built in each grid point. From these time series were computed the mean length of dry spell for each drought intensity, the longest dry spell and was established the number of months in the time windows (i. e. reference and future periods) that were undergo an specific intensity of drought.

2.3 Preliminary results

Initial results show a rise of droughts severity, located in Los Andes mountains from Colombia, Perú and Ecuador. Also, more intense droughts conditions are predicted in the Amazonian basin (tri-border area between Colombia, Peru and Brazil), the Gran Chaco natural region, and southern Chile.

The drought trends are, in general, coherent with the predicted changes on annual mean precipitation, estimated with SMHI-RCM. However, in some regions (e. g. central area of Chile), the rise of drought conditions does not go well with the diminishing on mean precipitation, which suggests a re-arranging of annual cycle of rain.

P-1119-07

Future precipitation extremes are linked to changes in moisture flux anomalies

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Understanding the response of precipitation extremes to anthropogenic climate change is currently based on a simple thermodynamic link to future warming (proportional to the Clausius-Clapeyron equation). While previous work has identified empirical links between observed flooding events and the occurrence of specific circulation patterns, often containing filamentary bands of anomalous moisture flux, the large-scale dynamics driving extreme precipitation remains poorly characterised. Here, we introduce a diagnostic measure of the explicit link between extreme precipitation events (>99.5th percentile) and incoming moisture flux anomalies. This represents a significant development over previous methods which sought arbitrarily defined 'atmospheric river' events. Robust links are found between anomalous moisture flux and corresponding extreme 24-hour precipitation accumulations, with a particular significance placed on meridional moisture fluxes of tropical origin. Using this metric, we explicitly calculate future changes to the likelihood of precipitation extremes attributed to changes in large-scale moisture and wind fields. Preliminary results of applying this analysis to the CMIP5 ensemble under an RCP8.5 warming scenario are considered, particularly for mid-latitude regions.

P-1119-08

Global Changes in Drought Historically and under Future Climate Scenarios

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Droughts are extremely costly hydrological events that can have multiple and long-lasting effects on society and ecosystems. Evidence has been put forward that the risk of drought has increased in recent years due to a changing climate and there is an expectation that droughts will become more severe in the future under projected climate scenarios in response to changes in precipitation and increases in atmospheric demand. Furthermore, direct human impacts on the water resources have already had large impacts on water availability locally and may have as much as, if not more, of an impact in the future. The

compound effect of increasing drought severity and increasing water demand is worrisome, especially for the most vulnerable populations.

This work quantifies and analyzes the evolution of drought during the instrumental period (back to the late 19th century) and under future climate projections from CMIP5 models. Drought is analyzed in terms of its characteristics (frequency, area, duration and severity) and the co-evolution of the forcings (precipitation and potential evaporation). The historical analysis is based on updated multi-model land surface simulations driven by a hybrid meteorological dataset that merges available station observations with reanalysis. Drought is quantified based on anomalies in precipitation, soil moisture and streamflow, representing different aspects of drought: meteorological, agricultural and hydrological. There are considerable uncertainties in long-term changes because of: uncertainties in changes in precipitation due to station sampling and errors in large-scale datasets (e.g. from satellites and reanalyses); uncertainties in changes in other less well observed surface meteorological variables such as humidity and windspeed, and in surface radiation that drive potential evaporation; and uncertainties among land surface models in how drought propagates from meteorological to soil moisture to hydrological drought. In particular, the uncertainties are highest in transitional to dry regions where the station density is generally lower and differences among land surface models becomes important.

Future projections of drought from CMIP5 models indicate an overall propensity towards increased drought severity in many regions due to changes in precipitation seasonality and atmospheric demand. In some regions, such as the Mediterranean and southern Africa, the changes are set against a background of increasing aridity. However, the magnitude of these changes is highly dependent on the climate model in addition to the emissions scenario. We focus on the uncertainty in drought projections with respect to climate model ability to replicate the observational estimates of land-atmosphere coupling as derived from our ensemble of land surface models. Results indicate that the representation of coupling in the models between soil moisture, evapotranspiration, and temperature plays a role in the uncertainty in future projected changes in evapotranspiration with implications for changes in available water and drought.

P-1119-09

Change of vulnerability towards flooding in the commercial sector

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Flood risks emerge from extreme hydrological events and exposure of human activities. Various studies have analysed past flood damage data for trends and tried to attribute it to specific drivers. A large part of the observed upward trend in damage is assumed to be related to socio-economic factors. Whereas changes in exposure are relatively well understood, there is hardly any knowledge about changes in susceptibility, particularly in respect to companies, which are quite heterogeneous but contribute a large share of damage.

Therefore, vulnerability data from companies affected by recent floods in Germany were analysed to gain quantitative information about changes in susceptibility during the last decade and how these changes are linked to flood experience and other physical and social drivers.

Preliminary results reveal that in the case of a flood event, most companies undertake emergency measures. The effectiveness of these measures is increased by recent flood experience, emergency plans, reliable warnings with long lead times, and low water levels. Additionally, larger companies that own their buildings seem to be more efficient in undertaking emergency measures. Additionally, many companies undertake precautionary measures after a flood, but still much more could be done. Perhaps the diversity of responsibilities in businesses and the institutional structure create hurdles as well as the level of uncertainty regarding which actions are most cost-effective and will provide significant damage reduction.

P-1119-10

Estimating extreme dry-spell risk in the Ichkeul basin northern Tunisia

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Drought is a natural phenomenon that can occur in all regions. Climate variability and climate change in the longer term consequences of economic, social and environmental. It is likely that climate change increases the frequency and duration of droughts, which could contribute to land degradation. One develops the event-based approach tailored to the sub-humid climatic conditions. A dry period is defined as a series of days with daily rainfall less than a given threshold. Unlike the dry period, a dry event may last only one day. Dry events are considered as a sequence of dry days separated by rainfall events from each other. Thus the rainy season is defined as a series of rainfall and subsequent dry events. Rainfall events are defined as the uninterrupted sequence of rainy days, when at last on one day more than a threshold amount of rainfall has been observed. The case study of Lake Ichkeul in north of Tunisia, at a Mediterranean climate, is used to illustrate the approach. One focuses here on the evolution of dry events in duration and frequency in the region under the influence of a changing climate. It identifies the longest dry and wet events on the history. For planning purposes, the longest dry spells associated with the various statistical recurrence periods are derived on the basis of the fitted GEV type probability distribution functions. The event-based rainfall analysis is used to calibrate the precipitation models with little rainfall records, the study of the effects of climate change and to generate long synthetic rainfall event time series. The synthetic sequences of rainfall events and dry events are used to define and calibrate simulation models for realistic planning of reservoirs or for estimating water demand irrigation.

P-1119-11

Historical floods in North Algeria

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the flood of 1974, which occurred in Kabylie and Algiers regions. This flood has produced 52 dead and 18 000 victims and enormous material damage in Kabylie. The corresponding rates for this event are 2972 m3/s (80-year return period), 2940 m3/s (92-year return period) and 2520 m3/s (130 year return period) at Baghlia, Belloua and Lakhdaria hydrometrics stations respectively in the region of Kabylie. The disaster also affected Algiers. Floods in eastern Algiers, and for the same period, has produced significant damage. At the Baraki station, a flow rate of 1,620 m3/s with a return period of 100 was raised. At the bottom of the Atlas Blidéen, the station of the Rocher des piégeons, a flow of 820 m3/s with a return period of 40 was recorded. The floods were followed a rain event, recorded at mountain pass Skamody (Atlas overlooking the Mitidja East) is 620 mm (58% of the annual total) in four days and 310 mm (30% of the annual total) in one day with 32-year return period. It is noted that the return period of rain is not as important as the maximum flow rates recorded for this period. The city of Azzazga in the Kabilye was also the scene of a spectacular flood in October 1971. The disaster killed 40 people. The return period of the recorded flow is 20 years and generator rain of this flood was 182.6 mm in one day with 300 years return period. The danger of these floods, which caused many deaths and material losses, is due to the combination of the nature of rainfall and the relief of the region. The region is characterized by rugged terrain very favorable to flow and the rapid progression of the flood wave.

In Western countries, the floods of Oued Rhiou, occurred in 1993, caused the death of 22 people. The recorded maximum flow was 719 m3/s with a return period of 17 years. In the same region, in 1965, major floods were recorded with 825 m3/s at Oued Rhiou station and 809 m3/s at Relizane station with a 30-year return period. Also on the west of the country (region I), the floods of October 2000 caused 4 deaths. The maximum flow was 550 m3/s with a return period of 80 years. The maximum rainfall recorded for this period was 85 mm with a return

period of 15 years. It finds that almost the maximum daily rainfall can not explain the dangerous flood but it should be considered a combination of relief and the moisture condition of the soil as important parameters in the genesis of these disastrous floods.

P-1119-12

A 2700 cal yr BP extreme flood event revealed by sediment accumulation in Amazon floodplains

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Climatic conditions are one of the most important factors affecting hydrological processes in fluvial systems. Higher discharges are responsible for higher erosion, greater transport, and also higher deposition. Consequently, sediment accumulation in Amazonia floodplain river-connected lakes can be directly related to hydrological patterns of the Amazon River mainstream. In this context, we analyzed five sediment cores taken in two floodplain systems situated in the lower Amazon River, to investigate sediment accumulation patterns during the Holocene. Our records show abrupt fluctuations in sedimentation rates in lakes that can reach more than 2 cm/yr during some periods. We find that in all cores, sediment stratigraphy is characterized by packages of sediments of uniform age, which are typically 10-80 cm thick and present a variegated color. The 14C age of the upper package is about 2700 cal yr BP. During this abrupt event, sediment accumulation rates in floodplain lakes can be at least 200 times higher than those of "normal" periods. This sedimentation event is interpreted as being the consequence of one or several successive extreme floods. The 2700 cal yr BP event has been also observed in other sites in South America and other regions in the world, although different impacts can be observed in each system. This event probably corresponds to a conjunction of favorable conditions for extreme Amazon discharge associated with the Middle to Late Holocene increase of austral summer insolation and shifts of the Intertropical Convergence Zone (ITCZ) from northern to southern positions. In this context, a marked negative peak in solar irradiance at 2700 cal yrs BP seems to have provoked cooling on the continents and a southward shift of the ITCZ associated with a probable reduction in Atlantic Meridian Overturning Circulation.

P-1119-13

Critical erosion rates in mountain catchments during catastrophic events El Niño: from the west central Andes to the Pacific Ocean (Peru)

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Erosion rates and sediment flux from the Andes to the coast of Peru, is largely unknown. The aims of this study is to bridging the knowledge gap by quantifying and understanding the magnitude and signal frequency of sediment fluxes from the west central Andes mountains to the Pacific coast. A new extensive suspended sediment yield (SSY) database from short to long-term erosion was collected (1948-2012). Measurements were taken at piedmont stations of twenty sub-catchments (638-16949 km2) located between 2°S to 18°S. Statistical analysis of suspended sediment fluxes (SSF) time series at daily and sub-daily frequency revealed that, Suspended Sediment Concentration (SSC) response immediately to runoff during water discharge peaks. However, annual correlation coefficient (R) between runoff and SSF along the Peruvian coast show a wide range from 0 to 0.9 ($p < 0.05$). Results also show strong latitudinal and longitudinal runoff gradient ranges from 2.4 to 25.5 l.km-2.year-1 and a wide SSY range from 9 to 2 000 t.km-2.year-1. SSY in Peru increased dramatically during extreme events El Niño (1982-83 and 1997-98) from 10 to 60 times in comparison with historical mean SSY. Finally, extreme events El Niño control SSY in the north of Peru (from 2°S to 9°S). Meanwhile, factors which control SSY during normal years are not fully understood, further studies on this topic are conducted.

P-1119-14

Modeling of maximal spring flood runoff on rivers in Ukraine with using CCSM3 and HADCM3 for the medium (2030-2050) and long term (2070 and beyond)

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Currently very relevant is the issue of changing the water cycle under the influence of global climate change. The main area of research is the study of the water balance components in general, such as surface runoff of rivers, underground flow, evaporation, etc. However, as the events of recent years, the quantity and quality of extreme events, such as catastrophic floods also significantly associated with climate change. Thus, the study of quantitative characteristics of maximum river flow rare probability of exceedance as well as their forecast for the near future (2030-2050) and long term (2070 and beyond) is an important scientific problem of modern science. The authors of this study are propose a variant of calculation formula of maximum river flow, that allows, on the one hand to count the maximum water flow rare exceedance probability (P=1,3,5,10%), and on the other hand - to predict possible changes in the values obtained using the data different models. In order to obtain predictive values of temperature and rainfall in the plains of Ukraine in the study were using simulation results of two different global climate models- HadCM3 (Meteorological Service UK MetOffice), and climate models (CCSM3) from National Center for atmospheric Research (NCAR, USA). The next task was to study the relationship between the predicted values (eg, annual precipitation) and calculated values - maximum snow supplies and precipitation during the flood. For the plain territory of Ukraine on data 103 weather stations (for maximum snow supplies) and 315 weather stations (for the precipitation) were obtained relevant dependencies that have high correlation coefficients, indicating the possibility of direct incorporation of climate change on flood runoff. The simulation results are presented in the form of the coefficients of runoff change. The value of the coefficient of runoff changes taken equal to 1.0 for current situation, respectively, the value of this ratio is greater than 1.0 indicate a possible increase in runoff, and less than 1.0 - the decrease. Comparing the results for different scenarios for the model CCSM3, we can mention that for the period 2039 three scenarios (A1B, B1, A2) give more or less similar results - no significant decrease in runoff spring flood in northern areas, and significant - in the southern. Conversely scenario COMMIT provides for increased discharges spring flood on rivers in zone of sufficient moisture (basins of Western Bug, Pripyat, Desna, Dnieper) by 10-20%, and on the rivers in the zone insufficient moisture (basins of Southern Bug and Seversky Donets) - reduction to 20%. As for Azov region rivers, for them, as well as in other scenarios expected to reduce runoff spring flood more than 50%. Analyzing the forecasting period from 2069 to 2099, it should be noted that the results differ significantly for different scenarios. So scenarios A1B and A2 on 2099 are predicting practical disappearance spring flood (water content decrease from 100 to 80%) on the rivers zone insufficient moisture, and to areas of sufficient moisture - reducing runoff by more than 50%. Slightly different results provide scenarios B1 and COMMIT. The scenario B1 for the period until 2069 predict is a gradual decrease in water resources of spring flood (from 20% to 50%), excepting to rivers Azov region, and on the period up to 2099 - a slight increase in the relative to 2069 for the rivers in area of sufficient moisture and stabilization - for rivers in area insufficient moisture. For rivers Azov region are predicting maximum loss of runoff in the spring - up about 80%. The scenario COMMIT, which implies that the

concentration of atmospheric greenhouse gases will be maintained at 2000 levels, predicted gradual increase in water content of rivers in northern regions from 10 to 20%, and a slight decline – for the rivers of the southern regions (10 to 20%). For rivers Azov region spring flood runoff will decrease by 50% to 2099.As already noted, the calculations of «climate amendments» were held in two models – CCSM3 and HADCM3. Simulation results for HADCM3 very different from model of CCSM3. Almost in all scenarios are projected sharp increase in water content (2.5–3 times) for the period until 2039, and then the same sharp decrease (especially for scenarios A2 and A1B) water content spring flood. The scenario B1 is predicted stabilization of water resources, ie, till 2099 coefficient of change of almost all rivers except the Azov region, is 1.0. As for the script COMMIT, there is projected to increase runoff of spring flood from 1.75 to 3.5 times by 2069.

P-1119-15

Extreme Hydrological Events, Vulnerability and Coping Mechanism for Sustainable Livelihood in Alaknanda River, Basin, Uttarakhand

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Extreme events are sudden calamities, which involve loss of life, property and livelihood. This paper presents a methodological approach for the integration of extreme events, climatic vulnerability, land use scenario modeling and flood risk assessment. Alaknanda river basin is located in the eastern part of the Garhwal Himalaya and represents one of the most acutely hazard-prone regions in the country. The important factor causing flood and also accelerate several hydrological hazards during monsoon periods in Alaknanda river are heavy rainfall, cloud burst, GLOF, landslides, Slope failure, earthquakes, deforestation, poor drainage due to urbanisation. These hydrological hazards are mainly responsible for several socioeconomic consequences (cultivated land degradation, infrastructure loss, human casualties, loss of transmission lines, and so on) in the Alaknanda river basin, Uttarakhand. Primary data from each hotspot has been collected through a questionnaire survey and a Participatory Research Approach (PRA) procedure that is based on the LIFE approach. The LIFE Approach is based on Livelihood options, Institutional participation in adaptation policy design and implementation, Food security and Empowerment parameters like health and education. These parameters are important in building resilience capacity and ensuring sustainable development pathways. The methodology will be consists of a number of steps with primary and secondary data analysis. This paper also provides various mitigation processes for the challenges faced and formulate sustainable development strategy for the development in the Alaknanda river basin, Uttarakhand.

P-1119-16

Hydrological extremes, food security and agriculture in western Amazon

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The water level of the Amazon and of its tributaries varies significantly from one season to another. For instance, at Iquitos station (Peru), the water level varies from 18 meters in May-June to 8 meters in September-October. That is why, during the low-flow period, cultivating becomes possible and is important on the riverbanks and in the inundation plains.

Agricultural production in a family-based system on the riverbanks and inundation plains is very important in terms of guarantee of supply for food security. In order to understand the important relation between agriculture, food security and hydrological system some characteristics of the local agriculture in the Amazonian region located between Iquitos (Peru) and the triple frontier between Brazil, Peru and Colombia are first presented using results from field observations, survey and data from the Peruvian and Brazilian Agricultural agencies.

Then, information about the interannual variability (1980-2014) of the hydrological cycle of the Solimões River are presented: discussion and definition of the dates of the beginning and of the end of the low-flow period, duration of the low flow period, velocity of the water level changes during the increasing and decreasing flow periods, presence of "false alarm" at the beginning or at the end of the dry and the wet period, ... This part is developed using water level data from the national hydrological services of Peru and Brazil and from the Environmental Research Observatory SO-HYBAM (Geodynamical, hydrological and biogeochemical control of erosion/alteration and material transport in the Amazon basin).

Finally, as a shorter than usual length of the low flow season, a rapid increase of the water level, a "false" beginning of the low water season, etc. are hazards that may put at risk sowing and plant development, hydrological parameters are related to yield values seeking possible correlations between extreme events and food security in the region.

P-1119-17

A mineralogical and organic geochemical overview of the effects of Holocene changes in Amazon River flow on three floodplain lakes

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A synthesis of the impacts of the Amazon River hydrological changes on the sedimentation process of organic matter (OM) in three different floodplain lakes (Santa Ninha, Maracá, and Comprido lakes) is presented in this study. Today the Santa Ninha and Maracá lakes are directly and permanently connected with the main channel of the Amazon River, in contrast to Comprido Lake, which is indirectly and periodically influenced by the Amazon River due to its greater distance from the main channel. All three lake sediment records showed a reduced river inflow due to dry climatic conditions during the early and middle Holocene followed by an increased fluvial input during the wetter late Holocene. In Santa Ninha and Maraca Lakes, the reduced river inflow period was recorded by sediments with a low abundance of smectite (on average ~20 wt.%), a clay mineral mainly transported by the fluvial system, and high total organic carbon (TOC) contents (on average ~8.2 wt.%). During the late Holocene, a higher smectite abundance (on average ~43 wt.%) and a lower TOC content (on average ~1.4 wt.%) pointed to greater dilution by riverine lithogenic matter. This change was accompanied by the increase in aquatic primary productivity, as shown by the increased δ13C values and by a C/N typical of algae, suggesting a higher lake water level. In Comprido Lake, a sedimentation gap occurred during the early and middle Holocene. The wetter late Holocene, from 3000 cal years BP onwards, a gradual increase of the TOC, chlorophyll derivatives and Aulacoseira sp. suggest an increase in the productivity and in water lake level due to the high water flow of the Amazon River and the catchment area as well. Consequently, our study shows that the sedimentation processes of organic matter in Amazonian floodplain lakes were strongly influenced by variations in the hydrodynamic regime of the Amazon River during the Holocene. However, the impacts of the variations on the three floodplain lakes were different depending on the distance of each lake from the main channel of the Amazon River.

P-1119-18

Run-off events registered in East Pacific equatorial region during the late Holocene: analysis of possible causes through IPSL model transient simulation

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An increase of clastic sediment inputs has been observed between 5 and 4 kyrs BP in lakes of the equatorial region of South America, in Ecuador and Galapagos islands as well as in marine sediments off Northern Peru. These changes in sedimentation have been interpreted as a strengthening of El Niño due to insolation change. Conversely, data from central and west-Pacific corals do not indicate a clear trend of ENSO change during the Holocene but strong centennial to millennial oscillations.

To help interpreting the climate change in this region we analyzed a transient simulation of IPSL CM5A LR global climate model from 6 to 3kyrs. The simulation indicates an increase of heavy rainfall events (monthly rainfall intensity) in the East Pacific (90-80°W, 0-6°S) since 5kyrs. Most of these events are linked to occurrences of El Niño events and the summer precipitations show a multi-decadal variability related with the variability of SST anomalies in El Niño 3-4 region.

However the model did not show important change in SST anomalies in ENSO 3_4 or ENSO 1+2 regions during this period although there is a 0.2°C increase of SST between 6 and 5kyrs. The comparison between 6 and 4 kyrs precipitation maps show that the main difference is a northern shift of ITCZ position during South Hemisphere summer that provokes more intense rainfall in the study region. This northern shift is also observed on the Atlantic Ocean in agreement with paleoclimate data from lakes and speleothems in Northeast Brazil. In conclusion the IPSL transient simulation suggest that the impact of El Niño events in term of precipitations in the East Pacific can have been modulated by shift of the ITCZ during the Holocene.

This study is supported by ANR El Paso n° 2010 BLANC 608 01 and by the french national programme LEFE/INSU.

P-1119-19

Changes in extreme hydrological events in highly regulated river basins of Catalonia (NE Spain): discerning between climate change processes, land cover modifications and water resources management

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Extreme precipitation events trigger floods with devastating effects, causing several economic and environmental impacts, and even human causalities. To understand how extreme precipitation events propagate spatially to the river response is a high priority in the Mediterranean region, where heavy precipitation events are frequent, but they tend to occur randomly in space and time and our predictive capacity of these events is usually low. In recent decades, climate change processes have been identified in the Mediterranean region, affecting the magnitude of extreme precipitation events. Nevertheless, the evolution of extreme hydrological events may be different to that observed by precipitation extremes in past decades, given strong land cover changes and/or river regulation, water management practices and water uses.

To know the effect of the management of hydrological basins on the evolution of extreme hydrological events may help to adapt the society response to future climate change scenarios. In this study we analyse the evolution of extreme precipitation and hydrological events in the past five decades in three basins of Catalonia (NE Spain): Muga, Ter and Segre. These basins have their headwaters in the Catalan Pyrenees and they have been highly regulated by numerous dams in the second half of the twentieth century. Nevertheless, they are characterized by different water uses, land covers and management strategies and they include one of the main irrigated areas of Spain (the Segre basin), the Metropolitan Barcelona area in which there is large urban water demand (more than 4.5M people), and also high pressure tourism areas in the Mediterranean coastland.

Analyses have shown how the progressive increase of the natural vegetation coverage and mainly the increased river regulation enhance the missmatch between the frequency and magnitude of extreme precipitation and streamflow events. Nevertheless, very extreme high flow episodes have also been recorded in the three basins in the last decades, reinforcing the hypothesis that although damming and water management may control hydrological extreme events to some extent, the high flow risk will probably remain or even reinforce under climate change scenarios.

This study has been developed in the frame of the project: «LIFE12 ENV/ES/000536 Demonstration and validation of innovative methodology for regional climate change adaptation in the Mediterranean area (MEDACC)» financed by the LIFE Programme of the European Commission and focused on establishing adaptation strategies to mitigate the impacts of climate change on water resources in the three analyzed basins.

1121 - Air Pollution and Climate Change linkages and Health Impact Assessment

ORAL PRESENTATIONS

K-1121-01

Air Pollution, Climate Change and Human Health

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Air quality is a major modifiable health burden around the world, especially in rapidly developing cities. Exposure to air pollution, including fine particles (PM2.5) and ozone, has adverse effects on human health throughout the lifespan. Adverse effects of air pollution include the development of chronic diseases such as lung cancer, chronic heart and lung diseases, as well as adverse effects on the reproductive system and on neuro-development. Action to mitigate air pollution brings immediate and lasting benefits for the health and well-being of the population. In addition, well-designed air pollution mitigation actions have the potential to reduce societal impacts on the climate system. In order to inform global, regional and urban scale air pollution and climate planning, there is a need for multi-scale health impact assessments that estimate the potential health impacts and/or benefits that may result from coordinated mitigation strategies. We describe several such recent and/or ongoing efforts of this kind. For example, the recently-completed AC-HIA project estimated the influence that policies aimed at reducing air pollution emissions could have on global, regional and urban public health in 2030 and 2050, compared to 2010, taking into account the influence of climate change and alternative air pollution mitigation scenarios. Assessments were carried out across three different geographic scales with increasing spatial

granularity, for the entire world, for Europe, and for the Paris metropolitan region. Two mitigation scenarios were evaluated: a business as usual scenario based on national regulations already on the books, and a maximum feasible reduction scenarios based on available technologies for air pollution control. The results showed the potential for substantial increases in global deaths due to PM2.5 and ozone under the business as usual scenarios, especially in south and east Asia. On the other hand, substantial health benefits could be achieved under the maximum feasible reduction scenario. In general, health assessments carried out at finer spatial scales yielded greater health benefit estimates. This and other studies are pointing the way to a new generation of tools for integrated air quality and climate planning.

Enormous health benefits can be achieved from well-chosen climate mitigation strategies that simultaneously reduce air pollution concentrations in the local and regional environments in which the emission reductions occur. However, to evaluate those benefits in relation to specific mitigation options, careful analyses are needed at appropriate spatial scales to link the air pollution reductions to locations of vulnerable populations. Through such analyses, alternative mitigation strategies can be compared and prioritized based on their potential health benefits, providing critical input to decision makers.

O-1121-01

Public health response to climate change in twenty-two European countries

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Introduction: WHO European Member States (53 countries) agreed on implementing the European Framework for action on climate change and health. One of the mandate is the assessment of health implications of climate changre and the development of national health adaptation plans, as a contribution to WHO and UNFCCC developments.

Scope: to assess the scale and content of the national adaptation plans and the assessments, to identify incremental, transitional and transformational approaches and to guide future political and scientific developments

Result: Between 2000 and 2014, twenty-two WHO European Member States, developed national adaptation plans with a health component; while 32 European Member States assessed the health implications of climate change. Most of the WHO European Region Member States have mainly focused on strengthening their health systems through a range of specific measures. All measures idenified mainly serve to address curent health problmes. Measures include: strengthened infectious disease surveillance; strengthened environmental health services, such as water, sanitation and vaccination; and nsynergise with the International Health Regulations. Fewer countries have been using new technologise and approaches, such as strengthened early-warning and disaster responses and integrated mapping. None has been using transfrmational approaches versus a 4 degree world, and large scale prevention of associated risks. Countries highlighted the need for health benefitting mitigation measures for adaptation: these include local community action, improving air quaility, greening health services and renewable energy technologise. Examples from MS will be illustrated

Discussion: Synergistic interventions on both adaptation and mitigation, can in particular be useful for health and well-being. The post 2015 development agenda will play an increasing important role. It will be important to provide an understanding of the wider dimension to health and environment decision makers.

O-1121-02

The impact of climate policies on European air quality in the 21st century

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Climate change, long range transport of pollutants and surface air quality share multiple interaction pathways. Tailoring efficient air quality mitigation strategies over the long term requires taking into account such external factors whose variability can be neglected for short term projections. We designed, developed and implemented a new regional air quality and climate modelling system to account for the possible penalties of climate change and long range transport of pollutants on European air quality. In order to ensure its relevance for environmental policy making, this modelling system is embedded in a quantitative cost-benefit analysis framework.

The regional air quality and climate modelling suite allowed proposing an assessment of European air quality in 2050. We highlighted the dominating influence of mitigation of anthropogenic emissions of pollutants in Europe. But the penalty brought about by climate change on ozone pollution was also confirmed, and the large impact of long range transport at the 2050 horizon was emphasized. For particulate matter, long range transport is less important; the impact of climate change is significant but also uncertain.

Thanks to the use of air pollutant emission projections based on emission factors reflecting the current legislation, we could assess the costs of climate mitigation and air quality legislation. We point out the economic benefit of climate policies for air quality legislation due to a low carbon economy requiring less end-of-pipe technological measures against air pollution. The total cost of mitigation (air and climate) remains however higher under the mitigation than under the business as usual pathway.

The analysis of air and climate modelling results within a monetised health impact assessment framework allowed assessing expected sanitary benefits. It is important to highlight that the expected monetised sanitary benefits compensates the costs of climate mitigation, showing that air quality can be considered as a positive externality of low carbon policies.

O-1121-03

Global and European scale health impact assessment (HIA) of PM2.5 over the 21st century

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Multi-scale approach to health impact assessment (HIA) can illustrate the difference in direct consequences of costly mitigation policies. Although this approach provides results that may help decision-makers choose between different policy alternatives at different scales, it has several limitations, such as the choice of concentration-response function (CRF). The recently developed integrated exposure-response (IER) model (Burnett et al. 2014) combines global relative risk information from different combustion types of PM emissions, and can describe exposure-response relationships between PM2.5 and leading global causes of death, such as ischemic heart disease (IHD), cerebrovascular disease (stroke), chronic obstructive pulmonary disease (COPD), and lung cancer (LC). Using this model and ECLIPSE air pollution scenarios (current legislation (CLE) and maximum feasible (MFR)), we estimated future impact of PM2.5 on health at global and European scales in 2030 and 2050. Our preliminary results showed that 1/3 of total global burden of ambient air pollution on IHD deaths is associated with PM2.5 (488 000 deaths/year). If maximum reduction measures are implemented by 2030, this should be reduced globally by 17%; on the other hand, with the current legislation scenario the number of IHD deaths should continue to increase, and by 2030 will reach 586 000 deaths annually. However, these results may be greatly underestimated, as the PM concentration levels produced by the global model were much lower compared to the regional scale estimates.

O-1121-04

Evaluating air quality impact on mortality and crop yields in South Asia

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Climate change has been shown to increase surface O3 in many regions of the world and have raised concerns about the O3 impact on mortality and the magnitude of yield reductions, primarily occurring in the developing nations.

Demographically agriculture is the broadest economic sector, rank worldwide second in farm output and principle source of livelihood for more than 58% of 1.2 billion populations which plays an important role in the overall socio-economic fabric of India. We have quantified, for the first time, a district-wise impact of surface ozone on cotton, soybeans, and rice and wheat crops for all of India. On a national scale, we eastimate fractional relative yield loss for wheat of about 5.0 (±1.2) %, 2.1 (±0.9) % for rice, 5.3 (±3.1) % for cotton and 2.7 (±1.9) % for Soyabean, with the losses concentrated in central and the Indo-gangetic plains of north India. In terms of absolute production losses by weight, wheat is the most impacted crop, with losses of 3.5±0.8 Mt followed by rice (2.1±0.8 Mt) sufficient to feed 94 million people living below poverty line in India. Translating crop production losses into national economic damage, we estimate an economic loss of 1.29 ±0.47 billion USD. Sensitivity studies with the integrated model study reveals NOx as the key pollutant causing as much as 93% of the crop loss.

Significant portion of human population in India is believed to be regularly exposed to higher surface ozone (O3) levels. Here, we have also evaluate total, cardiovascular and respiratory mortalities and hospitalizations (COPD) caused by population exposure to surface O3. Attributable mortalities are quantified using health impact function of long-term relative risk estimates (population attributable-risk proportion) for O3 from epidemiology literature. We calculated total mortality of about 1125 thousands, 404 thousands by cardiovascular deceases and 176 thousands by respiratory deceases, and COPD cases of about 175 thousands caused by O3 exposure to population of India in 2005. The highest number of total, cardiovascular and respiratory mortalities and COPD cases are found in the highly populated Indo-Gangetic region followed by metro-cities and sub-urban and industrial areas.

O-1121-05

Impacts of Climate change and seed dispersal on airborne ragweed pollen concentrations in Europe

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Common ragweed (Ambrosia artemisiifolia) is an invasive weed native to North America producing very allergenic pollen which causes serious health effects like rhinitis, asthma and atopic dermatitis. It was introduced in Europe since the mid-19th century and invaded large areas during the last few decades (Pannonian plain, Northern Italy and South-Eastern France). Furthermore, there is a high potential for ragweed spread in current suitable habitats and future changes in Climate and land use may increase the spread by altering the climatic niche determined by physiological thresholds or affecting cropping patterns. The rate of spread depends also on seed dispersal due to natural or anthropogenic processes and the efficiency of ragweed eradication policies. However, ragweed airborne pollen concentrations depend not only on plant infestation, but also on phenology, pollen production, release, dispersion and atmospheric transport.

Here, we present the first integrated modelling framework, based on an explicit representation of plant phenology, pollen production, and release to the atmosphere, to assess future changes in airborne pollen concentration under scenarios of climate and land use changes and seed dispersal. Two model suites are implemented differing in the atmospheric processing and in the driving climate models. The CHIMERE suite uses the Chemistry-Transport Model CHIMERE model, forced by regional climate simulations from the WRF model downscaling of the IPSL-CM5A-MR model. The RegCM suite uses the RegCM4 regional climate model forced by global climate simulations from HadGEM CMIP5.

We performed three types of simulations (50 km grid covering Europe), which are hind-cast (2000-2012), historical (1986-2005) and future (2041-2060) simulations. The hindcast simulations, forced by ERA-Interim reanalysis, are performed to calibrate and evaluate the modelling chain. The historical simulations are carried out using calibrated ragweed density to serve as a reference simulation for the future. We considered two contrasting RCPs (Representative Concentration Pathways) climate change scenarios including a high-end (RCP 8.5) and moderate (RCP 4.5) climate change scenarios and three seed dispersal scenarios (reference, slow and rapid).

We show that airborne pollen concentrations may drastically increase in 2050 by a factor of 4.5 under high-end (RCP 8.5) and 4.0 under moderate (RCP 4.5) climate change scenarios. This upsurge is largely dependent on the seed dispersal rate, making this increase vary in a range of factors from 2 to 12 according to the range of formulated assumptions. We estimate that about one third of the projected increases of pollen concentration are due to the on-going seed dispersal within the present niche regardless of climate change. Climate change will be responsible of two thirds of the future pollen loads increase. It will extend the habitat suitability for ragweed in Northern and Eastern Europe and result in higher pollen concentrations in established ragweed areas mostly due to a larger primary production with increasing CO2. Therefore, future increase of airborne pollen concentrations will be caused by the combined effects of climate change and ragweed seed dispersal in current and future suitable areas.

Our results indicate that controlling the current European ragweed invasion will become more difficult in the future as the environment will be more favourable for ragweed growth and spread, highlighting the need for the development of effective and regionally co-ordinated eradication programmes.

1121-POSTER PRESENTATIONS

P-1121-01

The Air Quality Improvement by Precipitation during the Spring Season

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Meteorological elements determining air quality are significant, given that many premature deaths each year are attributed to air pollution. The washout effect of summertime precipitation on air pollutants is of importance, since every spring yellow dust and high level of particulate matter (PM) in the Korean Peninsula has reduced visibility and threatened the health of the people. The air pollutant is a substance in solid, liquid, or gaseous form in the air, which is caused by natural action and human activities. Air pollution is a serious problem that threatens the health of the people, inflicts harm to plants or structures and causes toxic effects to the environment. These air pollutants are removed from the air by wet deposition process referring to precipitation, fog, and condensation. This study has analyzed air quality improvement with the concentration variation of four pollutants (PM10, NO2, CO, and SO2) during the spring season in the Korean Peninsula. During the period 2009 to 2013, we selected 56 cases that were accompanied by nationwide precipitation, and used the observation data on automatic air pollution from the Ministry of Environment (MOE) and the precipitation data from the Korea Meteorological Administration (KMA). We calculated the difference of air pollutant concentration during the

period with no precipitation and with precipitation. The concentration (PM10, NO2, CO, and SO2) during the precipitation period was lower (29.8%, 9.8%, 3.4%, and 21.5%, respectively) compared to that of during the no precipitation period. Furthermore, the air quality has greatly improved as the duration of precipitation increased. The result seems to imply that spring precipitation has a significant influence on the removal of the PM10, which penetrates the lung and threatens the health.

Acknowledgements:

This research was carried out as a part of «Development and application of technology for weather forecast» supported by the 2015 National Institute of Meteorological Research (NIMR) in the Korea Meteorological Administration.

P-1121-02

Aeolian flux quantification of the waste mining deposit: field measurement and empirical modelling. Case of the Hammam Zriba landforms (Zaghouan, Tunisia)

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The aim of this study is the quantification of the air flux mining waste pollution throughout the human landforms. The study field, located on the lee side of Jebal Boukhrouh mountain (Hmmam Zriba Locality, Zaghouan), is mainly exposed to the frequent dust strom event which entrains the dispersion of the dams deposit. Using the vertical sand trap (type Rosen, 1978) along three cross profiles (from the dam to the olive tree field) under a dust storm event of May 12, 2013 (direction: west to west north west, speed ≥ 15 m/s) , we quantify the aeolian waste mining flux. Vertical distribution of sand transport flux was studied with the 39 sand samples. Results show that the volume of the aeolian flux indicates variation. In fact, the topography of the area and the nature of the sediments, land use and climatic conditions (wind speed, humidity, etc.) are limiting factors in the transport and dispersion of mining waste particle. Considering these parameters, the measured wind flow can reach 6.4 kg/m/min at the dune feet, accumulated on the olive tree obstacle. However at the dune summit measured flux do not exceed 1.4 kg /m/ min. The steep slope of the dune lee side causes an acceleration of the flow. Wind fluxes measured at the blowouts and the corridors are between 0.2 and 0.6 kg /m/min. It corresponds to turbulent areas where wind velocity becomes higher than 9 m/s. The values of moisture percentages vary between 2.5 and 3.5 for all our samples. Threshold friction velocities (u* t) are between 0.22 and 0.311 ms -1. Making corrections to the values of measured flow and moisture such as the humidity of sediments, u* t reached 0.606 ms-1, the Dr correlation index (calculated flux/empirical flux index) becomes much lower. This confirms the close relationship between the threshold friction velocity and wind flow. Although the semi-empirical formulas established by Bagnold (1941) and Zingg (1953) do not involve this parameter, the correction of the measured flux reduced the difference. Of the frequently used models that described vertical distribution of sand flux, Zingg's model produced the best values with the modified measured waste mining flux.

P-1121-03

PM carbonaceous fraction in relationship both to the atmospheric budget and the new technologies

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As part of the energy decisions that are being considered, the extent of the budget of organic carbon (OC) and elemental carbon (EC) assumes a primary importance. in particular, it is essential to measure the relative fractions for a correct evaluation of air pollution from combustion processes. The use of these measures is used to define a specific index of pollution from motor vehicle traffic. iInfatti, these measures become very relevant for the protection of the health of the population for the high permanence of carbon particles in the atmosphere and the many chemical and physical processes of transformation that they may undergo in the atmosphere.

The good correlation between the values of OC and EC shows that the area of the historic center of Rome the most important source of particulate carbonaceous fraction is in the motor vehicle traffic, ie an element typically anthropic, as indeed in the main industrial area source is the combustion. instead different situation is found in a remote area, where this correlation is reversed from the point of view of quality and is. decisasmente lower by quantitatively indicating the presence of natural sources.

the separation between EC, of primary origin, and OC, the source primary and secondary, is of fundamental importance for the study of the effects pneumoconiogeni and, more generally, for the toxic effects and for the study of the mechanisms of formation of photochemical pollutants. it follows that, on a microscale, the carbon becomes more important negative for human health than other natural environmental factors.

You can make a first distinction between risk and risk widespread local anthropogenic natural; However, the local risk tends to increase rapidly as evidenced by all the curves and the time series presented recently by several authors.

The anthropogenic component becomes more important and fundamental as to require choices and impose serious and important related to the lifestyle of the population.

Finally, in this horizon quite accurate plus future situations by having to still monitor: the conversion of coal, for example, of new industries are not yet known, especially how it affects the territory locale.in any case, new energy technologies, definitely interesting for the greater energy yield, should be evaluated from the point of view of environmental compatibility.

P-1121-04

Evaluation of the Spatial Relationship between Air Pollution and Respiratory Infections in Meknes City, Morocco

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Background: With 3.7 million premature deaths in 2012, the World Health Organization indicates that air pollution is a major environmental risk. In Morocco, 41% of the morbidity associated to respiratory infections due to air pollution. Despite this health risk clearly linked to air pollution, there are few studies conducted in the relation air pollution- health in Meknes, the capital of the Meknes-Tafilalet region.

The analyses of geographical distribution of respiratory infections in Meknes city, as well as the study of its relation to potential environmental risk factors, have an important role to develop an efficient system for the monitoring and prevention of this type of diseases.

Methods & Results: The present study aims to elucidate the relationship between air pollution in the Meknes city and the spatial distribution of respiratory consultations as health indicator. First, we present an overview of the mobile and stationary sources of air pollution in the city, with measurements of key pollutants. What helped to reveal that Meknes city suffers from air pollution by diverse sources and characterized by spatial and seasonal variability.

Next, we analyze the epidemiological situation of the health indicator, depending on the age and time, and the spatial distribution of their accumulated incidence compared to sources positions. It follows that an increase in the number of new consultations is disclose specially in the Autumn-Winter period and between persons less than 15 years. This variability also observed in space distribution, with a net increase in neighborhoods in the vicinity of sources of air pollution, particularly those situated in the wind direction promoting the flow of pollutants.

Conclusion & Perspectives: Revealing the impact on the health of urban dwellers in the city of Meknes quite heavy, the identification of air pollution's risky areas and age categories is a milestone in the establishment of a support system for decision-making of air quality monitoring, for local authorities of Meknes city.

P-1121-05

Climate and risk of vector borne zoonotic disease emergence: examples of Rift Valley and West Nile fevers

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Vector borne diseases have a major impact on human and animal health, but also on society economy. Due to their transmission routes, zoonotic or not, these diseases are very sensitive to climatic changes. Actors, conditions and processes requested for disease transmission are part of a complex and dynamic system whose behavior, influenced by climate but also by other environmental and socio-economic components, drive potential for pathogen transmission and outbreak occurrence. We illustrate this complexity through two examples, ie Rift Valley and West Nile fevers.

Rift Valley fever (RVF) is one of the most important viral zoonoses in Africa. Transmitted by mosquitoes and direct contact, RVF affects both livestock and humans. Due to global changes, RVF also threats Northern Africa and Southern Europe (Chevalier, Pépin et al. 2010). Depending on areas, the influence of climate may differ, ranging from determining to insignificant.

In Kenyan regions characterized by large depression areas called « Dambos » and a succession of dry and rainy seasons, RVF outbreaks occur every 5-10 years: a strong correlation was shown between outbreak occurrence and heavy rainfall events that favor both massive hatch and development of Aedes mcintoshi and Culex sp mosquitoes that are the main vectors of RVF in that region. Similarly, the Ferlo area located in Northern Senegal is characterized by a Sahelian climate and temporary ponds (small water bodies that are filled during the rainy season and then dry). But in this region, no correlation between outbreaks and extreme rainfall events has ever been demonstrated. However Soti et al (2012) showed that these outbreaks occurred when the abundance of the two main mosquito vectors in this region, namely, Culex poicilipes and Aedes vexans arabiensis, was higher than average: these abundances are directly linked to specific rainfall rhythms now well described (Soti, Tran et al. 2012). Nevertheless, herd management, herd renewal rates and nomadic herd movements that influence the immunologic coverage of herds, are probably also involved. These variables will have to be incorporated in existing models to refine them and allow for an accurate surveillance and prediction of outbreaks. In other countries that recently experienced RVF outbreaks, such as Madagascar or South Africa, heavy climatic perturbation could not be incriminated in RVF occurrence (Anyamba, Linthicum et al. 2010). In Egypt and Yemen, the role of socio-economic factors, along with climatic factors, was found to be determinant in RVF emergence and outbreak severity(Abdo-Salem, Tran et al. 2011; Xiao, Beier et al. 2015).

Also transmitted by mosquitoes, mostly from Culex genus, West Nile fever (WNF) is caused by a Flavivirus. Reservoir hosts are wild birds, mostly passerines. Human and horses are dead-end hosts. Introduced in New-World in 1999, the virus spread throughout the USA in few years. It is now endemic and transmitted till South of Argentina. Between 1999 and 2010, nearly 1.8 million people were infected; more than 12 000 neurological cases were recorded, from which 1308 were fatal (Kilpatrick 2011). In Europe, the virus has been recorded in the Mediterranean Basin since the sixties without any human or animal health consequences. However, the incidence of human and equine neurological cases suddenly increased, in particular since 2010. Two recent studies showed that an above normal temperature during the preceding months of outbreaks was strongly linked to this occurrence : this high temperature increases the vector competency of mosquitoes and provokes a an increase of the mosquito population densities (Tran, Sudre et al. 2014).

Ecological disruptions induced by climatic variations, but also by landscape transformation by human or socio-economical disturbances, are the main component of disease emergence. The understanding of mechanisms and conditions that underlie these processes is part of the major challenges that scientist and health policy makers will have to face to in the coming years.

P-1121-06

Low cost portable sensors for measuring traffic related air pollution in tunnel

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Air quality monitoring in tunnel has relied traditionally on static measurement stations. However these are expensive methods to capture pollution heterogeneities and identify pollution hotspots. In recent years, the development of portable sensing technology has attracted considerable interest because of the possibility to reduce operating cost of air pollution monitoring.

Despite this, they are few examples in the published literature of pollution measurement using portable sensors in tunnel. In this work, low cost portable sensors are used to measure traffic related air pollution in tunnel within the framework of the research operation "SERRES". The objective of this research operation is to produce recommendations and solutions to limit the impact of road traffic on the environment. Within this research operation, low cost pollution portable sensors are characterized and air pollution measurement are correlated with the traffic data of the tunnel.

The present project was divided into four phases. Phase one was the characterization of the portable pollution sensors. A full set of preliminay tests was realised in laboratory to evaluate the portable sensor reliability and to analyze its performances in terms of accuracy, autonomy and memory capacity. Based on this preliminary tests, two sensors were chosen for their performances: Observ' Air sensor and Cairsens sensor. Phase two, the portable sensors were fixed to a static SIREDO measurement station close to a road. The two sensors were installed for 24 hours. The traffic data recorded by the SIREDO station were used to analyze the link between traffic condition and air pollution. A correlation between the road traffic condition and the evolution of the air pollution was verified. Phase three was the selection and the instrumentation of a tunnel. The Guy Môquet tunnel was selected as an experimentation site because it had the following characteristics: easy instrumentation, simple access and close to a static measurement station (SIREDO). The tunnel is located in the Val-de-Marne district of south-east Paris. An instrumentation was realized inside the tunnel in collaboration with the Ile de France territorial division unit in charge of air quality. It involved placing and instrumentating four pollution portable sensors inside the tunnel. In phase four, experimental measurements were conducted and studied. A spatiotemporal analysis was made. The measures given by the portable sensors were compared to the results given by the static measurement station. A link between pollutant concentrations and road traffic condition was demonstrated.

Aknowledgment

This works is supported by the Technical Division for Territorial Development and Urban Planning of the CEREMA.

P-1121-07

Seasonal pattern of the associations between daily mortality and PM10 in Korea and Japan

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Background/Aims: Many studies have shown that particulate air pollution exposures are associated with increased mortality. However, only a few studies in Asian countries have examined the modification effects by seasons on air pollution-mortality associations. The aim

of this study was to examine the air pollution-mortality associations within seasons in 13 cities, 6 cities from Japan and 7 cities from Korea, where with four distinct seasons.

Methods: We applied stratified time-series models to the data sets in order to examine whether the effects of particulate matter less than 10μm in aerodynamic diameter (PM10) on mortality was modified by four seasons, spring, summer, fall and winter. The effect of PM10 on daily mortality was first quantified within seasons at each location with a time-series model, and the estimates were then pooled through a random-effects meta-analysis using the maximum likelihood method.

Results: The daily means of PM10 in S. Korea were 69.98 □/□ for spring, 45.89□/□ for summer, 48.80□/□ for fall, and 56.94□/□ for winter. Every 10 □/□ increase in PM10 daily concentration was associated with an increase in non-accidental mortality of 0.17% (95% confidence interval [CI]: 0.05 to 0.29%) for spring, 0.44% (95% CI: 0.18 to 0.70%) for summer, 0.35% (95% CI: 0.13 to 0.58) for fall and -0.14% (95% CI: -0.06 to 0.33%) for winter for S. Korea. For Japan, the spring, summer, fall and winter daily PM10 means were 33.96□/□, 35.43□/□, 31.99□/□, and 27.93□/□, respectively. Percent change in daily mortality in Japan were 0.44% (95% CI: 0.18 to 0.72%) for spring, 0.15% (95% CI: -0.12 to 0.42%) for summer, 0.33% (95% CI: 0.15 to 0.52) for fall and 0.15% (95% CI: -0.23 to 0.53%) for winter, per equivalent increase in PM10.

Conclusion: The results showed that the effects of ambient air pollution on acute mortality differed within seasons and by locations. These findings may provide useful information to agencies for protecting local populations from adverse health effects of air pollution.

P-1121-08

Climate Change Epidemiological Health Reports in Michoacan State, Mexico since2009 to 2013

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Objective: To show the epidemiological reports of the impact on health with local and global environmental change. Data sources: our main reports were measured with parameters like temperature and precipitations during 1950-2000; and climate change scenarios projected to 2020-2030-2050. Also, ozone like air pollutant, 2009 pandemic A/H1N1 spring outbreak; floodings and acute respiratory and diaorrheal infectious diseases, dermatitis and conjunctival diseases related with contaminated food, air, water and soil after intense rainfalls; surveillance of vibrio parahaemolyticus; ocean pH and enterococcus.

Methods: Samples were obtained and sent to state public health laboratory in Morelia, Michoacan, Mexico. Meteorological reports were obtained and reviewed by the Delegational state of the National Commision of Water and analysed by the Athmosferic Science Center from the National University Autonomus of Mexico in Mexico City. Descriptive epidemiological reports were assessed to complete these reports from the epidemiological surveillance health system of michoacan.

Results: Acute infectious diseases were identified like A/H1N1 flu virus and ozone air pollutant in april and may in 2009. Respiratory and diaorrheal infectious outbreaks in heavy rainfalls and floodings in 2010 february in the Monarch butterfly biosphere region in East Michoacan. In the same year, in april an outbreak of vibrio parahaemolyticus were presented. And, recently in 2013 a serial reports related with a low level pH decrease in the Pacific ocean coast and the presence of enterococcus were measured. All these results were associated with temperature, precipitations and climate change scenarios since 1950-2000 and 2020, 2030 and 2050 measures in Michoacan.

Main Conclusions: Acute and infectious diseases were identified in places where our temperature and precipitations are increasing like world reports in ar4 and ar5 IPCC and others epidemiological data have been publishing.

P-1121-09

Pollen as a health indicator of climate change

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Climate change, which is now scientifically proven and well known by everyone, influences plant growth, with unavoidable consequences on pollen. There are still a lot of uncertainties about the changes affecting pollination, but it is not disputed that the prevalence of allergies is on the rise for a number of years. Similarly, the timing and severity of allergic symptoms does seem to be related to climate variations. Indeed, it certainly appears that a warmer climate (both observed in the recent past and projected into the future) leads to more pollen grains in the air, to earlier flowering and pollination dates, to longer pollen seasons, and to poleward and upward shifts in ranges in plant species. Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed rising levels in anthropogenic greenhouse gas concentrations. But the major greenhouse gas, i.e. the carbon dioxide (CO2) whose concentration has increased from a pre-industrial value of about 280 parts per million (ppm) to 400 ppm in 2014, has also a direct, extra-climatic effect. In fact, it acts as aerial fertilizer and helps plants thrive, causing increases in pollen production, in atmospheric pollen concentrations and, finally, in the number of allergy sufferers. The World Health Organization (WHO, 2003) classifies allergies as the fourth most important chronic disease in the world and considers that these diseases represent «a major public health problem in terms of quality of life, lost days of work or school, drug cost, and even mortality». Today, it is assumed that as many as 20 % of the French population currently have some form of allergy, about half of them suffering from pollen allergy (or pollinosis). Counting and identifying pollen grains over several years enables to estimate and, as a result, to predict the pollination dates of various plant families (in order to institute preventive actions for the benefit of allergy sufferers), but also to detect any changes in the pollen content of the atmosphere and alert the allergists. Moreover, it is well known that the prevalence of allergy in general and pollen allergy in particular has increased significantly in recent decades in industrialized countries. Exposure to environmental pollutants may partly explain such an upward trend. As a result of chemical pollution it is possible to observe a reduction in the sensitivity threshold to pollen, for example by deforming or breaking the outer wall of the grain, resulting in the dispersion in the environment of many fragments of pollen grains and cytoplasmic granules. Pollutants such as PM10, PM2.5, ozone and NO2 can also irritate airways and the increased airway responsiveness is able to reinforce the effects of pollen allergy. Phenological observations (occurrence of periodic, most often annual, life cycle events, influenced by seasonal and inter-annual variations in climate) are used to evaluate the influence of climate change on vegetation and biodiversity. These observations, when carried out on allergenic plant species, help to assess the influence of climate change on human health. At the request of ONERC (National Observatory of Global Warming Effects), RNSA (French Aerobiology Network) undertook in 2012 and then updated annually a study aiming at the construction of a health indicator in the Health and Society Chapter of the ONERC catalogue of climate change indicators. The results obtained from birch pollen data (high allergenic potential throughout Europe and sensitivity to long-term climate events) of six cities with different climates in metropolitan France, showed an increasing trend in pollen concentration with a rate of about 20 % during the last 20 years. This increasing trend has been associated with increasing regional temperatures, suggesting that climate change may already be having an impact on atmospheric pollen concentrations. In the future, global warming and rising temperatures could lead to a further increase in the amount of pollen in the air. This can only aggravate allergic hazards and thereby jeopardize public health. In view of the COP 21 conference in Paris at the end of 2015, the goal is to find solutions to limit the effects of climate

change on pollen and health. One of the main objectives pursued by RNSA is to inform the public on the risks and attitudes we must have in order to limit the health impact of pollutants and pollen on allergic sufferers. The missions of monitoring, warning and prevention of allergic risk given to the RNSA fit into this perspective and should allow the implementation of adequate policies by health authorities.

P-1121-10

Simulations of Pollutant Dispersal over Nairobi City, Kenya

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The current rapid deterioration of air quality in urban centres can be attributed to urbanization. Poor air quality has been associated with several negative effects on human health, climate and ecosystems. Most cities in developing countries, especially in Africa have poor or in some cases no air quality management systems in place despite having the fastest growing urban populations. City populations have high vulnerability to the impacts air pollution following high density of residents and economic activities as well.

Air pollution is evident in most cities; the case of Nairobi is an illustrative of this. The common air pollutants include carbon monoxide and total suspended particulates among others, the latter being the most widespread and the most serious for human health.

This study simulated air pollutant dispersal over the city using Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT), considering a case for emission of total suspended particles into the environment. The predominant wind speed over the city is 4-6 knots and the wind direction is easterly. The forward trajectory of a pollutant released in the city is generally observed to flow to the western side of the city. The pollutant is observed to be dispersed beyond 100 km from the city reducing the concentration of the same in the city.

The study thus recommends for a consultative planning process of the city that factors in the wind characteristics over the city; most industrial activities should be located to the extreme western side of the city to minimize concentration of pollutants over the city. The study further recommends studies that studies be carried out to ascertain the quality of rain water during the long rain season.

P-1121-11

Impact of hot weather on injuries and accidents in high income countries - a literature review

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Introduction: Given predictions of increased frequency of hot weather periods due to climate change it is crucial to have prevention measures in place to reduce the health burden of heat waves. Since injuries have often been overlooked in relation to hot weather the aim of this review is to summarize the evidence on the effect of hot weather on unintentional injuries in high income countries to inform policy and programme initiatives designed to reduce the burden of injuries. Methods: The following data bases were searched (28/02/2015): Global Public Health, Embase, Medline. Studies reporting heatstroke were excluded as the purpose of this review is to report on non-heat related injuries. Eligibility was assessed by one reviewer. 19 studies were included. Results: Preliminary results of this review showed for 15 out of 19 studies an increased risk of unintentional injuries during hot weather. A Spanish study reported that 60% (69) of all firefighter deaths due to a wildland fire entrapment occurred on high temperatures days. In the Netherlands an increase of 15% out of 354,150 trauma patients for each 10°C increase was observed above a threshold of 6°C. In France an excess mortality due to injury and poisoning in particular for people under 35 years was reported. Hot weather conditions in Italy showed higher risk for work-related accidents, in particular on early summer days. 3 studies from the US showed for high temperatures a strong increase in hospital admissions in accidental causes and an increased risk of fatality due to accidental cocaine overdose In contrast, 1 study from Australia did not find an association between emergency hospital admissions due to injuries during extreme heat events. Another Australian study reported decreases in sport accidents, falls and blunts in children and a decrease in motor vehicle related accidents among the elderly. Conclusions: To our knowledge, this is the 1st review of the effect of hot weather on unintentional injuries. Our review indicates that hot weather periods may increase the risk of unintentional injuries and accidents in high income countries. The results are valuable for health system planning and injury prevention strategies.

P-1121-12

Air Pollution Transport Processes and Human Health Impacts over the Middle Hill Urban Centers of Nepal Himalaya

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Urban centers of Nepal are mostly located in deep valleys, narrow river basins and in southern plain areas, more or less shaped like valleys and in proximity to the high mountains. The meteorological conditions associated with such topographic features have been found to be highly adverse and may build up severe air pollution even where the local emissions are low. In consideration with their associated topography and the meteorological conditions that could possibly prevail, Nepalese urban centers in the middle hills are expected to be highly vulnerable to air pollution. Prevalence of dust, particulate and other pollutants in the ambient air of these urban centers have already reached to an unacceptable level. The lack of necessary knowledge on air pollution emission pattern, the carrying capacity, mechanism of transport and formation of pollutant fields in these swelling urban centers have given rise to serious uncertainties with respect to the air quality degradation, development of control systems, and urban planning. Observations and numerical simulation studies on prevailing wintertime meteorology and air pollutants distribution and their dynamics have revealed that the bowl-shaped Kathmandu valley possesses high air pollution potential due to its adverse meteorological and topographic conditions particularly during the dry winter season. The poor dispersion power of the valley can easily reach into its saturation if substantial amount of air pollution is continuously loaded into its atmosphere. Concurrent investigation of human-air pollution exposure status based on the results of numerical simulation revealed that more than 52 per cent of total Kathmandu residents were living in areas with concentration above 40 µgm-3 of PM10. Significant health endpoints attributable to PM10 over the Kathmandu valley have been predicted. Other urban centers are developing in the same pursuits. In this paper, we will present the atmospheric transport processes over the middle hills of Nepal Himalaya and their role in pumping up the lowland pollutants up into the Himalayas including the prevailing wintertime meteorology, mechanism of air pollution transport and formation of pollutant fields, human exposure and health endpoints over the Kathmandu valley.

P-1121-13

Seasonal variations of aerosols in Pakistan: Contributions of domestic anthropogenic emissions and transboundary transport

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Air pollution has become a serious challenge for developing countries like Pakistan. Very scarce information is available regarding pollution levels in this geographic region. This study presents the first modelling work to simulate the spatial distribution and temporal variation of aerosol concentrations over Pakistan for using the Weather Research and Forecasting Model coupled with chemistry (WRF-Chem). Simulated aerosols species include sulfate, nitrate, ammonium, organic carbon, black carbon, and

PM2.5 (particles with a diameter of 2.5 mm or less), which are evaluated against ground-based observations and satellite measurements. In year 2006, simulated PM2.5 concentrations averaged over northeastern Pakistan (71–74.5°E, 28–34°N) are 55, 48.5, 31.5, and 98 μg m^{-3} in January, April, July, and October, respectively. The simulated highest PM2.5 concentration in October results from the relatively low temperatures that favor nitrate formation as well as the lowest precipitation that leads to the smallest wet deposition of all aerosol species. The simulated lowest concentration of PM2.5 in July can be attributed to the largest precipitation associated with the South Asian summer monsoon. Sensitivity studies show that transboundary transport contributes to PM2.5 aerosol levels in northeastern Pakistan by 10–20% in January and April and by 10–40% in July and October of year 2006. Wind over India and Pakistan is found to be the major meteorological parameter that determines the transboundary aerosol transport.

P-1121-14

Enhanced critical load capacity of soil due to buffering of atmospheric acidity through deposition of soil derived particulate matter in Delhi (India)

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This paper reports air quality characterization using data of MODIS-derived aerosol optical depth (AOD) and measured Suspended Particulate Matter (SPM), NO2 and SO2 values across India. The levels of these pollutants were mapped using geospatial techniques. The results show significant differences in the levels of SPM, NO2 and SO2 across rural and urban sites. In general, districts of central and northern India show relatively higher SPM concentrations as compared to southern India. The SPM values were noted to have a significant correlation with the AOD values at different sites. Further a trend analysis of SPM, NO2 and SO2 in the Delhi region, which was carried out using the Central Pollution Control Board (CPCB) data, revealed a continuous increase in the SPM levels in the city. This lead to the calculation of the critical load of atmospheric acidity for nitrogen and sulphur in order to check the vulnerability of the soil systems in Delhi. A Critical Load approach similar to the one used in European method, was applied to assess the vulnerability of natural systems to the present day atmospheric pollution scenario in the capital city of Delhi. The calculated values of critical loads of sulphur (225 – 275 eq/ha/yr) and nitrogen (298 – 303 eq/ha/yr), for the soil system in Delhi, were calculated with respect to Anjan grass, Hibiscus and Black siris. According to the results, present loads of sulphur (PL(S) = 26.40 eq/ha/yr) and nitrogen (PL(N) = 36.51 eq/ha/yr) were found to be much lower than their critical loads which means that the present levels of acidity do not pose any danger the soil systems. The study indicated that the system is still protective due to high pH of the soil. The nature of buffering capability of calcium derived from soil dust can be considered as a natural tool to combat acidification in the Indian region. The results showed that the pollution status in Delhi is still within the safe limits. However, at the pace at which the city is growing, it is likely that in coming decades, it may exceed these critical values. The approach is very useful, not only in abating pollution but also in devising means of cost optimal emission abatement strategies, and can be applied the across entire Indian region.

P-1121-15

Characteristics of aerosol optical and physical properties during major dust storm and intense biomass burning events over a mega-city of Lahore (Pakistan)

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Aerosol particles released due to natural and anthropogenic activities have very important effects on human health and climate of the region. In the present study aerosol optical and physical properties have been analyzed during major dust storm (March 2012) and intense biomass burning (October 2013) events over a mega-city of Lahore (Pakistan). In this work we have used AERONET data (level 2.0) to analyze the aerosol optical depth (AOD), Angstrom exponent (440/870) (AE), fine mode fraction (FMF), volume size distribution, single scattering albedo (SSA), real and imaginary parts of refractive index (RI), asymmetry parameter (ASY) and aerosol radiative forcing. We have also used available satellite based measurements during both events. ARL's HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) model backward trajectories were also computed to understand the transport of aerosol particles during both the events. The daily average AOD value (2.17) at 500 nm was found to be highest on 20 March 2012 with corresponding FMF value of 0.27 indicating the dominance of coarse mode particles due to dust storm over Lahore. While during intense biomass burning event peak value (2.36) of AOD was observed on 9 October 2013 with corresponding FMF value of 0.97 pointing towards the fact that fine mode aerosol particles have greater contribution towards total AOD in the atmosphere of Lahore. Volume distribution was observed to be maximum (~1.7) at a radius of ~1.69 on 20 March 2012, whereas volume concentration (~0.33) was found to be highest at a radius of ~0.27 during 9 October 2013. Significant increase in SSA with wavelength was observed during dust storm while during biomass burning period it decreased with wavelength. Aerosol radiative forcing was found to be -265 and -199 Wm-2 during dust storm and biomass burning periods respectively.

P-1121-16

Numerical Characterization of the NOx Formation during MSW Incineration

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A numerical model has been developed (Chemkin) to study combustion processes in a fixed bed reactor. The test section is divided into several successive Perfect Stirred Reactor (PSR). At the entry, the thermal degradation species of the solid are used as input and at the exit the exhaust gases are recovered. Comparison of previously experimental results and the current model output has been compared with good agreement. The study demonstrates that the NO formation and reduction is controlled by the combustion regime so are mainly dependant of the primary excess air of combustion. The model has been used to establish the reaction pathways of formation and reduction of the NOx at different locations in the reactor as a function of this parameter. This has allowed defining what is occurring at each specific location of the reactor. The reaction pathways and sensitivity study has shown that the production of NO is controlled mostly by local oxygen concentration, thus the location of the NO production region depends mostly on the primary air injection. From this description of the principal reacting zones and of the intermediate species it is possible to develop and to optimize primary technique of NOx reduction.

ORAL PRESENTATIONS

K-1122-01

Global warming and sea level rise

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It is now well established that the Earth's climate is warming because accumulation inside theatmosphere of green house gases produced by anthropogenic fossil fuel combustion and landuse change (mostly deforestation). Global warming has already several visible consequences,in particular increase of the ocean heat content, melting of glaciers, and ice mass loss from theGreenland and Antarctica ice sheets. Ocean warming and land ice melt in turn cause sea levelto rise. Sea level rise induced by global warming and its impacts in coastal zones has becomea question of growing interest for in the scientific community, and the media and public. Inthis presentation, we summarize the most up-to-date knowledge about climate change andassociated impacts on ocean warming, land ice melt and sea level rise. We also present sealevel projections for the 21st century under different warming scenarios, highlighting theregional variability that superimposes the global mean rise. Finally, we briefly discuss thecoastal zones case where climate-related sea level rise generally amplifies the vulnerability ofthese regions already impacted by many other factors due to natural phenomena and directanthropogenic forcing.

K-1122-02

Greenland ice cores tell tales on the extent of the Greenland Ice Sheet during past warm climate periodes

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Knowledge on the long-term response of the Greenland ice sheet to climate warming duringpast interglacials is essential for estimating the potential of future rise in sea level. Duringthe last million years, the Greenland Ice Sheet (GRIS) has waxed and waned in response toglacial and interglacial periods. The deep ice cores through the Greenland ice sheet containice from the time ice covered the site. Ice from the last interglacial period (the Eemian, LIG)130 to 115 kyears before present is present in most of the deep ice cores and can be used todetermine both temperature and extent of the ice sheet during this warm interglacialperiod.Going to the bed, basal material enclosed in the ice cores contain DNA remnants that can beused to determine the ecosystems present before ice covered Greenland.The reaction of the Greenland ice sheet to climate changes and the sea level change frommass loss from the Greenland ice sheet is discussed based on the ice core findings.

K-1122-03

Uncertainties in Mass Balance Studies of the Arctic Sea Ice Cover

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The longest continuous observations of the global sea ice cover are those derived from satellite passive microwave sea ice data starting with the launch of the Nimbus-7 SMMR in October 1978 and followed by a series of DMSP/SSM/I sensors launched from July 1987 to the present. These capabilities were further improved with the launch of Aqua/AMSR-E which provided higher resolution data from June 2002 to October 2011and followed by the launched of GCOM-W/AMSR2 which has been in operation from 2012 up to the present. Putting together an accurate time series data set has been a challenge because of differences in fields-of-view, antenna side-lobes, calibration and other physical attributes of the different sensors. Through comparative analysis of overlapping data, however, some of these problems have been minimized and the accuracy in the assessments of the variability and trends of ice extent and ice area has been optimized. The ice extent provides the sum of areas in the ocean that has ice cover of at least 15% ice concentration while ice area provides the actual area covered by ice and used to estimate the ice volume assuming that the average thickness of the ice cover is known. The current record from 1978 to 2014 shows a trend in ice area of about 4.3 ± 0.16% per decade for the yearly average but a more drastic change is observed for the thick multiyear ice the trend of which is about 14.9±1.6% per decade suggesting large declines in the average ice thickness of this ice type. Measurements of ice thickness have been the source of greatest uncertainties since accurate, continuous and consistent time series measurements of global ice thickness are not available. Historically, ice thickness measurements have been sparse and were done primarily using upward looking submarine sonar data which have been used to show a significant change in average winter ice thickness from about 3.6 m in 1980 to about 2.9m in 2000. Ice freeboard measurements from ICESat/GLAS (January 2003-February 2010) provide more extensive coverage and indicate a change in winter thickness from about 2.4 m in 2004 to 1.9m in 2008. More recent freeboard measurements from CryosSat2 (April 2010 to the present) provided a continuation of the satellite measurements and show a more stable ice cover. Although retrieve thicknesses from freeboard measurements have indicated relatively low biases (less than 0.1m) compared to in situ and other measurements, there are large standard deviations (0.7m) in the comparative analysis suggesting that more accurate snow thickness and ice density data are needed. The use of the improved measurements of average sea ice thickness separately for seasonal and multiyear ice in conjunction with passive microwave data would provide the desired estimate for average volume of the two major ice types. Time series of such data are needed in mass balance studies of the Arctic sea ice cover and uncertainties associated with the use of current data sets will be provided.

O-1122-01

What can we learn from the recent global warming hiatus about climate variability and climate models?

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The observed rise in global mean surface air temperature (GMST) has slowed down over the last 15 years, spurring outbreaks of skepticism regarding the nature of global warming and challenging the upper range transient response of the current-generation global climate models. Recent numerical studies have, however, tempered the relevance of the observed pause in global warming by highlighting the key role of tropical Pacific internal variability. Here we first show that many climate models overestimate the influence of the El Niño-Southern Oscillation on GMST, thereby shedding doubt on their ability to capture the tropical Pacific contribution to the hiatus. Moreover, model results can be quite sensitive to the experimental design. We argue that overriding the surface wind stress is more suitable than nudging the sea surface temperature for controlling the tropical Pacific ocean heat uptake and, thereby, the multidecadal variability of GMST. Using the former technique, our model captures several aspects of the recent climate evolution, including the weaker slowdown of global warming over land and the transition toward a negative phase of the Pacific Decadal Oscillation. Yet the observed global warming is still overestimated not only over the recent 1998-2012 hiatus period but also over former decades, thereby suggesting that the model might be too sensitive to the prescribed radiative forcings. Besides fully coupled ocean-atmosphere simulations, we therefore advocate the use of suitable partial-coupling techniques to control a fraction of the internal climate variability. This strategy could enable a more insightful comparison with the

observed climate variability and, thereby, lead to stronger observational constraints on model sensitivity to the prescribed radiative forcings.

O-1122-02

Eurasia winter cooling in a recent warming hiatus period of 1998-2012

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The global-mean surface temperature (GMST) has shown a comparatively small warming trend over 1998-2012, termed a hiatus [Meehl et al., 2011; Flato et al., 2013; Kosaka and Xie, 2013]. In addition to the warming hiatus of GMST in the recent decade, Cohen et al. [2012] found a significant winter (seasons refer to those for the Northern Hemisphere hereafter) cooling trend on the Northern-Hemisphere (NH) extropical land surface temperature. However, the relative magnitudes of the contribution from temperature trend at different latitude bands and also the mechanism of the NH mid-latitude winter cooling are poorly understood. Here we investigate the spatial pattern of surface temperature trends and the contribution of surface temperature trend reduction at different latitude bands with observational data, and the causation of NH mid-latitude winter cooling with large ensembles of AMIP-type sensitivity simulations.

In addition to the tropical Pacific cooling over 1998-2012, we find the GMST warming hiatus is strongly influenced by a pronounced DJF cooling trend over 1998-2011 in NH mid-latitude, especially in Eurasia. However, an absent of the strong mid-latitude winter cooling trend in the previous simulations with restoring the observed SST over tropical Pacific in a coupled climate model Kosaka and Xie [2013] underlines that mechanisms other than cooling in the tropical Pacific must contribute to the warming hiatus in recent decade. In the present study, we explore the impact of the dramatic loss of Arctic sea ice on the NH large-scale circulation changes and the NH mid-latitude winter cooling trend. We found that the Arctic sea ice does not drive systemic changes on the NH large-scale circulation as Arctic Oscillation (AO), Pacific/North American Pattern (PNA) and the Eurasia winter blocking frequency in the past decades. And the observed DJF cooling trend over 1998-2012 is a random internal variability and belongs to a extreme climate events. Although the dramatic loss of Arctic sea ice does not drive systematic cooling trend of Eurasia winter climate, but it can enhance the variability of Eurasia winter climate, and thus increasing the possibility of the Eurasia winter reaching an extreme cold trend over 1998-2012.

O-1122-03

Impacts of External Forcing on the Decadal Climate Variability in CMIP5 Simulations

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Decadal climate variability is usually regarded as an internal variability in the climate system. However, using the coupled simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5), we have demonstrated that the external radiative forcing plays an important role in modulating decadal variability of the global mean surface air temperature (SAT). In historical runs, the standard deviations of the global mean SAT exhibit robust increases relative to pre-industrial runs, indicating that external forcing acts on decadal variability of the global mean SAT through enhancing amplitude and modulating phase. By comparing model results using different external forcing agents, we find the natural-forcing agent has the strongest impact on the decadal timescale. Every type of simulation (e.g., the pre-industrial, historical, natural forcing and anthropogenic forcing runs) from almost all the CMIP5 models exhibits a high correlation between the net shortwave (SW) radiative flux at the top-of-atmosphere (TOA) and the global mean SAT with a 13 month lag. However, after taking the multi-model ensemble mean for the TOA SW and the SAT, respectively, the correlations from external-forcing run are much higher than those from pre-industrial runs. This is because that the decadal SAT anomalies from multiple models cancel each other out in the pre-industrial runs without external forcing, but generally follow decadal evolution of the external forcing with a 13 month lag. The most significant responses to external forcing are found in the tropical Indian and Pacific oceans, through with different physical mechanisms for the natural and greenhouse gas forcing agents.

O-1122-04

Change Points of Global Temperature

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We aim to address the question of whether or not there is a recent "hiatus", "pause" or "slowdown" of global temperature rise. Using a statistical technique known as change point analysis we identify the statistically significant changes in four global temperature records and estimate the rates of temperature rise before and after these changes occur. In each case the results indicate that three change points are enough to accurately capture the variability in the data with no evidence of any significant change in the global warming trend since ~1970. We conclude that a hiatus or pause cannot be statistically justified.

O-1122-05

Impact of initial conditions and atmospheric model resolution in predicting "Climate Hiatuses"

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The results from a set of multi-year hindcasts carried out with the ECMWF coupled system at two different resolutions of the atmospheric component will be presented. The first experiment consists of a control series of ensemble hindcasts with the atmospheric model integrated at T255 with 91 levels in vertical (this is the current resolution of the ECMWF System4). The ocean resolution is the standard NEMO-ORCA1. In the sensitivity experiment the atmospheric resolution has increased to T511 (the ocean resolution is the same). By comparing the control and the sensitivity experiment we estimate the impact of the increased atmospheric resolution on forecast quality.

The impact of initial conditions relative to external forcings in multi-year integrations is further assessed using specifically designed sensitivity experiments. They consist, for each atmospheric resolution, of three sets of ensemble hindcasts for three initial dates in 1988, 1994 and 2002 using either the external forcings from the 'correct' decade or swapping the forcings between the three decades. By comparing the three sets of integrations, the impact of external forcing versus initial conditions on the predictability over multi-annual time scales is estimated. In particular we estimate the sensitivity of the model to initial conditions and horizontal resolution in predicting the multi-year climate oscillations that modulate the global warming trend, also known as "Climate Hiatuses".

O-1122-06

Multi-model simulations of radiative forcing of aerosols and ozone during the 1990-2015 period

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Seven global models have simulated the changes in aerosols and ozone over the 1990–2015 period, and the associated radiative forcing. The models have used updated emission data from the EU-project Eclipse. The modelled changes in aerosol abundance at the surface in terms of PM2.5 show broad agreement with observations, whereas they generally underestimate the overall increase in surface ozone over US and Europe. We focus on model-mean radiative forcing and the spread among the models, and compare this to estimated radiative forcing in IPCC AR5. The models show remarkably good agreement for the direct aerosol effect of sulphate, and for carbonaceous aerosols from fossil fuel and biofuel sources. However, for nitrate the differences are large. Over the 1990–2015 period, the models simulate a positive direct aerosol effect radiative forcing of sulphate and black carbon, due to a reduction the sulphate abundance and increase in black carbon abundance. The model mean shows relatively small changes in the indirect aerosol effect over the investigated period. It is indicated that including semi-direct effect of black carbon is important, even though few models have been able to quantify this forcing. Overall the models have a more strongly positive aerosol radiative forcing over the 1990–2015 period than IPCC AR5. Similarly the ozone radiative forcing over the same period is simulated in this study to have a more positive radiative forcing than IPCC AR5. Based on these multi-model simulations using updated emission data of aerosols and ozone, we find no indications that these forcing agents are driving the global warming hiatus.

1123 - Climate change education for sustainable development

1123-POSTER PRESENTATIONS

P-1123-01

Climate Change Engineering: An emerging pathway to address Climate Change Challenges

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To survive in the future, the professional engineers should be qualified to deal with different and diverse subjects of climate change challenges. The focus of this work is to bridge the gap between the academia and the professional practice in the field of Climate Change CC. So, the professional engineers should have an adequate knowledge about wide and different Climate change engineering CCE disciplines. The focus of CCE is to promote Sustainability and optimally responding to CC challenges. CCE may be defined as the application of mathematical, scientific, environmental, and technical knowledge to invent, design, build, maintain, and improve structures, products, machines, devices, systems, materials and processes for the purpose of sustaining both the global and local properties of the Earth and its habitability. The paper focuses on the purpose, activities; and issues of CCE. The role of Climate change engineer has been addressed. The main finding of this article is to highlight CCE with invaluable insights into multidisciplinary engineering that help improve current operations and shape future strategies in the Era of Climate Change. The resultant conclusion is that the role CC plays in the success or failure of development efforts must be considered by applying CCE principles.

P-1123-02

Education on climate change through generation of local data

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Education covers a key part in the global response to climate change. Understanding the behaviour of ecosystems, the role of the cities or the orders of magnitude of atmospheric greenhouse gases concentrations help scholars and citizenship to gain a more conscious and active attitude on the climatic challenge and its causes.

Researchers from the Laboratory of the Atmosphere and Oceans (LAO) at the Catalan Institute of Climate Science (IC3) have developed several educational activities of outreach and workshops with scholars and citizenship to make the population aware of the causes generating climate changes and how they can contribute in reducing it. All these activities share a common aim: scholars or citizens generate and collect quality data allowing them to better understand processes that happen in our environment, regardless whether they are biological or anthropogenic processes. Another important objective of these educational activities consists in making scholars and citizenship active participants of the scientific community discussing and studying the generated data with other groups.

The kind of measurements can be, for instance, atmospheric greenhouse gases concentrations, meteorological parameters or radiation measurements. Data generated from these measurements allow knowing the general greenhouse gases concentrations in the atmosphere and the relative increase due to fossil fuel combustions: this kind of studies makes the citizenship much more aware in understanding the role of cities in the global emissions or the relation of the ecosystems behaviour with water and temperature.

P-1123-03

Mainstreaming climate change into fisheries and aquatic sciences curriculum and training in tertiary academic institutions

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Fisheries resources in Uganda contribute to food security, employment, income and livelihoods but are threatened by over-exploitation, pollution, habitat degradation, invasive species and climate variability and change. However, climate variability and change has been little studied yet it is adding to or interacting with other stressors to affect riparian ecosystems, fish habitats, aquatic productivity, fish yields and livelihoods. There is inadequate knowledge, training and institutional capacity to address climate change in fisheries in Uganda as in most African countries. There is therefore need to build capacity through mainstreaming climate change into the curriculum of tertiary training and research institutions. International, regional and national policies have recommended incorporating climate change into education and training from primary to tertiary institutions. Some training institutions in Uganda have curricula in basic and applied fisheries and freshwater science but many of these do not address issues of climate variability and change. This curriculum and manual was therefore developed to address this shortfall. Its overall objective is to mainstream climate change in inland freshwater systems and fisheries. The specific objectives are to: 1) develop a training curriculum and manual that will be used to train students in climate change and fisheries in tertiary education and research institutions and 2) mainstream climate change into the undergraduate and graduate fisheries and aquaculture curricula. This is expected to build scientific and technical capacity to: 1) anticipate and evaluate changes in climate and its impacts; 2) communicate information to stakeholders to enable them design, test and implement adaptation strategies and mitigation measures; 3) increase human resource capacity through reviewing and strengthening the national education system; and 4) promote science and technology

as stipulated in Uganda's National Development Plan (NDP) and Agriculture Sector Development Strategy and Investment Plan (DSIP). The manual is organized into six modules namely: Non-climate factors which together with climate change affect natural resources; Introduction to climate change; Climate change and physical, chemical and ecological properties and productivity of inland aquatic ecosystems and fisheries; Climate change and aquaculture; Socio-economic impacts, adaptations and mitigations; and Policy, legal and institutional frameworks. Each module consists of units to be delivered through lectures, brainstorming sessions, case studies, field visits, group discussions, computer exercises and seminar presentations. The training curriculum and manual was completed in 2014 and is ready for pretesting in tertiary academic institutions in Uganda.

P-1123-04

The Importance of Environmental Education for Sustainability

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It is an undoubted fact that human beings are having a significant impact on the nature environment. As the global population continues to rise, human place more and more pressure on a finite number of resources. Human environmental impacts can largely be attributing to consumption patterns. However, the ability to meet the needs of the current generation while preserving the ability of future generation to meet their needs, it would be reasonable to search for way to minimize human impact on the environmental and to build a sustainable world for the future.

It is considered that the best way to raise awareness of sustainability and environmental issued and finally, changing behavior to more sustainable practices is through environment education. Therefore, environmental education is not just about learning, it is about understanding issues confronting our planet and changing individual attitudes values and developing a community of environmental aware towards achieving suitability for the future.

This poster will discuss approaches and principles of environmental education and study case.

P-1123-05

Teaching climate change: An interdisciplinary challenge

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Climate change education is inherently interdisciplinary. It requires teachers to possess a broad range of competencies and to apply alternating teaching methods bringing into play the skills and knowledge of the whole classroom. If one defines interdisciplinary learning as the ability to know and coordinate a growing number of perspectives, it becomes the teacher's primary task to support students in their explorative and coordinative efforts. A research project running from 2013 to 2016 at the University of Copenhagen has investigated the pedagogical and didactical challenges in two interdisciplinary Master's Programs – one of them called 'Master of Disaster' (MDMa) at the Faculty of Health and the other 'Master of Science (MSc) in Climate Change' (CCIMA) at the Faculty of Science. Preliminary findings show a weak institutional support for interdisciplinary teaching and a lack of coordination among topics covered in the curricula. When worst, teaching becomes a kind of serial – or rather 'parallel disciplinarity' – where modularly formatted perspectives produce mutually incomprehensible monologues. When best, lead instructors use a variety of inductive teaching methods and provide an impartial overview of the conceptual schemes involved.

P-1123-06

Getting from here to a sustainable world: Why "handprint" measurement which drives pro-environment behavior be crucial to addressing climate change?

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Exponential increase in human population from 5 million in 8000 BC to over 7 billion humans in 2012 coupled with unsustainable consumption and production patterns is putting an undue pressure on the limited natural resources. It's not planet and the diminishing natural resources but our own species at risk if we continue with this present model of development. Thus climate change is not an issue in isolation, but rather, a symptom of a broader challenge: humanity's systematic overuse of the planet's finite resources. This accelerating gap between human demand and nature's supply is leading to another crunch of bio-capacity.

In a world facing climate change issues and a bio-capacity crunch, the winning economic strategies will be preserving bio-capacity on the one hand, and reducing demand for it on the other which in turn would serve as the leading strategies for minimising climate change. But how is this possible? Climate change and high carbon lifestyles as a narrative of future gloom and doom only disempowers people to act. What if we focus on solution rather than problem? What if we focus on accounting positive actions powered by pro-environment behaviour to drive low carbon lifestyles? Sustainable development would require changes in the way we think and act. And education is one of the most effective mediums to bring about changes in values, behaviour and lifestyles required to achieve sustainability.

Scientifically driven and educative accounting tools like carbon foot print, ecological foot print measures our actions either in terms of amount of carbon dioxide released in the atmosphere or in terms of resources of the earth which would be needed to match our lifestyles and suggests our negative impacts on the environment respectively. While Handprint is a symbol of positive measure for what we can do individually or through collective effort to restore the balance between consumption and the planet's carrying capacity. Studies suggest that positive accounting not only presents hope but also suggests how it affects behaviour changes benefiting society to drive more positive actions. Handprint accounting is one such educative tool to drive pro-environment behaviour and actions.

It answers questions like how my changes in behaviour and actions would result in greenhouse gas reductions and would contribute to safe guarding environment, promoting sustainable development and thus would help in achieving climate change mitigation caps. Such measures would act as a roadmap to achieve a sustainable future.

This research focuses on developing a scientifically driven educational tool for handprint which in turn establishes links between measuring positive actions via handprint scores driving climate smart behaviour and climate change mitigation potential.

P-1123-07

Studies on research initiatives for developing strategic knowledge on climate change impacts in India

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This is well-known fact that Indian economy is based on its natural resources, agriculture and forestry, which are climate sensitive sectors. Considering the above India may expect considerable variations in vulnerability due to projected climate change phenomenon. In response to the same Government has prepared a National Action Plan for Climate Change (NAPCC) comprising of eight

different national missions. Amongst these eight national missions, National Mission on Strategic Knowledge for Climate Change (NMSKCC) is expected to build an active knowledge system related to climate change issues in the country, that may help national actions for responding effectively to the objectives of ecologically sustainable development. This NMSKCC mission includes various issues to address climate change science with region specific modelling related to national objectives, international cooperation and strengthening the plans for development of new technologies for adaptation and mitigation and also expected to cover knowledge gaps that are to be bridged. It also proposes to develop human and institutional capacity-building actions related to climate change issues. These activities are being considered necessary for designing policy responses and implementation approaches at the national level and also for providing inputs to negotiations at the international platforms. This mission will work as a support mission to other seven national missions by providing strategic knowledge. Since considerable data resources are already available with various Ministries, academic and research and development institutes in India, a credible data sharing mechanism is also proposed to be developed under this mission.

In this presentation attempts are being made to discuss the development initiatives for "Strategic Knowledge on climate change in India» that includes establishment of knowledge networks in the areas of climate change science with modelling as well as health. Amongst the various R&D projects supported, under this mission, in the areas of seas level rise, forests fire, agriculture, ocean acidification, glacier studies and sustainable livelihoods, a number of strategic reports are expected to be published. Under the programme of capacity building, training of high quality climate change professionals and state institutions have been supported. For the International bilateral cooperation schemes, S&T cooperation with Switzerland and Iceland have been finalized. In order to maintain speed with the state-of-the-art technologies emerging worldwide in the key sectors of economy, a programme named "Global Technology Watch Group" (GTWG) is also being initiated that emphasises the different areas relevant to other seven missions on climate change such as solar energy, energy efficiency, water, agriculture, etc.

P-1123-08

Climate change and Health- Training Resources for capacity building

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As climate change and its respective health effects are being observed across Europe, it is being suggested that development and implementation of adaptation strategies to protect human health should be accelerated and strengthened. Health adaptation to climate change involves knowledge and skills in a range of professions and across various sectors - not only technical but also skills involving personal interactions. A systematic training approach has been missing for many years. The available information is now presented in a structured modular collection in order to make these valuable resources accessible and to fill identified gaps in knowledge and capacity development. The WHO Regional Office for Europe has developed a collection of training resources for capacity building on climate change and health. The overall aim is to support the development of climate change and health strategies and action plans by providing scientific, technical, methodological and practical background information and training to member states. Thus, the training resources offer the opportunity to raise awareness among professionals with regard to observed and projected climate change in Europe, and related health effects, and to support health adaptation policy development and implementation in an intersectoral setting. The training resources (manual + suggested training materials) contain a structured compilation of existing and new training materials according to defined cascades of learning objectives. The three modular thematic blocks cover the basics of climate change and associated health effects - one presents a framework for the development of adaptation strategies and programmes of action - and draw attention to co-benefits of health of climate change mitigation measures in the health sector and in other sectors. Use of a range of training methods creates an interactive and participatory learning environment. These are intended to enable WHO European Member States to respond to and anticipate capacity building needs for climate change and health. Training resources can assist health policy-makers, planners and practitioners in the process of harnessing the potential of adaptation to climate change in order to meet health goals and targets.

P-1123-09

Does the public policy for influencing pro-environmental behaviour in the developed countries take into account people's common future under climate change?

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Public policy in the richest countries regarding environmental protection is currently based on 'monetising' nature - regarding it as a form of capital. The UK government tries to tackle climate change using a multitude of approaches however; the most effective ones to influence pro-environmental behaviour in the long term are yet to be found.

In this paper, I will discuss the approaches followed by the UK government to influence people adopt a pro-environmental behaviour pursuing them to change their unsustainable lifestyle using financial incentives, nudging and population segmentation. These approaches give people strong reasons to take the 'right' actions in the short term; however, when the incentives are stopped, they need to find by themselves the motivation to act pro-environmentally. As a result, I state that the UK government does not set a straightforward connection between people's common future under climate change and the duty to protect the natural world.

In the UK context, individuals are not informed, but incentivised to act pro-environmentally via a series of price signals or nudges that encourage them to change their behaviour. I argue for the need to offer constructive feedback as a response to people's harmful behaviour and facilitate the necessary contexts to become aware of unsustainable daily actions.

Moreover, I state that environmental ethics are not often mentioned in the debate about influencing human action for climate change mitigation; even though morality is for the majority of us, a behaviour regulator that can motivate us to take the 'right' actions. Whatever the reason, there is not a lot of interest to bring to attention the interdependent relationship between human beings and the environment. Thus, many pro-environmental projects are implemented without having the discussion about what people's duties and responsibilities towards the environment are.

If people do not understand and assume the change they need to make, they will not acquire environmental attitudes to motivate them to act pro-environmentally in the long term. They will continue to act unsustainably whenever they are not guided by different governmental strategies or do not receive any financial incentive to take a pro-environmental action.

As a consequence, I propose a methodological innovation that explores an alternative form of motivation for pro-environmental behaviour: moral motivation. I am interested to test the capacity of morality to be skill knowledge. If we think of morality as a skill that can be trained and learnt, then we will have a starting framework for moral education. To that end I will develop the notion of a 'shared morality', or a form of considered 'common sense', which has the potential to inform and motivate individuals morally, irrespective of any particular normative theory they happen to have and, hence, to maximise the impact needed for environmental protection.

Correspondingly, by cultivating a sense of moral responsibility towards nature we might find an efficient way to address two current problems that concern environmental protection. On one hand, a sense of moral responsibility towards nature can help people calculate

the individual costs and impacts of personal actions on our shared environmental context and on the other hand, it will provide us with constructive feedback in order to understand the benefits of taking pro-environmental action in the long term.

At present, it seems easier to convince people to act pro-environmentally by working with their short term motivations for action, than helping them adopt sustainable habits in the long-term. As a result, the current UK governmental approaches to influencing pro-environmental behaviour have a negative impact on people's behaviour and might perhaps weaken their sense of moral responsibility towards nature, in the context of environmental degradation.

In conclusion, I hope that the 'shared morality' initiative in applied moral theory can become an ideational trend in environmental governance and policymaking that will offer activists and decision-makers alike grounds for an alternative approach to meeting the challenge of climate change mitigation and encouraging pro-environmental behaviour.

P-1123-10

Ciclania: Videogame for generating sustainable educational communities

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The challenges facing mankind today associated with the phenomenon global change put us in a scenario of crossroads, which will determine the conditions of our future together.

The increase in atmospheric temperature; biodiversity loss; changes in land use; problems of freshwater availability, ocean acidification; inequality and poverty are some of the effects of the phenomenon, widely studied by the scientific community and those who have sounded the alarm. (IPCC, 2013; Peters, 2011).

But this warning is not enough to change the countries and citizens behavior. During the last forty years we´ve learned that global change will not be solved solely by technological developments, but together with the creation of new citizens with transformed community living arrangements.

Thus, civic education on these matters becomes relevant in the transformation of sensitized responsible citizens. To achieve this transformation, the approach proposed by this work consists in civic education driven by the scientific education.

With this premise we develop Ciclania, a free game,build up from - and in accordance with-the science program for primary schools of the Ministry of Education of Chile. Ciclania includes 5 environments: beach, field, forest, industrial city, and Egopolis, the city of consumption. The player must explore the environment solving problems associated with global change. In addition to the game, we developed an interactive guide for teachers, which browses the game environments(without the need of playing the game) and experimental activities for the classroom, that will give teachers the knowledge and space to deepen the key concepts of global change.

The evaluation results, show that the use of Ciclania promotes learning and motivation in science through play and fun, but mainly promotes in children reasons why we need as a community a more harmonious relationship with the environment in order to battle the global change.

P-1123-11

Engaging Children for a Sustainable Earth: The Case with Global Climate Ambassadors

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Introduction

The paper tends to look at the role of engaging children to make a difference in their communities especially taking actions that are climate friendly at local level and paper further examines how Global Climate Ambassadors GCA program brought together 17 organizations and 131 children from 7 countries to participate in the program in developing best practices on involving children and youth for a sustainable future thus; the paper also looks at how their participation in the 40th Planery Session of the IPCC change the entire landscape of climate change negotiations and awareness campaign among children.

Objectives

Is to empirically research on whether there is any impact of engaging children as change agents and also if the yardstick measure of the outcome of their engagement is applied, look at the significance of children's engagement in climate change negotiations and the impact it has for global sustainability. To understand if cross boundary programs of children can have a positive impact on sustainable development.

Methods

The research uses both primary and secondary data; relevant research works from scholars was looked at and give more emphasis on the report of the program. Thus; 7 children were interviewed to know the extent of their understanding in the program and how positively it has impacted their lives, if the connection and networking at their level has anything to improve their capacity at the intercontinental connections. The work adopts analytical and descriptive method as well.

Results

The analysis of the work has shown significant understanding of sustainable development and how climate change affect everyone on earth, among the 7 children interviewed 6 strongly agreed that the program has impacted positively in their understanding of what climate change is all about, and they all strongly agree connecting them with their peers out their countries will increase their chances of sharing ideas and learning from each other.

P-1123-12

An Open-Source Climate Change Curriculum for University Education Based on IPCC Synthesis Science

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In order to meaningfully participate in a civic society increasingly shaped by climate change, a climate-literate citizen should be able to read and understand the summaries for policymakers produced by the IPCC, which represent the current state of the art in the scientific understanding of climate change. However, although outreach and dissemination efforts have been increasing, to date we are not aware of any efforts to link the IPCC reports with curriculum design in higher education. Developing such links is essential to ensure that students are equipped with the skills and knowledge they will need. It can also improve teaching experiences through increased efficiency in course preparation, linking teaching and research, and in sharing best teaching practices with participating colleagues.

Here we develop a framework for teaching a comprehensive university course on climate change that is aligned with IPCC synthesis findings, assess how many of its core elements are addressed by courses offered at top international universities, and compile suggested teaching resources to fully equip students to understand climate change.

To develop the framework, we identified six core topics derived from scientific literature and syntheses, as well as research on effective climate communication. The six core topics were given the short labels: (1) It's climate, (2) It's warming, (3) It's us, (4) We're sure, (5) It's bad, and (6) We can fix it. The six core topics were then broken down into two to four major components (e.g., "Observed changes"

under "It's warming"), each of which consists of one or more concrete elements (e.g., "Atmospheric warming"). To finalize the components and elements, two independent researchers used qualitative analysis software to code the entire text and graphics of the 2014 IPCC Synthesis Report – Summary for Policymakers to ensure that all aspects of the essential messages of the IPCC findings were represented in our framework.

Based on analysis of syllabi available online or provided by course instructors from seventy university courses, we found that the majority (56%) covered only one of the six core topics; only one course (at Harvard University) covered all six topics. Within the core topics, the most commonly taught (by 60% of courses) was "It's climate," focusing on the functioning of the natural climate system. Less than 20% included climate change impacts ("It's bad"), and less than a third focused on climate change policy and solutions ("We can fix it.")

We contacted the instructors at the ten universities who taught four, five, or six of the core topics and requested their contribution of teaching and assessment materials, which we used along with other materials we identified to develop a comprehensive curriculum. The curriculum is based on the principles of constructive alignment, and includes a course syllabus, readings, lectures, labs, problem sets, and suggested learning and assessment activities. The curriculum will be freely available online as a teaching resource.

We have shown that there is a need for a comprehensive, research-based climate change course in higher education, which at present is largely unmet. Such courses are essential to promote deep student learning using thoughtfully designed teaching and assessment activities to promote intended learning outcomes, as well as the real-world illustration of the method of scientific inquiry applied to socially relevant problems. Ultimately, using scientific syntheses as the basis for university curricula would help close the gap between research and classroom learning, promote increased scientific understanding, and help ensure that the resources devoted to scientific synthesis efforts are translated to broader benefits for society.

P-1123-13

Socio-Scientific Teaching and Learning: Climate Change Concepts and Issues

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One of the challenges the teacher faces in introducing contemporary scientific developments into science lessons are the lack of available teaching and learning materials. Materials that are engaging enough that inspires, encourages and develops meaningful learning among students. This paper will present the collaborative project on the development of a Teachers' Guide Book in Integrating Climate Change Issues in Southeast Asian Schools. Specifically it will present the experiences, best practices and lessons learned in developing a science lesson exemplar through the partnership of teacher trainers and secondary school teachers in Malaysia. The developed science lesson exemplar has undergone students' try-out in Malaysian secondary school. Then, the implementation of the said science lesson exemplar in Philippines' secondary school will be highlighted. This paper will conclude with lessons learned in developing science lesson exemplars that integrates climate change concepts and issues. It will also present its usability, applicability and replicability implications as the Association of Southeast Asian Nations (ASEAN) gears towards the realization of ASEAN Community later this year.

P-1123-14

Climate Adventure: a strategy game to keep the greenhouse effect in balance

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This abstract describes the design and the development of Climate Adventure: A Game of Balance and Strategy©, a pedagogical tool created by a team of doctoral students in the Climate Change and Sustainable Development Policy program offered by the University of Lisbon. Recognizing that most people find the subject of climate change to be abstract and distant from their daily lives (according to literature findings), the team focused its efforts on answering the question: how can we make tangible the subject of climate change in an ethical way? The first step of the project was to identify a tool that could help people gain awareness. For that purpose, the team used creativity techniques. Our chosen vehicle was a game, one that would be fun to play, use movements, provide information, and operate with a minimum of strategy. These criteria were the basis for the next step: design the model and build the narrative of the game. The model is a card game played between teams with questions and answers, fulfilling steps to get to an end. The narrative is based on two arguments: scientific and ethical. The scientific argument considers the atmosphere, the greenhouse effect, and concentrations of greenhouse gases. The ethical argument considers human rights, distributive justice, and climate ethics. The development of the Climate Adventure© game required three more steps. The second step was to test the game using the technique of improvement by peers from the design thinking methodology. In November 2014 we invited doctoral colleagues to play the game, and three of them acted as direct observers with the responsibility of responding to a set of questions. The authors incorporated the direct observers' responses into the model and narrative of the game. The third step was to identify competing games in the marketplace and to analyze the products and how they were marketed. Our research identified games for children and adults, most of them strongly focused on cognition and competition. Our fourth step was to conduct an online survey among students of two classes at the doctoral program: the class that had participated in the game testing and another class that was completely unfamiliar with the game. The objective of the survey was to gauge people's perception of the game's attractiveness, color, name, and potential for learning and distribution. The authors have already registered the game at the Portugal government office Inspecção-Geral das Atividades Culturais – IGAC (General Inspection of Cultural Activities), which gives them a copyright on the game. Climate Adventure© is aimed at the general public (age 14 and up), and it is a parlor game whose aim is to keep the carbon dioxide (CO_2) in balance in the atmosphere so that weather conditions continue to favor life on Earth as we know it today. The two teams each begin the Adventure with an equal amount of CO_2 molecules; as they interact, they should finish the game with the same amount they had at the beginning, accepting a difference of +1 or -1. Throughout the game, the teams move from one space to the next by answering questions as they walk from the entrance to the exit gate of the atmosphere. During the game, the teams are able to use sources and sinks of carbon to keep their players in balance but they cannot exchange carbon with each other. The team that crosses the exit gate with their CO_2 in balance wins the game. The plan for the future is to promote Climate Adventure© as a capacity-building tool for employees at companies that have adopted social responsibility policies, and for public officials at municipalities that have adopted and are implementing climate-change adaptation/mitigation policies. It is the authors' conviction that when the general public can experience climate change as a tangible threat, they will be more active in seeking solutions to the social, political, and economic problems created when the earth's average surface temperature increases by +2°C or +4°C over the current 15°C. Therefore, the goal of Climate Adventure© is to give climate change tangibility. The references used: AR 5 WG I, II, and III and Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC), 2014; books and articles by the Portuguese physicist and professor Filipe D. Santos; and concepts and fundamentals of communication theory and learning theory.

P-1123-15

The impact of the European Key Competences for Lifelong Learning on Sustainable Development

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There is international consensus about the importance

of culture for global sustainable development. Europe's Intangible Cultural Heritage (ICH) – the skills, music, dance, drama, gastronomy, festivals, crafts, etc which have been passed from one generation to the next – is a hugely important resource that has an impact on sustainable environment in two ways. ICH is a 'product' for the cultural and creative industrial sectors (arts markets, design and crafts), and also as a 'process' for the economy and society as an inspiration for creativity and innovation (for instance, in education, science, tourism and social cohesion). Education plays a key role in safeguarding ICH as it enables its transmission, awareness raising and capacity building to a widest community. The connection between ICH, education and sustainable development is acknowledged by international organisations, academics and political bodies alike. In order to implement the concept of sustainable development effectively, it has to be linked with policies and measures. To this end, the Key Competences for Lifelong Learning (KCLL) in the European Reference Framework can serve as a common foundation for the development of ICH and education and ultimately to sustainable development. These competences cover all forms of behaviour that equip individuals to participate in an effective and constructive way in social and working life, and particularly in increasingly diverse societies, and to resolve conflict where necessary. This paper explores how KCLL contributes to activate a sustainable regional development. This paper is part of the 'ICH-Bildung' European research project on intangible cultural heritage and education funded by the Marie Skłodowska-Curie actions – Research Fellowship Programme.

P-1123-16

Integration of climate change education into school: A case study in Da Nang City, Viet Nam

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Extensive damages caused by climate change are being reported daily all over the world, especially in developing countries like Viet Nam, where many people live in poverty, lack of infrastructure, lack of education, and limited access to technologies. The level of damages is highly dependent on the capacity of communities and individuals to response to climate change. Thus raising people awareness on climate risks, providing them with knowledge on local adaptation, and building their capacity to be resilient are the ultimate goals of climate change education (CCE). In order to find out appropriate approaches to promote climate change education in the specific context of Vietnamese education system, this research concentrates on two key important aspects including educational governance and educational activities. Educational governance includes activities related to educational management, policies, guidance, processes and decision-making on the application of climate change adaptation. Educational activities mentions to all teaching and learning activities in school, which target school students. The objective of the study is to maximize effectiveness of educational governance and educational activities in a way that help to facilitate and sustain climate change education in Viet Nam.

In the scope of this study, a case from Da Nang City will be presented. Da Nang is a coastal city of Viet Nam, which located in the central region. The city is considered as the largest education center of Central Vietnam and the third largest in the country. It is in top five provinces have the highest literacy rate and net enrolment rates at primary level. However, being a coastal city with three quarters of territory made up of hills and mountains, Da Nang is prone to frequent typhoons and heavy rainfall causing widespread flooding. In the last 10 years (2000 to 2010) there have been 21 typhoons directly hitting Da Nang with an average of two typhoons annually. In 2009, Typhoon Ketsana (Figure 4.17) directly hit south of Da Nang and left eight people dead; ninety-six injured, and damages costing 495 billion VND (about 25 million USD). In October 2013, Da Nang City was strongly hit by the typhoons Nari, which made landfall in Danang and Quang Nam areas with a Category 1 level on 15 Oct. It is reported that there was 11 injuries, 122 houses collapsed, 5449 house damaged/unroofed, 13 public buildings damaged. Aside from floods and typhoons, Da Nang was also impacted by droughts, river-bank and coastal erosion, and saline intrusion. Under the impacts of increased temperature and change of precipitation, droughts in Da Nang have become prolonged with more severe intensity.

Within this context, the Da Nang Department of Education and Training (DoET) has focused on preparing schools to reduce the impacts of climate change through improvement of CCE in school. The city has taken many steps foward such as developing plan for CCE, carrying out teacher training, strengthening the physical conditions of the majority of its schools located in vulnerable areas. However, at school level, the School Management Board appears to have taken very few steps towards reducing losses from disasters and ensuring the safety of their students. The performance of CCE in schools, in particular at primary level, remains inadequate. The capacity to respond to climate related disasters of school children and teachers is low, particularly the activities to return to normal teaching program after the disasters. This results in educational interruption and affecting educational quality.

By giving the overall pictures of existing conditions of CCE in Da Nang, it provides important insights to enhance the implementation of CCE into school through integrated approach. The result from the study shows that a coalescence of three approaches including textbook driven approach, symbiosis approach, and community-oriented approach will help to advance the level of CCE in Da Nang. The framework on how to consolidate these approaches in the application of CCE in school will be proposed.

P-1123-17

The potential for the implementation of an effective mechanism for improving local communities knowledge of adaptation to climate change

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Climate variability is one of the many stresses faced by local communities. While it is not always the most important stressor or risk affecting a community, it should nevertheless be considered when designing and implementing a local-level project, particularly in communities characterized by climate- sensitive and/or natural resource-dependent livelihoods. The onset of longer-term climate change, which will compound existing stresses associated with climate variability, provides an added incentive for addressing climate risk in our research. Mountain territories not only are some kind of «barometre» of global climate changes, but their reaction have a significant impact on the further strengthening of these processes. People are faced with the need to find ways to adapt to the negative impacts of this phenomenon. Vulnerable populations will be different categories, depending on the projected effects: from scarcity of water resources will suffer all, but especially the affected populations, their livelihoods and earnings are directly dependent on the availability of water, such as farmers and rural residents; changes in temperature will affect the mode energy demand in winter for people who depend on uninterrupted power supply; negative climate change will impact on the country's biodiversity, and thus on the people for whom it is important to the existence of biological resources. In Central Asia, glaciers ensures the drinking water of mountain valleys and piedmont plains areas. Because of the reduction of ice resources now for the territory of Central Asia is characterized by severe water stress, and projected changes in climate here could cause a further reduction of water resources and reducing water consumption. In the period from 1955 to 2000 the surface area of glaciers has decreased from 70 thousand to 45 thousand km2. On the other hand, the human impact on environment is not always beneficial – poaching, felling of trees, no rational grazing, no rational use of natural resources. In this context, issues of adaptation of the population of mountains and others marginal areas to the impacts of climate change, development of policies and measures to prevent the adverse effects of climate change in the future are actual. But. In developing economics the State has not enough finances for environment and heath protection. Meanwhile, the situation has not become better from year to year. What to do? Who or what can help? We assumed that the best option in this case – the mobilization capacity at the community level. That is as an outlet could be mobilization of efforts of

local communities for protection of local ecosystems and its own health and budget. Why is this not being done or done insufficiently now? The reason, above all, in the absence of the local population aware that they can and should try to solve these problems themselves and to be able to raise these issues with the authorities. Mechanism for the implementation of this approach is to obtain the necessary information, the acquisition of relevant skills and knowledge. We offer that problems with training youth and adults can be solved not only at the state level, but also the help of local initiatives – at a local level, that under present conditions for developing countries more effectively. And, probably, it is necessary to begin from below – from family. Central research objectives – Identification of the potential for the implementation of an effective mechanism for improving local communities knowledge for adaptation to climate change. As a methodological tools used a public opinion poll, case study, a priori and statistical data, methods of observation; as one of the impact tools used brochure "Environmental safety of family and environment conservation". The case study include questions: 1. Identification of parameters (factors), climate change (oligohydramnios, drought, mudslides, avalanches, floods, land degradation, etc.) That affect the social aspects (function) – income, health, etc.; 2. Analysis of existing methods of mountain population adapting to climate change. 3. Identifying the needs of the knowledge and methods of influence. The next step of our research was to determine the feasibility of learning communities on an ongoing basis taking into account regional specificities. We analyzed a number of possibilities and we have offered cost-effective and accessible mechanism for improving local communities knowledge for adaptation to climate change. This experience can be disseminated and used in developing countries.

2201 - Between the cracks of future climate projections: exploring weather events and climate scenarios with no precedence

ORAL PRESENTATIONS

K-2201-01

Tales of Future Weather

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Society is vulnerable to extreme weather events and, by extension, to human impacts on future events. As climate changes weather patterns will change. The search is on for more effective methodologies to aid decision-makers both in mitigation to avoid climate change and in adaptation to changes. The traditional approach uses ensembles of climate model simulations, statistical bias correction, downscaling to the spatial and temporal scales relevant to decision-makers, and then translation into quantities of interest. The veracity of this approach cannot be tested, and it faces in-principle challenges. Predictability beyond 'weather' time scales is limited and physical consistency is often lost when downscaling. Alternatively, numerical weather prediction models in a hypothetical climate setting can provide tailored narratives for high-resolution simulations of high-impact weather in a future climate. This 'Tales of Future Weather' approach will aid in the interpretation of lower-resolution simulations such as produced in the Coupled Model Intercomparison Projects (CMIP). At this presentation a number of real-world cases will be presented where vulnerability to meteorological conditions was exposed. These are typically high-impact, not necessarily extreme, weather events. For instance compounded events of storm surges and extreme rainfall in the midlatitudes and of heat and drought in the subtropics. We will show how narratives of those analogues can describe the events in an alternative climatic setting to aid decision-makers. Producing the narratives is a transdisciplinary process where scientistis and decision makers co-develop the information needed. Arguably, 'Tales' potentially provides complementary, more realistic and more physically consistent pictures of what future weather might look like.

K-2201-02

No-analogue Climate Futures in the Tropics

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Climatic extremes in the tropics—cyclones, floods, droughts, and heatwaves—currently kill tens of thousands of people a year, and damage or destroy the livelihoods of many others. Wild species are presumably adapted to these extremes and, although individuals are killed, their populations usually persist, except when natural weather extremes interact with land-use change and other human impacts to change fire regimes and exacerbate floods and droughts. Climate models predict a further 1-2oC warming by 2050 and 1-4oC by 2100 for the tropics, but trends in rainfall and other variables vary between models for most regions. In much of the lowland tropics, this warming will create climates for which there is no existing analogue anywhere on Earth. Moreover, the low variability of tropical temperatures means that a rise in mean temperature of 2-3oC will bring routine maxima as high as today's extremes and new extremes that are higher than any that occur today. Although less certain, there are also good reasons for expecting increases in other climate extremes, including floods, droughts, and high-intensity cyclones. Predicting the responses of both human and natural systems to novel climate extremes is inherently difficult. Human societies have a considerable capacity to adjust to change, but exposure to climate change is likely to be greatest and adaptive capacity least among the poorest and most marginalized people. Predictions for natural systems depend on models, but we currently lack the data needed to assess their reliability when extrapolated beyond current conditions. There is an urgent need for both better models, built on a mechanistic understanding of the processes involved, and large-scale experiments.

O-2201-01

Future projection of precipitation associated with Cutoff Lows over South Africa in a Coupled Global Climate Model

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In South Africa, Cut-off Lows (CoLs) are known to be responsible for tempestuous weather and some remarkable precipitation events. This work presents how precipitation associated with CoLs may evolve in the region of South Africa in a context of global warming. Using the historical (1976-2005) and the Representative Concentration Pathway 8.5 (RCP8.5, 2006-2100) simulations of the Centre National de Recherches Météorologiques coupled global climate model (CNRM-CM5), the trajectories of 500-hPa CoLs have been constructed following the methodology presented in Favre et al 2013. During the historical period, we find that the geographical and seasonal distributions of CoLs' frequency over South Africa and surrounding oceans are well simulated by the CNRM-CM5. In addition, the main observed features of precipitation associated with CoLs are correctly reproduced by the model. According to the RCP8.5 simulation, drier conditions are projected over South Africa by the end of the 21st century and the CNRM-CM5 also presents a general decrease in annual precipitation, except over the plateau in the Northern Cape province. Precipitation associated with CoLs is projected to decrease excepted over the Northern Cape where heavy and extreme precipitation days (RR > historical 75th percentile and RR > historical 95th percentile, respectively) attributed to CoLs may be more frequent. These changes are associated with a slight reduction of CoL annual frequency of and with a slight equatorward shift of their domain of occurrence in the studied region. Over the 21st century, these changes are expected to develop in parallel with decadal variability and with an increase in the inter-annual variability of CoL's frequency.

O-2201-02

Polar lows and Medicanes: Understanding how intense mesocyclones and their impacts might respond to climate change

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Polar Lows and Medicanes are very intense, small cyclones that occur in the Norwegian and the Mediterranean Seas. Although small in size, Polar Lows and Medicanes can generate damaging winds that have substantial impacts on shipping, coastal communities and infrastructure. Polar Lows and Medicanes have very symmetric structures, often having a central eye-wall that has led to them being referred to as Arctic Hurricanes and Mediterranean Hurricanes. Polar Lows and Medicanes are too small to represent in typical climate models. This means that there are very large uncertainties in how Polar Lows and Medicanes will respond to climate change, despite their large socioeconomic impacts.

This talk will discuss progress in simulating Polar Lows

and Medicanes in global climate simulations performed at very high resolutions. The results of historical and climate change simulations with a 25km resolution version of the HadGEM3 climate model will be presented. The HadGEM3 simulations suggest that the frequency of both Polar Lows and Medicanes will decrease under climate change, primarily due to increases in the stability of the atmosphere over the Norwegian and Mediterranean Seas. However, there are some indications that when they do occur, Polar Lows and Medicanes may become more intense in a warmer climate. The potential for improving climate model projections of Polar Lows and Medicanes will also be discussed.

O-2201-03

Forecasting heavy precipitation producing cyclones in the island of Crete

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The intensification of the hydrological cycle due to climate change will produce intense meteorological events, causing higher precipitation in shorter time periods. The island of Crete is located in the Eastern Mediterranean and is prone to high precipitation events which cause an increased risk of flash flooding. The objective of this study is to obtain a better understanding of the hydrometeorological processes that produce heavy precipitation in the island of Crete and result in flash flooding. Effective forecasting for these natural disasters will increase public safety by reducing fatalities and changing the policy for a better flash flood risk management plan. For this purpose, images and datasets of the following parameters were used for the Eastern Mediterranean: (a) Meteosat Meteorological Images (Infra-Red IR-10.8, 3h); (b) Mean Sea Level Pressure ERA Interim (6h); (c) Wind at 500 hPa from ERA Interim (6h); (d) Vorticity at 500 hpa from ERA Interim (6h); (e) Lightning (USLN Lightning Network - 3h) and (f) hourly precipitation from Crete Meteorological Stations Network (3h). At present, the data from the 15-17th of November 2012 storm event has been analyzed. In this event, one of the precipitation stations located in the northwest part of the island of Crete, recorded more than 100mm of rain on 16/11/2012 and about 45mm of rain in the following day. More specifically, on 16/11/2016, 56.6mm of rain fell within one hour (14:00-15:00 UTC), and 27mm of rain on 17/11/2012 between 14:00-15:00 UTC. This severe rain event was caused by a cyclonic system approaching Crete from the Atlas Mountains, entering the Mediterranean on 15/11/2012, and moving to the east, with its center being located south of Crete. The spatio-temporal distribution of the relative vorticity, wind speed, mean sea level pressure, lightning and the time of precipitation are used to shorten the forecasting time of a heavy precipitation event, in a probabilistic sense. More cases will be analyzed and presented in the conference, in order to validate the forecasting precipitation results in terms of sensitivity, specificity and accuracy.

O-2201-04

Expansion of the tropics: evidence and implications

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There is accumulating evidence that the tropical zone is expanding poleward in both hemispheres. The implications of a poleward tropical expansion are significant; subtropical arid, conditions may be seen in regions at higher latitudes which have historically enjoyed a more temperate climate, with implications for management of water resources and agricultural systems. However, some regions which currently border the equatorial zone may experience an increase in extreme rainfall, which could result in flooding, the displacement of communities and increased incidence of disease. The poleward expansion of the Tropics appears to be linked to a concomitant expansion in the tracks of tropical cyclones, potentially bringing cyclonic activity to regions which have previously not experienced such weather events. Changes to the tracks and activity of cyclones, and other extreme weather events, will impact on human health, biodiversity and the economy. The burden of vector-borne diseases on health and the economy of the Tropics may also increase as more regions become climatically suitable for insect vectors. The Tropics are the most biodiverse region on earth, with more endemic species and more biodiversity 'hotspots' than anywhere else. However research suggests that although many species are tracking climate changes, species in the Tropics may be lagging behind the rate of tropical expansion - meaning some species may not be able to sufficiently track their preferred environment and climate and may potentially risk extinction. This paper explores the implications of expansion of the tropics for societies and environments in the tropics, who are likely to experience futures with no precedence.

2201-POSTER PRESENTATIONS

P-2201-01

Assessment of Southwest Asia Surface Temperature Changes: CMIP5 20th and 21st Century Simulations

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Surface temperature variability in southwest Asia from CMIP5 20th century simulations and projected changes under three emission scenarios for the 21st century are assessed on the basis of a multimodel ensemble mean of seventeen CMIP5 runs and two observational datasets. Performance of individual model is also computed. Compared with observations CMIP5 models show seasonality in biases over southwest Asia. Cold biases over Himalayan range are significant in winter than in summer. Climatic warming during the 20th century is very well captured by the CMIP5 models. There is a limited agreement among the observations and CMIP5 models ensemble mean regarding the temperature trends and their spatial distribution over southwest Asia. Surface temperature variability over southwest Asia is best represented by three individual models i.e. BCC, HadGEM and NorESM. Temperature projections for the 21st century demonstrate that annual temperature rise for RCP 8.5 and RCP 4.5 scenarios is 0.55 C (10 year)-1 and 0.27C (10 year)-1 . RCP 2.6 scenario has the lowest warming rate at 0.11 C (10 year)-1. By the end of the 21st century annual mean temperature in southwest Asia is estimated to increase by 0.80 C to 4.85 C. Most of this warming is projected to take place around Pakistan and its surrounding areas.

P-2201-02

Investigation of uncertainty in the IPCC AR5 precipitation and temperature projections over Iran under RPC scenarios

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Upon release of new scenarios based on Radiative Forcing which are known as Representative Concentration Pathway scenarios (RCP scenarios), by Intergovernmental panel on climate change (IPCC) in fifth assessment report (AR5), a new set of 42 global climate models (GCMs) have been proposed for future climate projections. By increasing number of available models for running and application to 42 which have been metioned in AR5, three main sources of uncertainty including: measurement error, variability, and model structure, have been explained and studied. The main aim of this study is to investigate the uncertainty of outputs of 37 Coupled Model Intercomparison Project Phase 5 (CMIP5) for precipitation and temperature data in Iran. Required data consist of two main groups: Simulated historical data and Observations. The observed data of rainfall and temperature were retrieved from three sources. Two databases namely; Climatic Research Unit (CRU) and NCEP/NCAR Reanalysis Project, and selected synoptic stations over Iran. Comparisons were made between the data reported in the climatic databases and those observed in synoptic stations using Root Mean

Square Error (RMSE) and Mean Bias Error (MBE) indices. The Monte Carlo simulation approach was used for uncertainty analysis of the simulated values of monthly precipitation and temperature and study stations observations. The results showed that there exists a close agreement between NCEP/NCAR Reanalysis Project data and observed ones, hence it was chosen as an alternate to observations for choosing the best models among the 37 selected GCMs. The latter section of study revealed that among the selected models, MPI-ESM-MR, MPI-ESM-LR, and NorESM1-M have the best performance in generating the rainfall and temperature data for baseline period of 1960-2000. Further studies using different sets of GCMs is recommended for more scrutiny.

P-2201-03

The timing of summer climate departure in cities and its lethal impact

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Climate models for the 21st century predict a year-to-year variability in summer temperatures that lead to a significant increase in the occurrence, intensity, and duration of heat waves. These are especially deadly in urban areas that account for half the world population and are characterized by heat island effects, production of anthropogenic heat, and aging inhabitants. We investigated the projected times after which mean summer climate in large cities will shift beyond historical values, generating environmental conditions that will endanger human health. Data on urban extreme heat events and their related mortality during 1980-2010 were collected from an extensive literature review and relevant websites. When mapped, these data are predominantly distributed in the mid-latitudes, indicating either a more intense warming or/and a lack of available data in tropical regions. Climate variables and time of occurrence were extracted from actual data to identify the set of conditions that exceed human tolerance to extreme heat events. These thresholds were then combined with Earth System Models of the Coupled Model Inter-comparison Project phase 5 using different Representative Concentration Pathways (RCPs 2.6, 4.5, 8.5) to estimate the timing of lethal climates. Results indicate a strong association between climate anomalies and fatal weather events in the past and suggest that such events will occur periodically in all the largest cities of the world. Although it is possible that human adaptation and resilience to heat stress could reduce mortality, it is clear that ongoing climate change will pose a threat to human survival over vast areas of the world. The foreseeable urban summer climate departures call for a global and substantial reduction in greenhouse gas emissions. They also prompt for local implementation of sustainable mitigation strategies and for public health actions in order to reduce the lethal impact of climate change.

P-2201-04

Between the mazes of Climate Scenarios

B. Van Den Hurk (1)

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Climate scenarios, such as those prepared for the Dutch Climate Adaptation program, are useful instruments to cast a large collection of possible future evolutions in a generic reference framework. But these scenarios necessarily only describe the bigger picture, and miss the elementary details that govern every-day decision making. Challenging events are governed by a mixture of weather phenomena, infrastructure design, preparedness "on the ground" and compounding features. Here we illustrate a number of approaches relying both on past events and (synthetic) future weather cases that can provide the necessary additional "real life" material that is needed to support informed decision making.

2202 - Turn down the Heat: Climate Change Impacts, Development and Lock-in

ORAL PRESENTATIONS

K-2202-01

Development and the New Climate Normal

R. Kyte (1)

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As the planet warms, heat and other weather extremes which occur once in hundreds of years, if ever, and considered highly unusual or unprecedented today would become the "new climate normal" as we approach 4°C. Ending poverty, increasing global prosperity and reducing global inequality, already difficult, will be much harder with 2°C warming, but at 4°C there is serious doubt whether this can be achieved at all. The urgency for action is even more critical, with growing evidence that warming close to 1.5°C above pre-industrial levels is locked-in to the Earth's atmospheric system.

The consequences for development would be severe as crop yields decline, water resources change, diseases move into new ranges, and sea levels rise. This presentation will look at the consequences of increased warming for the key geographic regions that the World Bank Group is engaged in, and action areas which are urgently needed to confront the development challenge. [A new global climate agreement in Paris this year needs to speak as loudly of economic transformation as it does of carbon emissions target. 2015 is a critical year for countries to re-think the way they manage their economies]. It's increasingly clear that smart policy choices can deliver economic, health and climate benefits. Come hear how the Bank is working with client counties to address this unprecedented challenge.

K-2202-02

The implications of climate mitigation policy for the impacts of climate change

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The broad aim of climate mitigation policy is to avoid the dangerous impacts of climate change. The definition of 'dangerous' is of course contested, and there are many potential definitions. The Copenhagen Accord states the aspiration of limiting the increase in global mean temperature to 2oC above pre-industrial levels, and other groups are urging lower temperature targets. Meanwhile, existing and new pledges for future emissions will imply different - and probably larger - increases in global temperature. Most attention is given to the economic, technical, political and social implications of achieving specific emissions reductions, but it is also necessary to assess the impacts that are avoided or delayed by mitigation policies. This is partly because it helps define the benefits of climate mitigation, and partly because it highlights the impacts that remain: this helps inform

national and international adaptation policies.

This keynote talk will present results from the UK AVOID programme, which is concerned with both identifying and quantifying impacts of climate change under different potential emissions pathways and assessing the technical and economic feasibility of these pathways. The focus of this presentation is on the impacts avoided and delayed by climate mitigation. It considers global and regional impacts on a range of sectors including water resources, flooding, agriculture and energy demand, and evaluates how these impacts are affected – globally and regionally – under different mitigation pathways. The effects of climate change and mitigation policy are expressed in terms of the magnitude of impact and the risks of impacts exceeding specific thresholds.

The presentation concludes by reviewing the key issues involved in assessing the implications of climate mitigation policy for impacts, which include the representation of adaptation within global-scale impact assessments, the treatment of uncertainties, and the presentation of results in terms meaningful to climate policymakers and negotiators.

K-2202-03

Visions of Global Responses to Climate Change - Lock-in and Transformation

J. Dangerman (1)
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This keynote will discuss the central dynamics of complex systems that determine change and lack of change. Or, in more specific terms, that determine transformation and lock-in. It will also present a case that illustrates these dynamics and their effects in practice.

Important portions of yesterday's and today's socio-technological-political decisions extrapolate the past into the future and thereby profoundly constrain the possibilities of important systems to transform themselves non-catastrophically so that they can help mitigate their current and future effect on climate change and the ensuing impacts on nature and humanity. The transpiring rigidification of these systems is eminent from essential perspectives and in fact provides grounds for structural alternative decisions. However, the constraints caused are often underestimated and misinterpreted and the accompanying alternative decisions are frequently not so profoundly breaking with the past. The development of a key actor in climate change, the global energy system, provides ample examples of these instances and on a macro-scale shows the ensuing lock-in patterns.

This keynote therefore provides a simple and stylised view on the universal workings of the fundamental dynamics that determine the behavior of evolving complex systems, such as cells, the human brain, organisms, organisations, technologies, societies and economies. It uses the concepts of effectiveness & efficiency and chaos & organisation in the context of the cyclical and periodical behaviour of these systems to explain the dynamics of both transformation and lock-in.

It ends with a discussion of a research case about the role of energy efficiency policies in the building industry (called «Best Practice Policies for Low Carbon & Energy Buildings Based on Scenario Analysis, authored by the Center For Climate Change And Sustainable Energy Policy, Central European University) to elucidate the lock-in dynamics, their consequences and their implications for policy making. Three scenarios explain the potential for the buildings sector to mitigate energy consumption in China, the EU, India and the USA. The most ambitious scenario shows the benefit and necessity of taking today's best practice to a global scale.

O-2202-01

Hydrological variability, transboundary floods and institutions: an exploration of tomorrow's bottlenecks

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Floods are among the world's most frequent and damaging types of disasters and annually affect the lives of millions all over the globe. Over time, human exposure and vulnerability to floods has increased with a growing and increasingly urbanized population. The projected effects of climate change on hydrology, aggravated by a range of social, economic and political processes will continue to increase this vulnerability. Nonetheless, vulnerability of societies and their institutions to floods remains poorly understood.

Purpose
Using global data, we examine the nexus of transboundary flood events and social vulnerability: which international river basins (IRBs) have experienced transboundary floods, i.e. floods that affect two or more countries, in the past, and which are forecast to experience increased hydrological variability in the future, but lack institutional provisions, i.e. river basin organizations and/or treaties, to deal with these shared events?

Methodology
Current data and research on institutional capacity deriving from treaties as listed in the Transboundary Freshwater Dispute Database (Yoffe, Ward and Wolf, 2000; De Stefano et al. 2012) will be refined by looking more specifically at the roles that river basin organization functioning and treaty composition play in flood management. IRBs will be stratified by the type of climate-related stress they may face in terms of hydrological change and the aspects of society most affected by flooding. Then, this updated information will be merged and weighted to produce a vulnerability ranking specific to floods and the institutions designed to manage them.

Results and conclusions
A global vulnerability ranking of IRBs and cities when it comes to transboundary floods, climate-driven hydrological variability and institutional capacity.

Societal relevance
The findings of this research will significantly increase our current knowledge on transboundary flood events, projected variability regimes related to the shared waters between countries, and flood-related international institutional capacity. These insights will help policy-makers of tomorrow identify and evaluate potential tipping points related to transboundary river floods.

O-2202-02

Past and future weather-induced risk in agriculture

J. Elliott (1) ; C. Müller (2)
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The global food system has seen increased volatility in recent years, with spiking food prices blamed for civil unrest on several continents. Rising prices for global commodity products like maize, soy, meat and palm are increasingly driving deforestation around the globe, and with agriculture increasingly interconnected to global food and energy markets, weather-related risk and supply-side shocks have become a key issue of concern for governments and businesses alike. Speculation about the risk of future large-scale extremes have led some authors to contend that more people will suffer in future from large-scale drought and heat events than any other climate-change-related disaster.

Using best-available archives of global crop and climate models from the Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intersectoral Impact Model Intercomparison (ISI-MIP), we look first at the impacts of 65 years of continental and global extreme events using observation-driven models and data. We identify the most severe historical events in caloric terms at national to global scales and evaluate the ability of models and model ensembles to identify weather-induced extreme years, correctly assess the magnitude of large-scale extreme events, reproduce historical country-level variability, and reproduce spatial patterns of losses under extreme drought.

We next consider these global crop models driven with large ensembles of climate model output (both under historical forcing and with future scenarios) to characterize present day risk and the extent of non-stationary risk in

global crop production. We find increasing, and in many cases accelerating risk, of extreme global loss events even in scenarios with little to no climate-induced long-term mean changes. In some cases, global-scale production loss events that would have recently been called 1-in-100 year events are estimated to occur every 30 years by mid-century, and ever 10-20 years by end-of-century.

We present these scenarios and consider regional and global protective measures that might be introduced, including increased trade, stock-hoarding, crop breeding, and improved forecasts, monitoring, and modeling. We also consider the extent to which aggressive carbon mitigation may decrease the risk of extreme loss events in future.

O-2202-03

Climate indicators of pace and perception of changes over the 21st century

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In most studies, climate change is approached by focusing on the evolution between a fixed current baseline and a future period. They emphasize stronger warming and increasingly modified precipitation patterns as we move further from the current climate. This long-term vision is adopted in order to characterize quantitatively the magnitude and expected effects of mitigation policies across the globe, but is not well suited to discuss coming generations' experience. In this study, we propose an alternative approach that considers indicators of pace and perception of changes using projections of a General Circulation Model ensemble. It first consists in tracking statistics and their projected changes with a 20-year running baseline, defining the time evolution of the pace at which climate changes on the scale of a generation. Then, distributions of the following and previous 20 years are compared for each year to theoretically assess the perception of changes. We focus here on the annual and seasonal evolution of surface air temperature and precipitation.

Under the strongest emission pathway (RCP8.5), the warming rate and its perception become far stronger over the 21st century, with a maximum reached around 2060. While northern high-latitudes witness a higher temperature rise, all other latitudes highlight at least a doubling in the warming rate and indicators of perception are at their highest value in the tropics, especially in West Africa and South-East Asia.

As for precipitation under the same pathway, moistening and drying rates strongly increase at global scale. Regions with significant rate of change expand more and more over the 21st century. Moreover, rate patterns tend to spatially stabilize, making them persistent in some regions that also exhibit the largest rates and the largest increases of rate by 2080: e.g. the Mediterranean Sea, Central America, South Asia and the Arctic.

These trends are already visible in the current period, but could almost disappear if strong mitigation policies were quickly implemented. Only the strongest mitigation pathway (RCP2.6) leads to a global return to historical regime. This approach shows that, under strong emissions, one should be prepared for higher adaptation rates in the coming decades regarding temperature and precipitation change.

2202-POSTER PRESENTATIONS

P-2202-01

Mitigation and Adaptation are not enough: turning to emissions reduction abroad

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In this paper we focus on a long-term dynamic analysis of the optimal adaptation/mitigation mix in the presence of a pollution threshold above which adaptation is no longer efficient.

We account for accumulation in abatement capital, greenhouse gases, and adaptation capital in order to better capture the arbitrage between abatement and adaptation investments.

Pollution damages arise from the emissions due to the country consumption but also from the emissions of the rest of the world (ROW).

A pollution threshold is then introduced, above which adaptation is no longer efficient. We obtain that if this threshold is lower than the steady-state level of pollution, there is no way for the modeled economy to avoid it. In particular, such a situation will appear if the ROW's emissions are high.

Next step is then to introduce another type of investment allowing for lower ROW pollution ie. emissions reduction abroad through some mechanisms like CDM for instance. We obtain that CDM may be a means to avoid a pollution threshold above which adaptation becomes of no use.

P-2202-02

Two degrees or not two degrees: that is the question – interim results from ICA-RUS project

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Politically, the long-term target of climate change might not actually be a question at this moment. However, we have to repeatedly ask ourselves the question – whether it should really be "two degrees" and why – to ensure that the target is kept transparent, responsible and relevant.

We have tackled this issue from a risk management perspective in an interdisciplinary research project, called the Integrated Climate Assessment – Risks, Uncertainties and Society (ICA-RUS) since 2012, funded by the Ministry of the Environment, Japan. It has tried to integrate insights from the areas of climate risk assessment, energy economics modeling, energy-water-food-ecosystem nexus, and STS (science, technology and society). By a risk management perspective, we mean that the problem is framed as an informed, adaptive decision making under uncertainties (potentially including deep uncertainties), involving social value judgment.

We have supposed three "Alternatives left to humanity" represented by mitigation targets, 1.5, 2.0 and 2.5 degrees C, below which humanity tries to keep the global mean temperature increase relative to preindustrial levels at a probability of 50% (which roughly translate into 2.0, 2.5 and 3.0 degrees C targets at a higher probability like 80%).

For each alternative mitigation target, potential consequences have been assessed for various sectors including disastrous weather events, water resources, agriculture, health, ecosystem and tipping elements. The potential consequences are represented by a range taking into account uncertainties in climate, mitigation and socio-economics. Thus, for example, even if 2.0 degrees C target is set, the potential consequence includes a 3.0 degrees or higher global mean temperature increase associated with corresponding impacts, due to various kinds of uncertainties.

At the same time, possible combinations of mitigation options and associated mitigation costs have been assessed for each mitigation target with multiple energy economics models with different modeling assumptions. Various risks and opportunities (side-effects and co-benefits) associated with each mitigation option are also kept in mind.

Putting these assessments together, the project is currently in the process of characterizing the risks to be reduced and to be retained for each "Alternative" (i.e., each mitigation target). As a next step, adaptation effort needed

and potential effect of geoengineering consideration for each Alternative will be assessed. Possible public participation process in the risk decision to enhance social rationality is also being discussed.

P-2202-03

Modelling ecosystem response to present and future drought events in Western Europe with the CARAIB dynamic vegetation model

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With unprecedented speed and extent, future climate change can be expected to severely impact terrestrial ecosystems due to more frequent extreme events, such as droughts or heat waves. These extreme events might lead to severe impacts on terrestrial plants functioning, implying reduction in net primary production and possibly plant mortality in many regions. The Inter-Sectoral Impact Model Integration and Intercomparison Project (ISI-MIP2) has been explicitly designed to evaluate the models' ability to reproduce observed historical variability, and response to present-day and future extreme climatic events, reflecting the interest of the community as well as stakeholders in this particular topic.

In this contribution, we analyse the results over Western Europe of the ISI-MIP2 simulations performed with the CARAIB dynamic vegetation model (Dury et al., 2011, iForest 4, 82-99), for a series of well-marked drought events in the simulated historical and future periods. This analysis is performed at the species level, using a set of 99 species (47 herbs, 12 shrubs and 40 trees), especially designed to represent the European vegetation. Model response to drought events is evaluated in terms of several important environmental variables, such as soil water and hydric stress, runoff, PFT/species abundance, net primary productivity and biomass, fire frequency, and turnover of soil organic matter. Some sensitivity tests are performed to study the impacts of changing some not well-constrained model parameters, such as thresholds and response times for plant mortality induced by soil water stress.

P-2202-04

When can we expect to see the benefits of climate mitigation?

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We present a two 30 member ensembles of possible future climate using a single climate model, CESM, to assess the question of when climate mitigation action becomes evident in the presence of irreducible internal climate variability. Our business-as-usual and mitigation ensembles assume the RCP8.5 and RCP4.5 scenarios respectively, and we find that although internal varaibility causes a comparable uncertainty to the differences in forced climate response until 2050, significant differences in the risk of extreme warm events are evident in as early as 2025 in the two scenarios for some regions (and for most regions by 2040). Furthermore, the following decades from 2050-2080 see largely separate temperature distributions in the two ensembles for most regions, although we do not see significant differences in precipitation between the two scenarios even for periods after 2060. Hence, in the CESM's representation of the Earth System for the latter portion of the 21st century, the risks of impacts related to temperature extremes in the next 20 years can be significantly reduced by greenhouse gas mitigation, even in the presence of internal climate variability.

P-2202-05

Influence of Water Resource Management on Altering Hydrological Drought under Climate Change

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It is expected that global warming alters hydrometeorological cycle and influences on occurrence of drought. Future drought is projected to increase with high probability in some regions, such as the Mediterranean region, the west side of USA and so on, resulting in severer water scarcity. Nevertheless only few studies have investigated the effect of planned water management, such as dam regulation and irrigation, against drought. Understanding of the effect of existing infrastructures under changing water-environment is needed for our society to adapt to future climate changes. Therefore, this study aims to estimate the effect of the anthropogenic activities on terrestrial water cycle as well as the impacts of climate changes.

This study focuses on hydrological drought, particularly on stream drought. HiGW-MAT, a state of arts land surface model capable to reproduce energy and water cycle considering the anthropogenic water management, was used to simulate historical and future terrestrial water cycle under RCP scenarios. Five bias-corrected CMIP5 GCM outputs provided by ISI-MIP fast track for 1980-2099 were used to force a set of simulations.

Future drought was projected, and hot spots of climate change impact were detected with uncertainty discussion. It was found that number of hydrological drought days would increase and decrease over approximately 70 % and 25 % of global land. Increase of drought days in the first half of 21th century is larger than that of the second half in 19 out of 26 regions of IPCC regional classification. The effect of anthropogenic water management is depicted as a difference between simulations with and without anthropogenic components. As for time series variation, the difference showed that both of short-term variation and long-term change are alleviated by introduction of water management, though it was also suggested that exploitation of water from river due to water use accelerates drought. This model exercise presents a valuable preliminary evaluation of human impact for the purpose of planning of more practical assessment which provides optimal water management scenarios.

2203 - Defining dangerous climate change: Contributions from the AR5 ' Key Risks' and ' Reasons for Concern' frameworks and future directions

ORAL PRESENTATIONS

K-2203-01

The IPCC Reasons for Concern: History, current status, and future directions

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The Reasons for Concern (RFCs) framework, developed in the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), organizes scientific information to inform decisions relevant to implementation of Article 2 of the UN Framework Convention on Climate Change (UNFCCC). Article 2 contains the Convention's long-term objective of avoiding "dangerous anthropogenic interference with the climate system". The framework facilitates judgments about changes in impacts, risks, and vulnerability as a function of global mean warming by sorting and aggregating them into five categories viewed from a global perspective. The RFC framework and the associated "Burning Embers" diagram illustrating these judgments have been widely discussed and applied. We sketch the history of the use of the RFC framework in IPCC assessments and describe refinements made for the recent Fifth Assessment Report (AR5). In AR5, the RFCs were reframed to define all five categories in terms of risk. In addition, a more consistent approach to judging risk was used that was linked to the concept of Key Risks that was used across much of the Working Group 2 report. We also illustrate how risk judgments are grounded in the scientific literature and highlight remaining challenges to making such judgments. Useful improvements to the RFC framework include better accounting for alternative metrics of climate change beyond the level of global average temperature change, explicit incorporation of the future vulnerability of society and ecosystems, and better communicating the specific risks over which RFC categories aggregate.

K-2203-02

Reasons For Concern as a Tool for Assessing Dangerous Climate Change and their Utility for Climate Negotiations

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The Reasons for Concern framework has been used by the IPCC to communicate its results to policy makers in a policy informative, but not policy prescriptive manner. It assesses the risks in light of the UNFCCC Article 2 – to avoid dangerous interference with the climate system – by presenting a continuous representation of how key risks change with temperature rise. The framework has been used in the UNFCCC negotiations as one of the key inputs to the process of the 2013-2015 review of the adequacy long-term global goal under the UNFCCC.

Key issues that I will explore in this context are (a) how well do the RFCs reflect the full scope of Article 2, including impacts on ecosystems, food production and sustainable development? and (b) The extent of its use in the UNFCCC review, the results obtained from its use and the utility of these results.

From a policy perspective, the RFC framework has approached the analysis of these risks through a global lens. However, policy responses to these risks take place at the national and regional levels, primarily through adaptation action. It is therefore very relevant to also review the framework's applicability in informing policy at the national and regional levels. This will be done from the perspective of Small Island Developing States (SIDS).

Key questions to explore in this context include:

- What is dangerous Climate Change from the perspective of SIDS? What are their key risks? How well do the RFCs reflect these risks?
- How are these RFCs, and the associated risk levels, perceived by policy makers and does that match with the scientific definitions? Are these consistent with SIDS experience of the impacts from these risks and their perception of these risks?
- Does this framework help SIDS to assess these risks? What kinds of decisions can policy-makers arrive at from using this framework?

In reviewing these questions, two major obstacles can be identified, which may be of general importance beyond the SIDS context. Firstly, is the somewhat different character of the RFCs. While RFC 1,2 and 5 (unique systems, extreme events and singular events) are clearly defined and understandable, this is not the case for RFC 3 and 4 (distribution and aggregated impacts), where the names of the RFCs may imply a different assessment than what is in the scope of the RFCs.

A second obstacle identified is connected to the question of the translation from regional to global risks and relates to the assessment of the specific risk levels. In particular, the step from moderate to high risks is crucial. While moderate risks reflect that "associated impacts are both detectable and attributable to climate change", high risks indicate "severe and widespread impacts". From the perspective of a region that is highly vulnerable but not widespread in terms of land area, this is not an intuitive categorization, since there is a lot between these two risk levels and the question arises re how high, or very high, local risks translate to global risks in such an assessment.

In my presentation, I will reflect on these issues and discus the pros and cons of the RFC approach giving special consideration to its usefulness for the UNFCCC process and for SIDS. I will also discuss a potential way forward for further improvements of the concept.

O-2203-01

Key risks in the IPCC's Fifth Assessment Report: a basis for evaluating and responding to danger from climate change

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The Working Group II contribution to the IPCC's Fifth Assessment Report provides a cohesive and integrative assessment of key risks in a changing climate. The assessment informs judgments about danger from climate change, and it provides an actionable summary of the opportunities for response. This presentation will introduce the assessment framework developed, the resulting conclusions about risks and options across possible climate futures, and the implications for future research and assessment. In the Fifth Assessment Report, key risks are defined as potentially severe impacts relevant to Article 2 of the United Nations Framework Convention on Climate Change. They emerge from high hazard or high vulnerability or exposure of affected societies and systems. Across chapters of the assessment, authors identified key risks based on expert judgment using specific criteria, encompassing large magnitude or high probability of impacts, timing or irreversibility of impacts, persistent vulnerability or exposure contributing to risks, or limited potential to reduce risks through adaptation or mitigation. For key risks across sectors and regions, the assessment evaluates changing levels of risk over the next few decades, an era of some further locked-in

warming, and in the second half of the 21st century and beyond, a longer-term era of climate options. It considers the potential for risk reduction through adaptation along with the limits to adaptation. Throughout, the risk levels reflect probability and consequence over a full range of possible outcomes due to climatic and non-climatic factors. Key risks spanning sectors and regions include risk of severe ill-health and disrupted livelihoods from flooding and extreme heat, of food and water insecurity, and of ecosystem and biodiversity loss, as well as systemic risks from extreme events. Overall, the key risk assessment supports the report's overarching conclusion about risks globally with continued high emissions: increasing magnitudes of warming increase the likelihood of severe, pervasive, and irreversible impacts. The key risk assessment also highlights defining features of the climate challenge and priorities for future research. These include the importance of complex, multi-step interactions in shaping risks, the need for rigorous expert judgment in evaluating risks, the limitations in current abilities to quantify risks, and the centrality of risk perceptions, values, and goals in determining responses.

O-2203-02

Measuring the dynamics of risks at the global and local level: information for transformative change

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Key risks identified in the IPCC AR5 encompass various themes and dimensions, however, all these risks underscore the influence of climate change on hazards and the significance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5 the presentation examines how core determinants of these key risks and their dynamics, namely hazard patterns, exposure and vulnerability at the global and local scale, can be measured and quantified. Measuring changing hazard conditions, exposure of people and their vulnerability demonstrate that particularly increasing exposure contributes to increasing risks levels in various countries and urban areas (global overview). This global overview with national level resolution will be complemented by two local risk studies.

The second part of the paper examines risk configurations and changes in risk profiles for selected large-scale, coastal cities. Coastal cities are at the frontline of living with climate and socio-economic change. Existing adaptation and development visions that should address key risks tend towards policies for stability (resistance) or flexibility to protect existing core functions (resilience). There is increasing recognition in the academic literature that a third policy option of fundamental change (transformation) is needed in order to address key determinants of the key risks also named in the AR5. Against this background changes in local risk profiles and risk trends are examined and specific policy options to confront these risks are discussed. This part of the presentation draws from a Belmont Forum funded study, Transformation and Resilience on Urban Coasts (TRUC), that examines five coastal megacities to begin to profile transformative options based on the assessment of dynamics of hazards, exposure and vulnerability to climate change related risks.

Concrete examples of past and present risk patterns are presented using the case studies of New York and Lagos. In addition, methods and results of new scenario techniques are shown that underscore the importance of exploring future pathways of exposure and vulnerability next to climate change scenarios. Differences and synergies between quantitative and qualitative scenario techniques will be explored using the local level risk studies. In conclusion, we formulate recommendations on how to use this information on changing risk profiles for promoting resilience and transformative change at local level focusing on policy options for adaptation in the two case studies.

O-2203-03

Downscaling the "Reasons for Concerns" to the Local Government Level as a Prerequisite for Tailored Adaptation and Disaster Risk Reduction – A Case Study from Austria

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IPCC's Burning Embers – Reasons for Concern illustrate the future global risk development split into five categories and visualize the trends. To date, this holistic concept has not been transferred to the local government level where risks associated with climate change are mostly still understood and analyzed in a sector- and hazard-specific manner rather than in a scenario-based way.

In the project ARISE (Adaptation and Decision Support via Risk Management Through Local Burning Embers) funded by the Austrian Climate Research Program, closing this gap is a research focus, and a decision support system for climate-sensitive iterative risk management as a key adaptation approach is developed. The City of Lienz in East Tyrol, Austria serves as a pilot site for ARISE. The project's overall objectives are (i) to contribute to identifying and bridging the gaps between global frameworks, research and policy related to climate change and disaster risk reduction and national, subnational as well as local risk management and adaptation needs and requirements by coupling and integrating information across scales, (ii) to downscale the "Burning Embers – Reasons for Concern" to the local level (LBE) with respect to hazard types and sectors including a consideration of key risk drivers, and (iii) to support the building of resilience and adaptation capacities at the local level via an LBE-integrated, iterative risk management approach that takes participatory processes and learning from practitioners into account.

In order to meet the project's objectives, user-oriented methods in the form of hybrid techniques (top-down and bottom-up, model-driven and participatory) are used. To date, interviews with various stakeholder groups have been conducted and a comprehensive desk review on global, regional and national frameworks has been completed. Based on this input, the generic framework for downscaling the Burning Embers – Reasons for Concern to the local level has been developed. To apply this framework to the study site, regional climate scenarios for the City of Lienz have been computed. Further methods for determining the LBEs include the building of regional socio-economic scenarios by focusing on region-specific knowledge and visions (by means of a scenario workshop), supported by socio-economic modelling. Moreover, a land-use scenario is being developed and indicators have been determined that also take confidence levels into account. In order to integrate the LBEs into the local risk management of Lienz and design tailored climate-sensitive risk management measures, a collaborative approach will be taken again, test runs will be conducted as well as a monitoring&evaluation concept devised. All information and processes will be fed into a dynamic risk information tool. The decision support system for climate-sensitive iterative risk management will be standardized to enable a wider application and roll-out.

In this presentation, an overview of the ARISE project and its concept will be given. The generic framework as as well as its application to the City of Lienz will be presented and challenges discussed. Additionally, an outlook on the next steps and expected findings to be obtained through the integration of the LBEs with risk management and adaptation strategies will be provided.

P-2203-01

A regional differentiation of climate impacts at warming levels of 1.5°C and 2°C

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Article 2 of the UNFCCC specifies that the aim of the convention is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Limiting global mean warming below 2°C increase above pre-industrial levels has been widely accepted as a global goal in this context. However, many vulnerable countries, particularly small island developing states and least developed countries, have questioned whether this limit is sufficient to protect their interests, and as a consequence there is an international process underway to evaluate risks and damages at different levels of warming, including 1.5°C and 2°C. Studies of current and expected future impacts of climate change suggest that significant negative impacts, relevant to Article 2 of the UNFCCC may be felt at lower levels of warming than 2°C. Within the UNFCCC there is a formal process reviewing the 2° limit, and examining the possibility of changing it towards 1.5°C.

At present there is a gap in the scientific literature and methods to rigorously and qualitatively assess differential impacts at these levels of warming. Here we present a framework that allows for a differentiation of regional changes in climate impacts at different levels of global mean temperature (GMT) increase, focusing on the differences between 1.5°C and 2°C. Based on data from the CMIP5 archive as well as output from the ISIMIP project, we assess the climate impact projections for the 26 world regions used in the IPCC SREX report. We show results for several extreme event indices as well as projections of water availability and agricultural yields. Furthermore, we are able to test for statistical significance of changes in climate impact projections between the different warming levels across the model ensemble.

As climate impacts are not necessarily linear, it is important to understand whether a significant shift in the magnitude of impacts may occur between the different temperature levels and little attention has been given to such a shift at lower levels of warming. Furthermore, the consequences of average global temperature increase are not linearly distributed across regions. A differentiation of the spatial manifestation of change is therefore of high relevance for regional planning, in order to develop suitable coping strategies and adaptation options, as well as to inform decisions about the appropriate long-term global temperature goal.

P-2203-02

Defining dangerous climate change in accordance to international law: What is and is not "dangerous" and how to define "dangerousness"? International standards for certain basic considerations for "policy-makers", "policy-takers", scientist and jurists

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It has been a common theme among commentators the consequences for living forms on the change of climate. The main problem is to define "danger" before it comes to a natural disaster. Natural disasters have been faced in Chile and South American countries in the last ten years and they have been described since the beginning of the discovery by Christopher Columbus in 1492. The "El Niño" and "La Niña" environmental phenomena are some of the effects in the change of the weather defined by indigenous people and local communities. This might be described as the "minimum" danger, a danger that has been noticed clearly by none experts. On the other hand the "Chaiten" Volcano in 2008 and the Chilean Earthquake in 2010 show the degree of destruction of natural disasters. This might be described as a "strong" danger, a current one. In between is possible to find a danger that has been described but still is not defined by humans, it is subtle danger: Climate change is a "silence disaster" because it affects slowly but without capability to be aware of the danger and to contain the consequences that are established in between the defined basic change and the disaster, therefore in a moment it is necessary to define the concept of "current strong danger". This article will focus on the capacity of international law to present certain basic elements for policy makers and policy takers (defined as those that implement or propose change of policies and laws at the national level) in order to define "menace" on the human beings and on the plants, animals and microorganisms by the destruction of habitats when the change of the climate is able to destroy such habitats. In this sense rights and obligations between States, from States to human and "non-human" beings and for the Nature are proposals to define "current strong danger". When those rights to life have been affected by the modification of the climate a first approach towards the definition of "danger" will be in place. Therefore the process of prevention has to be detained and measures towards mitigation and recovery has to be established. International law and law in general has defined many of these words like equitableness, justice, "fumus bonis iuris" and now is necessary to define "danger" in a present and solid form based on international law. A first approach will be international conventions on climate change and economic rights of persons, human rights of the persons and possibly the Rights of Nature.

P-2203-03

A regional differentiation of climate impacts at warming levels of 1.5°C and 2°C

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Article 2 of the UNFCCC specifies that the aim of the convention is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Limiting global mean warming below 2°C increase above pre-industrial levels has been widely accepted as a global goal in this context. However, many vulnerable countries, particularly small island developing states and least developed countries, have questioned whether this limit is sufficient to protect their interests, and as a consequence there is an international process underway to evaluate risks and damages at different levels of warming, including 1.5°C and 2°C. Studies of current and expected future impacts of climate change suggest that significant negative impacts, relevant to Article 2 of the UNFCCC may be felt at lower levels of warming than 2°C. Within the UNFCCC there is a formal process reviewing the 2° limit, and examining the possibility of changing it towards 1.5°C.

At present there is a gap in the scientific literature and methods to rigorously and qualitatively assess differential impacts at these levels of warming. Here we present a framework that allows for a differentiation of regional changes in climate impacts at different levels of global mean temperature (GMT) increase, focusing on the differences between 1.5°C and 2°C. Based on data from the CMIP5 archive as well as output from the ISIMIP project, we assess the climate impact projections for the 26 world regions used in the IPCC SREX report. We show results for several extreme event indices as well as projections of water availability and agricultural yields. Furthermore, we are able to test for statistical significance of changes in climate impact projections between the different warming levels across the model ensemble.

As climate impacts are not necessarily linear, it is important to understand whether a significant shift in the magnitude of impacts may occur between the different temperature levels and little attention has been given to such a shift at lower levels of warming. Furthermore, the consequences of average global temperature increase are not linearly distributed across regions. A differentiation of the spatial manifestation of change is therefore of high relevance for regional planning,

in order to develop suitable coping strategies and adaptation options, as well as to inform decisions about the appropriate long-term global temperature goal.

P-2203-04

Detection of bifurcations in noisy coupled systems from multiple time series

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We generalize a method of detecting an approaching bifurcation in a time series of a noisy system from the special case of one dynamical variable to multiple dynamical variables. For a system described by a stochastic differential equation consisting of an autonomous deterministic part with one dynamical variable and an additive white noise term, small perturbations away from the system's fixed point will decay slower the closer the system is to a bifurcation. This phenomenon is known as critical slowing down and all such systems exhibit this decay-type behaviour. However, when the deterministic part has multiple coupled dynamical variables, the possible dynamics can be much richer, exhibiting oscillatory and chaotic behaviour. In our generalization to the multi-variable case, we find additional indicators to decay rate, such as frequency of oscillation. In the case of approaching a homoclinic bifurcation, there is no change in decay rate but there is a decrease in frequency of oscillations. The expanded method therefore adds extra tools to help detect and classify approaching bifurcations given multiple time series, where the underlying dynamics are not fully known. Our generalisation also allows bifurcation detection to be applied spatially if one treats each spatial location as a new dynamical variable. One may then determine the unstable spatial mode(s). This is also something that has not been possible with the single variable method. The method is applicable to any set of time series regardless of its origin, but may be particularly useful when anticipating abrupt changes in the multi-dimensional climate system.

2204 - A world above 2°C global warming: understanding risks and developing transformative solutions

ORAL PRESENTATIONS

O-2204-01

Transformative solutions to high-end climate change

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Current trends in greenhouse gas emissions show that limiting global warming to the international target of 2°C is likely to be difficult. Despite the increasing plausibility of high-end scenarios, there are few studies that assess transformative strategies and solutions to address potential synergies and trade-offs between adaptation, mitigation and sustainable development. The latest IPCC AR5 report defines transformation as 'a change in the fundamental attributes of natural and human systems [...that...] reflects strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation that supports sustainable development, including poverty reduction' (IPCC 2014; WGII, SPM p.5). However, the notion and implications of transformation in climate science and policy are poorly understood. On the one hand, transformation is an autonomous dimension which does not depend on, or is not necessarily conditioned by, either mitigation or adaptation strategies. But on the other hand, transformative adaptation and transformative mitigation policies can contribute to the development of decisive systems' innovations to cope with high-end scenarios, while at the same time fostering sustainable development. To achieve this goal, knowledge and new modelling tools on how to develop and implement 'global systems of interconnected solutions' are urgently required. The new emerging Global Systems Science (GSS) is a promising approach which could support Integrated Climate Governance by looking at new modes of science appraisal, global governance arrangements and engagement with stakeholders. In particular, innovative climate strategies and solutions could take advantage of, and support, a number of global transformative forces already evident outside of the strictly climate domain. These include: 1. Increasing interest in the creation of a global citizenship, e.g., to redistribute global climate rights and responsibilities; 2. The development of win-win solutions to generate a global green low-carbon economy, to replace the brown economy; 3. Opening Human Information and Knowledge Systems (HIKS) and coupling them with Social-Ecological Change, to connect knowledge networks and agents globally to deal with specific sustainability needs and problems; and 4. The generation of distributed and conducive conditions for global cooperation and institutional capacity building, to ensure the equitable implementation of transformative strategies and policies in the long-term. This presentation will introduce this cluster of interconnected systems of global solutions, referred to as the 'Global Transformation Propeller', and suggest how it could be used to develop and implement transformative responses in the face of high-end scenarios. Our goal is to stimulate an open debate to explore the implications for climate science and policy of existing or potential transformative forces that can be connected to innovative solutions which are able to cope with HES while supporting sustainable development.

O-2204-02

Avoiding the impacts of climate change: Results from the BRACE study

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Understanding the potential consequences of climate change for ecosystems and society is necessary for an informed response to the climate issue. A particularly important task is improving our understanding of how impacts differ across alternative levels of future climate change. Such understanding can help inform the balancing of the costs of climate change mitigation and adaptation with the benefits of reduced impacts. This talk will present results from a project led by the National Center for Atmospheric Research (NCAR) on the Benefits of Reduced Anthropogenic Climate changE (BRACE), which assesses the differences in impacts between two specific climate futures: those associated with Representative Concentration Pathways (RCPs) 4.5 and 8.5. The latter would lead to a likely global average temperature change of 3.2-5.4 C relative to pre-industrial temperatures by the end of the century, the former to a likely range of 1.7-3.2 C degrees of warming. This project is quantifying avoided impacts in terms of extreme events, health, agriculture, tropical cyclones, and sea level rise. Methodologically, it combines climate modeling, statistical analysis, and impact assessment to examine physical, ecological, and societal impacts, and draws heavily on the use of large initial condition ensembles of climate model simulations in order to better account for internal variability and extreme events and to develop new approaches to pattern scaling techniques. Results show that the benefits of reduced climate change vary substantially across sectors, and depend importantly on assumptions about future societal conditions.

O-2204-03

Understanding and Addressing Infinite and Existential Climate Risks

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Scientific evidence indicates humanity has entered a new geological epoch, the Anthropocene, where the world entreprise constitutes the largest driver of change at the planetary scale. Furthermore, we increasingly find evidence that the social and environmental response to rising human pressures on the planet are non-linear, and that the globalized world of the 21st century is associated with rising social-ecological turbulence. This raises the need to better understand risks of facing infinite or existential risks, i.e., risks that may affect a significant proportion of the global population or the entire world community. In this presentation a presentation is made of a scientific methodology to investigate infinite risks, including global climate risks, and a first assessment of global risks is presented, and compared, e.g,. with the WEF global risk report.

O-2204-04

Sensitivity of Amazonia to climate change: the main uncertainties are effects of Drought, Elevated Temperature and Elevated CO2

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Amazonia is under threat of the combined effects of unsustainable regional development and climate change. As summarised in the IPCC reports of 2007 and 2014, studies in the past ten years indicate that these pressures can lead to deforestation, regional and global disturbance of temperatures and the water cycle, as well as causing loss of carbon stocks and biodiversity. In turn, these transitions can result in forest loss, droughts, low river levels, floods, loss of hydropower energy and plenty of other ecosystem services. Even enhanced risk of livestock and human diseases and loss of agricultural productivity are inextricably related to these stressful alterations. Recognising that processes driving land-use change and fire in Amazonia are of overriding importance, here we address three biophysical uncertainties related to the impact of climate change on Amazonia: the effects of drought, elevated temperature and elevated CO2. Model experiments have shown repeatedly that these factors represent the highest uncertainly in projecting climate change impacts.

The EU-FP7 AMAZALERT project has investigated the threats through combining novel field measurements with modelling of feedbacks between Amazonian ecosystems, human-caused land-use change and the climate system. Field measurements indicate that leaf level maximum rate of photosynthesis is not significantly affected by temperature increases. Thus, also with climate change, trees may be well able to maintain high rates of photosynthesis, however, this negative temperature sensitivity is currently overestimated in vegetation models. Data from experimentally droughted forest and of dry years show that in particular large trees of some tree species, are vulnerable to drought, thus potentially risking significant biomass losses. Besides, prolonged (multi-year) drought appears to eventually lead to higher respiration rates, i.e., less efficient growth. However, basin-wide plot measurements indicate that at short timescales (months) forests are able to remain net primary production at constant level during, for example, the 2010 drought but photosynthesis was suppressed, autotrophic respiration decreased and carbon allocation patterns changed potentially leading to increased post-drought forest mortality. Such observations provide important insights for model development at the physiological level. The net effect means that under extended drought and warming, if no fire occurs, a long-term change in the species composition and structure of the forest is likely, together with an increase in the amount of dead and decomposing wood, potentially turning the forest into a carbon source.

The effects of increasing atmospheric CO2 on Amazonian forests can so far only be assessed from theory, which predicts that the forests may become more robust and may even grow through 'CO2 fertilisation', but this fertilisation effect is limited by the availability of nutrients such as nitrogen and phosphorus. At the same time, theory and some data sets predict that water use efficiency will increase, which may increase forest resistance but also l decrease water cycling, potentially causing a climate warming feedback. The magnitude of these limiting effects is still uncertain due to poor understanding of soil nutrient dynamics and this must be improved by rigorously combining measurements and new modelling approaches. Altogether, it is clear that new data are needed and it is essential that these processes will be investigated in a new, whole-ecosystem elevated CO2 experiment such as the AMAZON_FACE experiment which is currently being set up in the Amazon basin. These should be combined with other focused research projects further addressing drought and temperature dependence.

O-2204-05

Implications of growing CO2 emissions for staying below the 2°C limit

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Efforts to limit climate change below a given temperature level require that global emissions of CO2 cumulated over time remain below a limited quota. This quota varies depending on the temperature level, the desired probability of staying below this level and the contributions of other gases. In spite of this restriction, global emissions of CO2 from fossil fuel combustion and cement production have continued to grow by 2.5% per year on average over the past decade. Two thirds of the CO2 emission quota consistent with a 2 °C temperature limit has already been used, and the total quota will likely be exhausted in a further 30 years at the 2014 emissions rates. I present recent analysis showing that CO2 emissions track the high end of the latest generation of emissions scenarios, due to lower than anticipated carbon intensity improvements of emerging economies and higher global gross domestic product growth. In the absence of more stringent mitigation, these trends are set to continue and further reduce the remaining quota until the onset of a potential new climate agreement in 2020. Breaking current emission trends in the short term is key to retaining credible climate targets within a rapidly diminishing emission quota.

2204-POSTER PRESENTATIONS

P-2204-01

Climate change and very dangerous heat waves: Projecting frequency of high-mortality heat waves in 82 US communities in 2061—2080 under different climate, population, and adaptation scenarios

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Certain rare heat waves, like the 2003 heat wave in France, can have devastating effects on a community's public health and well-being. Here, we built models to predict which heat waves are likely to be such "very dangerous" heat waves, based on characteristics of the heat wave (e.g., intensity, length) and of the community in which it occurred (e.g., population), using recent (1987—2005) data from 82 large US urban communities. We built twenty potential classification models and used Monte Carlo cross-validations to evaluate these models, identifying three models capable of predicting the occurrence of very dangerous heat waves. Using these three models, we predicted the frequency of very dangerous heat waves in these 82 communities in 2061—2080 under two scenarios of climate change (RCP4.5, RCP8.5), two scenarios of population change (SSP3, SSP5), and three scenarios of community adaptation to heat (none, lagged, on-pace). We found that the frequency of very dangerous heat waves was most strongly influenced by the pace at which communities

are able to adapt to their changing climates. We found that the frequency also depended somewhat on climate change scenario, while it was practically unchanged across different population scenarios, although these scenarios did influence projected person-days of exposure to very dangerous heat waves. Our results suggest that it is critical to consider adaptation scenarios when projecting health impacts of heat under climate change scenarios. Further, our findings suggest that community-level adaptation measures are likely to be a critical protection against future very dangerous heat waves.

P-2204-02

Early Entrants of Rainfall Index Insurance: Insights from Rural Households in Central West Nigeria

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Farmers have traditionally adapted to weather-induced production risks over time. The failures of subsidized crop insurance schemes and rising trends of climate extremes have increases their vulnerability to higher risks. With ideal levels of adaptation, some residual impacts from weather shocks would still lead to economic losses. Rainfall index insurance can transfer farmers' risks and increase supports for agricultural lending. This study used cross-sectional data to analyze potential demand for rainfall index insurance as financial adaptation to extreme local climate in central west Nigeria. The study shows that monthly distribution of rainfall uncertainties thereby constraining optimal planning within the available production period. Farmers' vulnerability to rainfall delay, early cessation, and occasioned long dry spell has consequences on resource use productivity. There is demand for rainfall index insurance as nearly 65% demonstrated willingness to insure in the programme. Over 70% are risk-averse but are positively disposed towards insurance. There is a very low confidence in insurance and finance service providers as means of financial adaptation towards resilience. Farmers' education, farming as major livelihood, production risk index, and start bid are significant on households' decisions to insure in rainfall index insurance but households' size, distance to weather station, awareness of agricultural insurance, previous drought experience have inverse coefficient. The more farmers' education, dependence on farm income, production risk index and start bid increases; the higher the probability to belong to both somehow willing and definitely willing category to be insured. Farmers who have access to seasonal forecast are somehow WTP an amount that is 31.7% lower than farmers who do not on average and ceteris paribus. For every unit increase in production risk aversion, there is an increase of 43.7% in the farmers amount WTP on average and ceterius paribus since they are willing to secure their residual risk through market based indemnity transfers. Those already aware of agricultural insurance practices are also somehow WTP 37.6% higher than their fellows with no prior knowledge on average and ceteris paribus to secure their 'residual' risk. Mean (N352.91and median WTP (N250) obtained from the interval regression are higher for the definitely willing category than the somehow willing. In overall, farmers in somehow willing category are more elastic to price while those in definitely willing category are more inelastic to prices of microinsurance policy. For every unit increase in production risk aversion, there is an increase of 43.7% in the farmers amount WTP on average and ceteris paribus since they are willing to secure their residual risk through market based indemnity transfers. Farmers already aware of agricultural insurance practices are also somehow WTP 37.6% higher than their fellows with no prior knowledge on average and ceteris paribus to secure their 'residual' risk. Mean (N352.91and median WTP (N250) obtained from the interval regression are higher for the definitely willing category than the somehow willing. In overall, farmers in somehow willing category are more elastic to price while those in definitely willing category are more inelastic to prices of microinsurance policy.

P-2204-03

Managing Catastrophic Climate Risks under Model Uncertainty Aversion

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We propose a robust risk management approach to deal with the problem of catastrophic climate change which incorporates both risk and model uncertainty. Using a two-period model of optimal abatement, we show how model uncertainty and risk aversion interact. We disentangle the impact of preferences towards different types of uncertainty from the structure of model uncertainty on the optimal level of abatement, by means of a simple measure of model uncertainty. With data from expert elicitation about climate change catastrophes, we show the relative importance of these two effects and calibrate an integrated assessment model of climate change. The results indicate that the structure of model uncertainty, and specifically the convergence of agreement across models are the key driver of abatement, and that model uncertainty aversion warrants a higher level of climate change mitigation.

P-2204-04

Treatment of uncertainties in the IPCC's Fifth Assessment Report: Lessons learned for informing management of climate-related risks

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This presentation will discuss lessons learned through implementation of a common approach for characterizing the degree of certainty in findings of the assessment process in the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR5), with a focus on informing climate risk management in future assessments. Managing climate-related risks involves decision making in a changing world, with continuing uncertainty about how climatic and non-climatic factors will evolve and interact over time. Risks result from the interaction of climate-related hazards with the exposure and vulnerability of society, and vary substantially across plausible alternative development pathways. In the IPCC AR5, assessment of risks relied on diverse forms of evidence, including empirical observations, experimental results, process-based understanding, statistical approaches, and simulation and descriptive models. Expert judgment is critical in integrating such diverse evidence into evaluations of risks and in determining the extent to which risks can be quantified. The common approach used in the IPCC AR5 emphasizes assessment of the consequences and relative likelihoods of the widest possible range of future outcomes, including low-probability outcomes with large consequences, to inform risk management. It also emphasizes providing clear traceable accounts of the confidence in and support for assessment findings, describing an author team's evaluation of the type, amount, quality, and consistency of evidence and the degree of agreement underlying each finding. Clear traceable accounts ensure users of the assessment can understand the evaluation and integration of evidence supporting assessment findings. Further use of structured methods for organizing and quantifying expert judgment could aid future assessment efforts within and beyond the IPCC in delivering policy-relevant findings with clear traceable accounts and in quantifying climate risks based on a diverse evidence base mixing quantitative and qualitative information.

P-2204-05

Sensitivity of Natural Micro-Regions of North-East Hungary to Landscape Degradation

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The objective of our research is to survey degradation processes acting in each micro-region, as well, as to investigate the sensitivity of the micro-regions to degradation. A survey of land degradation processes has been carried out at medium scale (1:50 000) to identify the affected areas of the region. The methods include field work, analysis of topographic maps and remote sensing materials, statistical analyses, GIS methods and preparation of photo documents. The sensitivity of landscapes will change in the future because of global climate change. As a consequence of this, the extent and the intensity of degradation processes may change, too. Regional climate scenaria, based on GCM, RCM and empirical downscaling are all included and synthesized for the specified hilly region of ca. 20,000 sq. km. The scenaria, scoping at 50 years ahead with possible linear interpolation and extrapolation in time, include changes of seasonal means and expected changes in some extreme event, as well. The following land degradation processes are included in the database of the present and expected future states: (i.) Land (soil) degradation involving also mass movements (sheet erosion, gully erosion, wind erosion, mass movements, salinization, degradation due to soil structure changes, soil sealing). (ii.) Removal of vegetation due to deforestation and to the extension of urban, industrial areas, transport tracks, etc. (iii.) Degradation of waters. (iv.) Degradation of the scenic value of the landscape. (v.) Degradation due to land use change (other changes than those under (ii.)). (vi.) Wounds in the landscape (abandoned mines, open-cast mines, etc.). (vii.) Desertification. The sensitivity of the natural micro-regions to degradation are determined by applying sensitivity indices. Different factors are the driving forces of the various degradation processes and so different indices are created for each process with specific weighting of the identified factors, mostly based on empirical regression analyses. The concept of the index is based on the MEDALUS index (Kosmas et al. 1999). The factors included in the investigation are: (a) Soil properties (soil structure, soil water budget, organic matter content, salinity, soil parent material). (b) Climate properties (drought index, yearly precipitation, rainfall intensity). (c) Vegetation properties (forest fire risk, sensitivity of vegetation to drought, vegetation cover %). (d) Surface and subsurface water properties (ground water depth, flood risk, inundation risk). (e) Anthropogenic load (water use, waste disposal, population change, land use intensity). Finally the sensitivity index values are shown in maps. The sensitivity of natural micro-regions of North-East Hungary is also investigated under the circumstances of the expected climate change scenaria, applied to characterise landscape sensitivity in the future. The map of the existing land degradation processes, sensitivity maps of the present and simulated future climatic conditions are analysed by GIS methods. The map series and the evaluation provide important information about the state and sensitivity of the natural micro-regions and this information is useful for policymakers at different levels. The study has been supported by the OTKA-K108755 national project.

P-2204-06

The relative role of anthropogenic climate change on risk of heat mortality in the European heatwave of 2003

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The 2003 European heat wave was one of the most extreme meteorological events in terms of loss of life in Europe in recent times. Estimates of excess heat-related deaths for this event could be as high as 70,000, with France being particularly affected.

The chaotic nature of the climate system is such that extreme meteorological events of this magnitude will to some extent always occur "by chance". However external factors may increase or decrease the frequency of occurrence. Such factors include climate change related to anthropogenic influences, such as greenhouse gas emissions and land use change, but also natural influences such as changes in solar output, and large volcanic eruptions.

Here we use a unique modelling capability to perform massive ensembles of climate model simulations ("climateprediction-dot-net: CPDN"), which enables assessment of any changing probabilities of particular meteorological extremes of interest. We compare scenarios representing the year 2003 (i) as it actually was (i.e. where both natural and anthropogenic conditions are used to drive the climate model; "scenario 1"), and (ii) as it could have been, if humans had not altered atmospheric gas composition (i.e. with only natural conditions; "scenario 2").

This study considers each aspect of the 2003 heat wave, from the inherent warmer atmosphere due to raised greenhouse gas concentrations, and to any additional confounding and related changes in probability of altered large-scale atmospheric circulation patterns. We use baseline health and demographic data to estimate associated mortality impacts on the local populations. An additional feature of CPDN is that each global simulation contains a high-resolution "nested" regional climate model centred on Europe. This high-resolution modelling capability allows us to perform much of the analysis at the city level. For Scenario's 1 and 2, we therefore show how heat-related mortality changed over Paris during 2003.

P-2204-07

Climate Change Induced Excessive Heat Exposure Undermines Global Health Equity and Economic Development

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The physiological limits of the human body in coping with high heat exposure and heat stress are relatively well established since several decades. However, the implications of climate change trends of extreme heat have only recently been analyzed. The health effects include heat exhaustion (which reduces work capacity and labor productivity), clinical heat stroke, exacerbation of certain chronic diseases and acute fatalities. Physical work adds in a major way to the heat stress because of the internal heat production from muscle work.

Our analysis compares the population based estimates of health impacts of heat for selected climate models applied to RCP8.5 (the current emission track) and RCP6.0 (what may be achieved with more stringent climate mitigation policies). The global mean temperature increase this century for RCP8.5 using various models generally ranges between 3 and 5 oC, while the RCP6.0 increase generally ranges between 1.5 and 2.5 oC.

Whichever health outcome is analysed poor people are always at highest risk as they are likely to be in heavy physical work and they cannot afford air conditioning to the same extent as higher income people. Poor people in low and middle income tropical countries are at particular risk as most of these countries already experience several months of extreme heat each year. The heat exposure levels expressed as «millions of person hours of exposure above agreed heat risk limits» are particularly high in these countries from a global health perspective. For example, working people in SE China without air conditioning at the prevailing ambient heat levels, will lose as much as 30% of the daylight work hours in the hottest month and the annual loss will be 8% as these hours are too hot for moderate level continuous work. In SE USA the equivalent losses are 5% in the hottest month and 2% annually. (more examples will be added in the final presentation)

The increasing heat impacts on clinical health and labor productivity are a growing threat to improvements in health equity at global, national and local level, as the people most vulnerable to heat stress are those with poor living and working environments and many of them already have a poor health status. The labor productivity loss also undermines local economic development and slow down any progress in poverty reduction programs.

P-2204-08

Climate analysis at local scale in the context of climate change

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Issues related to climate change increasingly concern the functioning of local scale geo-systems. A global change will necessarily affect local climates. In this context, the potential impacts of climate change lead to numerous interrogations concerning adaptation. Despite numerous studies on the impact of projected global warming on different regions, global atmospheric models (GCM) are not adapted to local scales and, as a result, impacts at local scales are still approximate. Although real progress in regional climate modeling was realized over the past years, no operative model is in use yet to simulate climate at local scales (ten or so meters). It is therefore at a finer spatial scale, which considers land surface characteristics, it will be possible to assess the impacts of climate change. Our scientific approach aims to develop a methodology based on climatic observations in situ and on spatial modeling of climate, which permits to evaluate the spatial variability of atmospheric parameters at fine scales (mean values and climatic extremes). By completing the lack of data at local scales, this work allows to improve the understanding on climate changes that may appear at local scale and thus advance the assessment of the potential impacts. This methodology is developed and applied in agro climatology (viticulture) and in urban climatology.

In viticulture, the LIFE-ADVICLIM (LIFE13 ENV/FR/001512: ADapatation of VIticulture to CLIMate change : High resolution observations of adaptation scenarii for viticulture) project aims at observing climate at local scales in different European vineyards, representing the climate diversity in European wine regions ; simulating climate and climate change in order to produce a fine scale assessment of the climate change impacts, thereafter simulating scenarii of adaptation for viticulture. Climate modeling at fine scales will include (i) the output from numerical EURO-CORDEX models with a kilometer resolution (ii) the spatial modeling of climatic data from the measurement networks using multicriteria modeling at very high resolution (90 m), and (iii) the future climate simulations using meso-scale climatic model ran under different scenarios of climate change. (i) The coarse resolution output from numerical climate models require downscaling. We use the downscaling output of EURO-CORDEX. It will provide knowledge and understanding of climate variability at meso-scale in the different studied European wine regions. Climatic data from national weather station networks will be used to validate the outputs of modelled data. (ii) In order to construct fine-scale spatial temperature fields, the multicriteria modelling will be used. This approach takes environmental factors into account. Indeed, the role of topographic factors in the spatial variability of temperatures at fine scales, in addition to the influence of geographical location (latitude/longitude) at larger scale has already been demonstrated. This type of modeling will make use of the climatic data provided by the fine scale network. (iii) We use simulations of climate change scenarios (for Europe) carried out CORDEX program

For example, the results of the measurements and modeling adapted at terroir scales have permitted to highlight a strong spatial variability of climate at very small spaces. In terms of temperatures, the spatial differences generated by the local conditions (topography, etc.) are very often greater than the increase in temperatures simulated by the different scenarios of IPCC for the next 50 years. Vine growers adapt their practices to this spatial variability of climate that partly determines the characteristics and uniqueness of their wine. In the context of climate change, this approach of a spatial analysis could be a method to adapt to the temporal changes in climate, especially in the short and medium term.

In urban climatogy, the same scientific approach (measurement and modeling at fine scales) has been applied. The same methodology was applied in Rennes city. The results showed a strong spatial variability of the temperatures in relation to local characteristics of the city (eg green areas, densely built-up urban area...). In the context of global change, climate analysis at fine scales helps to define the development policies.

P-2204-09

The risk of drought in Ukraine under changing climate in the future medium term

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The territory of Ukraine almost every year is exposed the drought of different intensity and duration. The country is belongs to main agricultural area of East Europe, therefore the drought in vegetation season can considerably worsen the productivity of grain crops. As studies shows, the seasonal (or agricultural) drought is the widespread in Ukraine with dominating in spring and summer time. In last two decades the full vegetation season droughts were observed in 1999, 2007, 2009 and 2012. Most important spring-summer (April-June) drought occurred in 1996, 2003, 2007 and 2012. In this years were fixed the large crop losses of winter wheat and spring barley – 10-43% from the trend.

Under the climate changing is become important the estimates of future drought risks, which is necessary for long-term economic planning. For assessment of the drought frequency in the future was used data of CMIP5 (Coupled Model Intercomparison Project, phase 5) for period 2020-2050.

Analysis of spatial and temporal distribution of drought was held using the index SPI. For its calculation has been used multimodel (32 models) monthly mean precipitation data for two boundary scenarios, which represents the RCP (Representative Concentration Pathways), experiment RCP2.6 and RCP8.5.

Under the scenario RCP2.6 surface air temperature anomaly in Ukraine until 2050 will be +0.7, +2.1degrees Celsius compared with a baseline period 1981-2010. According to the scenario RCP8.5 increasing of temperature can be up to +2.8, +3.1degrees Celsius. Precipitation will be slightly increased in both scenarios.

SPI was examined for three timescales 12, 7 and 3 months, in order to cover droughts of different duration.

The SPI12 analysis for local points showed that at the RCP2.6 some significant dry periods will be observed in 2020's and 2040's, but at the RCP8.5 expected increasing the intensity and duration of drought episodes after 2035. The most severe drought is projected in 2042-2045.

The SPI7 analysis during vegetation season (April-October) showed that at the RCP2.6 total number of drought will be several larger than at the RCP8.5. The frequency of weak and moderate droughts at the RCP2.6 averaged to 12-14 cases per 31 years, according to the RCP8.5 is 10-12 cases. Severe and extreme droughts under both scenarios are expected in 1 to 4 years, but not everywhere.

Analysis of drought frequency in different seasons using SPI3 showed that during 2020-2050 expected a slight increasing the total number of drought and its redistribution within the warm season. The increasing of the number summer-autumn droughts (August-October) and reducing of summer droughts (June-August) are projected, especially in mild scenario RCP2.6. The frequency of drought could reach up one per every 2-3 years across regions. Maximum number of droughts in all seasons predicted for the northeast and western regions of Ukraine, which in the present climate are not too arid. Contrariwise in the Steppe the total number of droughts almost not changes, but remains a high probability of severe and extreme drought.

P-2204-10

Modelling the ice dynamics of Himalayan glaciers

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In the Himalayan-Karakoram glacier melt contributes to the runoff of the Indus, Ganges and Brahmaputra rivers affecting the livelihoods of more than 700 million people[1]. Future glacier melting is of particular concern for high-end climate change scenarios because of the potential impacts on water supply. Projections suggest that runoff may increase until 2050, due to enhanced glacier melting combined with an increase in monsoon precipitation [2, 3]. The uncertainty in these estimates are associated with an over simplified treatment of glaciers and a poor representation of monsoon precipitation.

To assess the impact of glacier retreat on food and water security in the region, we are implementing a 1-D glacier flow model [4] into the Joint UK Land Environment Simulator (JULES) integrated impacts model. The purpose of the JULES impacts model is to allow for an integrated, internally-consistent assessment of impacts of climate change on glaciers, water resources and agriculture. The JULES impacts model is currently under development and includes a river routing scheme [5], an irrigation scheme and crop plant functions types[6].

In this presentation, we describe the initial stages of the model development. The glacier model requires two inputs; knowledge of the present day ice thickness and surface mass balance (SMB) as a function of elevation. Ice thickness is calculated using an inversion technique based on the principles of ice flow dynamics [7, 8]. This technique uses satellite observations of glacier outlines [9] combined with a digital elevation model. A time series of SMB generated by JULES is used to drive the glacier flow model offline. We show preliminary results of glacier flow simulations in the Himalayan-Karakoram.

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P-2204-11

Heat stress in a warming world: implications for human health and productivity under different climate scenarios

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Projected changes in temperature and humidity over the course of the 21st Century will contribute to increased heat stress in many tropical and sub-tropical regions. Heat stress, arising from a combination of high temperature and humidity impacts on human health and wellbeing by causing illness and death, with the young and old the most vulnerable. Increased heat stress impacts workforce productivity, especially those engage in manual labour in open environments such as construction, mining and agriculture. These impacts will be of increasing concern during coming decades due to projected significant increases in the rate of warming and rapidly growing populations tropical and sub-tropical regions. We evaluated the impact of different emission scenarios on the heat stress conditions for the 21st Century in tropical and sub-tropical regions using wet-bulb globe temperature (WBGT) heat stress index. Projected changes in WBGT were used to assess the future impacts of heat stress by combining time-varying changes in heat stress and human population numbers. We found that people living in cities in coastal tropical regions and cities are highly vulnerable to changes in the number of heat stressdays, with these increasing in some instances from close to zero to two hundred days per year by 2100. West Africa, the Caribbean and the Indian sub-continent will be particularly hard hit. We show the benefits of mitigation by comparing the distribution of heat stress under RCP8.5 and RCP2.6.

P-2204-12

Estimated impacts of emissions reductions on wheat and maize crops

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An ability to quantify the impacts associated with different emissions scenarios across a broad range of economic and environmental outcomes would be helpful for guiding policy on energy and greenhouse gas emissions. One outcome of particular interest, especially for food insecure populations, are effects on agricultural productivity. In this study we use empirical models of the relation between climate and CO2 concentration on the one hand, and changes in crop yields on the other, to characterize the differential impacts on the future productivity of two major crops of two level of forcings: those associated with RCP4.5 and those associated with RCP8.5. This study is part of a larger project on the Benefits of Reducing Anthropogenic Climate changE (BRACE). We consider differential effects on maize and wheat yields at the global scale from expected changes in mean temperature and precipitation under the two scenarios. We also characterize differential levels of exposure to damaging heat extremes. Several time horizons are considered, characterizing expected impacts over the short, middle and long terms over the 21st century.

P-2204-13

Evaluating the risk of hydrological drought to the irrigation sector under future climate scenarios: the case study of Puglia Region (Italy)

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In several regions, but especially in semi-arid areas, the raising drought events caused by climate change are expected to dramatically reduce the current stocks of freshwater resources, also used for irrigation purposes. The achievement of a sustainable equilibrium between the availability of water resources and the irrigation demand is essentially related to the planning and implementation of evidence-based adaptation strategies and actions. In this sense, the improvement (of existing) and the development of (new) appropriate risk assessment tools to evaluate the impact of drought events on irrigated crops is fundamental in order to assure that the agricultural yields are appropriate to meet the current and future food and market demand. The present study aims at assessing the risk of hydrological droughts due to climate change on the irrigated agronomic compartment that cover a large portion of Puglia, a semi-arid region with the largest agriculture production in Southern Italy. Based on the theoretical framework of Regional Risk Assessment (RRA) approach, the methodology is applied within a scenario-based hazard framework, where future climate projections provided by COSMO-CLM are considered under the radiative forcing RCP4.5 and RCP8.5 in two different timeframes (2021-2050 and 2041-2070). The run-off feeding the water stocks of the most important reservoirs for irrigation purpose in Puglia has been modelled by means of the Arc-SWAT model. The risk methodology followed four subsequent levels of analysis (i.e. hazards, exposure, vulnerability and risk assessments) where each step has been characterized by specific algorithms for their spatial and numerical quantification. Hazard scores have been modelled as the degrees of fulfillment of Reclamation Consortia irrigation demand when compared to the volume of available water supplied by the different reservoirs. Exposure assessment consists on the spatial characterization of the most valuable irrigated areas in Puglia Region, according to the specific crops that are cultivated. Vulnerability scores have been designed as function of three different factors that accounts for the agronomic and structural pattern of irrigation schemes (i.e. crop yield variation according to water stress; water losses along the irrigation network; diversification of water supplies other than the reservoirs' alone). Finally, relative risk maps (GIS based) and related statistics have been produced allowing the identification of hot spots and areas at risk as well as the spatial characterization of the risk pattern. The assessment allowed: the identification of Reclamation Consortia at higher risk of not fulfilling their irrigation demand in future perspectives (e.g. Capitanata Reclamation Consortia in RCP8.5 2041-2070 scenario); to identify the most affected crops (e.g. fruit trees and vineyards); and finally, to characterize the vulnerability pattern of irrigation systems and networks. According to these results, tailored and knowledge-based adaptation strategies and related actions can be developed, to reduce the risk pattern at both agronomic level (preferring crops with low vulnerability score, as olive groves) and at structural level (differentiating the water stocks and supplies and reducing losses and inefficiencies).

P-2204-14

The impact of high-end climate change scenarios over Europe

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The latest scientific evidence suggest that the increase in global mean temperature is likely to exceed the 2°C and target the 4°C to 6°C by the end of the 21st century. Furthermore, most of Europe is expected to warm more than the average global warming in the 21st century. The potential environmental, economic and social impacts of such high-end warming scenarios has drawn the attention of the scientific community, which has a crucial role in advising future policy making. In the framework of High-End cLimate Impacts and eXtremes (HELIX) FP7 project, five biophysical impact models are set up to investigate the effect of high global warming levels over Europe. Impact models are focused on water management (JULES), floods, water resources and droughts (Lisflood), coastal hazard (Liscoast), Energy (Poles) and crop (Orchidee). Models are tested and validated against large scale past extreme events such as major droughts and flood events that have occurred in the recent past. Calibrated models are then forced by the newly available Euro - CORDEX regional climate projections to evaluate changes in key indicators within the considered sectors over Europe. Output simulations are then used to examine possible implications of uncertainties in global patterns of climate change at 4°C for impacts at regional scales. Results are assessed and compared to the available CMIP5 based projections included in the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) over Europe. Here, first results of the coordinated modeling effort are presented for the examined sectors.

P-2204-15

How does urbanization modify climate related risk in urban areas on global scale?

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Climate change and urbanization are two global megatrends that will influence risk to climate change as well as adaptation opportunities and constraints. Sea-level rise, storms and floods as well as droughts will be modified by climate change and most likely impact particularly urban areas in coastal zones in the future as the IPCC fifth assessment report (AR5) underscored. Since 1950 the world population has grown rapidly from 746 millions to 3.9 billion. Hence, today more than 50% of the population is living in urban areas implying new challenges for risk reduction and adaptation. Projections of urban population growth estimate that by 2050 additional 2.5 billion people will live in urban areas whereas 90 percent of this increase will take place in Africa and Asia. Against this background and also considering the discussion of sustainable develoment goals (SDGs) and the post-2015 framework for disaster risk reduction there is an increasing need to assess whether future urbanization will increase risks related to climate change or in contrast whether urbanization might provide a vehicle for risk and vulnerability reduction regarding climate related hazards.

Consequently the question of how urbanization influences core determinants of risk, particularly vulnerability - either in a positive or negative way - has not yet been clearly answered. The paper examines the nexus between urbanization, urban growth and vulnerability, based on new global remote sensing based land-use data for 140 countries. In this regard, vulnerability is defined as a combination of susceptibility, coping and adaptive capacities. The findings show among other issues that a high level of urbanization (>75%) and a low urban growth rate (<1%) at national scale in general implies a rather low level of urban vulnerability. In contrast, countries that are characterized by a low level of urbanization(<40%), but very high urban growth rates (more than 3%) often tend to be countries with a high level of vulnerability in urban areas. The paper presents in detail selected findings and methods used to assess urban vulnerability and risk patterns in various countries, also based on the WorldRiskIndex concept. The triangulation of different data, such as remote sensing data, hazard data and global available socio-economic indicators, is presented as well as constraints and limitations of it. Exposure, vulnerability and risk maps for urban areas with a national scale resolution will underscore that risk and adaptation strategies need to consider different urbanization types in order to improve regional management approaches.

Overall, the presentation provides new insights in risk and vulnerability data and respective assessment methods for urban areas. Based on these findings specific recommendations for policy making and new risk monitoring tools will be derived that also consider priority actions defined in the fields of climate change adaptation (programme on loss and damage) and disaster risk reduction.

P-2204-16

Current structural changes in global economic network amplify heat stress-induced production losses

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Above a certain temperature threshold labor productivity has been shown to decline in exposed sectors such as construction and agriculture. Under future warming daily temperature will increase and thereby affect economic output. Here, we assess primary, secondary and higher-order losses from reduced labor productivity under past and present economic conditions under unabated climate change. Unsurprisingly, we find that relative damages increase linearly with rising temperatures.

Crucial for future adaptation strategies we observe that the structure of the global economic network plays an important role in absolute damage level. A new static network measure is found to represent the network's vulnerability to propagation of unanticipated damages well. This Global Adaptive Pressure (GAP) is shown to increase with the network's sensitivity to heat stress-induced damages.

From data of the global economic network we learn that the Global Adaptive Pressure has been steadily increasing since 1998 (with an exception for the post-financial crisis years 2009 and 2010). As GAP is a relative measure, this increase does not merely represent economic growth but a structural change.

Our finding suggests that the current evolution of the global economic network may amplify heat stress-induced damages and thus necessitate structural adaptation that requires more foresight than currently prevalent.

P-2204-17

Mapping of risk interconnection under climate change

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Anthropogenic climate change possibly causes various impacts on human society and ecosystem. Here, we call possible damages or benefits caused by the future climate change as "climate risks". Many climate risks are closely interconnected with each other by direct cause-effect relationship. In this study, the major climate risks are comprehensively summarized based on the survey of studies in the literature using IPCC AR5 etc, and their cause-effect relationship are visualized by a "network diagram". This research is conducted by the collaboration between the experts of various fields, such as water, energy, agriculture, health, society, and eco-system under the project called ICA-RUS (Integrated Climate Assessment - Risks, Uncertainties and Society).

First, the climate risks are classified into 9 categories (water, energy, food, health, disaster, industry, society, ecosystem, and tipping elements). Second, researchers of these fields in our project survey the research articles, and pick up items of climate risks, and possible cause-effect relationship between the risk items. A long list of the climate risks is summarized into ~130, and that of possible cause-effect relationship between the risk items is summarized into ~300, because the network diagram would be illegible if the number of the risk items and cause-effect relationship is too large. Here, we only consider the risks that could occur if climate mitigation policies are not conducted. Finally, the chain of climate risks is visualized by creating a "network diagram" based on a network graph theory (Fruchtman & Reingold algorithm).

Through the analysis of network diagram, we find that climate risks at various sectors are closely related. For example, the decrease in the precipitation under the global climate change possibly causes the decrease in river runoff and the decrease in soil moisture, which causes the changes in crop production. The changes in crop production can have an impact on society by changing the food price or food supply. Changes in river runoff can also make an impact on the hydropower efficiency. Comprehensive pictures of climate risks and their interconnections are clearly shown in a straightforward manner by the network diagram. We will have a discussion how our results can be helpful for our society to recognize the climate risk

2205 - Multi-sectoral analysis of risks to climate change (hot spots) at 2 °C warming

ORAL PRESENTATIONS

K-2205-01

Cross-sectoral analysis in IMPACT2C and IPCC AR5 Europe Chapter

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Political discussions on the European goal to limit global warming to 2°C relative to pre-industrial levels, needs to be informed by the best available science on projected impacts and possible benefits.

Here we'll provide a recent update of the scientific evidence on which regional changes and associated impacts will be induced by 2 °C global warming.

First, original insights and findings from the FP7 project IMPACT2C will be presented and discussed. IMPACT2C identifies and quantifies the impacts and most appropriate response strategies of a 2oC global warming. IMPACT2C analyses a number of major cross-sectoral issues for Europe and three selected vulnerable regions: Bangladesh, Africa (Nile and Niger basins) and the Maldives

The IMPACT2C project adopts a clear and logical structure within climate- and impact-modelling, vulnerabilities, risks and economic costs. Detailed climate change scenarios are provided and tailored to the needs of various sectors. Here the information from the new EURO-CORDEX simulations will be presented. Furthermore, selected innovative methods (e.g. ensemble model selection which represent the entire ensemble's spread) and tools (e.g. web atlas) will be shown.

On the pan-European level this research is also linked to the Europe-Chapter from AR5, IPCC, which assesses evidence of climate change in a regional chapter and therefore could describe impacts across sectors and identify interactions between impacts. Regional information on climate, vulnerability and adaptation strategies are also major topics. The cross-sectoral decision making which is required to address climate change is reviewed in the Chapter. The main findings of the Europe chapter of WG II IPCC AR5 will be presented.

O-2205-01

Projected changes in drought at 4C and 2C of global warming: Impact of mitigation on regional drought hotspots

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We use the CMIP5 data from historical and RCP8.5 simulations to complete a multi-model assessment of changes in regional patterns of warming and precipitation changes at 4oC and 2oC of global warming. Inter-model agreement of projected changes in magnitude and sign of annual and seasonal precipitation has been calculated to illustrate the patterns of change in hydrological cycle. In addition projected changes in precipitation have been used to derive a meteorological drought using the Standardized Precipitation Index (SPI).

Analysis of multi-model distribution of SPI during the 21st Century show progressive increase in frequency of wet events in high-to mid-latitudes and increased frequency of droughts over large parts of Australia, Africa, south-east Asia, southern Europe, the Middle East and Northern and Southern Americas. Using this data we identified a key hotspot with extreme drought (SPI<-2) and computed regional statistics of drought frequencies at 4oC and 2oC in order to illustrate the regional benefits of climate mitigation. In addition we have completed regional analysis of join distribution of precipitation and temperature changes at 4oC and 2oC using standardized precipitation and standardized temperature index. We will also show results of analysis focusing on hemispheric contrast in SPI drought distribution during the 21st Century.

O-2205-02

Projection of Heat Waves over China under Different Global Warming Targets

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Global warming targets, which are determined in terms of global mean temperature increases relative to pre-industrial temperature levels, have been one of the heated issues recently. And the climate change (especially climate extremes) and its impacts under different targets have been paid extensive concerns. In this study,evaluation and projection of heat waves in China were carried out by twelve CMIP5 global climate models (GCMs). In evaluating the ability of GCMs, a new daily observed gridded dataset CN05.1 (0.5°×0.5°) was also used. And four indices (heat waves frequency, longest heat waves duration, heat waves days and high temperature days) were adopted to analyze the heat waves. Compared with the observations, the twelve GCMs and their multi-model ensemble (MME) have a remarkable capacity of reproducing the spatial and temporal characteristics of heat waves. The time correlation coefficients between MME and the observation results can all reach 0.01 significant levels. Based on the projection data of twelve GCMs, both the median year of crossing 1.5°C, 2°C, 2.5°C, 3°C, 3.5°C, 4°C, 4.5°C and 5°C global warming targets and the corresponding climate change over China were analyzed under RCP 4.5 and RCP 8.5 scenarios, respectively. The results show that when the global mean surface air temperature rise to different targets with respect to the pre-industrial times (1861-1880), the frequency and intensity of heat waves will increase dramatically.To take the high emission scenario RCP8.5 as an example, under the RCP8.5 scenario, the warming rate over China is stronger than that over the globe, the temperature rise(median year) over China projected by MME are 1.82°C(2023), 2.48°C(2038), 3.23°C(2049), 3.93°C(2059), 4.59°C(2069), 5.29°C(2079) and 5.97°C(2088) under 1.5°C, 2°C, 2.5°C, 3°C, 3.5°C, 4°C and 4.5°C global warming targets, respectively. With the increase of the global warming targets, the difference between global and China's temperature rise increases gradually. The linear trends of regional mean heat waves number, longest heat waves duration, heat waves days and high temperature days over China are 0.9 times/°C, 2.7days/°C, 8.0 days/°C and 7.2days/°C with the enhancement of global warming targets.It is noteworthy that the increase rate of heat waves indices under the latter global warming target relative to the former one is expected to decrease sharply as the global mean temperature rise increases from 2.5°C to 3°C. For example,the increase rates of longest heat waves duration under 2°C, 2.5°C, 3°C, 3.5°C, 4°C, 4.5°C and 5°C global warming targets are 45.77 %, 37.37%, 22.91%, 27.51%, 16.60%, 24.55% and 25.64 % , in relation to that under 1.5°C, 2°C, 2.5°C, 3°C, 3.5°C, 4°C and 4.5°C target respectively. Moreover,the areas with severe heat waves occurring display a vast expansion correspondingly.For example, the percentage of area with annual longest heat waves duration longer than 12 days will increase from 0.27% under a 2°C target to about 42.75% under a 5°C target. The percentage of area with annual heat waves days more than 30 days will increase from 0.45% under a 2°C target to about 49.64% under a 5°C target.

O-2205-03

Impacts of a global 2 degrees C climate change upon European air quality

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Several policy statements, including the 2009 Copenhagen Accord, stated that global temperature rise should be held below 2 degrees C above pre-industrial levels in order to limit the impacts of climate change. In this context, the impacts of 2-degree increase in temperature have been analyzed in the European project IMPACT2C. The objective of the present study is to evaluate how these changes will have an impact on European air quality and will potentially affect human health, using four offline atmospheric chemistry transport models. The first step was to perform air quality simulations for the current climate, using two sets of meteorological forcings for each model: reanalysis of past observation data and global climate model output. The differences between the simulations allow to evaluate how global climate models modify climate hindcast by boundary conditions inputs. Among others, we analyze whether the chemical composition of PM is affected by the use of climate models. We then investigate the contributions of the changes in meteorological parameters (precipitation, temperature, boundary layer height, etc) on surface primary and secondary compounds of PM (Lacressonnière et al., under review). For the future scenarios, the time period that corresponds to a 2-degree C global warming, such as predicted from climate simulations using RCP4.5 scenario, was run; this time period varies depending on which global climate model is used. We separately calculate the effects of climate change and emission reduction scenarios, and show that the fate of European air pollution is primarily controlled by emission reductions. A 2-degree C global warming will not hinder beneficial effects of air quality legislation, albeit inducing small changes in ozone and particulate matter changes. We then evaluate the uncertainty associated to the air quality projection under regional climate change, with a focus on annual PM2.5 and SOMO35, two indicators commonly used for health assessments (Lacressonnière et al., under preparation). We assess the robustness/uncertainty of model predictions, by comparing the inter-model spread to the climate change signals. Our results highlight that the inter-model variability is mainly due to differences in regional climate projections, affecting several meteorological parameters, which are crucial for air quality. Beyond the model uncertainty, climate penalty or benefit have been made evident over different European areas. The use of four different models, and additional uncertainty evaluations, make our study one of the most comprehensive ones up to date to assess the impact of regional climate change on air quality and health.

O-2205-04

Studying the climate change impact at 2 degree warming on Water Resources for the island of Crete: A cross-sectoral approach

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Ensemble pan-European projections under a 2°C global warming relative to preindustrial period reveal a more intense warming in south Eastern Europe by up to +3°C indicating that impacts of climate change will fall disproportionately on certain regions. The Mediterranean is projected as one of the most vulnerable areas to climatic and anthropogenic changes with decreasing rainfall trends and a continual gradual warming leading to a progressive decline in the average stream flow. Many Mediterranean regions are currently experiencing high to severe water stress induced by human and climate drivers. Changes in average climate conditions will increase this stress notably because of a 30-50% decline in freshwater resources. For small island states, where accessibility to freshwater resources is limited the impact will be more pronounced. Here we use a generalized cross-sectoral framework to assess the impact of climatic and socioeconomic futures on the water resources of an Eastern Mediterranean island. Crete, the fifth largest Mediterranean island covers more than 6% of Greece with an area over 8,000 square km. Total water use is estimated to be about 420 million cubic meters (6.3% of total precipitation). The majority of the water use (over 80%) is used for irrigation while the rest is distributed to other uses such as domestic, tourist, and industrial uses. A set of representative regional climate models simulations from the ENSEMBLES and EURO-CORDEX initiative driven by different RCP2.6, RCP 4.5, A1B and RCP8.5 GCMs were used to form a comparable set of results and a useful basis for the assessment of uncertainties related to impacts of 2 degrees warming and above. A generalized framework of a cross-sectoral water resources analysis was developed in collaboration with the local water authority exploring and costing adaptation measures associated with a set of socioeconomic pathways (SSPs). Transient hydrological modeling was performed to describe the projected hydro-climatological regime and water availability for each warming level. The robust signal of less precipitation and higher temperatures that is projected by climate simulations results to a severe decrease of local water resources. Adaptation to water scarcity includes a group of measures ranging from soft measures to infrastructure investments for achieving safe and secure water futures.

2205-POSTER PRESENTATIONS

P-2205-01

Carbon Sink in the Timbered Biomass for Mountainous Tropical Wildlife Reserve using Geospatial Approach

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Carbon storage and biomass sequestration are the two important terms that come across when it is talked about our forest or plant ecosystem. It has been found that very little research had been conducted on the potential of carbon storage in trees of the region having low rainfall. Here Remote Sensing can play a vital and useful role by its vast usage in ecological application as it is quick, accurate, cost-effective as well as a time effective method for vegetation cover mapping and modeling. In this study the objective was to quantify the above ground biomass accumulation and carbon storages in the various species found in Ranthambore Tiger Reserve. For this purpose the satellite data of LISS III (2014) is used giving precise information of vegetation through reflectance value. For assessing the carbon sequestration potential of plantations, individual above ground biomass models were developed and scaled to stand level. Thereafter the carbon content of the different layer of soil was assessed in sample plots. The result shows that the total amount of carbon stored in by Anogeissus pendula is higher than that stored by the other three forest type. The result also showed that the carbon storage is higher in thorn as compared to the deciduous trees in the region of low rainfall.

P-2205-02

The 2°C global warming threshold and associated hydrological changes over France

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The Copenhagen Agreement states that the global temperature should increase less than 2°C to prevent dangerous changes on the climate system. The 2°C threshold offer to climate scientists an easy way to communicate and present their results close to policy decisions and meaningful for the public. However, it hides strong differences and uncertainties at a regional scale. This study focuses on impacts of the 2°C level and above on the continental hydrological cycle over France.

An ensemble of Global Climate Models (GCMs) simulations from the Coupled Model Intercomparison Phase 5 (CMIP5) is downscaled with a statistical method developed in a previous study (Dayon et al. 2015). Atmospheric variables obtained on a 8 km grid over France are used to drive the Isba-Modcou hydrological system developed at Météo France and Mines Paris-Tech. Isba is a land surface model that calculates the energy and surface water budgets. Modcou is a hydrogeological model that routes the surface runoff given by Isba and computes aquifers and river flow evolution.

Future impacts of climate change on the hydrological cycle of the main French rivers basins are evaluated as a function of global temperature warming. The respective importance of uncertainties from the internal climate variability and climate models is adressed thanks to large ensemble of simulations used in the study. Hydrological changes are also compared among the Radiative Concentration Pathway (RCP, mainly RCP4.5 and RCP8.5) to ensure the independence of results to emission scenarios.

Finally, based on a large ensemble of simulations on the historical period (28) and long-term river flow observations, future hydrological changes are put into perspective with past hydrological variability. Those elements will might allow to reach a conclusion on the meaning of the 2°C global warming threshold for hydrological changes over France.

References :

Dayon et al. (2015), Transferability in the future climate of a statistical downscaling method for precipitation in France, Journal of Geophysical Research : Atmosphere.

P-2205-03

Climate change will impact carbon balance of old-growth temperate rainforests of southern South America

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Understanding how forests might respond to climate change is important because of their role in storing and sequestering carbon, sustaining biodiversity, and providing ecosystem goods and services. There is a growing body of evidence indicating that ecological effects of climate change on forests are apparent and may vary among regions of the world. Little is known about future changes that climate change could exert on temperate rainforests of southern South America (SSA). Here, I present results of a process-based, dynamic forest model. The model integrates climatic variability and allows projecting forest responses to climate change in this region. Using the developed model, I projected potential futures for temperate rainforests of SSA given likely climate change scenarios. I focused on primary, old-growth temperate rainforests of SSA located on Chiloe Island (-42°S, Chile). Drier climate predicted for this century will alter forest

structure, leading to decreases in above ground biomass by 27% of the current value. Compared to current climate, mean net primary production will be reduced in ~30% for year 2100 (from 7.6 to 2.4 tC ha/year). As a result of warming alone, i.e. without accounting for the direct effects of carbon dioxide, temperate rainforests in SSA will become sources of carbon during this century (average among forest stands of -3.7 tonnes of carbon -tC- ha/year in 2100). These results inform the debate about forests responses to future climate in SSA. Future research should focus in developing experimental and long-term monitoring still not available in this region. In the meantime, models provide a useful synthesis of current knowledge that allows exploring these and other additional effects of global change on hitherto overlooked regions of the world, such as southern temperate rainforests

P-2205-04

Seepage Processes in Permafrost near a Hydro Unit in a Changing Climate

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Regular water and energy supply in permafrost areas are vitally important conditions for inhabitants of the large North territories of Russia, Canada, US and Alpine areas of China. Dam and flank shore stability is the key point for safety of reservoir (power pool, water supply, tailing pit, etc.). In permafrost areas stability of many engineering structures, including hydraulic work, associated with thawing - freezing process. Emergency situation of the unit we have when seepage occurs in originated permeable talik zone adjoining to reservoir. We present original results of long-term geophysical study on hydro technical objects of Western Yakutia analyzing problems associated with use of geophysical methods for the study of rocks in permafrost area. The primal problems of studies were focused to I) eliciting and checking of a position of talik zones and places of filtering of water in a body of foundation and coastal contiguity of Sytikan dam and Vilui HPS (constructing and operating reservoirs) dams; II) estimation of dynamics of seepage progressing processes for a development of a complex of measures, directional on exception of losses of water from reservoir and supply of stability of a body of a dam. Due to a difficult and hardly predictable geocryological situation in this area, the geophysical methods were included into the system of local monitoring. From ground-level methods of studies in composition of operations were included high frequency electric profiling, electric profiling on a method of a natural field, georadar, seismic profiling and seismic sounding. Down-hole observations on dams included long-term regime temperature measurements and complex of logging studies (resistance, flow meter survey, gamma logging, neutron gamma logging, caliper measurement, radio wave cross-borehole testing). On the ground of geophysical studies the detailed geological section was studied and the binding of seepage spacing to definite lithologic horizons was established. The purpose of geophysical investigations was, first, to control the thawing of frozen rock (talik) within the coastal zone of the reservoir and to assess the dynamics of the process, and second, to identify and to locate places of the most intensive thawing and filtration of water from the reservoir. Alongside field studies, numerical evaluation of permeable talik zone (thawing) origination and development in a broad zone around a dam was made. The non-steady problem of heat-mass transfer in fractured-porous saturated frozen media, interbedded in frozen impermeable strata is discussed. The model takes into consideration the main conditions causing initiation and development of talik near a reservoir: annual temperature and snow cover variation, seasonal water temperature distribution with depth in the storage basin adjacent to the dam and evolution of permeability in rock due to thaw-freeze processes. The results of 2D heat-mass transfer modeling indicate that the development of talik formation depends on the specific thermal and hydraulic material parameters, thickness of the frozen layer covering talik and winter snow blanket insulating ground rocks, seasonal and global temperature trend as well as of presence of fractures in frozen rocks. It seems that proposed model can be used to analyze situations like rapid drainage of ice-rich permafrost-dammed lakes, Alpine frozen slope instability as well as the role of global temperature change influence on a system "ice-rich permafrost-aquifer".

P-2205-05

The Challenges of Communicating Unwelcome Climate Messages

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As a recent report on communication of climate science has noted, '[t]here is widespread public acceptance of the reality of climate change, but not of the urgency and scale of the challenges that the science indicates it represents' (UCL 2014: 14). This discrepancy, the report suggests, derives from psychological factors and from cues from influential elites and the media. Communication efforts based on the linear-rational model have failed sufficiently to motivate either publics or political decision makers. Better engagement of policymakers and society more generally with climate scientists and other experts, to evaluate scientific evidence and determine adaptive responses, requires new narratives to be found. With the probability that global temperature rise can be kept below the 2oC target continuing to diminish, the urgency of this task increases. How best to engage individual citizens and organisations with the kind of knowledge about the likelihood and implications of severe future impacts that few want to hear becomes an acute issue. How can adaptive responses be encouraged - by individuals, organisations and policymakers - rather than denial, fatalism and withdrawal?

This paper presents the findings of a workshop organised to bring together climate scientists, social scientists, policymakers, consultants, communications specialists, psychologists, the private sector, the media and artists etc., to wrestle with the challenges of communicating findings from research into high impact scenarios, in a world where the 2 degrees limit is increasingly in doubt. As well as 'the public', the paper considers how best to engage with other audiences, including infrastructure planners who may not yet be in the habit of 'climate proofing' particular investments, and politicians and policy makers who would prefer to ignore the full, transformative implications of the climate crisis. It also reflects on the need to move discussion beyond the narrow framings offered by the geosciences, which tend to provide legitimacy and credibility to catastrophic framings that reinforces the message of climate change as 'an unfolding, almost predetermined, disaster' (O'Neill et al. 2010: 1000), to incorporate insights from a wider set of disciplines.

O'Neill, S.J., Hulme, M., Turnpenny, J. and Screen, J. (2010), 'Disciplines, geography and gender in the framing of climate change', Bulletin of the American Meteorological Society, 91, pp. 997-1002.

UCL (2014). Time for Change? Climate Science Reconsidered. The Report of the UCL Policy Commission on Communicating Climate Science.

P-2205-06

How significant is the climate impact of Black Carbon?

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Mitigation of Black Carbon (BC) aerosol emissions is an attractive policy option, due to co-benefits on climate and air quality. However the climate impact of present day BC emissions is not well constrained.

BC interacts with the climate directly, through absorption and scattering of incoming sunlight; indirectly, through modification of cloud properties; and semidirectly, through changes to atmospheric stability. To gauge the net effect of BC, these processes need to be well understood and coherently treated. Regional emissions of BC, and how it ages and is transported in the atmosphere, must also be known.

Since the publication of the IPCC AR5, several studies have indicated that the atmospheric lifetime of BC may be overestimated in present climate models. Through comparisons of flight measurement data with model calculations, both geographically and vertically, we show how models tend to overestimate BC concentrations

aloft, where it has the strongest direct radiative forcing efficiency.

Other studies have improved our understanding of the semidirect effect of BC, which tends to counterbalance the positive BC direct radiative forcing. We show the vertical dependence of direct, semidirect and net BC forcing efficiency, and illustrate how the interaction of the direct and semidirect effects can lead to a virtually unchanged net BC forcing even for a doubling of emissions.

Based on these recent results, we here present an updated, holistic view of the present and historical climate impact of BC. We present policy relevant values of BC impact metrics, i.e. its radiative forcing per gram of emission, constrained by recent observations. We also argue that while further work is needed to constrain all mechanisms of BC-climate interactions, present emission inventories remain a dominating source of uncertainty in BC climate forcing.

In conclusion, we argue that the climate impact of BC may be lower than has been assumed in recent assessments. While its impact on air quality is clear, this makes BC less attractive for use in climate mitigation policy.

P-2205-07

Water Quality Index for the Evaluation of Irrigation Water Quality and its Impact on Climate using MODIS Sensors' Based MOD13A1-NDVI Data

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Ground water quality has reflective outcome on crop yield potential in semi-arid zones. Water can be poor quality due to salinity it contains as impurities present. Excessive salinity of irrigation water leads to interdiction of crop growth while smaller concentration of salt abates the water infiltration process. Water quality index has an ultimate goal for obtaining maximum production per unit of available water supply along with significance for remedy of domestic, industrial and irrigation water supply. Natural water body's response environmental conditions which have been studied by scientists for identify sources and fates of contaminates. Water Quality Information Center provides electronic access to information on water quality and agriculture. The most important water quality directive on crop yield efficiency is the water salinity hazard as measured by electrical conductivity (ECw). The high ECw generally leads to physiological drought. The higher the EC, the less water is available to plants, even though the soil may appear wet. Geospatial technology plays a vital role in geospatial data acquisition of the water quality index at local, regional, and global scale. The advantage of Remote Sensing and GIS is that it helps in getting wide area observation, periodical and continuous measurement, and availability of digital data for processing standardization. This research paper focuses to assess the water quality for irrigation practices. The data of MOD13A1-NDVI (A Moderate-Resolution Imaging Spectroradiometer derived 16 day composite normalized difference vegetation index product, with spatial resolution of 500 m). (September, 2013) was used in GIS frame. Geospatial technology helps in getting spatial distribution of chemical parameters using inverse-distance weighted and modified Shepard's method for spatial interpolation. This research paper illustrate statistical multiplication of water quality in terms of suitability index using pH, total dissolve solid, total hardness, alkalinity, sodium, chloride, nitrate, electric conductivity, and express the impact of water quality on regional crop yield. Higher water quality index depicts the best appropriateness for irrigation practices. In order to strengthen the crop productivity, we have suggested the diversified triple-based cropping systems with satellite mounted sensor derived NDVI products shown in Figure 1 as a holistic and feasible monitoring approach.

P-2205-08

The Effect of Climate Change on Cocoa Production in Ekiti and Ondo States of Nigeria: A Co-Integration Analysis

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The study examined whether or not there is short run and long run equilibrium relationship between cocoa output and climate change variables (i.e. Rainfall, Temperature and Humidity). This is to ascertain the effect of climate change on cocoa output both in the short run and long run in the study area. The short run was considered to be within the period of 1971-1990 and 1990-2010, while the long run was considered to be within the period of 1971-2010. It was established at the long run that cocoa output and rainfall were non-stationary among the three selected climate change determinants (i.e. Rainfall, Humidity and Temperature.). In the long run, both at 1% and 5% level of significance, their absolute values were greater than the critical values (i.e. for cocoa;-2.855384>-3.610453 & -2.938987 and for rainfall; -1.591781>-3.610453 &-2.938987). Also, the co-integration test was carried out in the long run; the trace statistic test revealed that at both 1% and 5% level of significance 2 and 1 equations were co-integrated. The Max-Eigen values also revealed that at both 1% and 5% levels of significance, that at most 2 and 1 equations were co-integrated, since their absolute values 25.27>15.41 and 20.04; 20.61>14.07 and 18.63,. This corroborated the trace statistics, therefore, it was concluded that there is a long run equilibrium relationship between cocoa output and rainfall. The results established the fact that cocoa is highly susceptible to drought and the pattern of cropping of cocoa is related to rainfall distribution in the study area. Therefore, the study recommended that drought management policy through information systems about changing climate conditions and patterns, preparatory practices and options to deal with eventuality of drought must be set in place.The study examined whether or not there is short run and long run equilibrium relationship between cocoa output and climate change variables (i.e. Rainfall, Temperature and Humidity). This is to ascertain the effect of climate change on cocoa output both in the short run and long run in the study area. The short run was considered to be within the period of 1971-1990 and 1990-2010, while the long run was considered to be within the period of 1971-2010. It was established at the long run that cocoa output and rainfall were non-stationary among the three selected climate change determinants (i.e. Rainfall, Humidity and Temperature.). In the long run, both at 1% and 5% level of significance, their absolute values were greater than the critical values (i.e. for cocoa;-2.855384>-3.610453 & -2.938987 and for rainfall; -1.591781>-3.610453 &-2.938987). Also, the co-integration test was carried out in the long run; the trace statistic test revealed that at both 1% and 5% level of significance 2 and 1 equations were co-integrated. The Max-Eigen values also revealed that at both 1% and 5% levels of significance, that at most 2 and 1 equations were co-integrated, since their absolute values 25.27>15.41 and 20.04; 20.61>14.07 and 18.63,. This corroborated the trace statistics, therefore, it was concluded that there is a long run equilibrium relationship between cocoa output and rainfall. The results established the fact that cocoa is highly susceptible to drought and the pattern of cropping of cocoa is related to rainfall distribution in the study area. Therefore, the study recommended that drought management policy through information systems about changing climate conditions and patterns, preparatory practices and options to deal with eventuality of drought must be set in place.

P-2205-09

An integrated approach for assessing climate change impacts on the European electricity sector

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Due to the development of new technologies and the necessity for reducing greenhouse gases emissions, the electricity sector is expected to hold a large share in the future energy activity sector. However, this sector is vulnerable to changes in climate in several aspects both on the supply and demand sides, which may affect the supply-demand balance. On the supply side, wind power generation could be affected by changes in surface layer

wind speed, solar power by changes in solar irradiance and temperature, alteration of the hydrological cycle with temperature increase could impact both the potential for hydropower and the availability of cooling water for thermo-electric power plants. On the demand side, temperature increase will reduce electricity demands for heating while the use of air-conditioning is expected to increase. This study aims at investigating the potential impacts of climate change on the European electricity sector by integrating the different effects of changes in climate variables on wind and solar photovoltaïc power, thermo-electric and hydropower supply along with the effects on electricity demand. Climate information is taken from a multi-model ensemble of high-resolution regional climate model projections (CORDEX) over Europe. Impact models are then used to compute changes in power generation and demand due to changes in climate variables. Several electricity mixes are considered (current mix, contrasted mix scenarios). The assessment is conducted for a +2°C and a +3°C global warming to quantify the impact of climate change limited or not to the +2°C target.

This study has been carried out in the framework of the European FP7 project IMPACT2C.

P-2205-10

Space-time distribution of China's water resources under the global climate change

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The water resource is the basic proposition of agricultural and industrial development in China because of our big population. It is noteworthy that what climate change will effect on Chinese future water resource. The influence of climate change includes precipitation and evaporation, of which the former is more discussed and the latter is readily ignored. This article is based on the regional climate model (RegCM4) which is developed by NCAR/PSU(National Center of Aatmospheric Research/University of Pennsylvania). We made a simulation to estimate the future climate change in China with A1B scenario. And got the spatial distribution characteristics of temperature and precipitation in historical period (1981-2000 average annual value) and future period(2041-2060 average annual value). The P-M evapotranspiration model recommended by the FAO is used to calculate the evaporation. And the moist degree is used as the index of water resources. In general, the results showed that water resources in China present latitude zonal distribution, gradually reduce form south to north. From the trend of the change, the water resources in the south of Yangtze river will decrease in the future, on the other hand, in the north of Yangtze river , especially in the north of the Huai-he river , the water resources condition will get better. The most obvious regions for the growth of water resources include the western of northeast China ,Huai-he river basin, Si-chuan province and the south of Tibetan autonomous region.

P-2205-11

Better Representation of Climate Change Impacts from Multi-model Ensembles

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We present an innovative application of intelligent computing that constrains simulations of river discharge from an ensemble of multiple global hydrological models (GHMs) against observations for 110 large catchments across the globe to provide a single estimate of discharge that is both more robust and better informed than more traditional, simplistic techniques such as the ensemble mean. The approach uses evolutionary algorithms (EAs) through symbolic regression (SR) to develop catchment-specific multi-model combination (MMC) solutions that combine simulated discharge values from seven GHMs participating in ISI-MIP1 (Inter-sectoral Impact Model Intercomparison Project). The MMC algorithms are optimised by evaluating individual models (GHMs) performance against observations and then weighting and/or discounting GHMs accordingly in the MMC. In addition, the performance of the ensemble mean in simulating the observations is explored. A numerical integrated metric, ideal point error (IPE) with the privilege of assessing different behavioural aspects of the models simultaneously, is used to measure the performance of GHMs, MMC technique and ensemble mean approaches. Comparisons between simulated and observed discharge show that the optimised MMC algorithms can outperform the simulations of discharge from the best performing GHMs by reducing simulation error up to a magnitude of 30%. The MMC technique also outperforms the ensemble mean method in virtually all of the 110 catchments. Our analyses demonstrates the value of evaluating climate change impact model performance and using the results to provide indicators of hydrological change from multi-model ensembles that are more informative than traditional ensemble averaging techniques.

2206 - The World in 2050 – What does it look like and how do we get

ORAL PRESENTATIONS

K-2206-01

The Sustainable Development Pathway

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The world has several partial pathways towards sustainable development that cover specific areas, such as agriculture or climate change. Yet, we do not have an integrated pathway that demonstrates how the economic, social, and environmental imperatives of sustainable development can be achieved in harmony with one another. Such a pathway would inter alia have to stay within global "planetary boundaries", allow all countries to meet national development objectives, and maintain social inclusion. Moreover, a global pathway will need to be downscaled to major regions and demonstrate that every region can achieve sustainable development.

Working with my collaborators on "The World in 2050" we will partner with major modeling organizations to establish an integrated sustainable development pathway. We will use the Sustainable Development Goals proposed by member states of the United Nations as a shorthand form of objectives for sustainable development.

This presentation will focus on the economics of sustainable development. A key research question is how mid- to longer-term economic models can incorporate the SDGs. This will be illustrated using a few examples from the emerging research.

K-2206-02

The World in 2050

J. Rockström (1)
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One of the most pressing issues facing the global community post 2015 is how to realize the benefits of future global economic development within a safe and just operating space of a stable planet.

The World in 2050 Project will explore the implications of the necessary transformative sustainable development pathways and the possible 'degrees of freedom' to meet economic development goals within a safe operating space of a stable planet.

The project will generate the 1st generation of global scenarios that meet the twin objectives of economic growth and planetary stability and thus provide improved evidence, including macro-economic assessments, to political leaders in the SDG process, and other key decision makers, on the feasibility, challenges and opportunities associated with meeting long-term development goals, i.e., development goals that are truly sustainable at a global scale.

K-2206-03

Beyond Paris to 2050 and thereafter - multiple benefits of a global transformation toward sustainable futures

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An objective of The World in 2050 Initiative is to explore the transformative development pathways at the global and regional scales that achieve convergent economic and social development within planetary boundaries. The presentation will focus on the main drivers of the transformation, their relationships including some of the Sustainable Development Goals (SDGs) and their targets, on policy measures, and on technological and social changes that would be needed for achieving the transformation toward the "safe and just space" that characterizes sustainable futures.

An important research question is how high are the degrees of freedom in achieving this transformation, what are the prerequisites and implications. In other words, are there multiple transformative pathways especially at regional levels. For example, Global Energy Assessment (GEA) developed 41 transformative energy pathways toward sustainable energy futures that included universal access to energy services for all, improvements in energy efficiency and decarbonization needed to stabilize climate change at two degrees Celsius above pre-industrial levels. Energy is one of the SDGs, but the challenge is to assess to what extent different SDGs, such as energy and water, can enhance each other and to what extent tradeoffs will be required in achieving different SDGs.

Finally, the presentation will conclude by assessing multiple benefits and opportunities that would emerge from the transformative changes toward sustainable futures. A key question to explore is the potential for achieving co-benefits and/or trade-offs of addressing multiple SDGs at the same time, which can provide critical information for policy and investment decisions, their synergies and possible conflicts among them.

K-2206-04

The World in 2050 – the contribution of model-based scenarios

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In 2012, governments worldwide renewed their commitments to a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems, and initiated a process to create a long-term agenda of action by formulating Sustainable Development Goals (SDGs). These SDGs will be agreed upon in 2015. Studies that depict pathways that relate near-term actions and a long-term vision could help implementing the SDGs by 1) providing a link between the 2030 SDG targets and an inspirational vision about a sustainable world in 2050 to a medium-term set of sustainable development goals (say by 2025 or 2030), 2) exploring what efforts would be needed to realize the goals and 3) providing information on the inter-linkages (synergies and trade-offs) between the achievement of the goals.

Integrated assessment models have been used extensively in the last few years to develop model-based scenarios to depict possible future trajectories with respect to human development and environmental consequences. They have also been used to develop scenarios that achieve certain future goals (e.g. the 2oC climate target). Most of these studies have looked into specific topics, but there has also been studies that took a broader set of goals comprising both environment and development targets such as the Global Energy Assessment, the Global Environmental Outlook and the study "Roads from Rio+20". Overall, these studies have shown that it is possible to achieve an ambitious set of sustainable development targets simultaneously. However, this will require fundamental changes in the energy and food system. There are also important synergies and trade-offs between different objectives that depend on the specific strategy that is used to achieve them (e.g. specific technologies, different types of management and the role of lifestyle changes).

In the proposed presentation, we will discuss how integrated assessment models can provide further insights into the question how to achieve the a set of sustainable development objectives (including the SDGs) in the 2030 / 2050 period, among others by using specific examples from existing studies. We will also discuss how the Shared Socio-Economic Pathways (SSPs) can be used within the context of such an exercise.

2207 - Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems

ORAL PRESENTATIONS

K-2207-01

Ecological challenges for life in a rapidly changing ocean

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Ocean warming and acidification share the same primary cause, which is the increase in atmospheric CO2. The fossil record indicates that the rate and magnitude of the present, human-generated carbon perturbation leads to changes potentially unparalleled in the last 300 My of Earth history. Ocean warming and acidification are two key global environmental drivers that challenge marine organisms and ecosystems. Responses can be influenced, often exacerbated by other drivers, such as hypoxia, eutrophication, habitat loss and overexploitation of resources.

A large range of approaches are used to assess the present impacts and project future risks: paleo-observations,

observations in natural gradients and around CO2 vents, perturbation experiments in the laboratory and in the field, as well as modelling. All approaches indicate that the effects of ocean warming and acidification on individual organisms are or will be widespread, and that they propagate at the ecosystem level. Warming induces shifts in the abundance, geographic distribution, migration patterns, and timing of seasonal activities of species, generating changes in the composition of ecosystems. Such distributional shifts will continue in the coming decades, increasing species richness at mid- and high latitudes and decreasing it at tropical latitudes. This will result in a global redistribution of catch potential for fishes and invertebrates, with implications for food security. A wide range of sensitivities to projected rates of ocean acidification exists within and across diverse groups of organisms, with a trend for greater sensitivity in early life stages. A pattern of positive and negative impacts emerges. The rate of calcification decreases in most, but not all, sea floor calcifiers such as reef-building corals, coralline algae, bivalves, and gastropods, reducing the competitiveness with non-calcifiers. The combined effects of ocean warming and acidification have resulted and will further result in changing interactions between species, including competition, predation and pathogen dynamics.

A considerable number of biological, chemical, and physical processes act at enormous ranges of space and time scales to control ecosystem properties. Few of these processes and interactions are understood because most studies are short-term, organism-centric and examined just one driver at a time. Gaps in our understanding and uncertainty in future projections therefore remain. Coral reefs are the main ecosystem which already exhibits prominent signs of the impact of climate-related variables but it must be pointed out that seemingly stable ecosystems maintained by feedback mechanisms can be subject to abrupt ecological shifts. Taken together, these observations as well as the fossil record confirm links between ocean warming and acidification and responses of ocean ecosystems. There are no plausible alternatives to immediate, deep reduction of greenhouse gases emissions for limiting future ecological challenges and maintaining ocean services. It should be emphasised that reducing CO2 emissions to address ocean acidification will simultaneously address climate change but reducing emissions of other greenhouse gases to limit warming will not necessarily address ocean acidification.

The Oceans 2015 Initiative comprises 17 experts (D. Allemand, R. Billé, L. Bopp, W. Cheung, M. Colombier, S. R. Cooley, J.-P. Gattuso, O. Hoegh-Guldberg, F. Joos, R. Kelly, D. Laffoley, A. Magnan, H.-O. Pörtner, A. Rogers, T. Spencer, C. Turley and S. Treyer). It is supported by the Prince Albert II of Monaco Fondation, Ocean Acidification International Coordination Centre, and BNP Paribas Foundation.

K-2207-02

Climate change and the Ocean: regional challenges and opportunities

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Earth's ocean plays a central role in its climate, absorbing 93% of the extra heat from the enhanced greenhouse effect, and approximately 30% of the CO2 emitted by the burning of fossil fuels and landuse change. While these contributions play an important role in reducing the rate of change in the average global temperature, they have come at a price in terms of shifts in ocean temperature and chemistry, and consequently a wide range of other key variables such as surface salinity, wind, pH, carbonate chemistry, stratification, ocean currents, nutrient availability, and oxygen content. According to AR5 of the IPCC we are now seeing changes in ocean conditions that are unprecedented, which in the case of ocean acidification, are "unprecedented within the last 65 Ma (high confidence) if not the last 300 Ma (medium confidence)."

These rapid changes within the Ocean are affecting the distribution and abundance of organisms and ecosystems, with important consequences for the goods and services that the Ocean provides to communities and nations worldwide. Fisheries and ocean-related livelihoods play important role in the lives of at least 3 billion people globally, with many nations receiving more than half of the protein requirements from the Ocean. While often overlooked in terms of national accounts, contributions by the ocean to key issues such as food security, employment, health, and coastal protection are large and are only likely to become more important over coming decades. Consequently, understanding the regional challenges posed by a changing ocean is critically important in terms of adaptation challenges and opportunities.

A regional analysis of climate change reveals a range of responses by ocean ecosystems. Recent changes to wind and ocean mixing are influencing the transfer of organic carbon to deep regions, which has had knock-on effect of stimulating microbial respiration and reducing oxygen levels. There is considerable evidence and agreement that fisheries in regions such as the High Latitude Spring Bloom Systems (HLSBS) in the North-Eastern Atlantic are changing in response to warming and ice retreat, with both positive and/or negative implications depending on the particular HLSBS fishery. Other fisheries are relocating at a high rate, placing stress on regional management.

Equatorial upwelling systems (EUS) which support highly productive fisheries off Equatorial Africa and South America, have warmed significantly over the past 60 years. While warming is consistent with changes in upwelling intensity, more work is needed to understand how EUS will change in response to warming over time. The risks, however, a significant given the importance of these changes for ecosystems, fisheries and communities. Coastal ecosystems such as coral reefs mangroves are under significant pressure from climate change, along with local stresses. Elevated sea temperatures are driving impacts such as mass coral bleaching and mortality, with models projecting that coral-dominated reef systems will have disappeared from most regions by 2050. Given that an estimated 500 million people depend on coral reefs for food and livelihoods, addressing this growing source of exposure for some of the least resourced nations must be a priority going forward.

The regional analysis of climate change for ocean systems reveals an important yet poorly understood source of risk and vulnerability for the world's nations. As a consequence, there is a major need to address these information gaps, and pursue otherwise poorly developed adaptation options, especially in terms of building socio-ecological resilience for the large number of exposed nations. Establishing communities of practice, knowledge and solutions platforms, as well as creating an alliance of nations around the challenges posed by a rapidly changing ocean will only grow in importance over the coming decades and century.

The Oceans 2015 Initiative comprises 17 experts (D. Allemand, R. Billé, L. Bopp, W. Cheung, M. Colombier, S. R. Cooley, J.-P. Gattuso, O. Hoegh-Guldberg, F. Joos, R. Kelly, D. Laffoley, A. Magnan, H.-O. Pörtner, A. Rogers, T. Spencer, C. Turley and S. Treyer). It is supported by the Prince Albert II of Monaco Fondation, Ocean Acidification International Coordination Centre, and BNP Paribas Foundation.

O-2207-01

Climate sensitivity across marine domains of life: limits to evolutionary adaptation shape species interactions

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Organisms in all domains, Archaea, Bacteria, and Eukarya will respond to climate change with differential vulnerabilities resulting in shifts in species distribution, coexistence, and interactions. The identification of unifying principles of organism functioning across all domains would facilitate a cause and effect understanding of such changes and their implications for ecosystem shifts. For example, the functional specialization of all organisms in limited temperature ranges leads us to ask for unifying functional reasons. Organisms also specialize in either anoxic or various oxygen ranges, with animals and

plants depending on high oxygen levels. Here, we identify thermal ranges, heat limits of growth, and critically low (hypoxic) oxygen concentrations as proxies of tolerance in a meta-analysis of data available for marine organisms, with special reference to domain-specific limits. For an explanation of the patterns and differences observed, we define and quantify a proxy for organismic complexity across species from all domains. Rising complexity causes heat (and hypoxia) tolerances to decrease from Archaea to Bacteria to uni- and then multicellular Eukarya. Within and across domains, taxon-specific tolerance limits likely reflect ultimate evolutionary limits of its species to acclimatization and adaptation. We hypothesize that rising taxon-specific complexities in structure and function constrain organisms to narrower environmental ranges. Low complexity as in Archaea and some Bacteria provide life options in extreme environments. In the warmest oceans, temperature maxima reach and will surpass the permanent limits to the existence of multicellular animals, plants and unicellular phytoplankter. Smaller, less complex unicellular Eukarya, Bacteria, and Archaea will thus benefit and predominate even more in a future, warmer, and hypoxic ocean.

O-2207-02

Differential synergistic adverse effect of increased sea temperature and acidity on corals

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Global climate change is predicted to affect marine organisms and ecosystems reliant on the accumulation of calcium carbonate structures, as coral reefs, potentially reducing the socioeconomic benefits these habitats provide. In the marine realm, two of the main stressors causing significant changes are ocean warming and ocean acidification.

Projections of future climatic change estimate a 0.6-2.0°C average increase in surface ocean temperature by the end of 2100, posing a major threat for marine organisms. In temperate areas, the effect of warming is expected to be even greater. The Mediterranean Sea is already showing warming rates three times higher than the global ocean. Increased seawater temperature in the Mediterranean Sea has determined longer stratification periods associated with mass mortality events. The first well-documented Mediterranean multispecies mass mortality events were during the summers 1999 and 2003. In both years, a positive correlation was observed between mortality rates and exposure to heat stress, indicating that shallow water corals are living, at least in the North Mediterranean, near their upper thermal limits during summer. Since the frequency of abnormally warm summers is expected to increase in the next century, as a result of climate change, such mortality events in summer may also become more frequent as a direct response to elevated temperatures.

Also ocean acidification is a global phenomenon which impact varies locally. The Mediterranean Sea has experienced a pH decrease of up to 0.14 units since the pre-industrial era, larger than the global average surface ocean pH decrease. Hence, understanding how enhanced acidity has already affected and how it will likely affect Mediterranean Sea ecosystems and their key taxa is urgent and crucial.

Given the projected decrease of seawater pH, the mass mortality events could be exacerbated by the combination of high temperatures and low pH. Studies like this one, assessing the synergistic interaction between low pH and elevated temperatures, are essential to detect possible interactions between multiple stressors and establish to which extent corals inhabiting shallower ranges will be threatened by climate change.

Here we assessed the combined effects of in situ exposure to different acidity and seasonal temperatures on the mortality and growth rates of three Mediterranean scleractinian corals; the solitary zooxanthellate Balanophyllia europaea, the solitary azooxanthellate Leptopsammia pruvoti and the colonial azooxanthellate Astroides calycularis. The corals were transplanted and observed in different seasonal conditions in proximity to a volcanic vent where water is naturally acidified to levels matching different future Intergovernmental Panel on Climate Change scenarios.

The results suggest differential synergistic adverse effects of increased sea temperature and acidity and different levels of resilience/resistance to climate change among temperate coral species, probably related to different modes of nutrition and/or biomineralization processes, making symbiotic species relatively less sensitive due to the increased photosynthesis at high CO2.

Acknowledgements: The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013)/ERC grant agreement n° 249930 - CoralWarm: Corals and global warming: the Mediterranean versus the Red Sea.

O-2207-03

Rising reef carbonate dissolution due to bioeroding microflora under climate change - an overlooked buffer process?

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Since the industrial era, the atmospheric partial pressure of CO2 (pCO2) has been rising. Consequently, the world's ocean is getting warmer and acidified. By the end of the century, IPCC models in the worst case scenario predict an increase of sea surface temperature of 4°C and a decrease of seawater pH estimated at 0.3-0.4 pH-units. As a consequence, the saturation state of surface seawater (Ω) with respect to calcium carbonate minerals (CaCO3) will also decrease. All these climatic factors are expected to affect calcification and dissolution processes, putting for instance in jeopardy coral reef ecosystems which are entirely made of carbonates. Among those processes, biogenic dissolution of carbonates due to bioeroding microflora (or euendoliths), which comprise cyanobacteria, algae and fungi, has been the most overlooked process and is currently not taken into account in biogeochemical models. So far, rates of biogenic dissolution were estimated by quantifying the volume of calcium carbonate removed by bioeroding filaments using microscopy observations. Although those rates are significant (up to 1.1 kg CaCO3 dissolved per m² per year in coral reefs), the question is how much alkalinity bioeroding microflora are able to release in the ocean, and how they are influenced by climate change (pH and temperature). In addition, all experiments recently carried out which highlighted the positive effects of ocean warming and acidification on biogenic dissolution, were realized under controlled conditions (mesocosms) in tropical regions over short periods of time (2-3 months). The long term dynamics of the process of biogenic dissolution under natural conditions remains poorly known. Here we present results of five experiments carried out in tropical (Hawaii, New Caledonia reefs) and temperate regions (Ischia in Italy) at different time scales (a few hours up to 4 years), to show that (1) the amount of alkalinity produced by bioeroding microflora is significant (as high as 71 mequiv m-2 d-1 which converts to a CaCO3 dissolution rate of 1.3 kg m-2 y-1 under constant light conditions in tropical regions), (2) biogenic dissolution can occur under various saturation states ($0.8 < \Omega \leq 5$ both in temperate and tropical regions) and increases under rising pCO2 (by 50% to 250% depending on conditions) as long as the saturation state is above 1 (otherwise carbonate dissolution due to chemical conditions limits euendolith development and thus, biogenic dissolution), and (3)

biogenic dissolution is more efficient (x2.7) when new carbonate substrates become available for colonization by microboring communities in the summer season (higher temperature, light intensities, etc…) than in the winter season in tropical regions as colonization by the main agents of biogenic dissolution is faster in summer than in winter. These results suggest that at least in coral reef systems, global warming and ocean acidification will most probably stimulate the process of carbonate bioegenic dissolution due to microboring flora, accelerating the transition from a net coral reef accretion towards net coral reef dissolution. We estimate that today, at ambient temperature and pH in coral reef ecosystems, at most 20% of produced carbonates are dissolved by bioeroding microflora. By 2100, these organisms may be responsible for the dissolution of up to 70% of reef carbonates that are expected to be produced. If all dissolution processes are taken into account, i.e. chemical dissolution driven by water chemistry and bacteria metabolic activity, biogenic dissolution by bioeroding flora and biogenic dissolution by macroborers (such as boring sponges), reef carbonate budget may become negative much earlier than 2100. The capacity of carbonate biogenic dissolution due to bioeroding flora in buffering seawater remains however, unknown and needs to be investigated in order to better understand carbon biogeochemical cycles and to improve predictions of the fate of carbonate coastal systems.

O-2207-04

From natural science to management: Pteropods as sentinel species for OA waters status assessments

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Pteropods are ubiquitously distributed pelagic marine zooplankton of importance in productive upwelling and high-latitude systems, where they represent an important prey item for variety of economically, ecologically, and culturally important fish species. Because of their extreme sensitivity to ocean acidification (OA) conditions, pteropods can be used to establish cause and effect relationships between OA status and biological condition. As a result, pteropods can be used as a robust bioindicator for use in OA assessment. To demonstrate this utility, newly developed methods were used to determine and quantify pteropod responses in the natural environment. Biological responses, such as shell dissolution, shell calcification, changes in vertical distribution, and survival success were assessed to establish pteropod condition under a variety of OA conditions. We used modelling to estimate population survival rates based on future regional ocean acidification scenarios and to determine the level of sampling required to make confident predictions. We found that pteropods provide a repeatedly quantifiable measure that can be used as a rapid and cost-effective biomarker to monitor biological response to ocean acidification conditions across scales of time and space of relevance to managers.

O-2207-05

Ocean acidification and its relevance to the United Nations Framework Convention on Climate Change in Paris in December 2015

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Ocean acidification is a relatively recently recognised phenomenon, with recognition of its importance growing rapidly over the last few years. It is caused by anthropogenic carbon dioxide emissions and it has the potential for widespread, damaging effects on marine ecosystems that will also impact human society. It therefore must be part of the debate on emissions reduction at the United Nations Framework Convention on Climate Change Conference of the Parties (COP-21) in Paris in December 2015. Ocean acidification brings additional arguments for encouraging national governments to rapidly reduce CO2 emissions and accelerate the transformation to a carbon-free economy, thereby reducing the impact of both climate change and ocean acidification. Emission pathways to stay within the 2oC global warming target are under discussion by nations. However, ocean acidification impacts at the CO2 equivalent of a mean global temperature increase of 2oC would already be substantial for some regions and ecosystems. To bring this important issue fully into the discussion, recognizing that ocean acidification is a major threat to societies worldwide, there would be considerable merit in the UNFCCC process formally embracing the ocean acidification issue in its COP-21 text and post 2015 agenda. Thus the UNFCCC could promote the mitigation of ocean acidification, and adaptation to its impacts, in all relevant policy documents and regulation instruments.

2207-POSTER PRESENTATIONS

P-2207-01

MEAs, Mandates and More - A coordinated regime complex for ocean acidification

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Ocean acidification, a complex global issue, results from the emission of anthropogenic carbon dioxide (CO2) and is exacerbated by a myriad of local stressors. Its consequences are not limited by geography and largely occur in an area of the global commons. It has uneven impacts, results in both ecological winners and losers and has implications for biodiversity, economic stability and sustainable development, with its solutions intimately tied with other global problems. As a result, it is of relevance to many treaties and yet, does not fall neatly within the mandate of any.

It has been suggested that ocean acidification appears to exist in somewhat of a legal twilight zone (Baird et.al. 2009), with no treaty body seemingly willing and able to take on the issue. Kim (2012, p.257) observes that ocean acidification "sits within a very complex institutional landscape, at a rather cracked interface between the climate, biodiversity and oceans regimes." This ambiguity and lack of clarity around the responsibility for addressing ocean acidification within the international policy space is likely to be a contributing factor in the apparent lack of action to mitigate and further respond to ocean acidification (Kim 2012, Herr et.al. 2014). As it currently stands, no single treaty or international instrument has been established to address ocean acidification as a stand-alone issue.

In response to the apparent lack of policy action on ocean acidification, the development of a completely new comprehensive treaty to respond to ocean acidification has been proposed. However, this is unrealistic, as there is likely to be little interest among states to do so. In light of this, this paper offers an alternative path forward by proposing the parsing out of activities needed to respond to ocean acidification across a range of existing multilateral environmental agreements (MEAs), overseen by an umbrella body and thereby forming a coordinated ocean acidification regime complex.

A variety of applicable treaties already exist that could take on elements of a broader coordinated response to ocean acidification. Indeed, a number are already taking action to address ocean acidification within their own institutional capacity. For instance, the Convention on Biological Diversity is well placed to expand monitoring and assessment as well as address issues of biological adaptation; and MARPOL, concerned with issues of ocean dumping, has taken steps to regulate iron fertilisation and other geoengineering schemes. Despite clear concern about ocean acidification these treaty bodies are unable to act further to mitigate OA due to their inability to regulate carbon dioxide emissions. Conversely, the UN Framework Convention on Climate Change (UNFCCC) - the treaty deemed responsible for the regulation of CO2 emissions - is seemingly hamstrung by the lack of mandate to incorporate ocean acidification into its activities. This paper concludes with an examination of the UNFCCC

mandate, and finds that ocean acidification falls within its purview, and hence proposes ways to better incorporate OA across its workings.

P-2207-02

« Bridging the Gap between Ocean Acidification Impacts and Economic Valuation »

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Ocean acidification, is a growing environmental concern. The chemistry and therefore biology of world oceans will be impacted to varying degrees depending on region and type of ecosystem. Ocean acidification, through impacts on marine organisms and ecosystems, has the potential to seriously impact coastal communities and their economies. Communities ranging from mega-cities to subsistence fishing villages differ significantly in population, maritime activity, reliance on marine natural resources and therefore their respective adaptability. Identifying the magnitude and types of impacts ocean acidification will have on communities will become a concern of governments of coastal countries seeking to maintain current marine activities and benefits.

In 2008, the Monaco Declaration (requested by HSH Prince Albert II) advocated for the development of links between economists and scientists in order to better evaluate the socioeconomic impacts of ocean acidification. In line with the Monaco Declaration and in accordance with the wishes of Prince Albert II, an International workshop series - « Bridging the Gap between Ocean Acidification Impacts and Economic Valuation » - was launched by the 'Centre Scientifique de Monaco' and the Environment Laboratories of the IAEA. Three workshops have been organized since 2010 all gathering multidisciplinary international experts, to work on providing recommendations and an appropriate methodology for considering different policy or management options. These workshops resulted in clear conclusions and recommendations for policy makers.

The first workshop (2010) focused on the impacts of ocean acidification on the global economy. For the first time, economists and scientists came together to open the lines of communication and foster cooperation and coordination. The second workshop (2012) focused on impacts of ocean acidification on fisheries and aquaculture in different regions of the world. Social and economic impacts of ocean acidification on livelihoods, commerce and food security were discussed. What are the socio-economic impacts of ocean acidification on coastal communities? The third workshop (2015) discussed impacts on major coastal fisheries and tourism activities, and considered ways to model the cascade of potential impacts of ocean acidification on human activities. The workshop also discussed potential adaptation and capacity-building options and policy responses available to these various sectors and governments. Each of the workshops provided a set of specific recommendations for policy makers on possible mitigation and adaptation measures, and research priorities.

P-2207-03

Response of the Eastern Mediterranean planktonic ecosystem to elevated CO2 and temperature: results from a mesocosm perturbation study

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One of the fastest global changes caused by human activity is the continuing increase in carbon dioxide (CO2) levels in the atmosphere which have now reached over 400 ppm (http://www.esrl.noaa.gov/gmd/ccgg/trends/). Rising atmospheric CO2 is causing global warming and ocean acidification which can independently affect many marine organisms in a variety of marine habitats from tropical to high-latitude ecosystems.

Both acidification and warming are expected to alter the ecology of the Mediterranean Sea, although the evidence to date is sparse. A large scale mesocosm experiment focusing on the study of the simultaneous impact of warming and acidification on the planktonic ecosystem of the Eastern Mediterranean took place from August 30th to September 14th 2013 at the mesocosm facilities of HCMR in Crete, in the framework of the EU funded MedSeA project (www.medsea-project.eu). Natural plankton assemblages were incubated in 3 m3 mesocosms to examine the impact of changes in carbonate chemistry and temperature on biogeochemical variables and processes.

Two different pCO2 levels (present day and predicted for year 2100) were applied in the mesocosms for 2 weeks and tested in two large concrete tanks with different temperatures (ambient seawater: 25°C, ambient+3°C : 28°C). Four triplicates of mesocosms were deployed simulating the conditions of: current temperature and pCO2 (served as Control; C), Ocean Acidification (OA), Warming (W) and Greenhouse (GH).

The control of temperature in the two large tanks was made by means of a heating and cooling system connected to a control unit. Temperature was successfully controlled, exhibiting a nycthemeral variation of less than ± 0.5oC of the target temperature throughout the experimental period. The 'acidified' conditions were achieved by additions of CO2 saturated seawater during three consecutive days at the start of the experiment and then were let to evolve due to biological activity and air/sea exchanges of CO2 till the end of the experiment.

The effect of acidification was evident in the Chla concentration (highly dominated by the pico-sized fraction) and also in the pico-eukaryote density; Chla and pico-eukaryotes increased in both acidified treatments, whereas primary production was likely more dependent on temperature than OA. Bacterial abundance and production were not or only slightly affected by OA. There was also no effect of warming (even combined with acidification) on bacterial abundance; however a slight effect of temperature on bacterial production was observed. Alkaline phosphatase activity showed higher values under warm conditions, while it remained suppressed at lower levels in the GH mesocosms. No significant differences were measured for the phosphate turnover time between treatments, while the turnover times suggest P deficiency in all treatments for the duration of the experiment. P-uptake from different size fractions also showed no notable changes between treatments and experimental days. However, there was some indication of enhanced nitrogen fixation under warming conditions. Copepod (eggs & Nauplii) production (CP) varied significantly with time during the experiment. Acidification had no clear effect on CP, whereas acidification and warming resulted in a significant decline of CP and this decrease was higher than that observed at the warming conditions only.

The overall mesocosm experiment results showed that, for CO2 conditions forecasted for the end of this century, the pelagic ecosystem in the eastern Mediterranean Sea will prove resilient to increases in the ocean acidification. However, the warming will have a more important effect than acidification; and will enhance the effect of acidification on pelagic ecosystem functioning. The results obtained will help to gain insight on the dynamics and trophic efficiency of the food web under increased CO2 levels and temperature and may allow better predictions of the overall effect of ocean acidification and warming on the functioning of marine ecosystems.

P-2207-04

Ocean Acidification: Global Issue, Local Effects

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Ocean acidification is a global problem already impacting our coasts and oceans at scales that span from individual species to ecosystems to indigenous communities to human industry such as aquaculture. Efforts are underway at several scales to observe ocean acidification and its effects on biological organisms. In this talk we present the Global Ocean Acidification Observing Network (GOA-ON), as well as how national, regional and local networks can integrate within GOA-ON. The major characteristics of GOA-ON will be presented, including how this international network is interoperable with observing networks on smaller scales. As an example, we present data from the Pacific Northwest United States and observed impacts on shellfish growth and pteropods. Programs from the states of Washington and Oregon and from the United States are being synergized to afford better observing and communication of these data in near real-time. This effort seeks to optimize interoperability and sharing of data. These contributions nest within GOA-ON and help to define our global status based on the mosaic of local views.

P-2207-05

Projected changes, climate change signal, and uncertainties in the CMIP5-based projections of ocean surface wave heights

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Ocean surface waves can be major hazards in coastal and offshore activities. However, wave observations are available only at limited locations and cover only the recent few decades. Also, there exists very limited information on ocean wave behavior in response to climate change, because such information is not simulated in current global climate models.

In a recent study, we used a multivariate regression model with lagged dependent variable to make statistical global projections of changes in significant wave heights (Hs) using mean sea level pressure (SLP) information from 20 CMIP5 climate models for the twenty-first century. The statistical model was calibrated and validated using the ERA-Interim reanalysis of Hs and SLP for the period 1981-2010. The results show Hs increases in the tropics (especially in the eastern tropical Pacific) and in southern hemisphere high-latitudes. Under the projected 2070-2099 climate condition of the RCP8.5 scenario, the occurrence frequency of the present-day one-in-10-year extreme wave heights is likely to double or triple in several coastal regions around the world (e.g., the Chilean coast, Gulf of Oman, Gulf of Bengal, Gulf of Mexico).

More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-model 3-run ensemble, the 4-model common signal of climate change is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0% and 82.2% of the area by year 2005, 2050 and 2099, respectively. For the annual maximum, the signal is much weaker. The signal is strongest in the eastern tropical Pacific, featuring significant increases in both the annual mean and maximum of Hs in this region. The climate model uncertainty (i.e., inter-model variability) is significant over 99.9% of the area; its magnitude is comparable to or greater than the climate change signal by 2099 over most areas, except in the eastern tropical Pacific where the signal is much larger. In a 20-model 2-scenario single-run ensemble of statistical Hs simulations for the period 2006-2099, the model uncertainty is found to be significant globally; it is about 10 times as large as the scenario uncertainty between RCP4.5 and RCP8.5 scenarios.

2208 - Deep-sea ecosystems and climate-change: new perspectives to address knowledge gaps in impact assessment

ORAL PRESENTATIONS

K-2208-01

Climate Change Challenges Ecological Functions of the Deep Half of the Planet

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Half of the planet's surface, and over 90% of its volume is covered by deep ocean below 200 m. We now know this realm hosts a wealth of different species and ecosystems that provide services critical to the health of the planet. Nutrient recycling, carbon sequestration, habitat and food web support of biodiversity occur on vast scales. The deep sea also contains fish, shellfish, hydrocarbons, mineral and genetic resources subject to growing demand from human society. The deep ocean is highly connected to the surface ocean and accordingly experiences both natural and anthropogenically induced climate variation. Ocean warming, ocean acidification, ocean deoxygenation and altered organic matter fluxes to the seabed are among the major deep-water manifestations of rising CO2 in the atmosphere. We are just beginning to document these changes and understand the implications for ecological function and resilience in the traditionally stable deep sea. Deep waters have absorbed significant heat from the atmosphere, with potential effects on species metabolic rates, distributions, and interactions. Warming margins will experience gas hydrate dissociation, releasing methane, a potent greenhouse gas. Increasing CO2 and carbonate undersaturation threatens the process of calcification and the resilience of deep-water coral reefs in the face of disturbance, particularly in the North Atlantic. Ocean deoxygenation and expanding oxygen minimum zones at upper bathyal depths can lead to biodiversity loss, habitat compression, and changes in food webs - all of which affect fisheries and livelihoods. Interactions among stressors are likely. Warming will interact with oxygen and the carbonate system (pH, carbonate saturation) to cross tipping points and shift ecological functions. Changing ocean conditions will alter fluxes of particulate organic carbon to the deep sea, influencing energy budgets and organism abilities to cope with climate stressors. Insights into potential future changes can be drawn from the study of deep-sea faunal responses to environmental gradients in space and to changes over time. By combining information from the paleo record and from patterns in the modern ocean, and by conducting experiments we can begin to assess how climate change might be manifested in the future deep sea. There remains an urgent need however, for a network that measures essential climate-change variables in the deep ocean over time and documents biological responses from the molecular and genetic to the population and ecosystem level. The influence of climate change on the function, resilience and recovery of deep-sea ecosystems and on the services they provide takes on added significance as societal exploitation of the deep sea introduces novel forms of disturbance and stress.

K-2208-02

Evidence of change in deep-sea ecosystems: a societal concern?

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Concerns over the potential impacts of recent global change have prompted renewed interest in the long-term ecological monitoring of large ecosystems. The deep sea is the largest ecosystem on the planet, the least accessible, and perhaps the least understood. Nevertheless, deep-sea data collected over the last few decades are now being synthesised with a view to both measuring global change and predicting the future impacts of further rises in atmospheric carbon dioxide concentrations. For many years, it was assumed by many that the deep sea is a stable habitat, buffered from short-term changes in the atmosphere or upper ocean. However, recent studies suggest that deep-seafloor ecosystems may respond relatively quickly to seasonal, inter-annual and decadal-scale shifts in upper-ocean variables. At some deep-sea sites, progressive changes can be detected that could be linked to recent climatic change.

Why should society be concerned about changes in the deep sea when it is so apparently remote from most humans economic, social, cultural, aesthetic and ethical world? One answer is that it is one of our last great wilderness regions, filled with an astonishing reservoir of mostly undocumented biodiversity. Where it is documented, we have found examples of remarkable evolutionary and ecological novelty that have challenged the notions of where life may exist, or have existed, in elsewhere in the solar system and beyond. The deep-sea, less constrained by time, has become a vast evolutionary experiment across one of the great ecological gradients on the planet, that of depth. Knowledge of this diversity, how it has formed and what role it plays in the global ecosystem should not be a hobby for enthusiasts, but a key tranche of the scientific and public understanding of our planet and how we attempt to manage it.

K-2208-03

Marine cabled observatories as a new technology for the highly integrated environmental and biological monitoring

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Marine depths below 1000 m represent approximately the 65% of the planet surface, making of the deep-sea the largest biome on Earth. Presently, there is a lack of capability in fostering high-frequency sampling in deep-sea areas, which is limiting our understanding of oceanographic processes and their influence on continental margin and deep-sea life. Additionally, this constraint is hindering development of the marine ecological framework. In this context, marine species show rhythmic and massive population movements synchronous with geophysical cycles (light intensity, hydrodynamic tidal and inertial variations), over timescales not comparable with the frequencies of trawling surveys. As a result, significant errors in population/stock and biodiversity assessments occur over 24-h and seasons as a result of use of this "classic" sampling method. Also for more advanced ROV surveys a time-consuming and costly vessel support can be required, limiting the sampling repetition. A new technology should therefore be implemented in order to establish reliable: i. Faunal lists, key in deep-water ecosystems exploration; ii. Cause-effect principles, which link animal behavior to environmental changes; and finally, iii. Population assessments, with sampling stations coordinated into geographic networks. Cabled seafloor observatories allow the continuous and real-time video-counting of animals, and allow these counts to be related to the oceanographic, chemical, and geologic multiparameters, as measured by sensor systems mounted alongside the imaging equipment. Video cameras may be the first true "intelligent" ecological sensors operating at high level of ecological complexity (i.e. ecosystems fauna), as these can capture species rhythms and resulting overall community dynamism in an automated fashion. Automation may transform cameras into sensors delivering numeric outputs (i.e. visual count time series for the different species). Presently, networks of fixed monitoring stations, which include cabled seafloor and water column observatories, are being deployed to provide scientists and generic users with relevant data for the environmental research and sustainable management of marine ecosystems at all depths, considering the geosphere, hydrosphere, and biosphere as integrated components. These observatories are "historicizing" data acquisition, delivering multiannual time series (i.e. into decades) of physical, chemical, and geological parameters. International networks include the European Multidisciplinary Seafloor and water-column Observatory (EMSO; www.emso-eu.org) as a Research Infrastructure of the European Strategy Forum on Research Infrastructures (ESFRI; ec.europa.eu/research/esfri/). At this stage of technological development, cabled observatories may be used forreliable ecosystem monitoring at discreet locations, i.e. the sensor platforms. In order to expand their field of coverage, crawlers (Univ. of Bremen; http://www.jacobs-university.de/ses/research/oceanlab/crawler; L. Thomsen IP) are a promising tool for extending the reach of the observatory to the surrounding area. Crawlers connected to benthic observatory nodes by umbilical, are movable multiparametric and multisensor expandable platforms. They can monitor the marine environment around the node with nested transect procedures which may be modified according to required changes in sampling strategies. Presently, crawler technology is in use at the largest infrastructural observatory network in the planet, the Ocean Network Canada (ONC; http://www.oceannetworks.ca/). A unit (named Wally) has been in operation for 5 years in Barkley Canyon (~890 m depth), video-surveying fauna in a geomorphologically active, hydrocarbon cold seep region of Pacific margin. In the future, crawlers could be standard equipment deployed with benthic platforms. Current developments are underway to automate crawler movements, with umbilical cables being superseded by submarine wifi communications, wireless power transfer and automated docking procedures similar to those developed for Space robotics (ROBEX; http://www.robex-allianz.de/en/).

2208-POSTER PRESENTATIONS

P-2208-01

Habitats characterization of the New Caledonia deep sea ecosystems

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The impact of climate change on marine ecosystems at different levels is demonstrated by many studies focusing on various regions of the globe. New Caledonia and other south west Pacific islands are very vulnerable to these threats with sea level rise or ocean acidification which impacts coral reefs. New Caledonia Exclusive Economic Zone is 1.3 million km² and most of it belongs to the deep sea with ridges and seamounts which represent unique ecosystems not easily accessible. It has been shown that deep sea ecosystems can also be impacted by climate change and to evaluate these potential effects the considered ecosystems must be precisely described and characterized.

The exploration program "Tropical Deep Sea Benthos" launches sea surveys in the south west pacific for more than 30 years and 37 surveys (3800 stations) sampled the New Caledonian waters. This program gathers a worldwide taxonomist network and led to numerous new species descriptions. Here, we used this large taxonomic database to develop a multi taxa approach to describe species associations on the New Caledonia seamounts in relation to stable physical environment like depth or slope. Some of the studied species have really narrow distributions or are only know from one location; hence they can strongly depend on very local environmental conditions. The change in sea level or sea surface temperature and their consequences on the deep sea habitats could have a strong influence on these organisms.

This study represents a first attempt at the habitats characterization and species associations' description of the deep sea ecosystems of New Caledonia and will be used to implement conservation and management plans of the area.

P-2208-02

Impact of climatic events on deep-sea ecosystems: the response of cold-water corals to dense water shelf cascades

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The cold-water scleractinian corals (CWC) are the main ecosystem engineers in the deep-sea, and thus play a key role in deep-ecosystems. They form reef structures that provide niches and nursery grounds for a variety of species, including commercial an patrimonial species, making these reefs significant centers of biodiversity in deep water shelf settings. In submarine canyons, these habitats depend on the exportation of organic matter from the shelf to the deep-sea, and thus are closely related to climatic conditions. Particularly in the Mediterranean Sea, in the Gulf of Lion canyons, which is characterized by seasonal meteorologically-driven hydrological events, resulting from severe coastal storms or from the formation and sinking of dense water masses (i.e., cascading). The dense water formation occurs as a result of wind-induced cooling and evaporation of surface waters during winters. This annual pulsed phenomenon last several weeks, with strong inter-annual variation in intensity. The effects of the dense water shelf cascades on cold-water coral reefs are however poorly known. High densities of organic particles associated to the cascading events should constitute an energy supply but the strong currents result in major disturbance in the ecosystem functioning, with breaking of coral fragments.

Therefore, studying the response of cold-water corals to these cascading events is essential (1) to better assess the resilience of present reefs to the environmental dynamics, particularly in Mediterranean where the range and frequency of cascading events will change with in the next future with the global warming, and (2) to determine the growth dynamic of fossil reefs, probably linked to past climate conditions.

The development of mark and recapture techniques, coupled with sclerochronological analysis, allows growth rate estimations at the polyp scale based on the identification of staining as a time marker in the skeleton (Lartaud et al., 2013), whereas the use of support cuttings of coral fragments give growth rate information at the colony scale (Lartaud et al., 2014). In situ growth experiments were conducted in the Lacaze-Duthiers canyon (between 340 and 520 m depth) on two reef-building cold-water coral species (Lophelia pertusa and Madrepora oculata). The results show temporal changes in the growth dynamics, with a seasonal response of M. oculata, whereas L. pertusa appear less sensitive, and inter-annual variability presumably relied to the cascading intensity. Nevertheless, the two species living in the same habitat exhibit distinct growth response both at temporal and spatial scales, which should be take into account for further management strategies in the conservation of these species.

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P-2208-03

The climate-sensitive deep-sea ecosystem of the Lacaze-Duthiers submarine canyon: first steps of a long-term study of ecosystem dynamics and functions

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Submarine canyons are recognized as ecological hotspots on continental margins providing a number of services to ecosystems and humans. In the Mediterranean sea, these canyons are particularly threaten by cumulated anthropogenic impacts and climate change effects (including changes in deep water convection and extreme meteorological events). Several of these canyons host abundant populations of deep-sea corals and may display even higher vulnerability to climate change, as these ecosystem engineers are particularly sensible to warming and acidification of deep waters.

Despite recent efforts in seabed mapping and dedicated physical oceanography monitoring, constrained access to these marine habitats largely limited the capacity to acquire basic knowledge on ecosystem dynamics. The complex links between environmental fluctuations and ecosystem functions therefore remains largely unknown. There is a critical need to fill these gaps in order to understand how climate forcing may challenge ecosystem stability and functions.

In this perspective, we established a multiannual integrated ecological study in the Lacaze-Duthiers submarine canyon (western Mediterranean Sea), which aimed to investigate key ecological functions in naturally variable conditions. The integrated experimental approach combined in situ growth studies of dominant cold-water coral species with the multidisciplinary study of sediment biogeochemistry in relation to microbial and meiofaunal communities.

The strong temporal variability of ecosystem components and functional rates revealed by these pioneer works further documents the strong influence of atmospheric fluctuations on these deep-sea environments, while providing first insights to the mechanisms underlying these interactions. These results set the basis for a long-term ecological study of this climate-sensitive deep-sea ecosystem and supports the implementation of effective monitoring strategies of the Lacaze-Duthiers canyon in the frame of the Marine Protected Area of the Gulf of Lion (Parc Naturel Marin du Golfe du Lion).

2209 - Transformative pathways to sustain marine ecosystems and their services under climate change

ORAL PRESENTATIONS

K-2209-01

State of the art in oceans and climate change research: Synthesis of the 3rd International Symposium on the Effects of Climate Change on the World's Oceans (Santos, Brazil; March 2015)

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There are global concerns over the potential impacts of global environmental change on marine ecosystems and the services they provide. Initial assessments indicate geographically diverse impacts (Cheung et al. 2010), with significant consequences for the wellbeing of dependent communities (Barange et al. 2014). In March 2015, the IOC-ICES-PICES 3rd International Symposium on the Effects of Climate Change on the World's Oceans was held in Santos (Brazil). This symposium followed the recent IPCC 5th

Assessment Report, which included a number of dedicated ocean chapters. The symposium was a significant event in the challenge to provide evidences and project impacts of climate change on ocean physics and biogeochemistry, ecology, phenology and biodiversity, fisheries and foodwebs, as well as on the use and communication of uncertainties in projection methodologies. In this presentation, the convenors of the IOC-ICES-PICES 3rd International Symposium on the Effects of Climate Change on the World's Oceans, will summarise the main results and highlights of the conference, to update the research and user community on the rapidly developing research field of oceans and climate change.

Barange, M., Merino, G., Blanchard, J. L., Scholtens, J., Harle, J., Allison, E. H., Allen, J., Holt, J. & Jennings, S. (2014). Impacts of climate change on marine ecosystem production in fisheries-dependent societies. Nature Climate Change, 4, 211-216.

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K-2209-02

Improving climate-resilience in fisheries through rebuilding fish stocks in an uncertain future

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Seafood is an important source of livelihood, nutrition and culture to many people, in particular, those in coastal communities. The Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC AR5) highlights that climate change (CC) is challenging sustainable management of fisheries by redistributing fish stocks and therefore catches, particularly with many tropical regions suffering decreases in fisheries production. Overfishing further exacerbates climate risks on fisheries by depleting fish stocks while stock rebuilding is expected to help improve climate-resilience. However, quantitative assessment of the contribution of stock rebuilding in reducing the vulnerability of global marine fisheries to CC, with considerations of projection uncertainties, is not included in IPCC AR5. Using multiple climate-living marine resources models driven by a range of emission and fisheries scenarios, we examine the scope of vulnerability reduction of fisheries under CC and different pathways to stock rebuilding. We show that both CC and fishing scenarios contribute significantly to changes in global fisheries yields in 2050. Overall, stock rebuilding increases climate-resilience of the fishing sectors and marine ecosystems. However, even with stock rebuilding, substantial climate risks, particularly in sensitive ecosystems such as tropical oceans, may not be avoided without substantial reduction in greenhouse gas emission. Our results highlight the need for implementing integrated mitigation-adaptation approaches to improve climate-resilience for the fisheries sectors.

K-2209-03

Challenges and advances in climate projection methodology and their use in projecting oceans futures

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Increasing computational power, improved fidelity of climate models and data obtained by global observing networks have advanced our understanding of both climate change and climate model evaluation. In addition, Coupled Model Intercomparison Projects (CMIPs) have contributed to improving climate model ability to reproduce past climates as well as climate variability through the use of ensemble modeling approaches. Nevertheless, typical model resolution is a half to one degree in latitude/longitude in the ocean model component, which makes it difficult to represent many ocean structures and phenomena important to marine ecosystems (e.g. upwelling, western boundary currents, eddies). Coastal areas are some of the most productive and biodiverse regions, and are dominated by mesoscale phenomena, which cannot be properly resolved by the climate models. One approach that is being used to achieve regional high-resolution climate-scale simulations is by nesting of a high-resolution limited-area model within a lower resolution large-scale model. Typically, information is downscaled from the coarse- to the fine-resolution region through an overlap in the domains. The high-resolution nest can explicitly resolve features missing from the large-scale model. However, when making a future projection, regional changes may also possibly affect the global climate (i.e. upscaling effects). Furthermore, model requirements are often different when considering ecosystems. For example, phenology is one of the most important items for marine ecosystems; a slight difference in the start of the spring stratification may result in a quite different marine ecosystem response.

Earth system models (ESMs), which include the carbon cycle, couple physics to lower-trophic-level marine ecosystem models. A common major weakness of ESMs lower-trophic-level models is the coarse functional group representation of zooplankton and lack of calibration with zooplankton abundances. This is partly because of the lack of a global database for zooplankton and partly because ESMs lower-trophic-level models have been designed to obtain accurate simulations of nutrient cycling and primary production but not necessarily for zooplankton dynamics. Nevertheless, zooplankton is a key component of marine ecosystems and it is our challenge to improve their representation, as well as the full marine ecosystem in climate models.

K-2209-04

Socio-governance considerations and the impact of climate change on oceans and fisheries

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Climate change represents a host of challenges and opportunities for the regulation of fishing effort. Stock displacement may lead to new and improved fishing opportunities in certain locations in a short time, while for other species climate change may truncate their natural ranges and biological processes. Fisheries management bodies will face difficult and often highly politicised choices in addressing the future regulation of fishing effort. These developments will clearly have a considerable impact both on fishing economy, society and the legal norms governing fisheries management and allocations. This paper accordingly examines the implications for international oceans governance raised by the impact of climate change on global fisheries, from both a societal and regulatory standpoint.

This paper will first examine the fundamental challenges posed to legal and societal governance by global climate change in the context of fisheries, identifying faultlines within the current regulatory regime advanced under the law of the sea that will be most affected by shifts in fish populations. This paper then moves to examine a case-study of how RFMOs and other regulators have responded to population shifts and climate-induced reductions in fish stocks in the emergent regulation of new and exploratory fisheries. To this end, it will be demonstrated that RFMOs exhibit strong potential to regulate new fishing effort in a precautionary manner and in accordance with ecosystem-based management, perhaps in contrast to the way in which many current stocks are being managed, although the process remains nascent and iterative.

This paper also acknowledges that stock mobility and regime changes could result in immediate stresses to those are considered to be vulnerable socially and economically. Accordingly, this paper will examine

the response of small-scale fisheries (with a particular emphasis on indigenous groups) to climate-induced changes to populations, noting the potential implications to these communities. These elements will accordingly frame an appraisal of current and emerging demands upon fisheries governance and evaluate the ability of the present system to address human dimensional impacts of climate change on fisheries across global and local scales.

O-2209-01

Forecasting climate change impacts on tuna populations and fisheries

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The industrial development of High Seas pelagic fisheries targetting tuna and associated (billfishes) species since the 1950s has taken place in a warming Ocean. The short-living skipjack tuna is the most tropical and productive species while bluefin tuna is the most temperate and long living species, providing small but extremely valuable levels of catch. Rather than a single oceanic habitat, these species have overlapping vertical and horizontal habitats defined by their preferences and tolerances developed over the evolution for several key physical and biological variables. Though some tuna and billfishes can move far in high latitudes searching for rich foraging grounds they all return to warm waters (roughly >24°C) for spawning, leading to seasonal migrations and complex population dynamics mechanisms interacting with several environmental variables. Therefore, characterizing habitats and projecting them in the future using IPCC scenarios is a useful but incomplete approach when investigating the impact of climate change on these species. The progress in the study of climate change impacts on tuna and associated species is reviewed with highlights on recent results based on a modeling framework developed to simulate the spatial dynamics of fish with mechanisms constrained by relationships based on the bio-physical environment predicted from coupled 3D models of ocean physics and biogeochemistry. This framework includes a Maximum likelihood Estimation approach allowing reconstructing past history of fish population, to dissociate fishing impacts from natural variability, and to forecast population dynamics under climate change scenarios.

2209-POSTER PRESENTATIONS

P-2209-01

Multi-model ocean biogeochemical predictions: an innovative approach

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Ocean dynamical-biological models are required tools to address consequences of climate change upon marine biogeochemistry and halieutic resources in the future. For the Intergovernmental Panel of Climate Change (IPCC) report, the Coupled Model Intercomparison Project (CMIP5) gathers results of simulations computed from several Coupled Global Climate Models (CGCM, with different physical/biogeochemical Oceanic and/or Atmospheric components). Despite their ability in producing a consistent global warming trend for the future, they are known to display significant biases in the mean state as well as in the variability of the ocean for the historical and present periods along with tremendous regional discrepancies for the future climate variability and marine ecosystems. The discrepancies between the biogeochemical response in these coupled models may arise from the very different biogeochemical components used, whose complexity varies from simple nutrient restoring schemes to the explicit representation of several plankton functional types based on very different physiological assumptions. As a consequence, the comparison of the predictions of these different coupled models, crucial to assess how biogeochemistry may vary in the future, has proven to be very challenging. However the tremendous consequences on higher trophic level predicted by models that use future climate scenarios advocate more than ever for a better understanding and quantification of the predictions uncertainties.

To pin point the most robust changes in response to future climates, we propose an innovative method using a single physical/biogeochemical ocean model (NEMO/PISCES) forced with a mix of more realistic atmospheric forcing fields (improved ERA-interim reanalysis) and atmospheric trends extracted from the coupled climate models for the RCP8.5 scenario. With this method, we produce «state-of-the-art» simulations of the dynamic and biogeochemical state of the ocean which span over the historical (1979-2010) and the future (2011-2100) periods using different climates from different climate coupled models but with common ocean/biogeochemical model. The advantage of this method is to constrain the mean spatial patterns of the ocean forcing fields to remain close to the observations, to retain the desired observed modes of variability while having the changes induced by the anthropogenic perturbations. Using outputs from six CMIP5 coupled models, this method has been successfully applied and the produced forcing datasets have been used to force our dynamical/biogeochemical model for the future period.

These forced simulations exhibit spatial pattern of the Sea Surface Temperature (SST) warming similar to the one seen in the corresponding coupled climate models. However, a noticeable difference between the forced and the coupled models can be seen in the equatorial Pacific, and is related to a well known bias of the coupled models (i.e. too weak equatorial upwelling) mostly attenuated with our method. The different forced model simulations exhibit either contrasting or similar patterns between what is produced by our simulations and what is produced by the corresponding climate coupled models. They also exhibit a weaker spread in their biogeochemical projections as compared to the original coupled solutions. It suggests that discrepancies in the modeling of biogeochemical processes in the coupled climate models play a crucial role in the projections spread. However those projections produced by our forced strategy do still show significant differences. As an example, our forced simulations predict a decrease at the end of the century between 5% and more than 10% of the global Primary Production. The volume of the oxygen minimum zone (O2<5mmol.m-3) is also increasing with values bracketed between 10% and 50%. Those changes depend only on the diverse climates used to build our forcing sets. This allows understanding which of the biological patterns are robust across the diverse climates but also which of the biogeochemical models have a functioning different from ours, under a similar climate.

In a companion abstract, our simulations of future biogeochemical states of the ocean are used to force a model of tuna stocks (SEAPODYM) to characterize the potential for future tuna stock changes.

P-2209-02

Evidence for trophic amplification and attenuation of climate change impacts on groundfish species productivity in the Bering Sea, AK

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Climate change is expected to impact marine ecosystems globally, with largest changes anticipated for arctic and

sub-arctic ecosystems. We used multi-species stock-assessment models to link climate-driven changes in physical and trophodynamic conditions to recruitment and mortality of three Eastern Bering Sea groundfish species (Gadus chalcogrammus, G. macrocephalus, and Atheresthes stomias, herafter pollock, P. cod, and arrowtooth, respectively) in order to distinguish harvest impacts on fish populations from large-scale climate pressures. When we compared model projections under climate scenarios to those under mean historical conditions, we generally found declines in estimated acceptable biological catch (ABC) for pollock and declines in recruitment for both pollock and P. cod. However, projected declines in ABC were sensitive to model specifications of trophic interactions, specifically the strength of bottom-up or top-down controls. Stock assessment models with predation had the largest projected declines in ABC, whereas single-species models without bottom-up controls on recruitment had the lowest projected changes in ABC. Inclusion of trophic interactions amplified climate-driven declines or increases in fish abundances, implying that fisheries models that do not include trophic interactions or climate effects might over-estimate sustainable harvest rates for fish species negatively impacted by climate change (e.g., pollock), and under-estimate harvest rates for predator species positively impacted by climate change (e.g., arrowtooth). Our work emphasizes the need to evaluate multiple future scenarios and model structures when projecting climate effects on fishery species.

P-2209-03

Climate Change Affects Marine Fish Distribution: Temporal and Latitudinal Evolution. Approach using GIS Technique and Satellite Data for Data-poor Areas

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Accurate knowledge of physical ocean conditions, i.e. sea surface temperature distribution and temporal variation is needed as a key input in many modeling types that are widely used for various applications. Climate varies naturally across a range of temporal and regional scales reflected by the change in pattern of marine species. Currently, global studies on how temperature changes have been performed in several articles, while studies in smaller region are still few. Besides, collecting the necessary quantitative data on a smaller region is costly.

The most powerful way to collect such comprehensive data is through the use of satellite sensors that measure different types of energy coming from the Earth. Using 30 years recent version of AVHRR SST dataset Pathfinder 5.2 from NOAA polar-orbiting satellite, we observed change of sea surface temperature and its effect in marine species distribution in three marine regions defined in LME (Large Marine Ecosystems) and ICES (International Council for the Exploration of the Sea): Canary current, the South European Atlantic Shelf and the Celtic Seas. Species richness in the middle region is generally higher because many species have their southern or northern distribution limits. The zoogeographic importance of this latitudinal area has long been recognised, representing the transition between north-eastern Atlantic warm-temperate and cold-temperate regions, which makes the zone an area of great sensitivity to the detection of climate change. The magnitude and variation change are differences among the ecosystems. We modeled the potential distribution of three fish species living in different environments: pelagic (Pomatomus saltatrix), benthopelagic (Balistes capriscus), and demersal (Solea senegalensis) to demonstrate the effect of climate change in marine fish distribution. The ability of GIS technique with the integration of Python programming language and the use of global marine environmental raster data from satellite remote sensing, such as sea surface temperature from AVHRR over the past three decades and other oceanic parameters from MODIS and the incorporation of world bathymetric data from GEBCO along with its derivates, we were able to demonstrate the potential distribution of marine fish species in space and time and to capture their northern and/or southern limits as well as to follow the evolution of their suitable area from 1981 to 2013. All species showed a northbound trend. This confirms a clear evidence of ocean warming effect in shifting marine fish distribution.

The models of species potential distribution were built by projecting the species environmental envelope on the environmental raster time series data. Species environmental envelope or the species realized niche were calculated by estimating the relationship between species records at given sites and the environmental characteristics of those sites with respect to the time of observation. The species records came from various databases. The use of Python programming language for GIS under ArcGISTM environment, allows us to extract the environmental raster values at the locations of species records at the time of observation. This new approach minimizes the biases from different sampling techniques among data sources as well as issues of small sample data size. When cross-checked with the species' environmental envelope defined in experimental or observational studies, the result yields coherent results for all species observed. Presentations in the form of animated maps, tables and graphics show the evolution of species' suitable area over time. This approach can be used to generate environmental envelope for a wide range of organisms as well as their potential distribution in data-poor areas and bring a better understanding of climate change effects in the ecosystems. The model will enhance the prediction models available today and will provide valuable information for conservation planning, fisheries, and climate change studies and furthermore contribute in the comprehension of species distribution study as well as management and conservation strategies.

P-2209-04

Slight impacts of marine animals on ocean biogeochemistry under global climate change

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We compared two transient climate change simulations of a global coupled biogeochemical-ecosystem model with and without feedbacks of marine animals on biogeochemistry. We found that marine animals have little effect on the biogeochemistry of carbon, but they modify the Net Primary Production (NPP) and oceanic oxygen content. These results imply that marine animals take no significant part in the oceanic storage of carbon under climate change. However, as a link of the food chain, they may attenuate the decrease of NPP under climate change through top down effect, favoring their food supply. On the other hand, as aerobic species, marine animals contribute to decrease the oxygen concentration in the ocean subsurface and increase the volume of hypoxic/anoxic water in the ocean, reducing their habitats.

P-2209-05

Effect of rising sea surface temperatures on the extension rates of the massive coral Porites spp from the Philippines

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The integrity of coastal ecosystems is threatened by the effects of warming ocean waters brought about by global climate change. Thermally-sensitive species such as zooxanthellate corals and the reef structures they form are to suffer as they operate at optimal temperatures between 25 to 28°C. Long term coral growth band data provide a continuous record of the responses to increasing sea surface temperatures (SST). Extension and calcification rates of massive corals were enhanced at the onset of warming in the twentieth century but recent studies on the Great Barrier Reef, the Red Sea and the Thai-Malay peninsula reported declines with the further increase in SSTs after the 1990s. Other reefs however showed contrasting results with extension and calcification rates higher at present. The variable results of the studies highlight the need to investigate local responses to increasing SSTs. Philippine reefs comprise 8% of the world's total, following Indonesia

and Australia and is part of the Coral Triangle, described to be centre of marine biodiversity. The impacts of climate change to the country's reefs cannot be understated. In this study coral growth band data was used to establish the responses of Porites spp from reefs in the Philippines to changes in sea surface temperature over a period of 48 years (1956 to 2004). The linear extension rates (LERs) of Porites spp coral cores from the Calaguas Islands (north Philippine Sea), Parola Island, Kalayaan Island Group/ Spratlys (West Philippine Sea), Pamilacan Island (Bohol Sea) and Ayuki and General Islands, Surigao (south Philippine Sea) were measured from the density banding patterns of the coral skeleton revealed through x-radiography. Linear regression and time series analyses were performed to determine interannual and long-term changes in the extension rates. Time series of standardized anomalies of annual LERs of the Porites spp corals from the Philippines all show high interannual variability but the long-term trend displayed a decline in extension rates. The LERs of Porites spp are highly correlated to calcification rates and this decline in extension consequently reflect a decline in the calcification rates of Philippine corals. Different responses at the local level are also evident: the Porites spp from the Calaguas and Surigao reefs the LERs declined significantly at ca 0.38 mm per year and ca 0.16 mm per year respectively. Pamilacan Island showed a significant increase in extension of 0.22 mm per year however a sharp decline in the extension rates of the Pamilacan colony after 2000 is evident. The LERs of the Spratlys colony also decreased but the trend was not significant. The variable results even at the local level indicate complex responses of corals to warming ocean waters. Local factors such as wave energy exposure and interannual climate oscillations such as ENSO may enhance or counteract the effects of higher SSTs. Nevertheless, an overall decrease in the mean extension rates of the Porites corals on a national scale (0.097 mm per year) with an increase of mean annual SSTs of ~0.6°C from 1956 to 2004 was determined and is a cause for alarm as the decline in extension rates and calcification rates of a major reef builder coral, the Porites spp, maybe widespread throughout the Indo-Pacific region.

P-2209-06

Will atmospheric changes impact bioluminescent organisms in the abyss?

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The sampling and understanding of complex environmental systems over long time scales aims at the detection of potential disturbances as a shift from the intrinsic variability of these systems. Marine systems are variable at all time and space scales and their variability is still poorly understood due to sampling strategy, instrumentation and spatio-temporal heterogeneity challenges. In response to this lack of knowledge, there is an international effort to capitalize oceanographic data and costs of autonomous and for mobile infrastructures that enables the detection of long term environmental context as well as episodic events or perturbations.

The deep-sea ecosystem is unique because of its permanent darkness, coldness, high pressure and scarcity of carbon and energy to sustain life. Most of its biological activity relies on the arrival of carbon in the form of organic matter from surface waters. Ninety percent of the numerous pelagic organisms that inhabit the deep ocean are capable of emitting light through the chemical process of bioluminescence. In this context, the ANTARES* neutrino telescope is a deep-sea cabled observatory situated in the north-occidental Mediterranean sea, close to the French coast. An unanticipated application is to provide a direct method to detect in situ bioluminescence from deep marine organisms, between 2200m and 2500m depth.

Our two recent studies show that high bioluminescence intensity periods have been detected since 2006 and are attributed to major water-mass changes due to winter convection. Dense deep water formation occurs during late winter and early spring due to cold, strong and persistent northern winds (Mistral and Tramontane) causing surface cooling of the Modified Atlantic Water both on the shelf and over the deep basin. When the cooled shallow waters on the shelf become denser than the ambient waters, they start sinking, overflow the shelf edge, and cascade downslope until they reach their density equilibrium depth, which may vary from 150 m to more than 2,000 m. These open-sea convections represent a major vector in fueling the deep-sea ecosystem with nutrients, carbon, oxygen and potentially organisms. Such water mass changes have been shown to induce higher bioluminescence emission. Indeed, the input of organic matter into the deep water has the potential to fuel the deep-sea biological activity. Bioluminescent bacteria are potential contributors to high bioluminescent events affected by environmental growth conditions.

Dense water formation is likely to be altered by the on-going global warming. Recent models based on the A2 IPCC scenario indicate a strong reduction in the convection intensity in the Mediterranean Sea for the end of the 21st century. This will induces a massive reduction in organic matter supply and ventilation by oxygen input of the deep basin with clear impact on deep organisms that could be detected by bioluminescence survey.

*Astronomy with a Neutrino telescop and Abyss Environnemental RESearch

P-2209-07

National ocean modeling for Philippine coral reef connectivity

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The Philippines being an island nation of 7,100 islands, has one of the longest (34,000 km) coastline in the world characterized by highly complex bathymetry and hydrography. The country's reef system is extensive (25,000 km2) and its rich marine life is world acknowledge. Coral reefs are critically important ecosystems, as they provide valuable services including resources for coastal communities, buffer vulnerable coastlines from storm surges and habitat to various marine organisms. However, the country's coral reef system is in a degraded status attributed to various factors including unsustainable exploitation, sedimentation, and more recently events related to climate change such as extreme storms and coral bleaching which have led to declines in the function and resilience of these important ecosystem. Furthermore, Philippines is among the ten most vulnerable nations in the world affected by the impacts of climate change such as sea-level rise and severely damaging typhoons. Key capabilities such as numerical and biophysical modeling and their visualize outputs are valuable due to their capacity to provide a broad overview of connectivity patterns by tracking population sources and sinks as well as predictions of past and future hydrodynamic events. There is a growing evidence and efforts acknowledging connectivity and tracking population sources and sinks play an integral role to bolster resilience and ability of the reef populations to survive disturbances particularly related to climatic change such as typhoons, bleaching events, crown-of-thorns predation and diseases, any of which may increase and severity with changes in climate. This information as well can assist in the identification and monitoring of important or vulnerable habitats and designing management and conservation strategies. Here we present and describe the application of these approaches in determining pattern of reef connectivity in the Philippines. Philippine scale HYCOM model nested to the global HYCOM model runs for both real-time and hind cast mode and Lagrangian particle tracking model driven by the HYCOM hydrodynamic model to estimate coral reef connectivity patterns and matrices will be implemented. Model output will be offered for access near real-time via an OPENDAP server to be setup for disseminating model results. Ongoing model simulations and preliminary results are presented.

P-2209-08

The High-latitude Coral reefs of South Africa: A Canary in the Coral Coal Mine?

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Coral reefs are amongst the ecosystems most vulnerable to climate change. They occur at high-latitude in South Africa where they are at the southernmost limit of their

African distribution and are not accretive. While aragonite saturation and temperature are at levels that limit their growth, other factors including turbulence also play a role in their attenuation. The reefs are nevertheless rich in biodiversity, having 90 scleractinian and 40 alcyonacean species. Temperature and community monitoring commenced on the reefs in the early '90s and subtle shifts in coral community structure have been recorded, shifting from a tendency toward soft coral dominance to that of hard corals. Significant coral bleaching occurred in the austral summer of 2000/2001 when sea temperatures exceeded 28°C during a period of high insolation. Molecular work has shown that the corals are regionally rather isolated and ecologically independent of gene flow from northern reefs along East Africa. There even is a measure of spatial genetic structure in the corals studied at the reefal scale; the populations appear to be largely self-seeding. Furthermore, some of the more northern South African reefs seem to act as landing sites for putatively recruited migrants and have high levels of unique or private alleles. This degree of isolation and the stress to which these high-latitude corals are naturally subjected make them an excellent laboratory to examine the effects of climate change, viz. increasing temperatures and ocean acidification (OA). They may well manifest some of these effects in advance of the global future of corals. Representative coral species are thus under intensive study in the face of these stressors, in terms of their reproduction, recruitment, the incidence and progress of disease, and genetic adaptation. This is being accomplished in the field and a research aquarium equipped to manipulate temperature and OA. Results will be presented of completed and current work, showing the responses of the corals to these stressors, as well as observations on range shifts in their distribution. However, all the South African coral reefs are well conserved in a marine protected area and reef health appears to mitigate against some of the effects of global change.

P-2209-09

Projecting the state of the Mediterranean Sea Ecosystem under contemporary and future climate

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A suite of validated three-dimensional physical-biogeochemical-ecological models is used to assess the impact of future climatic and management scenarios on biogeochemical and ecological properties of the Mediterranean Sea. Results are discussed in term of temporal and spatial distributions of variables and indicators related to physical fields, carbonate system, cycles of carbon and inorganic nutrients, potential changes in higher trophic level organisms dynamics and in the distributions of critical habitats such as Posidonia oceanica and coralligenous formations.

The models properly describe available experimental information on contemporary seasonal dynamic and spatial distributions at the basin and sub-basin scales of the major biogeochemical parameters, as well as of primary production, carbon fluxes at the air-ocean interface and spatial distribution of critical habitats.

Model projections suggest that the future Mediterranean Sea will be globally warmer and more acidic, but with significant space variability. Plankton productivity and marine carbon sequestration would increase, even if the net primary production will remain at present level. Model results also indicate that changes in environmental parameters will alter the suitabilities of Poseidonia and Coralligenous over large areas, likely causing a reduction of those habitats. Intensification of extreme events occurence will impair the survival of red coral banks, decrease marine carbon sequestration, negatively impact aquaculture production. Simulations also highlight the possibility to compensate for adverse effects of climate changes on economic activities by relocating them or by changing management policies.

P-2209-10

Economic valuation and ecological status of coralligenous habitats under climate change

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Climate change first impacts are on ocean temperature, acidification, nutrient content. In this context marine ecosystems may evoluate in a «no return state». How will be this state ? Study are on progress on marine living beings, but many incertitude remains.

Coralligenous habitats are typical Mediterranean marine coastal habitats identified on most Mediterranean coast at depths between 20 and 120 m. These biogenic hard bottoms, mainly formed by calcareous rhodophytes develop in conditions of reduced light, and at temperature of 13-20°C. With about 1670 species recordedThey are among the most important sources of marine biodiversity in the Mediterranean with Posidonia meadows (UNEP, 2007). This rich biodiversity and ecological functions inherent to the ecosystem are the source of a set of ecosystem services or «biological processes which man can benefit» (Bouvron, 2009). Their use or their perception by Human gives amenities that can lead to an economic evaluation. Current knowledge on coralligenous allows to affirm their contribution to (i) the production of food resources and raw materials, (ii) the regulation of coastal ecosystems, and (iii) the realization of recreation diving fishing thanks to their attractive landscape and abundance of «gourmet» species.

Are the "right" to access to this ressource around Mediterranean sea equal? What are the differents factors that influence the repartition of valuable species, for food security and food "confort"? The study will demonstrate that ecosystem services from coralligenous habitats and economic value of some of these services are impacted by climate change. The impact in quantity and quality of services, may affect the access to differents services, and thus their value.

2210 - Coastal Impacts of Climate Change

ORAL PRESENTATIONS

K-2210-01

Towards a coastal vulnerability typology for small islands: Assessing diversity and similarity via a common framework

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The Small Islands chapter of the IPCC AR5 reaffirmed the vulnerability of small islands to climate change threats due to their inherent physical and human characteristics, high exposiure to extreme events, and to the high dependence of island communities and economies on threatened ecosystems such as coral reefs and mangrove forests. It also emphasized that small islands present diverse risk profiles – a point that has not been sufficiently recognized in the literature. The chapter invited the scientific community to include island diversity in future V & A assessments within a consistent methodology approriate at regional, archipelagic and island scales.

Envisaged was the design of a new island typology reflecting both the heterogeneity and homogeneity of islands and island coasts that also included a range of climate-ocean processes and not just sea-level rise.

Over the past three decades many coastal vulnerability assessments have been undertaken in the Caribbean, Mediterranean, Indian and Pacific Oceans most of which have applied a predetermined methodology with an emphasis on sectors, e.g. water, human health and agriculture, on certain coastal types, e.g. deltas, mangrove shores and sany beaches, and with an almost singular focus on sea-level rise. None of the assessments have: (1) covered whole regions; (2) dealt with the full range of coastal types on islands; or (3) considered the entire suite of climate-change drivers.

A protoype of a new typology that satisfies these criteria has been developed in the Pacific covering 15 countries and 1532 islands. The objective was to produce a regional coastal vulnerability typology based on the inherent geomorphological characteristics of islands and all relevant climate-ocean processes that drive coastal change. Development of the typology comprised a series of nested scales with increasing spatial and temporal resolution at each step from all islands to a coastal segemnt of a single island. Initially islands were classified into 8 types based on two simple characteristics: lithology (rock type) and maximum elevation. To these attributes were added island area and shape to develop an 'indicative susceptibility'. This index recognized that certain island types are inherently more susceptible (less resistant) to change than others, for example a low elevation sedimentary reef island is more susceptible than a high elevation volcanic rock island. A five-point susceptibility rating was derived for all 1532 islands that included all island types within each country in the region, e.g. the 431 islands in the Solomon Islands.

The second step was to refine the scale from whole-island to coastal-margin with more variables added to the diagnostic criteria, including measures of insularity and proximity to other islands. Further downscaling to coastal compartments with more diagnostic criteria enabled development of higher resolution susceptibility measures. The third step was to identify the key climate and oceanographic drivers of coastal change together with their projected future changes through 2100 based on AR5 and recent Pacific-wide projections of tides, wind and waves, distant-source swell, ENSO, tropical cyclones and sea-level change. Finally, how these processes interact with different island and coastal types in different regions of the Pacific was documented through a 'coastal sensitivity' measure based on island location and projected changes in that part of the Pacific. Sensitivities were calculated for the 1532 islands. Some surprising patterns emerged from these data including the fact that atoll islands do not all fit into the very high sensitivity class but range over moderate, high and very high on a five-point sensitivity scale.

This coastal vulnerability typology developed for small islands in the Pacific provides a consistent and defensible methodology that should: (1) enhance the capacity of decision-makers to take climate risk into coastal adaptation planning and management; (2) enable agencies to invest in targeted and transferable adaptation projects with island partners; and (3) be applicable at all scales from global to local including other small island regions.

K-2210-02

Benefits of mitigation of climate change for coastal areas

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This presentation will review the possible benefits of mitigation of climate change for coastal areas with a strong emphasis on sea-level rise. This is one of the most certain consequences of human-induced global warming and has significant impacts. Importantly, there is a long-term 'commitment to sea-level rise' due to the long thermal lags of the ocean system and hence the response of sea-level rise to mitigation is slower than for other climate factors. Therefore, while climate stabilisation reduces coastal impacts during the 21st century, compared to unmitigated emissions, the largest benefits may occur in the 22nd century (and beyond). While we cannot avoid some global rise in sea level, we can still avoid significant losses of the Greenland and Antarctic ice sheets, with significant long-term benefits to coastal inhabitants. The available results suggest that a mixture of adaptation and mitigation policies need to be considered for coastal areas, as this will provide a more robust response to human-induced climate change than either policy in isolation. This point has been clearly articulated in coastal impact chapters of the Fourth and Fifth IPCC Assessments. This approach requires the joint evaluation of mitigation and adaptation in coastal areas which has not been systematically considered to date. Because of the long time constants involved such assessments need to continue beyond 2100 to provide the full implications of the different policy choices. While the basic science of the commitment was available and presented in the First IPCC Assessment, the policy implications are less appreciated and need wider discussion.

K-2210-03

Marine and Coastal Ecosystems: what are the impacts?

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Coastal areas have traditionally been important to the development of human communities. Those who have exploited ecosystemic resources they provide them. These systems have been overexploited and polluted modified by human activities. Associated with these pressures, climate change may be impacting these ecosystems. The objective of this study was to analyze the factors affecting coastal and marine ecosystems and their conservation. For this analysis, the province of Limon was selected on the Caribbean coast of Costa Rica, including the southern sector. The evaluation was conducted in the communities of Wesfalia, Vizcaya, Cahuita, Puerto Viejo, Manzanillo and Gandoca. For the analysis of the beaches, the width of the beach, vegetation cover, type of dominant roots of vegetation, plant species composition, average height of vegetation and substrate type were evaluated. For evaluation of the reef and seagrass beds community, we use the methodology AGRRA 2.2 modified for depths between 1 and 6 m. In the mangrove, we applied the methodology of using Murdiyarso et al. (2009). NOAA satellite data for sea surface temperature, chlorophyll, precipitation and atmospheric CO2 were used. In the analysis, the Integrated Health Index Reef showed Isla Uvita, Cahuita, Puerto Viejo and Manzanillo have values of 3.7; 2.6; 3.45 and 2.86 respectively. The first and third places have good condition. Meanwhile, the second and fourth showed regular condition. Seagrass beds coverage showed 71.67 ± 10.4, number of offshoots 39.00 ± 77.93 and average heights of 7.00 ± 1.0 for Thalassia testudinium in Uvita Island. In Cahuita and Manzanillo, 2 species were observed (Syringodium filiforme and Thalassia testudinium) with coverage (%), number of offshoots and average heights with lower values than those reported in Uvita Island. In Puerto Viejo, the coverage was negligible. In all areas, small patches were observed connected reefs. For beaches, quality indicators showed that Gandoca and Manzanillo are the most impacted areas. Erosion was 91% and 56% respectively. As for coverage was 95 ± 8.13 and 65 ± 6.6 respectively. The other localities showed regular conditions. Cahuita mangroves and Gandoca were analyzed. The area was 2.85 and 13, 58 ha respectively. The number of species was 7 and 12 respectively. The dominant species Pterocarpus officinalis (16.78%) and Rhizophora mangle (29.45%) respectively. The number of dead trees was 15 and 26 individuals per ha respectively. The densities were of 53 ± 3.26 and 77 ± 9.87 individuals per ha respectively. There is significant difference between the temperature of a surface of the sea between 2001 and 2013 ($W = 1.14284E7$; $p = 0$). According to the comparison of medians (Mann-Whitney test) there is a significant difference in the concentration of chlorophyll «a» between 2003 and 2013 ($W = 0.86652E7$; $p < 0.05$). Increased wave and tide, caused by the increase in sea level and global climate change to produce more intense hurricanes and Norths winds, affecting upper parts of the beach that normally were not affected, being more vulnerable low slope beaches. It is concluded that the composition and structure of the shallow coral community in the 4 locations were evaluated regularly, in the case of Puerto Viejo, right on the Isla Uvita. The most important sites in both species Rhizophora mangle was also found Laguncularia and Avicennia germinans with other associated species. Riverine mangroves are two types during the dry season but a sand bar that prevents water flow is established. For Gandoca is stable as a coastal lagoon and in the case of Cahuita, like a swamp. The conservation status of these systems as ocean acidification that seems to reduce the number of sperm released by corals and agrees that

recruitment of larvae and the effect may start slowly or perceived, can be mitigated by the resilience of whose mechanisms of macroevolution system could not hope to provide answers to climate change. The strategies by reduce pressures on the species referred must be reduced the pressure in this ecosystem. In that sense, they must have the flexibility to confront climate change and that seems to be the most recommended practice in marine and coastal areas due to the difficulties of direct management in these areas. Some actions to mitigate climate variability are rehabilitating habitat mitigation program of coastal erosion control plan and mitigate the impact of lionfish and adaptation measures in management plans for marine turtles.

O-2210-01

Assessing the vulnerability of Air and Sea Ports in Small Islands: Risk Factors and Adaptation Guidance

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Since publication of the IPCC First Assessment in 1990, all subsequent reports have identified key reasons for and drawn global attention to, the vulnerability of small islands to the adverse consequences of climate change, particularly sea level rise. The Summary for Policymakers of the recently released Working Group II Contribution to the Fifth Assessment Report (AR5-SPM-WGII), notes that various forms of disruption in islands and low-lying coastal states due to storm surges, flooding and sea level rise can be expected, with high confidence. Specifically, the AR5 emphasizes the risk of loss and damage to vital living and non-living coastal and marine resources in islands (e.g. beaches, coral reefs, seagrasess, mangrove wetlands) and their associated goods and services. While impact severity will vary within and among regions, the AR5- SPM-WGII projects that some small island states could suffer damages and adaptation costs of 'several percentage points of GDP' over the 21st Century and beyond.

By virtue of the 'openness' of their economies and the consequential reliance on imports and exports to sustain livelihoods, small islands are heavily dependent on the functionality and efficiency of their air and seaports. Unlike many larger continental-scale countries, international trade in SIDS is not facilitated by other transportation media such as road and rail. Between fifty and ninety percent of all food and beverages consumed in SIDS come from external sources, and more than ninety percent of all energy products used in SIDS, including hydrocarbon fuels, are handled through air and sea ports. On average, in excess of seventy-five percent of the consumables that support other sectors pass through these ports of entry. In addition, SIDS earn considerable local and foreign revenues from various port-related activities, including berthing and bunkering, airport landing and maintenance, containerized and other storage charges, waste reception fees and cruise passenger imposts, inter alia. As in other countries, considerable direct and indirect employment is also generated by air and sea ports in SIDS.

The climate-related risks posed to ports must therefore be of considerable concern to small islands and low-lying coastal states. While an increasing number of vulnerability assessments conducted on islands have evaluated the impacts of climate change and climate variability on coastal infrastructure, few have specifically examined the implications of the threat for ports in these regions. Hence, this work attempts to contribute to filling that gap by focusing on the vulnerability of air and sea ports in SIDS to climate change related impacts. More specifically, the risks posed to port infrastructure by sea level rise and projected changes in the behavior of some hydro-meteorological events will be examined. Equally, the potential for disruption to critical port-related functions as a consequence of climate change, will also be explored.

Some guidance on the selection of criteria for evaluating the appropriateness of adaptation responses is offered, which it is hoped would be helpful to port managers and planners in the SIDS regions. In this regard, while the similarities among small islands will help to form a basis for identification of some criteria, the guidance emphasizes that island diversity in its many forms - biogeophysical, economic, socio-cultural and political - helps to shape the risk profile of each country, and should therefore be an important consideration when making adaptation choices, including in the air and sea port sub-sector.

Finally, it is cautioned that notwithstanding the uncertainties, delaying adaptation in this crucial sub-sector, the lynch-pin of many island economies, may not be prudent, given the conclusions of the IPCC-AR5. It is suggested that an approach to adaptation which judiciously integrates what is known about the present-day vulnerability of ports with our 'best understanding' of future climate risks, would constitute a meaningful risk management strategy for air and sea ports in SIDS.

O-2210-02

Managing increasing risks in coastal cities

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Coastal areas are particularly exposed to climate change and sea level rise, and large coastal cities represent hotspots of vulnerability and risk. In particular, coastal protections calibrated for current hazards and environmental conditions can quickly become inappropriate, leading to major increases in risk level: with rapid climate and economic trends, good protections can be more dangerous than helpful, in the absence of continuous adaptation. This presentation illustrates on major coastal cities how risk responds to change in sea level with and without adaptation, and discusses policy implications regarding coastal protection, risk management, and investment needs. A specific focus will be given to the need for comprehensive risk management packages that combine ex ante prevention actions with ex post actions that enhance the ability of the affected cities and people to recover and reconstruct. Finally, implications on poverty and inequality will be discussed, as protection choices will have large distribution and wealth impacts.

O-2210-03

Coastal forested wetlands as affected by sea-level rise and land-use in Caribbean islands: lessons from the past

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Tropical coastal plains and estuaries have developed large forested wetlands during the present postglacial transgression. In the Caribbean islands, such wetlands are subjected to specific hydrological characteristics due to small tidal range, seasonal rainfall, low mineral siltation, and frequent powerful hurricanes. In this context, a large amount of the atmospheric carbon fixed annually by the vegetation is stored underwater and form peat deposits several meters depth. As a result, these autochthonous organic sediments act as invaluable paleoecological archives of past climatic changes and catastrophic events that have affected coastal ecosystems over times. Recent and ongoing research conducted in the Lesser Antilles is presented to document this issue and put into a broader perspective the expected changes for the near future. In Guadeloupe, peat sediments over 10 meters depth have accumulated at an average rate of 1 mm/year during the last 3000 years, with no significant variation of the coastline. However, recent data indicate that before 4000 years B.P. faster sea-level rise (≥ 1,5 mm/year) may have cause dramatic coastline retreat. In the meantime, periodic climatic changes (dryer/wetter) have caused functional and structural changes whereas human activities inside these wetlands contributed to reduce forested areas (especially swamp forests) and, comparatively, promote herbaceous vegetation. Current trends in sea-level rise indicate that compensatory threshold of soil-level rise is being exceeded; as a result, landward intrusion of saltwater wedge is expected to occur farther and more frequently, especially under a forecasted dryer climate. Conversely, endangered freshwater ecosystems like the Pterocarpus swamp forest could be at risk of extinction because of the limited possibilities of upward migration, due to land use and inland steep topography.

P-2210-01

Short- and long-term impacts on coastal power plants under sea level rise

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Unmitigated greenhouse gas emissions may increase global mean sea-level by up to 1m during this century. Such elevation of the mean sea-level enhances the risk of flooding of coastal areas. Assuming, that existing power plants are protected against a 100-year flood risk, we compute the additional risk of flooding by the end of the century for different US states, if no adaptation measures are taken. The additionally exposed capacity varies strongly between states. For Delaware it is 80% of the currently generated power. For New York this number becomes 63% and for Florida 43%. The capacity that needs additional protection compared to today's status increases by more than 250% for Texas, 90% for Florida and 70% for New York. Current development in power plant building points towards a reduced future exposure to sea-level rise: Currently operating power plants are less exposed than those who have been retired or canceled and currently planned plants will be less exposed than those operating at present. If sea-level rise is properly accounted for in future planning, an adaptation to sea-level rise appears to be possible.

A complete melting of the Antarctic ice-sheets leads to a long-term sea-level rise by up to 65 meters over a time period of several thousand years depending on the amount of carbon emissions within the next decades to centuries. Decommissioned nuclear reactors that will be entombed but not dismantled may represent a long-term risk under sea-level rise. Since potential unstable socio-economic situations or other circumstances may prevent premediated dismantling intentions, it is necessary to know which sites will be affected by future sea-level rise. We computed the available dismantling-time for all nuclear reactors in the world. Operating, planned and nuclear units under permanent shutdown were considered. Our results show that, for example, for a 5120 Gt CO2 emission scenario more than 50% of all nuclear reactors in the world are exposed to sea-level rise within the next 5000 years. Of those exposed, 90% already within the next 2000 years.

P-2210-02

Climate change impacts on mangrove ecosystem

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Mangrove forests are a major ecosystem of tropical coasts that support a wide range of ecosystem services, including protection against coastal erosion, a significant carbon storage capacity, nursery sites for marine species, and retention of terrigenous pollutants. Over the last few decade, mangroves have, however, been significantly decimated by direct human activities with the development of shrimp farming, urban expansion and agricultural practices.

Mangroves are also particularly sensitive to climate change, with different impacts on ecosystem structuring, functioning and dynamics. Sea level rise could promote landward mangrove migration, while high levels of atmospheric CO2 could enhance mangrove tree growth. A lower frequency of extreme low temperatures should facilitate a poleward expansion of mangroves, whereas extreme events such as cyclones and tsunamis should lead to mangrove retreat or demise. These processes are recognized variably worldwide. In particular, climate change impacts associated with direct, growing anthropogenic disturbances should drastically alter mangrove ecosystem services.

In this presentation, specific impacts and adaptive strategies of mangroves in the face of climate change will be addressed, with a specific emphasis on the mangroves of the French tropical overseas territories, and in the framework of the CNRS/IRD's 2015 Year of the Mangrove initiative.

P-2210-03

Islets of New-Caledonia lagoons in the perspective of Climate change and sea level rise

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Context and problematic: On July 7th 2008, UNESCO included parts of Lagoons of New Caledonia in the list of the Reef Diversity and Associated Ecosystems. Sandy islets from New Caledonian lagoons lie on lagoonal reef platforms or on the reef barrier.They have a major role in these specific and rich ecosystems, being the seat of nesting for turtles, seabirds, sea kraits etc. In addition, islets have a high importance in the Caledonian culture and way of life; economy of the islands has been developed around tourism and services with specific activities such as sports and relaxation. One of the recurrent issues for people and governmental agencies concerns the islets's future in the perspective of Climate Change and Sea Level Rise. In this context, the Coastal Observatory of New Caledonia (OBLIC) has initiated research about the recent and present evolution of islets in order to predict their "behavior".

Method: Around twenty islets from the southwestern and eastern lagoons of Grande-Terre (New Caledonia main island) and one from Nokanhui atoll (Ile des Pins) have been studied. Such studies integrate field work and observations (erosion scars, accretion area, sedimentology, etc.) and analysis of historical photographs and satellites images. Geomorphological and sedimentological data have been collected during 2013 and 2014 field surveys. Past extensions of each islet have been interpreted using available aerial views and satellite sensing. Old aerial photographs are rather rare because islets being sometimes quite away from the shore, they were not covered by aerial survey of the main island. All available data have been integrated in a GIS. Thus, islets's reconstitution extends from one decade to 70 years. Time evolutions of shape and surface of each islet have been mapped in order to compute surface changes and the present percentage of coast's lengths in erosion, in accretion or stable. Moreover, the forcing factors such as winds, wave, tropical storms or cyclone, and the ENSO have been analyzed, in order to understand potential links with the islet behavior.

Results: In terms of size and shape, a high diversity and a variety of evolution trends of islets during the past decades can be noticed. Actually, processes affecting the coast of each islet (erosion, accretion, stability) are highly variable. All islets have at least 50% of their coasts affected by erosion and for four this rate is close to 100%. Islets showing increasing surface during the past years are very rare. Analysis and observations show that five main stages constitute the life-cycle of Caledonian islets, namely: nucleation, growing, maturity, decay, relic or endangered. Changes of environmental parameters and forcing factors as well as the inherited geomorphology lead the islets from one stage to another. The becoming of each islet is linked to its past evolution, its present state and future evolution of environmental parameters. Parameters are linked to the climate variability like ENSO or IPO which control the intensity and direction of trade winds and the average sea level in the SW Pacific. Forcing factors include also extreme events like cyclones, storms and austral swells which can trigger at very short term powerful erosion or accretion with high impact on the islet. Sea level rise induced by the anthropogenic climate change has also to be taken into account. Using our data and informations and postulating that the current situation remains identical, we consider that : 19% of the islets are in a critical state with a very likely disappearance in the next future (few years); 10% of the islets are in a critical situation with a likely disappearance in the next future

and very likely disappearance in the middle term (next decades); 19% of the islets show a rapid evolution which can lead to their disappearance in the middle term but not in the next future; 10% of the islets are not endangered at short and middle time scale and 43% of the islets are not endangered at all (stable or accreting, large surface, relatively high altitude). Our results show that situations are contrasted from one islet to another. We have also to emphasize that uncertainties are higher for middle and long term future due to uncertainties about the sea level. Uncertainties are also linked to the potential reaching of a thresholds value (value and rates) which would lead to a modification of the resilience capacity of each islet. Thus, a coastal observatory will be of first importance in monitoring the impact of climate change and sea level rise on such systems.

P-2210-04

Sea-level rise impact on European shelf tide dynamics

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Sea-level rise (SLR) affects not only the total water level, but can also modify the tidal dynamics. Several studies investigated the SLR effect on the tide of the Western European continental shelf, analysing the tidal dynamics (mainly the M2 component) for various SLR scenarios or coastal defence schemes.

The present study aims at completing existing knowledge, using a modelling based approach, investigating 11 uniform SLR scenarios from -0.25 to +10m, and analysing the effect on high/low tide water level as well as the amplitude and phase tidal components. Sea-level rise scenarios include the present sea-level, as well as several idealized scenarios that correspond to plausible sea-levels for more or less distant past or future. On the one hand, the -0.25m scenario can be considered as a low bound for the preindustrial sea-level. On the other hand, positive SLR scenarios correspond to more or less plausible sea-levels in the future: according to IPCC, a rise of sea-level of +25cm is likely by 2046-2065 whatever the climate change scenario, and the likely range for high emissions scenarios reaches 0.5 to 1m by 2100. While higher SLR scenarios are not excluded by 2100, sea-level will continue to rise beyond 2100, and it is likely to reach values of several meters by 2200 and beyond. Finally, the +10m SLR scenario corresponds to a situation where most Greenland and west-Antarctic ice-sheets have melted.

Assuming that coastal defences along the present day shoreline are maintained and upgraded, the patterns of increase / decrease of high tide level (annual maximum water level) are almost stationary in most of the area (70%), with an increase in most of the domain and a decrease mainly in the Western English Channel. These changes are globally varying linearly with the SLR, till the +2m SLR scenario, with rate ranging between -15% and +15% of SLR. The main patterns are: (1) a decrease in the Western English Channel, (2) an increase in the Irish Sea, Southern North Sea and German Bight. The analysis of tidal component contributions shows that high tide level changes patterns are not exactly similar to M2 pattern changes (e.g. along the French Atlantic coast, high tide level increases whereas M2 amplitude decreases). This highlights the need to take into account all the components when analysing SLR effect on the tide. The main changes in the maximum water level result from the changes of the M2, S2, N2, M4 and MS4 components. Sea-level rise pushes several areas (e.g. Atlantic coast, Irish Sea) closer to resonance, leading to the increase of the resonant tidal components (especially semi-diurnal or quart-diurnal, depending on the area).

The linear behaviour of tide dynamics with the SLR is highly sensitive to the coastal defence strategy (i.e. let flood or not), the high tide level varying much less linearly with SLR when flooding is allowed, like for instance in the German Bight. However, several areas appear not sensitive to this choice, such that the estimated trends there are highly probable: an increase of ~6% SLR (resp. decrease of ~15% SLR) in the North of Irish Sea (resp. in the Western English Channel).

Finally, preliminary investigations show that, at least, for the non-uniform SLR scenario we computed, the high water level is very weakly sensitive to the (non)-uniformity, local rates of increase/decrease (relative to local SLR) being similar to the ones obtained from uniform SLR scenarios.

P-2210-05

Vulnerability of Coastal Crop Land to Climate Change in the Northern Part of Bay of Bengal: Issues, Challenges and Future Prospects

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The coastal communities of northeastern part of Bay of Bengal are used to live and survive through facing different types of natural disasters since primitive time. Among the natural disasters, salinity intrusion due to climate change and sea level rise in the coastal agriculture land is the major unpleasant incident now days. Because of that wide area of the coastal agricultural land, coastal forest, drinking water facilities and fresh water availability are in critical condition which may cause 40 million people of 147 coastal districts covering 47201 km area are placed in danger. The nation wide assessment on the detected of coastal soil and water salinity is not conducted since 9 years. The survey on the coastal soil salinity on 1973 and 2000 found that the saline effected land is increased from 0.83 million ha to 1.20 million ha within 27 years. It is assumed that at present the rate of salinity intrusion in the coastal agriculture land will be higher than those of 1973 and 2000. The soil salinity was recorded 18-20 ppt after AILA in the south-eastern coast of Bangladesh and increased further 2-4 ppt due to low precipitation which causes crop burning. This paper aims to know the salinity intrusion in the coastal soil and water of Bangladesh, which would help to plan and improvement of the sustainable agriculture production. Study revealed that to face any extra stresses on the coastal agriculture land due to climate change requires extensive inventory, awareness activities, mitigation measures, adaptation techniques and extension of indigenous technology.

P-2210-06

Impact of climate change on estuarine ecogeomorphology, and application to the Loire estuary

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Besides temperature increase, the main expressions of climate change in estuarine environments are sea level rise and possible change in storm regimes downstream, variations of river flow and solid fluxes upstream. For instance, in northern Europe, lengthening of the low river discharge duration is often predicted, leading to salinity intrusion and upwards shift of turbidity maximum in estuaries, with possible effects on water quality.

Previous modelling work on the Loire and the Seine estuaries (France) suggested that sea level rise (SLR) would only induce a moderate upstream shift of saline waters and turbidity maximum. These computations assumed no morphological coupling. However, expected changes in erosion/deposition patterns due to modified forcing conditions are likely to modify the estuarine morphology. These morphological processes have the same time scale as climate change, so that SLR consequences are likely to depend on the rate of climate change. Supported by the French Ministry of Environment (project GICC/C3E2), the present study aims to answer these questions, with a focus on the impact on tidal marshes frequently located on estuarine banks. Because these areas have the same elevation as spring tide high water, they are occasionally flooded and even a slight SLR is likely to dramatically alter their inundation frequency. A main question is to know whether the marsh elevation is likely to increase at the same rate as the sea level, or flooding will become more frequent.

Two models have been developed to address these

questions. A first one accounts for morphological coupling and deals with schematized and simplified morphologies. The study aims at classifying the estuarine systems response to climate change according to various types of hydrodynamic forcing (tidal amplitude, river flow), bed sediment nature and sediment inputs, and morphological configurations. The model is fully process-based, with a sediment module that accounts for sand and mud behaviour. Long term simulations (typically 100-200 years) are achieved thanks to the use of a morphological factor.

A second model is a similar process-based model with muddy mobile sediment, applied to the Loire estuary. The computation grid is refined in intertidal areas, allowing accurate simulation of specific hydrodynamics in a realistic and complex network of creeks and vegetated areas. This model is used to predict sediment deposition on lateral marshes, and its variation according to the location of the turbidity maximum which is related to the river flow. The model has been validated against field measurements, in terms of inundation heights, flow structure and intensity, suspended sediment concentration and sedimentation rate.

Tests on schematic geometries show that (1) SLR increases the tidal oscillating volume and consequently the hydraulic energy within the estuary, which results in channel widening or the development of creeks in elevated marshes; and (2) a strong dependence on the upstream sediment input : high sediment fluxes increase the sedimentation on the intertidal flats, while these flats are likely to be eroded in case of sediment deficit.

In cases of reasonable sediment input, a 1 cm/year SLR is never compensated by sedimentation, and flooding rate increases. When the SLR stops, lateral sedimentation is likely to continue, inducing a following reduction in the inundation rate. All these features are strongly dependent on the initial configuration, in particular the cross profile of the alluvial plain which allows or not any lateral extension of the flood. Surprisingly, vegetation on marshes does not seem to impact these processes much.

Simulations on the Loire estuary were run for the coming 30 years, and based on a 34cm SLR and longer low river regime duration, as predicted by hydrological regional models (project ICC Hydroqual). Results show that the turbidity maximum would slightly increase (despite a reduction of upstream sediment input) and would shift 5 km upstream, like salinity intrusion. Only a small fraction (5-10%) of the mobile sediment stock would supply lateral sedimentation, not enough to compensate SLR. Based on recent observations and comparison with 30 years old data, the potential effect on vegetation was assessed : upstream shift of halophytes and development of helophytes on marshes.

P-2210-07

Coastal erosion and Shoreline Changes assessment in different climatic periods in Kalpitiya Peninsula, Sri Lanka

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Sri Lanka is an island located in Indian Ocean with a total coastline of length approximately 1600km. Western part of Sri Lankan coastal zones are facing shoreline retreat problems, losing territory due to monsoon wind sea actions, negative sediment transport balances and climate change phenomena. To deal with this problem, efficient tools are necessary to help decision-makers choose the right procedures to follow. These tools should assess, estimate and project scenarios of coastal evolution in a medium-to-long-term perspective. To perform reliable projections, as many variables as possible should be analyzed, and the impact of each of these variables on the shoreline evolution should be understood. The study has been conducted to evaluate and identify the Shoreline changes during the past 15 years in Kalpitiya peninsula. Both Remote Sensing and Image processing techniques were used to extract Shoreline. Shoreline vector data method was used in Digital Shoreline Analysis System (DSAS) of ArcGIS10.1 to estimate the change in shoreline (positive or negative). R 2.14.0 was used to calculate relationship between time and sand deposition/erosion in Kalipitya Peninsula. In this ongoing study, temporally shoreline changes of Kalpitiya peninsula to be investigate on ArcGIS 10.1 with DSAS tool. It was find out maximum and minimum Shoreline Change rete as well as Shoreline erosion rete in Kalpitiya Area. The Multiple R-squared of time and Shoreline change distance was recorded positive relationship such as 0.97, at the confidence level of 0.05. These results shows North Western part coast area in Sri Lanka. The study defined a methodology for classification of risk areas in Kalpitiya coast, considering the uncertainty associated with erosion and wave climate sequences. The study help to identify and prepare different risk maps according to considered climate change effects were obtained, defining areas of high, medium and low risk of territory loss due to erosion.

P-2210-08

Urban Landscape Remodeling for Climate Resilient Neighborhoods in Coastal Mega-cities of India Using Integral Geographic Information System: A Participatory Urban Climate Change Risk Reduction Framework for Greater Mumbai Metropolitan

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Indian coastal metropolitans represent the most densely populated and highly congested urban areas and rank among some the largest urban settlements of the planet in terms of population. However these mega-cities are characterized by inadequate infrastructure, lack of civic amenities and constraints of access undermining carrying capacity and resilience of urban ecosystems. Climate change has increased vulnerability of large population, particularly poor and marginalized, living in rapidly growing coastal mega-cities to increased frequency, severity and intensity of extreme weather events, particularly high intensity rainfall, floods and cyclone. Moreover, long-term impact of climate change is expected to result in uncertainty pertaining to energy consumption, and thereby reducing efficiency of urban energy systems and pushing carbon footprint further. Furthermore, temperature extremes are likely to adversely affect the accessibility to green and open spaces, and community services, particularly water, sanitation, health, public transport, markets and community centers posing serious threat to live-ability and resilient lifestyles. These changes are offsetting the interconnected network of urban infrastructure and services in sprawling coastal cities. Study aims at evolving participatory climate resilient urban neighborhoods through urban-surface 'remodeling' approach in 'Integral Geographic Information System' (GIS) environment for coastal megacities with the illustration of Mumbai.

The paper uses terrain analysis tools in integral geographical information system platform to identify and map the climate susceptible urban fabric and check its scope for urban landscape remodeling without adding to its (often) complex fragmentation. Harmonizing with people's perception and adaptation knowledge, and incorporating options and priorities of city administration and other stakeholders, the urban surface remodeling through integral GIS ensures inclusive solutions with reduced vulnerability and increased resilience. The application of integral GIS resolves conflicting perspectives, interests, and approaches of the multiplicity of stakeholders involved at various levels in climate smart urban planning. It ensures barrier-free climate communication process for decision making while looking for long term feasible outcome of remodeled surfaces. Surfaces available for remodeling include paved ground, streetscapes, commercial facades, rooftops, open areas, public spaces as well as dark corners (such as under flyovers). Remodeling alters certain characteristics in the intrinsic or extrinsic cross-section profile or in both (if suitable) with blue and green infrastructure measures that collectively involve ecosystem services for greater hydrological connection. The method fairly reduces exposure of vulnerable surface and minimizes risk to achieve an extremity-neutral state, forming the key to urban resilience.

The outcomes of this paper included measures for prevention of choking of drainage system during high intensity rainfall, therefore minimizing the risk from extreme weather events. Remodeling looked for efficient

heat transfer without contribution to urban heat island during upper extremes of temperature. The blue and green infrastructure measures enhanced natural services namely: temperature regulation and maintenance of humidity, which are otherwise lost during climate-extremes, through cooling via evapo-transpiration. Experience gained through study is likely to help individuals, stakeholders, and organizations involved in the process of urban climate change adaptation governance in coastal megacities all across the developing countries.

P-2210-09

Control of mangrove abundance by decadal changes in oceanic wave fields

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The ocean surface is crossed by fields of wind-generated waves. These can travel over basin-wide distances and drive a large portion of coastal sediment transport when they reach continent margins. The variability of wave fields is thus of crucial importance to understand observed natural changes of coastal areas such as tidal wetlands. However, to date, no studies have tackled this issue at regional scale and over the course of several decades. Here, we provide a 64-year analysis of coastal changes on the open-coast mangrove shoreline situated downdrift of the mouth of the Amazon River. We show that over 1950-2014, changes in North tropical Atlantic wave heights have primarily affected sediment dynamics leading to important natural variations observed in mangrove surface area. We show that mangroves mostly respond to low frequency fluctuations of wave fields mainly associated with the decadal variability of the wintertime North Atlantic Oscillation. Our results emphasize the need for a better understanding and quantification of the role of natural climate variability on coastal dynamics. This can be crucial in anticipating the near future evolution of tidal wetlands and their Carbon stock in the context of anthropogenically climate change.

2211 - Climate change in mountains: from impacts to resilience

ORAL PRESENTATIONS

K-2211-01

Impacts on society and economy of a changing climate and climate-generated hazards on mountain water resources

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Mountains represent significant features covering nearly one-quarter of the world's terrestrial surface. Mountains support a range of socioeconomic sectors (e.g., tourism, forest production, ecosystem resources) that have experienced considerable change in the last two centuries, resulting from pressures on natural resources and traditions imposed by increasingly-industrialized societies. Development trajectories of these high-value environments vary considerably across the globe, but certain mountain regions have been extensively transformed, converting them from inaccessible and relatively poor hinterlands into attractive destinations for the wealthy, sometimes excluding longtime inhabitants from economic benefits. In certain cases, outmigration and an aging population have led to economic declines in agro-pastoral and forestry production. Across the world, such transformative processes in mountain social-ecological systems have been accompanied by profound social, institutional, and environmental changes. As a major supplier of resources, mountains collectively represent in particular the source region for more than 60% of surface waters. A significant fraction of world's population in lowland regions depends on mountain water resources for agriculture, industry, energy, and domestic water supply.

Rapid climate change occurring in mountains carries broad implications, given that such regions have long been a source of valued ecosystem services and natural resources. For example, future shifts in temperature and precipitation patterns, and changes in the behavior of snow and ice in many mountains may ultimately change the quantity, seasonality, and possibly also the quality of water originating in mountains and uplands. Natural processes controlled by hydro-meteorological triggers (e.g. floods, landslides, debris-flows, earthflows and rockfalls, glacier melt, river erosion) will in a future climate add further environmental pressures on both social and natural systems, thereby highlighting the need to promptly conduct proactive adaptation plans.

The challenge for both mountain societies and those located downstream but dependent on mountain water resources in particular is thus to estimate as accurately as possible future changes in water availability. This will help to prepare the way for appropriate adaptation strategies and improved water governance. Enhanced awareness and appropriate policies aimed at alleviating the more adverse climate impacts would help indigenous populations to better adapt to rapid change, and for water-dependent economic sectors to pursue their activities with lower risks of economic rivalries or conflicts.

O-2211-01

Challenges and Possibilities for Sustainability in Mountain Social-Ecological Systems: Results from a Global Analysis

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Mountain regions provide critical hydrological and diverse ecosystem services to over half the planet's human population, most of whom live in the lowlands. At the same time, mountain systems face mounting pressures from climate, policy and economic change. Based on 48 mountain case studies from around the world, we describe the suite of characteristics and incongruities that create particular challenges for mountain sustainability, and also present a conceptual model of mountain social-ecological systems (MtSES) that highlights the broad processes driving mountain system dynamics and their ecosystem services from local to global scales. We focus our analyses across all of the mountain case studies, between subsistence and non-subsistence based mountain regions, and among land use groups that are dominated by tourism, pastoralism and crop agriculture. We then explore the use of coupled models explaining social behavior, policy and management, and economics with models simulating biophysical processes as a potential tool for identifying sustainable trajectories in mountains, particularly when used within a transdisciplinary framework. We present an analysis of existing coupled social-ecological models in mountains and examine how these models are currently employed to address critical mountain sustainability issues.

Our analyses reveal patterns in mountain characteristics, livelihood strategies and associated challenges for sustainability. Mountains are geographically and culturally complex systems that deliver ecosystem services from local to global scales and are prone to hazards and extreme events. Particularly among the subsistence-based sites, mountains continue to be physically remote and distant from centers of power and decision-making. These

features, combined with high representation of indigenous peoples and cultures, result in social, economic and political isolation and marginalization. Stemming from the dynamic and non-linear interactions of the mountain characteristics are mountain-specific problems that are multidimensional, often lacking clear definition and optimal solutions, so-called "wicked problems", which we identify as incongruities. The most ubiquitous incongruity across all of our mountain case studies is that 'policies affecting mountain systems are made by outsiders', a phenomenon that results in perverse policies and present barriers to climate change coping mechanisms and adaptations.

Climate change, extreme weather events, markets, policy, and land use change are key drivers across all case study sites, while phenomena such as land tenure change, resource extraction, and land cover change are more important within subsistence-based mountain sites. We explore the primary scales at which these drivers occur and how they interact with mountain land use and livelihood groups, and with the delivery of mountain ecosystem services across scales.

Based on our analysis of social-ecological modeling studies in mountains, we suggest that a coupled model involving multiple levels of participation, such as local resource users and policymakers, could be a powerful tool for engaging stakeholders and decision-makers about future trajectories of MtSES. We also conclude that while modeling efforts are currently focused on system understanding and prediction, there is great potential to also employ models that foster social learning and communication.

We conclude by identifying knowledge gaps and challenges regarding mountain sustainability. For a next step, we propose to use transdisciplinary modeling approaches in mountains, including co-creation of knowledge, participatory approaches, and coordinated practices, all of which are essential for sound decision-making and building resilient futures.

O-2211-02

Facing climate change in the Peruvian Andes: implications of shifts in precipitation patterns, river discharge and the availability of water resources for local communities and options for adaptation

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Communities in the high Andes are considered among the most vulnerable to climate change for various reasons. For instance, they rely on an agriculture that is largely practiced at a subsistence level and exposed to droughts, frosts, late season warm spells, pests and diseases. Also human settlements are often endangered by floods and landslides, which have not only been the cause of damages to buildings and infrastructure but also responsible for numerous casualties in the recent past. In view of a possible decrease in seasonal precipitation amounts but a more frequent occurrence of intense rainfall events, this situation is likely to worsen in the future as a consequence of climate change. This calls for cross- and interdisciplinary programmes that can help improving the resilience of Andean communities.

In response to this call, the Peruvian Ministry of the Environment, in collaboration with the Swiss Agency for Development and Cooperation (SDC) under the Global Programme Climate Change (GPCC), initiated in 2009 the "Programa de Adaptación al Cambio Climático en el Perú" (PACC), a programme that is now in its second phase. Involving practitioners and scientists from various disciplines, the specific goal is to build awareness, improve preparedness, and support and promote the process of adaptation. Its implementation includes the scientific assessment of climate impacts, vulnerabilities and risks, and the practical evaluation of adaptation options. This can be considered as a minimum framework to move from impacts to resilience.

With a focus on the implications of seasonal shifts in the precipitation regime for water availability and river discharge, in this contribution we present a few examples that illustrate the two steps involved in the implementation process. We first report on a modelling study of the impacts of climate change on the water resources in the Vilcanota river basin. The results indicate an increase in river runoff during the rainy season, but an overall decrease in water storage. The former is expected to lead to higher flood peaks, whereas the latter is expected to entail water shortage, in particular during the dry season. This is of concern because communities have already to face loss of glacier ice in the Cordillera Vilcanota, a process that is already changing the seasonality of water availability.

The second example is drawn from studies aiming at assessing the potential impacts of changes in temperature and precipitation on rainfed annual crops in the Central Andes of Peru. While in the near future not all crops would suffer from the projected decrease in water availability, it is shown that adaptation of the agricultural practices are necessary in the mid and long term to sustain production and improve the livelihood of the local population. Suggested adaptation measures include the adjustment of cropping calendars, the introduction of more robust crop varieties and alternative cropping systems and reconsideration of land use.

The third example shows how the rediscovery of low-cost, traditional technologies can contribute to improve the resilience of rural communities facing a decreasing availability of water resources. Specifically, we report on the outcomes of an effort to promote rustic micro-reservoirs called qochas. These were already used in ancient Peru but had largely fallen in disuse until recently. As a test, about 150 qochas were built between 2012 and 2013 in two small watersheds of the Peruvian Altiplano with the help of farmers and their families. Benefits from their establishment have included the recovery of downstream springs, the recovery of vegetation in the surroundings of the reservoirs and an overall easier access to water during the dry season.

O-2211-03

Impact analysis of Climate Change on Glacier and Water Potentiality in High Altitude Region of Western Himalaya

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Present research aims to investigate the issues concerning ecohydrology and potentiality of water in high mountain areas of Western Himalaya. Hindukush-Himalaya (HKH) region are the source of perennial rivers of South and East Asia which feed almost half of the world population. For the climate, people, economy and ecology, Hindukush-Himalaya region are known as "Human Equator" as drinking water for humans and animals; water for irrigation of food other agronomic practices; and, a very mountain-specific use: hydropower depend on water of the HKH Mountains. Increasing populations and economic transformations have exerted considerable pressure on land and water resources in Western Himalaya. Such changes have brought modifications in water flows, nutrients, sediments and pollutants as well as loss of biodiversity. Hence, the ecohydrological processes in headwater regions of western Himalaya, especially the role of natural processes, impact of human interference and climate change on the availability of water, highland-lowland interactive linkages, and sustainable use of water require attention for planning and conservation. Therefore, there is an urgent need for a better understanding of the vulnerability of the land-water system to human activities and climate change impacts in high mountain region of Western Himalaya.

O-2211-04

Past and future changes in seasonal snow in the French Alps : implications for water resources, mountain tourism and avalanche hazard

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Snow on the ground is a key environmental and socio-economic component of mountain regions. Storage of water in the form of snow during the winter period provides freshwater input to ecosystems, agriculture and human consumption. Natural hazards such as snow avalanches and snowmelt floods cause loss of lives and disruption of human activities. Snow plays a pivotal role for numerous socio-economic activities such as hydropower (electricity generation and industry) and winter tourism.

The French Alps have encountered significant changes of snow conditions over the past decades, which can be inferred at the massif scale using the dedicated meteorological analysis system SAFRAN feeding the detailed snowpack model Crocus. Superimposed over a large year-to-year variability, these changes are most pronounced in mid-altitude areas which are highly sensitive to the rain/snow partitioning of precipitation. Such an extensive reanalysis of meteorological and snow conditions has been further used to un-bias and downscale regional climate model projections spanning the XXIst century. The presentation will highlight key results at the scale of the entire French Alps obtained using CMIP3 projections and preliminary results using CMIP5/EUROCORDEX projections.

The interpretation of the numerical simulations spanning the observational era for the past decades and an ensemble of climate projections into the XXIst century not only addresses changes of snow conditions in terms of snow water equivalent, relevant for water resources, but also trends in the seasonality of discharge in selected catchments, avalanche hazard and resort-level snow viability. The latter is currently being developed accounting not only for meteorological drivers of snow on the ground but also socio-economic components of mountain tourism including snow management practices and the spatial organization of ski resorts. This approach seeks at contributing to an integrated representation of the impact of climate change in mountain areas thereby helping to quantitatively assess the resilience of these sensitive environmental and socio-economic systems.

O-2211-05

Challenges and needs for interdisciplinary studies on mountain water resources: curent issues and perspectives

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Hydro-meteorological observations coupled with snow and ice measurements are the basic material for a number of scientific and operational issues linked to socio-environmental needs. They are required for studies aiming at understanding and/or modeling climate-environment-society interactions along with their spatial and temporal variations. They constitute also the basic information for estimating hydrological resources and risks, real time operations or prospective studies for water management. The aim is to foresee adaptations strategies required by societies to face changes in resource and risks induced by ongoing global change. In mountainous areas, such observations are even more pronounced and variable than anywhere else, as hydro-meteorological events are more pronounced and variable than anywhere else. Major difficulties due to topographic constraints as elevation and slopes, added to strong local weather conditions, reduce the capabilities of long-term observation networks in regard of lowlands observing systems.

Supported by the Laboratory of Hydrology and Environment (LTHE) and the Laboratory of Glaciology and Environmental Geophysics (LGGE), Grenoble (France), we focus here on some "Hot-Spot" application areas which federate cross-disciplinary approaches over several thematic fields (hydrology, glaciology, natural hazards versus socio-ecological systems), linked to national Programs (ANR, local stakeholders) and long term Observatory Programs (e.g. Glacioclim, Great Ice/IRD). Specific examples of case studies will be presented: the Chamonix-Mont Blanc area in the Alps (Europe), the Koshi river basin in the Himalayas (Nepal), and the Zongo glacierized catchment in the Andes (Bolivia). The interest of such federative application areas is highlighted by various key hydrological issues, taken from the operational research or environmental monitoring domains. Measurement networks and observatories developed to meet the corresponding objectives are presented. Limits of observations, associated to the measurements themselves, spatial representativeness and temporal coverage are discussed. Some perspectives for improving current observations systems are finally suggested.

2211-POSTER PRESENTATIONS

P-2211-01

Society adaptation for coping with mountain risks in the climate change context

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Mountains represent an important part of the global earth system. Because of their vertical extent, climate varies drastically with elevation and thus differs from those in adjacent lowland areas. Natural processes controlled by hydro-meteorological triggers (e.g. floods, landslides, rockfalls) will add further environmental pressures on both social and natural systems, stressing the need to promptly conduct proactive adaptation plans. The relevance of mountain hazard and risk zonation for environmental policy and decision making is set forth in the European Thematic Strategy for Soil Protection and the associated proposal of a Framework Directive, in which hydro-meteorological hazards are considered as one of the soil threats for which it is necessary to identify risk areas where risk reduction measures have to be implemented. However, to implement risk mitigation strategies in an integrated way (e.g. including physical but also economic and social adaptation), additional research is needed on how climate controls mountain hazards occurrence. The influence of climate and climate change on slope stability and floods over various spatial and temporal scales has to be better understood and quantified; studies are also needed on how the main economic, social and political stakeholders interact for the definition of adaptation scenarios at the region scale.

The SAMCO (Society Adaptation for coping with Mountain risks in a global change Context) project aims to develop a proactive resilience framework enhancing the overall resilience of societies on the impacts of mountain risks. The project aims to elaborate methodological tools to characterize and measure ecosystem and societal resilience from an operative perspective on three mountain representative case studies.

To achieve this objective, the methodology is split in several points with (1) the definition of the potential impacts of global environmental changes (climate system, ecosystem e.g. land use, socio-economic system) on landslide hazards, (2) the analysis of these consequences in terms of vulnerability (e.g. changes in the location and characteristics of the impacted areas and level of their perturbation) and (3) the implementation of a methodology for quantitatively investigating and mapping indicators of mountain slope vulnerability exposed to several hazard

types, and the development of a GIS-based demonstration platform.

The strength and originality of the SAMCO project is to combine different techniques, methodologies and models (multi-hazard assessment, risk evolution in time, vulnerability functional analysis, and governance strategies) and to gather various interdisciplinary expertises in earth sciences, environmental sciences, and social sciences.

The climate change inputs of the project correspond to at least 2 scenarios of emission of greenhouse gases. The used simulations available on the portal DRIAS (http://www.drias-climat.fr) were performed with the GHG emissions scenarios (RCP: Representative concentration pathways, according to the standards defined by the GIEC) RCP 2.8, RCP 4.5 and RCP 8.5 for the ALADIN-Climate model of Météo-France, and RCP 4.5 and RCP 8.5 for the WRF model used by the IPSL. The impact of climate change is then firstly addressed through the use of these climate scenarios into hazards computations. In that way, future changes in temperature and precipitation volume and patterns are analyzed, permitting to address the direct and indirect impacts of climatic change on mountain societies and their vulnerability to change.

Secondly, the climate change is also considered in global scenarios, with taking into account political actions at local and global scale that might influence the climate change as well as the land use planning in the areas of interest. It is then possible to identify the most important factors of community resilience (e.g. coping capacity) and their dependence upon controlling factors in order to propose risk management strategies adapted to possible impacts of global changes.

P-2211-02

Hazard Assessment of Glacial Lake Outburst Flood and Potential of ICTs for Coping: A Case of Eastern Himalaya of Nepal

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Retreat of glaciers and formation of glacial lakes in Nepal Himalaya have been reported to be related with the temperature rise in the region. Glacier Lake Outburst Floods (GLOF) are the growing climate induced hazards in the Himalaya. GLOF has increased the vulnerability of community and fragile ecosystem in the mountain valleys. This study has analyzed the potential impacts from GLOF in the highland of eastern Nepal and the potential role of Information Communication Technologies (ICT) to cope with such impacts. I analyzed the trend of climatic pattern (temperature and precipitation) of the Eastern Himalaya Region of Nepal available from the Department of Hydrology and Meteorology, Government of Nepal, and prepared the latest location map of the glacial lakes using google earth and ArcGIS applications in the highland of the Kanchanjungha Conservation Area of the region. Tiptala glacial lake, located at an elevation of 4950 m, within the conservation area, was selected for the GLOF hazard assessment. I used semi-structured questionnaire survey and key informants' interviews in the community in order to assess the potential hazard of GLOF. With the varying sizes, 46 glacial lakes were located in the region, which covers over 2.57 sq. km in total. Though the larger portion of the downstream area of the Tiptala glacial lake fall in the remote location away from major residential area, few villages, major pasture lands for Yaks, foot trails, and several bridges across the Tamor River below the lake are in risk of GLOF. Poor access due to extreme geographical remoteness and capacity to afford the modern technologies in the community are the major limiting factor to the knowledge and information about the climate change and related impacts. Modern ICTs has high potential to reduce the risk of climate related hazards in the remote area by information dissemination and awareness.

P-2211-03

On the impacts of global warming on the deep peri-alpine Lake Geneva

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Observations over the period 1880 to 2012 indicate that the globally-averaged surface temperature data has increased from 0.65°C to 1.06°C IPCC (2013). During the 20th century, European climate experienced a surface air temperature warming of 0.9°C, resulting in a wide range of impacts that followed the first signs of change. Global-mean surface temperature exhibits temporal and spatial variability. According to projections made for future climate, southern and central Europe would experience the largest changes in mean air temperature during summer while the northern regions would be more strongly affected during winter. Higher inland freshwater temperatures have been reported in response to warmer conditions. In many western European lakes climate warming has resulted in increased water column stability, longer stratified periods, and warmer temperatures in the epilimnion. These findings are in agreement with the observations for other middle- and high-latitude lakes. Jeppesen et al. (2012) analysed the impacts of climate warming on the long-term dynamics of key fish species in 24 European lakes and found the mean water temperature of Lake Geneva increased by 0.17°C per decade since 1986, and lake stratification occurs "apparently" one month earlier than it did 30 years ago. This has impacted the fishery, with conditions favouring warmer water species and a dramatic reduction in some others. While the impacts of changes in climate in the Alps have been reported by many authors, very few studies have attempted to relate future climate projections to their potential impacts on peri-alpine lakes. This enhances the need to lead investigations on a variety of lakes, grabbing the opportunity to develop new methods. In order to avoiding the computational load of complex models such as Global or Regional Climate Models, the use of a Single-Column atmospheric Model (SCM) coupled to a lake model provides a practical and economical framework for assessing the sensitivity of water temperature profiles to current and perturbed climatic conditions. Lake Geneva is a 89 km3 body of water shared by Switzerland and France, and greatly exceeds in size and depth all others that are connected with the main valleys of the Alps. Analyses reported by Anneville et al. (2013) from long-term observations and findings of research projects both led to the conclusion that climate change has already impacted Lake Geneva ecosystems and these are likely to continue when considering the predictions based on complex climate models. In a recent study on Lake Geneva by Perroud and Goyette (2012) using a SCM coupled to a lake model, it has been shown that increasing the atmospheric greenhouse gas concentration impacted the lake's thermal structure, increasing the stability of the water column and extending the stratified period by 3 weeks. Epilimnetic temperatures were seen to increase by 2.6°C to 4.2°C, while hypolimnion temperatures increased by 2.2°C. Climate change modified components of the surface energy budget through changes in air temperature, moisture, and cloud cover. A strong rate of change in the epilimnion temperature found in Spring, would lead to an earlier onset of thermocline formation and this may explain the advance in spawning as reported by Gillet and Quetin (2006). At the same time, changes in plankton population dynamics with an advance of the spring bloom can be expected and may affect the timing of the clear-water phase of the lake. Climate, freshwater, biophysical and socio-economic systems are interconnected in complex ways (IPCC, 2008). Freshwater-related issues are critical in determining regional and sectoral vulnerabilities, as aquatic ecosystems provide a wide range of goods and services. Therefore, the relationship between climate change and freshwater resources is of primary concern to human society and also has implications for all living species.

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P-2211-04

Projected changes on the surface water resources of the Rherhaya basin (High Atlas, Morocco) by a set of Med-CORDEX models

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To anticipate the potential changes in water quantity available within the Rherhaya mountainous watershed (near to Marrakech), it's important to know the evolution of this resource in relation with climate changes. In this study we use the GR4J model with a snow module with time series of precipitations and discharge (1989 – 2009). The model was calibrated and validated successfully over various periods. Then we used an ensemble of 5 regional climate models (RCM) provided by the Med-CORDEX program with a method of perturbation by quantiles to simulate future scenarios of flow predictions.

The evaluation of the precipitations simulated by the RCMs models (RCM) shows a strong underestimation of ~50% but a good reproduction of the cycle for the temperatures. The future changes according to two scenarios RCP4.5 and RCP8.5 show a rise of the temperatures (+1.4°, +2.6° respectively) in conjunction with a decrease in total precipitation (-19%,- 31%). Concerning the hydrological modeling with GR4J, stable results are obtained for calibration and validation whatever the chosen period, with maximum bias of 15% in validation on the monthly flows. Flow forecasts (2049-2065) present a strong projected decrease in surface runoff (-30%, -60%) and significant drops of the snow-covered reservoir levels, related to the precipitation decrease and the temperature increase.

P-2211-05

Debris flow in the French Alps in changing climate

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In the Alps, debris flows are a major threat as they periodically damage infrastructure, may even cause loss of life. The triggering process is definitely sensitive to climate change due to an interaction between meteorological and geomorphological factors, such as extreme precipitation, the local topography or the accumulation of rock debris. Evaluating the link between climate and debris flow activity is the necessary pre-request to estimate the impacts of future climate change.

Here we analyze the evolution of debris flow occurrence in the French Alps over the last four decades using an innovative probabilistic model which makes it possible to analyse the main environmental and climatic drivers of debris flow occurrence simultaneously, so as to quantify their respective influence at a regional scale.

As a case study, we extract 124 debris flow events triggered between 1970 and 2005 in 27 catchments located in the French Alps from the French national natural hazard survey and model their variability of occurrence considering environmental and climatic predictors at the same time. We document the environmental characteristics of each debris flow catchment (morphometry, lithology, land cover, and the presence of permafrost). We also compute 15 climate variables including mean temperature and precipitation between May and October and the number of rainy days with daily cumulative rainfall greater than 10/15/20/25/30/40 mm day-1. Application of our model shows that the combination of environmental and climatic predictors explained 77% of the overall variability of debris flow occurrences in this data set. We also note that the occurrence probabilities depend mainly on climatic variables, which mostly explain the variability through the number of rainy days and maximum daily temperature. This important time component in the variability of overall debris flow occurrence is shown to be responsible for a significant increase in debris flow activity between 1970 and 2005 at regional scale. Environmental variables, which accounts for 1/3 of the overall variability, includes mostly the morphometric variables of the debris flow catchments.

P-2211-06

Diurnal cycle processes associated with precipitation in central Andes (Peru)

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The identification of regional atmospheric processes is important to understand how the greenhouse gases increase in the atmosphere could affect the precipitation and the water resources at a regional scale.

The atmospheric processes in the tropical Andes climate are of particular interest because in this region, mechanisms are associated with the interplay of complex orography and convective processes characterizing the tropical climate. In the central Andes, physical processes associated with the humidity transport between the wet Amazon on the east and the dry Pacific on the west, and the spatio-temporal distribution of the precipitation are little understood.

The Andes cordillera is extended over almost all South America, that are 7000km between 45°S and 7°N. Its maximum width is 1800km in its central part. This configuration is unique in the planet, and consequently the glaciers in the tropical Andes represent 99% of the world tropical glaciers. These glaciers show a retreat since the PIA with an unprecedent acceleration since 70's. The risks generated by such glacier retreat are here in terms of hydrological resources, agriculture, hydro-electricity, and turism. Tropical glaciers mass balance is strongly depending of humidity and precipitation, so it is important to study localized associated atmospheric processes. The identification of high-resolution horizontal scale climate mechanisms (some km) in terms of diurnal cycle could particularly help to understand how the atmospheric circulation influence the glaciers mass balance at diurnal time-scales. The characterization of humidity fluxes and of the associated spatial distribution of the precipitation in central Andes, with in addition the understanding of localized atmospheric processes in terms of diurnal cycle variability are the main objectives of this study.

Due to a poor number of in-situ meteorological stations in the region of the central Andes, we consider that a dynamical downscaling using a regional climate model is the most adequate methodology to improve the understanding of localized orographic processes in this region. The WRF (Weather Research and Forecasting) model is used to simulate the climatological diurnal cycle of the wet season (austral summer) in the Cuzco region (central Andes), at a 9-km horizontal resolution and 3-hourly time resolution. The precipitation model outputs are compared with radar products of TRMM-2A25 and in-situ observations. Results show that the model is able to reproduce the main diurnal precipitation features with rainfall maximum in the western cordillera during the afternoon, and in the eastern part of the cordillera during the night. The model also simulates both mechanical and thermo-dynamical orographic processes. For example, while some valleys are mainly affected by the well-known diurnal thermal valley/mountain circulation, others are more influenced by the large-scale moisture flow. This difference seems to be linked with the width and the orientation of the different valleys.

P-2211-07

The Himalayan Cryosphere and Highlanders' Adaptability: A Case Study of the Miyar Valley of Himachal Pradesh and North Sikkim in the Indian Himalaya

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Rugged topography coupled with high altitudinal areas between the Great Himalayan Range and the southern flank of the Tibetan Plateau presented a stage where the elements of Nature has been more pronounced than normally they are at other places. Thus, the history of the highlanders of the area has been basically the history of their direct response to the vacillation in the various elements of the climate. The highlanders of 3000 meters and above in both the Himalayan and Trans-Himalayan mountain-scape responded directly to such changes which basically lead to changes in the Cryosphere.

Wandering of the Highlanders across rugged valleys and jagged pastures and passes in and across the Himalaya for trans-ecological exchanges. Initially, it was more of an ecological compulsion for a tenable survival amid harsh environmental conditions of higher altitudinal regions than for fortune or better resources. Thus, leading to making of the neighbouring highland societies both collaborator and competitor at the sometime.

With the basic premise that like any other place on the planet; Himalayan landscape did registered episodes of cooling and warming resulting into both glacial maximum and glacial minimum periods. Thus, resulting into advancement and retreat of permanent snowline in the area. This paper is an attempt to study the human inhabitation response to the cryospheric fluctuations based on the field investigation from Miyar Valley of Himachal Himalaya and North Sikkim in Sikkim Himalaya lying in Western and Eastern Himalaya respectively. This paper also underscores that remote Himalayan valleys have been inhabited since quite an early time rather than being colonised in the recent past.

The study combines the moraine sampling and Optically Stimulated Luminescence (OSL) analysis with simple random sampling and Focus Group Discussion to comprehend and capture the rough period of legends of rise and fall of remote Himalayan Villages which seems to be following the pattern of glacial maximum and minimum periods.

P-2211-08

Impact of the Nurek Mountain Water Reservoirs in Tajikistan on Meteorological Conditions and Agriculture of Coastal Area

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The purpose of the present research is the retrospective comparative analysis of statistical parameters of 60-year temporary ranks of temperature, atmospheric precipitation and humidity and monitoring of influence of the Nurek reservoir on a trend of change of these parameters. For establishment of influence of mountain reservoirs on possible changes of agroclimatic conditions we analyzed a trend of meteorological parameters of two regions of Dangara and Yavan of the Republic of Tajikistan with the developed agricultural branch coastal to the Nurek reservoir. Dynamics of change of humidity of Yavan district demonstrated that humidity of this area had everything the reducing character up to 1980 and was characterized by moderate increase of precipitation. After 1980 sharp increase and humidity and an atmospheric precipitation is observed. Calculations indicate about reduction of an atmospheric precipitation of Yavan for the periods 1950-1979 on 4.7 mm at their increase for the period 1980-2011 to 443 mm that in comparison with 1979 makes about 30%. Change of temperature of Yavan for the period 1980-2011 equals 1.1 C against his increase on 0.97 C for the period 1950-1979. Consequently, existence of the developed network of meteorological stations in mountain districts is pledge of receiving a real scenario of dynamics of meteorological parameters. It should be noted that continuous monitoring of meteorological parameters of large water reservoirs is important from the point of view of development of agriculture. Timely establishment of variations of weather conditions and development of technology of adaptation to the modern meteorological conditions and selection of agricultural grades steady against changes of climatic factors and stressful situations pledge of ensuring food security.

P-2211-09

Creation of modern approach adaptation of water consuming branches to climate changes and degradation of glaciers

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One is actual problems of modernity is Global Climate Change and adequate behavior of the each component of ecosystems to this change. For the Tajikistan 93% territory, which do mountains and which characterized by availability more 8500 glaciers by the total area of 8476.2 km2 occupy, or about 6% of all territory of the Republic of Tajikistan is very important. There is a large unit of conglomeration in mountains of Northwest Pamir with the center of Fedchenko glacier - the largest mountain glacier in the world. By 1988, the glacier has receded more than on 500 m and has decreased on the area for four square kilometers. Average speed of step of Fedchenko glacier for the last century made 10-12 meters one year. Average speed of movement of glacier in connection with loss of weight has decreased with 72 up to 69 sm daily. In total for 20th century the glacier has lost about 12-15 km3 ice. For last 16 years (1990 - 2006 years) a glacier of the Zeravshan River Basin has receded on 35-55 m annually the average its speed has made about 3 m per year though in the eightieth years of the last century it has made about 8 m annually. The created situation and prospect of development of the given trend of reduction of glaciers stimulates search of modern methods in preservation and an effective utilization of water resources. In this plan, building of reservoirs for water accumulation and corresponding corrective amendments in planning of the water use in agriculture is actual.

P-2211-10

Historical and future changes in precipitation and snow in the Hindu-Kush Karakoram Himalaya region as seen by CMIP5 models

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The Hindu-Kush Karakoram Himalaya (HKKH) mountains and the Tibetan plateau are the world's largest snow and ice reservoir outside the polar regions and they are often referred to as the "Third Pole". These mountains feed the most important Asian river systems, and changes in snow and precipitation dynamics in this area could severely impact on water availability for downstream populations, agriculture and energy production, ecosystems and biodiversity.

Despite their importance, precipitation and snowpack characteristics in the HKKH region are still poorly known, owing to the limited availability of surface observations in this remote and high elevation area. Global Climate Models (GCMs) still have too coarse spatial resolution to reproduce the small scale variability of precipitation and snow in orographically complex environments. Nevertheless, they may be effective in providing, even at a regional scale, a smooth but coherent picture of the large scale temporal and spatial patterns of these two variables in these areas. The quantification of the uncertainties in GCM simulations is essential to define the models skills in reproducing climate variability and to critically analyze future climate change projections.

We investigate how the spatial and temporal variability of precipitation and snowpack in the HKKH region is represented in historical and future simulations of the state-of-the-art GCMs participating in the CMIP5 effort, and we investigate the role of elevation-dependent surface warming. The model outputs in the historical period are compared with the main, currently available, observational datasets including surface- and satellite-based observations and reanalysis data.

P-2211-11

Implications of Depleting Himalayan Cryosphere under Changing Climate

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Lidder tributary in the Upper Indus Basin (UIB) of the Alpine Himalayas, India, an important source of surface and ground water, is experiencing clear indications of climate change. In the basin, minimum, maximum and average temperatures are showing a significant increasing trend in all the four seasons. Precipitation is showing insignificant decrease over time in the basin, however the proportion of the snow in precipitation has decreased and the proportion of the rain has correspondingly increased. The temperature projections also show increasing trends for the end of this century. The time series analysis of the Normalized Difference Snow Index (NDSI) from MODIS satellite shows a depletion of the snow-cover in the region. Furthermore, during the last 51 years, the glacier area in the basin has decreased from 46.09 km2 in 1962 to 33.43 km2 in 2013, a depletion of 27.47%. As a result of the glacier recession in the basin, the streamflow fed predominantly by snow- and glacier-melt, is overall showing a statistically significant decline. However, the spring disharge is showing an increase, might be due to the early melting of the snow due to warmer springs. The declining streamflows have potential to adversely affect agriculture, energy production, tourism and even domestic water supplies. In the Kashmir Himalayas, one of the major concerns about the climate change relates to its impact on streamflows in the Indus basin, whose waters are shared between India and Pakistan under the Indus Water Treaty. Snow and ice reserves of the Himalayan river basins, important in sustaining seasonal water availability over South Asia, are likely to be substantially affected by climate change, but to what extent is yet unclear. Therefore, it is of utmost importance to develop strategies for the conservatizing of the depleting water resources in the region. Accordingly, Snowmelt Runoff Model (SRM) was tested for estimating the runoff from this glaciated basin on an operational basis. The average simulated runoff at the outlet 11.94 m3/s is in concordance with the average measured runoff 13.51 m3/s showing R2 of 0.82. The model could thus be used for snowmelt runoff estimation, on an operational basis, for judicious utilization of the depleting water resources in the region.

P-2211-12

Climatic and Socioeconomic Drivers of Water-Related Changes in the Andes of Peru: Challenges and Future Implications

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One sixth of the world's population lives in river catchments supplied by snow and glacier melt, and is therefore considered to be affected by climate change impacts on the cryosphere and water resources. In the tropical Andes glaciers have been a crucial source for societies and livelihoods for thousands of years. Nonetheless, climatic and non-climatic stressors pose potential risks and challenges to the provision of water resources and linked ecosystem services, both in terms of quantity and quality. Mountain communities in Peru are considered to be highly vulnerable to changes in water availability due to a strong exposure to climate change impacts and limited adaptive capacity. However, comprehensive analyses of water-related risks considering multi-dimensional drivers across different scales in the framework of climate change are complex and barely addressed in climate-sensitive mountain regions with limited data availability.

Here we present a comprehensive data assessment study for two major catchments in the Andes of Peru: Santa River (Ancash region) and Vilcanota River (Cusco region). These river basins, which comprise various ecosystems, hold the largest tropical glacier mass worldwide and are particularly exposed to climate change impacts. In the upstream areas, snow and glaciers store fresh water and buffer low flows during the dry season. Decreasing ice volume and changes in climatic patterns will subsequently alter river runoff characteristics.

For these study areas, we analyze to what extent both water supply and demand of two mountain catchments can be assessed using multiple data sources such as ground-based (air temperature, precipitation and discharge records) and remote sensing (TRMM precipitation, MODIS evapotranspiration and snow cover) data. Furthermore, we include a first assessment of socioeconomic key drivers identified by expert interviews with local and international stakeholders, decision-makers and water users. We propose an integrative water balance model approach which combines the main key variables of water supply and demand under hydrological risks considering climate-related hazards, human and natural vulnerability and exposure assessments.

P-2211-13

The impact of climate change on mountain landscapes of the North Caucasus

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Changes in the boundaries of high-altitude mountain belts can be treated as a proof of climate change. These changes were caused by termination of human activities. The presentation shows the role of climatic factors in changes of the boundaries and state of sub-alpine landscapes in the North Caucasus, where the transformation of land use system was observed. These are mainly mountain meadows, which were being shaped for centuries of grazing and are semi-natural formations. The system of mountain land use has been changing for the last decades: nowadays more than 60% of sub-alpine meadows are abandoned.

Heat and moisture are the limiting factors of vegetation existence. The estimate of changes in heat and humidity was made for the territory of 42-44N 42-44.5E using vegetation index (NDVI), the index of vegetation conditions (VCI), Satellite Climatic Extremes Index (SCEI) and the sum of active temperatures (air temperature above + 10 °C).

Analysis of index changes shows normal humidification on the slopes of the main Caucasian ridge throughout the more humid period (2000-2006). In the second - dry period (2007-2013) for most part of the southern European Russia, the situation is changing. In the foothills moisture decreases, whereas in the middle mountains the increase in moisture is seen. The estimate of the amount of active temperatures and precipitation for the period of modern warming (1981-2010) compared with the previous period (1951-1980) shows the increase of these parameters in the early twenty-first century in the foothills of the North Caucasus. These changes cause the increase in vegetation in the middle mountains of the North Caucasus. It is evidenced by the growth of vegetation index (NDVI) at the beginning of the twenty-first century in this area. And in the areas with low altitudes (500-1000 m) vegetation index decreased after 2006, reflecting degradation of vegetation state. In the middle mountains the increase of vegetation index is observed, showing the improvement on conditions of vegetation.

In the middle mountains of the North Caucasus regeneration of natural boundaries of altitude zones is observed: the expansion of mountain-forest belt and restoration of pine forests on the southern slopes; restoration of mountain meadow steppe and steppe sub-alpine meadows on former agricultural terraces; northern slopes overgrown with crooked birch. These processes occur in the context of climate change (rising temperatures, increasing moisture) and reduce of human impact. Thus, climate change and weakening economic activity on the territory lead to restoration of vegetation in the area of middle mountains.

Researches were supported by RFFI grant № 14-05 00233A.

ORAL PRESENTATIONS

K-2212a-01

Impacts of Climate Change on Freshwater Resources and Managing Global Risks

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The real hydrological cycles on the Earth are not natural anymore. Humans are now driving changes in atmospheric processes through emission of green-house gases and land cover changes directly and indirectly. Global mean temperature is projected to rise approximately proportional to the cumulative total anthropogenic CO2 emissions from 1870 (AR5, IPCC WGI). Temperature rise itself will have direct impacts on the availability of water resources through changing flow regimes in snow-dominant or glacier-effluent river basins, and it will also be associated with sea level rise because thermal expansion is one of the major causes of observed and projected sea level rises. Further, climate change is projected to alter hydrological cycles: changing temporal and geographical patterns of hydrological components, such as precipitation, evapotranspiration, runoff, and ground water recharge, and particularly in their extremes. Consequently, the frequency of floods and/or droughts is projected to increase some parts of the world.

However, as articulated in the AR5 of IPCC WGII, "Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems", increasing frequency of natural hazards, such as torrential rainfall or long-lasting heat wave, alone will not cause damages on human and natural systems, and both climate and social changes are relevant for planning sustainable development in the future.

AR5 (WGII) also says "Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions". Mitigation and/or adaptation actions should not be planned in an isolated manner, but should be integrated into wider frameworks, such as integrated water resources management and sustainable development. It would preferably be integrated into a risk management framework assessing and managing possible global risks, and ultimately pursue increasing human well-beings.

K-2212a-02

Hydrometeorological and hydroclimatic worldwide monitoring, data sharing, cooperation and services

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Freshwater resources are essential to all forms of life and, in a changing environment, hydrometeorological and hydroclimatic information are critical to ensure that resources are managed sustainably. Our precious freshwater resources are under increasing stress due to a range of factors. These include, inter alia, growing populations, increasing food and industrial production and a changing and variable climate. Unless we improve the availability of, and access to, good quality hydrometeorological and hydroclimatic information, we will not be able to fully understand and manage our water resources in a sustainable manner and monitor the implications of future decisions.

In this regard, the current status of monitoring climatic change and its impacts, with an emphasis on global freshwater resources is reviewed. In particular, the value of comprehensive hydrometeorological and hydroclimatic monitoring is described, including international efforts to facilitate and improve data collection and accessibility. Benefits from monitoring include improved understanding of the state and variability of freshwater resources, as well as reduced uncertainty in resource management decision-making under climatic change. Additionally, the status of, and efforts associated with, the promotion of regional and international data sharing are described. The value associated with the combination of monitoring, data sharing and cooperation between relevant agencies are realized through the services that can be provided. Finally, the efforts of the hydrological community to provide hydrological services, the importance of a quality management framework for the collection and presentation of data, the development of associated information systems, data registries, and web services for data sharing are emphasized.

In order to manage our freshwater resources in a sustainable manner, we must learn from the mistakes of the past and support the collection of hydrometeorological and hydroclimatic data into future. This requires two actions: 1) reversing the current trend in declining monitoring stations and the data and information derived from them; and 2) improving the collection, processing, and presentation of these data through innovative new technologies.

K-2212a-03

Responding to the Challenges of Water Security: the Eighth Phase of the International Hydrological Programme 2014-2021

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This paper presents the major water challenges at global, regional and local level, including adaptation to climate change, based on the AR5 IPCC findings. It relates how the International Hydrological Programme (IHP) will respond in its VIIIth Phase to water-related risks and seize opportunities to contribute to water security at all levels. Cooperation between science and innovation and policy lie at the core of this strategy.

Management of natural resources must draw on science and innovation to be sustainable. From this perspective, the UNESCO-IHP Member States periodically define priorities for research, technological development, innovation and education. To implement the priorities in a coordinated manner, Member States works with the IHP Secretariat based at UNESCO HQ, as well as the UNESCO "Water Family", consisting of UNESCO-IHE, a Category I Centre located in the Netherlands; the World Water Assessment Programme, based in Italy, which produces the UN World Water Development Report; thirty Category II Centres under the auspices of UNESCO; and thirty-five water Chairs around the globe.

IHP's role in this context is to put in place procedures for the use of knowledge and innovation to adapt to climate changes impacts in the water sector, and to increase resilience to water-related disasters.

O-2212a-01

River flood risk and climate change

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River floods are an important problem area related to freshwater resources, at any spatial scale - from local to global. More than 10% of the global population are currently living in flood-prone areas and about 1% of the global population are, on average, exposed to floods each year. Average global flood damage reaches tens of billions of US$ and the number of fatalities amounts to thousands. Flood losses are higher in developed countries, while relative fatality rates and economic losses expressed as a proportion of GDP are higher in developing countries.

Observations of changes in climate, hydrological /

terrestrial, and socio-economic systems influencing flood risk are examined. Despite the diagnosed extreme-precipitation based signal, and its possible link to changes in flood patterns, no gauge-based evidence had been found for a climate-driven, globally widespread change in the magnitude/frequency of floods during the last decades. There are strong regional and sub-regional variations in the trends. Moreover, it has not been generally possible to attribute rain-generated peak streamflow trends to anthropogenic climate change. Indeed, economic losses from floods have greatly increased, but this has been primarily attributed to increasing exposure and damage potential and not to climate change.

Further, model-based projections for the future are critically discussed. Projected changes from both global and regional studies indicate that it is likely that the frequency and intensity of heavy precipitation, or the proportion of total rainfall from heavy falls, will increase. Physical reasoning suggests that projected increases in intense rainfall would contribute to increases in precipitation-generated flooding, while less snowmelt flooding and earlier spring peak flows in snowmelt-fed rivers are expected in the warmer climate. Increase of flood hazard is projected over many areas.

Studies that project future flood losses and casualties indicate that, when no adaptation is undertaken, future anthropogenic climate change is likely to lead to increasing flood losses, alongside the increase in exposure linked to ongoing economic development, and the total increase would depend on the degree of warming.

Finally, uncertainty in our understanding of past floods and projections for the future is reviewed, with identification of gaps in knowledge. The impacts of climate change on flood characteristics are highly sensitive to the detailed nature of those changes and presently we have only low confidence in numerical projections of changes in flood magnitude or frequency resulting from climate change. Attention is drawn to the fact that over less than a decade, projections of flood hazard in Europe have dramatically changed. This is of vast practical relevance, hence interpretation of such changes has to be sought, related to both different climate scenarios and different modeling approaches.

O-2212a-02

Adaptation to changing water demand and climates in Sub-Saharan Africa: the role of groundwater

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Freshwater demand in Sub-Saharan Africa (SSA) is expected to increase substantially in coming decades with projected rises in land under irrigation and water volumes required for domestic and industrial purposes. Anthropogenic warming is projected to further amplify variability in rainfall and river discharge that is already the most extreme in the world. Current metrics of freshwater availability (e.g. water stress index, relative water demand) misrepresent the "water crisis" in SSA as they greatly exaggerate freshwater demand, define renewable freshwater resources in terms of mean river discharge and, critically, exclude groundwater storage. Total groundwater storage in Africa (~0.66 million km3) is more than 100 times annual renewable freshwater resources, and more than 20 times the volume of freshwater stored in African lakes. Although substantial quantities of fossil groundwater in Africa have long been known to exist and are heavily exploited in arid landscapes remote from people (e.g. Great Man-Made River Project), less well understood is the comparatively small (equivalent to water depth of 0.5m) but vital groundwater storage that underlies much of SSA where people live. The extent to which this estimated groundwater storage is both accessible and renewable remains unclear. Recent research based on ground-based observations in semi-arid and humid areas of Tanzania and Uganda reveals the strong dependence of groundwater recharge on heavy rainfall events (>10 mm per day) and extreme rain events associated with the El Niño Southern Oscillation (ENSO). Consequently, the shift to fewer but heavier rainfall events projected under climate change may enhance groundwater recharge while reducing rain-fed soil moisture and exacerbating flooding. Under such circumstances, increased use of groundwater resources not only to supplement soil moisture through irrigation but also to meet increased freshwater demand may prove a hydro-logical adaptation in SSA. Increased reliance upon groundwater resources has led to groundwater depletion of regional aquifer systems in the USA, China and India through competitive abstraction and aquifer mismanagement. In contrast, aquifer systems underlying much of SSA are localized and characterized by low transmissivities and low storage. 'Small is beautiful' since these systems greatly restrict the impact of competitive, unregulated abstraction witnessed in other groundwater-dependent countries and enable low-intensity abstraction for which the impacts of overuse are largely localized. Thus, the prevailing geology naturally resolves the 'Tragedy of the Commons' that complicates management of productive, regional aquifer systems. Indeed, the potential for distributed, low-intensity groundwater use strongly complements land tenure systems in SSA that are characterized by a large number of distributed, smallholder (< 1 hectare) plots. Groundwater in SSA therefore represents a low-cost, distributed and potentially renewable store of freshwater that can enable many communities to adapt to changing water demand and climates. Two key physical challenges that currently constrain the realization of this potential are: (1) reducing the prohibitively high cost of drilling that currently impedes the development of groundwater by small landholders; and (2) resolving the aggregated impact of multiple low-intensity groundwater users to ensure the continuity of groundwater supplies and groundwater-dependent ecosystems.

O-2212a-03

Groundwater on North Sea islands in a future climate – a geophysical approach

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For the North Sea Region climate change scenarios predict a shift of precipitation to the winter season leading to an enhanced groundwater recharge and rising water table. Additionally a sea level rise is expected leading to a new balance of freshwater and groundwater in the subsurface with consequences for, e.g., water supply, wetland drainage, construction stability. In the EU Interreg project CLIWAT (climate and water) the consequences of climate change to the groundwater systems were investigated in seven project areas in Denmark, Germany, the Netherlands and Belgium (CLIWAT Working Group 2011, Hinsby et al. 2012). Here the approach is shown exemplarily for the German North Sea island Borkum (Sulzbacher et al. 2012, Wiederhold et al. 2013).

The main challenge in the study of coastal aquifers in Northern Germany is the freshwater/saltwater environment. The water supply of the North Sea offshore islands is in many cases restricted to a freshwater lens and intrusion of seawater is a major constraint on groundwater utilization. To study the impact of climate change on the freshwater lens of a barrier island, a density-dependent groundwater model was developed. The structure and parameters of this model were designed using information from boreholes and various geophysical and hydrogeological investigations. To characterize the hydrogeophysical setting of a freshwater/saltwater system, we need a description of the actual situation including temporal changes in the freshwater/saltwater transition zone. This concerns the study of water salinity and its changes. Due to the strong contrast in electrical conductivity between seawater and freshwater, resistivity and electromagnetic methods are most suitable to map salinity in the subsurface. To overcome ambiguity in interpretation, the combination with methods such as nuclear magnetic resonance or seismics turned out to be successful.

This data were used to generate a hydraulic model for density-dependent groundwater modelling that is able to predict the long-term behaviour of the system under changing climatic conditions. To monitor the temporal behaviour, permanent resistivity installations are a cost-efficient alternative to repetitive soundings. The data acquired in periods of years or decades can help to improve the groundwater model and its implications.

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2212a-POSTER PRESENTATIONS

P-2212a-01

Nubian Sandstone Aquifer System

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The Nubian Sandstone Aquifer System (NSAS) is the world's largest known fossil water aquifer system. It is located underground in the Eastern end of the Sahara Desert and spans the political boundaries of four countries in north-eastern Africa, it covers a land area under boarders for Egypt, Libya, Sudan and Chad. The geographical position between latitude 14°-33° north; longitude 19°-34° east. It contains and stored water volume 150.000 km2.

Many studies were made looking for the hydro geological setting of the area's aquifer; its results indicated that litho logical characteristics and tectonic settings are having a substantial effect on groundwater flow patterns and the area's overall aquifer potentiality.

Many surface bodies and groundwater traverse boundaries with no restrictions; any action which may be caused by one country could affect the water resources, and also could vary in significant consequences to the quality or quantity of water in another country.

In sub-Saharan Africa, freshwater withdrawals for agriculture are less than in Asia, Europe and North America. Also, estimation of freshwater demand assume annual withdrawals for irrigate and industry which are 20 times that required for domestic water use. Groundwater in many parts of sub-Saharan Africa can play a strategic role in adapting to changing freshwater availability and improving food production and security through groundwater-fed irrigation.

The actual withdrawal rates as follows; Egypt draw 1029 Million m3/yr; Libya 851 Million m3/yr; Sudan 406 Million m3/yr and Chad Million m3/yr. There're two different systems because of different water bearing strata; The Nubian Aquifer System (NAS), the second system is the Post Nubian Aquifer System (PNAS).

One of the great project that consumption a huge amounts of Nubian Aquifer Groundwater that made by Libya and called "The Great River", which be constructed on 1980. Withdraw water for municipal, industrial and agricultural use should be enough to produce adequate water and food to meet the countries own needs, it reduces the dependency on imports from foreign market.

So, we have to manage and implement a good convention for states that sharing in the same aquifer to control their draw and to implement a good plan to recharge the same aquifer using floods and other resources.

P-2212a-02

Green and Blue Water Impact Assessment under AR5 Climate Change Scenarios in Asian Monsoon Region

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The evaluation of continental-scale water availability is an important issue for sharing and distribution of transboundary water resources. Water resources are abundant in some regions, but water scarcity has been a major disaster in many other regions. In particular, the water resources in Asia monsoon region are more important, because they provide many benefits but also cause serious drought problems. There are various reasons for these water-related disasters, but the current climate change will be one of the critical triggers for the upcoming water scarcity.

In this sense, the understanding of climate change impact on green and blue waters and the development of climate change adaptation framework for water resources over the region will be important and urgent issue. The objectives of this study are to investigate the future climate change impacts on green and blue waters in addition to the changes of temperature and precipitation and to delineate the highly variable regions under future AR5 climate change scenarios in the Asian Monsoon region. Several GCMs representing the better performance in this region were selected and used for climate change projections. The change factor method with bilinear interpolation method was used to project climate change at 0.5 degree horizontal grid resolution. The Variable Infiltration Capacity (VIC) macroscale hydrological model was employed to project runoff using future climate change scenarios. Average temperature, precipitation, green and blue waters were projected for all future periods i.e. 2020s, 2050s, and 2080s. These findings can be useful for the better implementation of climate change adaptation strategies and wise water resources management in this region.

P-2212a-03

Spatial distribution of the vegetation and rainfall over West Africa during the last three decades (1981-2012) and associated atmospheric patterns

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Decadal variability of the rainfall and the vegetation over West Africa is revisited from 1981 to 2012 using Climate Research Unit (CRU) observation rainfall data and Normalizied Differentiel Vegetation Index (NDVI) from NOAA. From decade 80s to 90s, we observe a significant return to wetter conditions over West Africa confirmed during the decade 2000's (00's) except over Central Benin and all the western side of Nigeria where there are a decrease in annual rainfall magnitude. From decades 80s to 90s, we observe a regreening of the Central Sahel and Soudano-Sahel regions. From decade 90s to 00s, this regreening belt is observed toward the South and the Coastal areas, mainly over the Guinea Coast, Soudano-Guinean and Western Sahel regions. Factors of the atmosphere associated with the vegetation and rainfall changes over West Africa during the last three decades was investigated: During the last two decades, the West African monsoon (at 925hPa) and the Tropical Easterly Jet (at 200hPa) were stronger than in 80's, and the African Easterly Jet (at 700hPa) is weaker. This synoptic configuration is known to be favorable to wet conditions.

P-2212a-04

Synthesis Report on Climate Change Vulnerability Assessment over Niger River Basin

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The Niger River Basin encompasses an area of 2.2 million square kilometer from this only 1.5 million square kilometer is hydrologically active. Development activities are going on along the basin such as mining, construction of dams for generating electricity and irrigation. The construction of dams is increasing across the Niger River basin by riparian countries. Most of the riparian countries recorded economical growth in recent years. The sustainability of the economical development and the achievement of million development goals are threatened by climate change.

In this paper, we tried to assess climate change vulnerability over the basin. The climate of the region varies from tropical humid climate to arid climate and one of the most vulnerable regions to climate change. The Basin suffered from desiccation in 1970s and 1980s and catastrophic recent flood events. The drought of 1984 reduced the GDP of Mali and Niger by 9% and 18% respectively. The inner delta is one of the most vulnerable parts of the river basin because of the dependency of millions of lives and livelihoods including the pastoralist on it.

Studies of National Adaptation Programme of Action of riparian countries indicated that the surface temperature increased by less than 10C in the second half of the 20th century. The surface temperature is expected to rise between 3-60C at the end of the 21st century under different socio-economic scenarios. The decadal and multi-decadal observed variability of the rainfall in the Niger River basin was clearly figured out in the national and international reports. The rainfall variability in the Niger River Basin is associated with the sea surface temperature of global oceans, ENSO and complex interacting processes including land surface and desert dust aerosols.

Among the hydro-meteorological disasters of sub-Sahara Africa, 25% of the disasters occurred in West Africa which is the second vulnerable region after East Africa in the period 1974-2003. The number of days with heavy rainfall is expected to increase in 21st century in West Africa. Furthermore, the projected mean sea level rise coupled with land subsidence due to the oil and gas extraction in the Niger delta will threaten the existing physical, biological and socioeconomic systems.

Rain-fed agriculture is dominated the Niger River Basin which is highly sensitive to climate variability and change. The population growth compounded with climate variability and change is a major challenge for agriculture sector to meet the demand. The major impacts of climate change for agricultural sector are a reduction in crop yield and total failure of the crops as well as the death of livestock and reduction of productivity.

The Niger River basin is considered as one of the basin which is affected by fresh water shortage in West Africa and the River itself influenced by the ground water base flow. Climate variability and change impacted the river basin in the past. A significant decrease in rainfall amount resulted in two fold decrease in the surface and sub-surface runoff. The projection of rainfall in West Africa is uncertain due to the disparity of climate models; however, the water sector will be under stress as result of population growth, urbanization, water for agricultural growth and land use change.

The basin is affected by climate sensitive diseases such as malaria, meningitis, cholera, dysentery and diarrhea. The expected increase in surface temperature will exacerbate the incidence of climate sensitive disease in the basin. The multi-model forecast which consider climate factor only as an outbreak of malaria revealed that the malaria belt zone will shift 10 to 20 south wards in West Africa.

P-2212a-05

Impacts of climate change on the performance indexes of a water resource system: A case study of Boura reservoir in Burkina Faso

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In developing regions like Africa, availability and access to freshwater largely determines patterns of economic growth and social development. Burkina Faso, as others Sahelo-Sudanian countries pledged for some decades to control water resources after the severe droughts that occurred during the 1970s and 1980s through the construction of small reservoirs. Thus, thousands of small reservoirs dot the landscape and they are used for multiple purposes with especially irrigation in order to increase food production. The Boura reservoir, located in the southern of Burkina Faso, is a representative pilot site of many small reservoirs in the Volta Basin in West Africa. The ungauged catchment area upstream of the Boura dam of about 150 km2 is lying to the Centre West Region, Burkina Faso and Upper West Region, Ghana. This study aims to assess the performance indexes such as reliability, resilience and vulnerability of the Boura reservoir under the climate change conditions.

The methodology is organized in steps: (i) Firstly, climate change scenarios for the periods 2041-2070 and 2071-2100 relative to the reference period 1971-2000 were projected by using the outputs of regional climate model RCA4 (Rossby Centre Atmosphere model, version 4) under two emission scenarios (RCP4.5 and RCP8.5); (ii) Secondly, the impact of climate change was then investigated on the input runoff of the Boura reservoir by using the hydrological model GR4J (daily lumped four-parameter) for the future periods and also on the crop water requirement of the irrigation schemes downstream the Boura dam; (iii) Thirdly, the simulation of reservoir performance in the delivery of agricultural water demand was implemented by using the water evaluation and planning (WEAP) model.

The analysis of the inter-annual average changes in rainfall and potential evapotranspiration (PET) between the future two 30 year horizons (2041-2070 and 2071-2100) and the reference period (1971-2000) showed upward trends with increases up to +23% for rainfall and +9% for PET, dependent on the RCP emission scenario (RCP4.5 or RCP8.5).

These projected changes in rainfall and PET will cause higher inter-annual variability of future inflow to the Boura reservoir compared to the reference period, necessitating increased reservoir capacity to meet future irrigation water demands. However, the performance indexes of system revealed that failures in agricultural water demand satisfaction would be observed in the future periods. In terms of overall performance, the reliability and vulnerability indexes decreased in the future relative to the reference period, especially for the socio-economic development scenario with an increase in agricultural water demand under climate change conditions.

This approach enable a comprehensive understanding of the functioning of a water storage reservoir under future climate scenarios and can also be a robust tool to predict future challenges faced by water supply systems under climate change conditions.

P-2212a-06

Result of numerical modelling of groundwater resource in the Shiraki catchment

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Eastern Georgia encounters, due to its semiarid climate, a big deficit of 1040 million cubic meters of water for irrigation and domestic use. One of the most important examples is the agricultural area of Shiraki Plain, which occupies over 80.000 km2 on a large, partly artesian aquifer of the Alazani basin and on the upland synclines between the rivers Alazani and Iori (1). In order to assessment water resource, numerical model of groundwater hydrodynamics was elaborated for this area based on the conceptual model, which based on the provisional data (geological, geophysical, hydrogeological, hydrological, etc). Model of the aquifer have been processed by special software Visual Modflow Package. In order to assessment water resource, a numerical model of groundwater was elaborated for Shiraki area. It is consists of 3 layers. Each layer represents a porous material with different infiltration properties. The model was calibrated in transient transport mode to tritium concentration measured in boreholes and springs located in Shiraki area. Tritium was assigned as a single mobile species, not reacting with chemical elements and concentrated in water, what allowed determining the residence time of groundwater flow. The model estimated

discharge and recharge zones, groundwater flow directions and velocities as well as groundwater age for Shiraki area. It is recommended to enhance the use of waters from the karstic formations as alternative drinking water sources.

P-2212a-07

Flooded area characterization and loss estimates for improving the water balance of the niger inland delta, mali

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Water availability is an ongoing challenge for West African countries in general, and the Niger River basin in particular. The Niger Inland Delta (NID) has experienced annual flood events from the Niger and Bani Rivers. During such events, the flooded area can cover 40,000 km2, and extend to 350 km long and 100 km wide in Mali. While these NID events can have considerable influence on downstream flow regimes due to water loss significantly impacting water availability, the processes that occur in NID are not fully incorporated in the conceptual development of many hydrological models of Niger Basin runoff. Though several studies in this region have developed conceptual models to represent hydrological processes in the system, the models have been criticized for their limitations and unsophisticated concepts for explicitly representing all the hydrological processes. This paper discusses an attempt to better assess the NID hydrological processes by considering more physical information about the system, and incorporating wetland processes into an existing hydrological model to improve model simulations of the basin.

The approach illustrates how flooded surface area estimates from large amounts of remote sensing data can be used to monitor flood dynamics with adequate spatial and temporal resolution. Characteristics of the extent of the flooded area are determined from monthly scale inflow levels data, and flooded areas within a non-linear regression based model. Previous correlations between flow levels and flooded areas were refined to account for the hysteresis as flooding recedes, and the timing of the area expansion. The model of the spatiotemporal extent of the flooding over the NID shows that the flooded areas varied between 25,000km2 in wet periods and 2,000 km2 in dry periods, resulting in actual evapotranspiration loss of between 17 km3 and 10 km3. The contribution of water abstraction from irrigated fields and direct precipitation assessments of flooded areas refined the NID water balance and infiltration estimates. The results of the timing and extent of the flood and water loss across the NID helped determine both the development of storage in one year, and the year-to-year variations. Furthermore, information about the NID flood dynamics and water budget can be used to develop and calibrate a specific model of the NID, and thereby account for the loss in hydrological models.

P-2212a-08

Impact of Rapid Urbanization on Water Resources in the Context of Climate Change (A Case Study of Urban Area through Multi-Temporal Remotely Sensed Data and GIS)

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One of the many environmental problems incurred by climate change is creating a negative impact on water resources in urban areas. The effects of climate change on water quality and availability are significant, including shortages and contamination that directly affect health of people and proper functioning of urban development and government. Unplanned growth of urban area further deteriorates the situation. The present paper provides an overview to some of the effects of rainfall variability due to climate change coupled with urbanization on water quality as well as quantity in Jaipur urban Agglomerates, the most populous area in the state of Rajasthan (India). The study has been carried out using Indian remote sensing data, Survey of India topographical sheets and GIS techniques.

During the course of study, a series of thematic maps covering climatic parameters and anthropogenic activities have been prepared to depict the changes in land use pattern, surface hydrology, geo-hydro-morphology, rainfall pattern and its impact on urban water resources. It was found that increasing pressure of population and un-systematic anthropogenic activities have made negative impact on water resources. It encroached upon lakes, rivers, streams, and ponds etc in the vicinity of urban area. As a result, out of total 518 rivulets in urban area and surrounding, 13 first order , 37 second order and 10 are of third order stream are completely blocked by settlements (Total 60). □Out of 2600 wells, 1116 well/tube wells have stopped recharging due to increase in pavement area between years 1986 to 2003. :• Seven fresh water reservoirs have dried-up which were supplying drinking water to Jaipur city •The surface drainage network of rain water has been converted into municipal sewerage :• Local source of water supply from surface as well as ground is closed due to scarcity of water •Recharge of ground water has stopped due to increased pavement area for urban development like infrastructure development, industrial development and other urban development activities.

Finally, it is suggested that by using remote sensing and GIS technique one can prepare an integrated plan for urban development in which surface water bodies can be protected which in turn would take care to recharge ground water and also provide the surface water in decentralized manner in the urban area.

P-2212a-09

Developing adaptation strategies to face the impact of climate change on the freshwater resources of India

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Major challenge associated with the management of freshwater resources in India is the abnormalities and uncertainties in climate. With changing climate, increasing water demands in the domestic, agricultural and industrial sectors, and fast deterioration of the water resources, India is heading towards a water crisis. Life of millions living in climate sensitive river basins and wetlands make India one among the countries highly vulnerable to the impacts of climate change. Drylands are potentially threatened by desertification. Indian economy and life of the majority has been traditionally linked to agriculture, the largest consumer of water. Abnormalities in rainfall seriously affect water availability and agricultural production. Extreme hydrological conditions affect hydropower generation and industrial development. Increasing rainfall seasonality in certain parts reduces groundwater recharge and summer water availability. Changes in the intensity, frequency and tracks of storms increasingly salinate coastal aquifers. In the Western Ghats Mountain area, increasing intensity of rainfall results in erosion and sedimentation, reducing reservoir capacity and summer flow in rivers. Retreat of Himalayan glaciers is likely to have large impact on water resources in entire north India. Water related health issues are worsening. Vector-borne and water-borne diseases extend into new areas. Even the heavy rainfall zones face serious water shortage as a result of drawbacks in water conservation and management. Most of the surface and groundwater resources are highly contaminated. Falling availability of reliable water leads to socio-economic issues such as water disputes, migration, pricing of water that is unaffordable to millions and large investments for the adaptation and mitigation. Present economic growth is likely to be haltered. India's preparedness for the effects of climate change is poor and India was too late to develop a climate policy. National polices including are only guidelines and they lack information on the effective implementation. Though several initiatives have been started in the water sector as part of adaptation such as cleaning of major rivers, protection of wetlands, groundwater recharge and introduction of water efficient technologies in agriculture and industries, the progress is slow because of issues like lack of coordination of departments, weak and corrupt administrative mechanism, social issues and vested political interests. Vulnerable groups are often neglected in decision making and policy development. Projects lack transparency and

accountability. India urgently needs appropriate policies and strategies and an efficient implementation mechanism to face the challenges in water sector. A mix of traditional, environment-friendly methods and modern technologies in water conservation and quality improvement could perform better. This paper assesses the impact of climate change on water resources of India and its reflections on different sectors. Changes in water availability in two decades from now under an altered climate have been estimated using hydrological model, based on the projections of climate models. Existing policies and adaptation strategies have been critically reviewed to suggest guidelines for adaptation and mitigation measures in the water sector to face the impending water crisis.

P-2212a-10

Key findings on groundwater and climate change from the UNESCO IHP GRAPHIC network

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Groundwater is an essential resource. It provides baseflow to lakes and rivers and supports numerous terrestrial ecosystems during dry spells. Today groundwater is also paramount to freshwater and food supply. Globally it covers the demands for around 36% of domestic water and 40% of irrigation water requirements. Groundwater is often regarded as a key resource for adaptation strategies to climate change. Aquifers often represent large stores of slowly evolving water. Groundwater has generally a lower variability and vulnerability than surface water. Groundwater resources are consequently more resilient to drought and the impact of human activities than surface water.

Under the International Hydrological Program (IHP), the UNESCO is home to a scientific network examining the relationships between groundwater resources and global change, called GRAPHIC (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change). The GRAPHIC community is composed of academics, researchers, government employees, and professionals from the water industry located across 34 countries. By encouraging and coordinating international collaboration, GRAPHIC aims to strengthen global research efforts on groundwater impacts from climate change and adaptation strategies. This presentation provides a geographic synopsis of progress made and lessons learnt to date by the GRAPHIC network.

Through a number of case studies in a variety of climatic and geologic settings, GRAPHIC has identified challenges that are important when considering the inclusion of groundwater in climate change adaptation strategies. Though generally less responsive than surface water, groundwater can still be substantially impacted by climate change. The magnitude of this impact can vary greatly from region to region. At the same time, compounding effects from other global anthropogenic changes also impact groundwater. It is possible to identify a number of hotspots where groundwater may be particularly vulnerable to climate change and will require careful sustainable management.

Key lessons learnt from GRAPHIC network include the need to account for groundwater in 1) monitoring of freshwater resources; 2) climate models; 3) land surface and water models; and 4) the management of transboundary basins. There is a great need to include and more carefully consider groundwater into climate change adaptation schemes and strategies.

Future activities will include, amongst others, applying satellite gravimetry for evaluating trends in groundwater storage across large transboundary aquifers (TBAs) in regions where data access is very limited either because of data scarcity or accessibility. Such activities will contribute to establishing water budgets at aquifer scale for better-informed water management decisions and policies.

P-2212a-11

Identifying Hydro-climatological Contributions to Hydrological Drought Formation with Uncertainty in Satellite Datasets: An Examination over the Poyang Lake Basin

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Hydrological droughts are generally the combined consequences of hydro-climatological influences. Identification of the individual influences on drought formation is essential to effective drought prevention. The identification with the principle of water balance requires all the major hydro-climatological measures. However, it is impractical to measure all the components from ground observations. While satellite remote sensing now provides spatio-temporally consistent retrievals of the components over large regions, its relevant uncertainty often remains undocumented. The uncertainty may propagate into total water deficit which is a residual of water balance. It casts a shadow on the reliability of drought analysis. This study addresses the uncertainty for drought analysis, and proposes to use a signal-to-noise ratio for quantifying the reliability. The approach is examined with satellite datasets of evapotranspiration and soil moisture, in addition to station data of precipitation and river discharge, for the Poyang Lake Basin with an area of 162,000 km2 for the periods of 2001-2010. Satellite datasets are processed for the cases with and without field validation. Hydrological drought events are identified with river discharge data for each of five sub-basins within the basin. The validated satellite datasets are used to quantify hydro-climatological contributions to individual drought events. The contributions are then compared to those from the datasets without validation. The results show that the difference in quantified contribution varies from 5~40% for the individual events in each sub-basins between the two cases. The signal-to-noise ratio is generally higher than 2.8, indicating the robustness and usefulness of the satellite datasets in water balance analysis for identifying hydro-climatological contributions to drought formation. The findings provide an approach to addressing hydrological droughts from water balance analysis, especially valuable for studying droughts under climate change with satellite datasets with limited accuracy.

P-2212a-12

Degradation of the Nyong River by the climate changes (Cameroon)

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Nyong is a river of the south- Cameroon, length of 640 km. It has its source 40 km in the east from the town of Abong- Mbang, in the large equatorial rainy forest. It runs parallel to the lower course of Sanaga's river, following an east-west direction. It crosses the towns of Mbalmayo and Ayos and flows into the gulf of Petit Batanga, Guinea village located at 65 kilometres in the south-south-west of Edéa. Rapids intersect its course with Mbalmayo and Déhané. In the city Ayos, one can fish fish called "Kanga".

The Nyong river flows through a good part of the south-Cameroonian tableland. It nourishes approximately 4 million individuals. With the varied and formerly abundant natural resources, the river Nyong is about today in the process of undergoing an ecological disaster without precedent. This river has been for several years, the seat of a series of aggressions (overfishing, bush fires, deforestation, erosion of the banks, silting, various pollution), which affects its medium of life and destroys its biodiversity. This constant rise of the dangers enabled possibly to conclude in an alarmist and pessimistic way that: if nothing is done in the twenty next years, the river could disappear.

The conditions of flow of the river are unfavourable with its blooming. Pollution, anthropic activities and the phenomena of eutrophication are hardly favourable to the survival of the hydrological rate of flow of the Centre and the South region. Lost in meanders of the forests of east-Cameroon at the Atlantic coast, this river is dying.

Because, attacked by the combined action of the man and the climate changes.

This river with almost still water on most of its course dies blackened by the drying of silts. The first drawback is the action of the human being, through his demographic pressure on the banks, the deforestation of the valley of the river for cultures, the discharge of waste by the sawmills and other abattoirs, the confluence of the Mfoundi river via the Mefou river, carting all kinds of pollution of the town of Yaoundé, in an absence of an environmental culture. The nature is also one of the causes. Climate changes alternating draining of affluent and devastated floods. We are not mentioning these unforeseen elements, concerning the invasion of part of the bed of the river by the hyacinth water and other luxuriant vegetations. And yet, the river Nyong brought satisfaction to the needs of its residents. Furthermore, his economy based on fishing; especially the fishing of the "kanga" and collects of other halieutical resources. It is also harnessing, the industrial treatment and the drain of its water to the taps of Yaoundé. Then, the question that brings up these findings is: What to do, to lend the river Nyong his patent letters of nobility?

P-2212a-13

L'eau virtuelle des produits agricoles d'importation : Un moyen de contrecarrer le problème du manque d'eau en Algérie

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Algeria is ranked among the 17 countries that suffer most from lack of water worldwide.Indeed, with less than 300 m3 / capita / year of renewable water, Algeria has less than 30% of the theoretical scarcity threshold set by the World Bank in 1000 m3 /hab./an.

Being unable to expand its agricultural land UAA and / or increase irrigated areas, to fill the food gap, Algeria resort to massive food imports, especially cereals and their derivatives.

Added to these non-food agricultural products.

These imports, although they represent a major financial drain for the country, they have at least one positive aspect represented by the virtual impressive amounts of water they provide to Algeria estimated at over 40 billions m3 2012.

It is in this framework that guides our study in which we try to quantify these virtual amounts of water that contribute greatly to temporarily relieve the country of its water shortage problem.

Keywords: Water scarcity, food security, water resources, virtual water, Algeria.

P-2212a-14

Climate Change and water resources in the Maghreb

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The Mediterranean area, known as hot spot area of Climate Change by IPCC, is expected to increase mean annual temperatures between +2,2°C and +5,1 °C, a decrease mean annual rainfall between -5 and -35 % and an increased of extreme events, in 2100. The combination of Climate Change and human impact could lead to water shortage for 290 million people (Plan Bleu of United Nations), particularly in North Africa.

The aim of this work is to provide an overview of the climate change and its effects on the water resources, at the Maghreb scale for the temperature and rain evolutions (30 synoptic stations located in the North and center of the 3 countries of the Maghreb, from 1970 to 2013) and 5 watersheds for the water resource (Soummam and Khébir Rhumel in Algeria, Tensift and Sebou in Morocco, Cap Bon en Tunisie). This study is performed in the framework of the 2 AUF and PHC Maghreb projects on the evolution of the water resource in Maghreb.

At the Maghreb scale and the studied watersheds, we observe an increase of minimum and maximum annual temperatures from the 80s. We observe 3 periods on the rainfall time series: a humid phase before the 80s, then several years of drought from 80s to the early 2000s, then a return of more humid phase with more of storm events.

However, it is difficult to dinstinguish and quatify the respective roles of the climate change and anthropogenic impact on the evolution of the water resources. The combined effects of these two factors led to a decline of the quantity and deterioration of the quality of water resources. Indeed, the groundwater, the main drinking water resource in the Maghreb, show a strong decrease, which can reach -50 cm to -1 m per year, and a deterioration of the water quality by infiltration of the anthropogenic pollutants from surface water (rivers) and by a water salinization in the coastal aquifer (related to the seawater intrusion), such as the examples of the Haouz and Sais aquifers in Morocco (Marrakech and Fès regions) and Cap Bon aquifer (North of Tunisia).

Nevertheless, a study of the hydrological variability carried out on 2 watersheds (Soummam and Tensift), by wavelet analysis, showed similar energy bands or variability modes (1, 2-3, 5-7, 15 years) in rainfall, streamflow and aquifer piezometry: 1, 2-3, 5-7 and 8-15 years. Moreover, 3 major temporal discontinuities are observed around 1970-1975, 1980-1985, 1990-1995 in all times series. The 1970-1975 and 1990-1995 discontinuities were also found in other hydrosystems on both sides of the of the Mediterranean Sea and the Atlantic Ocean, in various climatic and geomorphological contexts (USA, NW Europe, N Africa), in different hydrological compartments (surface and groundwater) and at various spatial scales (watersheds smaller than 1000 km2 and large rivers): the Seine watershed (streamflow and aquifer piezometry) and small high-Norman watersheds, Mississippi, Colorado and Texas small watersheds. Therefore, these discontinuities can be described as global disruptions. In addition, they are also present in climate indices NAO and SOI and can therefore be described as climatic discontinuities at the global scale. There is no satisfactory explanation of the phenomenon causing these discontinuities, although the first discontinuity coincides with the second phase of global warming (which also began in the early 1970s) and the second coincides with an apparent intensification of warming. However, the link between these phenomena is not yet established.

P-2212a-15

Impact of climate change and overexploitation in semi-arid areas on the water resources. Example of Essaouira Basin (Morocco)

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The Maghreb countries Algeria, Morocco and Tunisia are affected by the climate change, which is manifested by the tendency to increased temperatures and decreased rainfall. This has several negative effects on natural resources such as water resources. Among them: (i) The scarcity of water resources. (ii) The increased salinization of soil and, consequently, the salinity of waters. (iii) The drought, which leads to soil erosion, which causes the silting of the dam and, consequently, the decrease in the rate of mobilization. Overexploitation of coastal aquifers and pollution vulnerability are among the main problems related to groundwater resources assessment and management in arid and semi-arid regions threatened by desertification being the only source for agricultural and public water supply. The behaviour study of the aquifer system in the Essaouira basin (the object of our study) in the face of climate change, based on the interpretation of hydrochemical data (major elements), piezometric and isotopic (18O, 2H, 3H and 14C) was used to determine the degree of impact of climate change on aquifer system. The follow-up of the quality evolution of groundwater in the Essaouira Basin through the electrical conductivity and the chlorides concentration showed that this quality is in close relationship with the vagaries of the weather.. Changes in groundwater levels in the study area, brings up these levels would decline over the years to rainfall deficit and would renew for excess. The use of the technique of

isotopic tools showed that the recharge of this aquifer system is recent and carried out by the direct infiltration of rainwater.

P-2212a-16

Salinisation: A social, ecological and health issue in the Bengal Delta

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The Bengal Delta is formed by three major rivers; Ganges, Brahamaputra and Meghna. This region is particularly vulnerable to climate change and densely populated with 650 million inhabitants. Climate change causes a complex multitude of social, ecological and health problems. Salinisation (referring to the buildup of salts in both soil and water) may be exacerbated and amplified by climate change and is a growing threat to this delta.

Sea level rise, land subsidence, rapid transition from agricultural land use to shrimp cultivation, upstream fresh water extraction (which normally flushes out saline sea water), increasing cyclone and storm surges all contribute to increased salt intrusion in the South-West coastal region of Bangladesh; constituting the majority of The Bengal Delta. Salinisation affects both rural and urban coastal communities through changes in livelihood, contamination of water sources, reduced agricultural productivity, and declining trends in ecosystem services. Furthermore, salinization adds a huge public health burden both upon individual health (hypertension may just be the tip of the iceberg) and population level social and economic development.

Recent research has explored broad impacts of salinization in this region, however, we lack a concise summary of the evidence required for the formation of much needed meaningful solutions. This paper is a critical systematic review to assess and condense salinization's impact on life, livelihood and wellbeing of coastal populations. Different community based adaptation options will be discussed and conclusions will be drawn from a systematic literature review, recent field work and results from several ongoing project experiences.

P-2212a-17

The Implications of Climate Change on Water Quality and Ecosystem of Nasser Lake, Egypt

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Climate change can affect water resources and its water cycle. Through it climate change can affect the quantity and quality of water resources available to meet human and environmental demands, affecting water availability and quality for flora and fauna, lower minimum flows in rivers, drinking water intake, energy production (hydropower), thermal plant cooling and navigation. High Dam Lake is one of the largest man-made Lake in Africa, It includes Lake Nasser which extends for about 330 Km in Egypt. Lake Nasser water is a major source used for drinking, irrigation and domestic purposes in Egypt. Aquatic ecosystems of the Lake region support delicate, deeply interconnected webs of life which are highly adapted to the physical, chemical and biochemical characteristics and cycles of the lakes themselves. Warmer water temperatures affect physical, chemical, and biological processes. It reduces dissolved oxygen concentrations, which are a critical aquatic ecosystem requirement. Changes in rate of chemical reactions in the water column, sediment-water interface, and water-atmosphere interface are also expected. The present study aims to monitoring climatic change on Lake Nasser through the past 20 years (since the year 1991). The monitoring includes the physicochemical parameters (Temperature, pH, conductivity, dissolved oxygen, CO2 and Nitrate and other chemical parameters) in Lake water and sediment , and fish since the year 1991 to the year 2014. The obtained results indicated that as the Lake water temperature increases from the year 1991 to the year 2013, dissolved oxygen decreased from 10.8 to 6.1 ppm. Also, other parameters affected by temperature.

P-2212a-18

Impact of future global climate and land use and land cover changes in Amazonian run-of-river hydropower plants

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Brazilian strategic interest in Amazonia includes the development of hydropower to satisfy the country´s growing energy needs and new waterways to boost regional trade and economic development. Of the total amount invested in the Amazon until 2020, 37% will be allocated in the constructions of hydropower dams, which correspond to 45% of planned energy expansion during the period. Due to environmental constraints, hydropower dams under construction in Amazonia are run-of-river (ROR) type plants, thus is, with a limited storage reservoir to minimize the area of natural forest to be flooded. Although it is widely recognize that ROR plants dramatically reduce environmental local impacts compared to traditional large dams, they are subject to seasonal river flows. Considering that the Amazon Basin is characterized by high interannual variability, and have been recently affected by the occurrence of extreme droughts (for instance, 2005 and 2010), it is clear that the generation capacity of ROR plant could potentially be seriously compromise during extreme events. Besides this, IPCC scenarios indicate that climate change can seriously impact the hydrological regime South American rivers, which might also affect the distribution of biomes in South America due to the synergistic combination of impacts due to both land cover (deforestation, forest fires and fragmentation) and global climate changes. Therefore, the aim of this study was to critically assess how different global climate change scenarios associated with regional land-use and land-cover changes caused by deforestation could affect the power generation of run-of-rive power plants under construction in Amazonia. Power generation was analyze in the following ROR hydropower plants: Estreito, on the Tocantins River Basin, Santo Antônio dam, in the Madeira River Basin, Serra da Mesa in the Tapajós River Basin.

To achieve this goal, we calibrated the MHD-INPE hydrological model for the period 1970-1990 using hydrological, meteorological and soil data from different sources from Brazil, Bolivia and Peru. We analyzed the ability of the model to simulate the present hydrological regime when climate model simulations were used as input. Climate change projections produced by different climate models were used in the hydrological model to generate scenarios with and without regional land-use and land-cover changes induced by forest conversion to pasture for the period from 2011-2099. Finally we assessed the impacts of climate change on annual energy production based on the differences in the power duration curve - PDC produced by each scenario. The PDC of each scenario was estimated using hydraulic head and efficiency of each plant constrained by the minimum flow, under which the plant cannot operate, and the plant installed capacity. The use of PDCs allow to analyze the impacts not only of the annual average discharge, but also the effects of seasonal changes of climate. Despite of the differences among climate projections, results show that the climate change projections lead to a decreasing annual energy production and an increasing idle time at hydropower plants. Even when it is not possible to conclude about which projected climate scenario is the more appropriated, this work suggests to assess climate change impacts on energy production through an exploratory analyses, evaluating the robustness of the plant design under several plausible scenarios.

P-2212a-19

Impacts of climate change in epicontinental water systems of Mexico

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Continental aquatic systems in Mexico exhibit a high vulnerability to climate change. In particular, variation in the patterns of precipitation and drought associated to climate change threatens both: a) the availability and quality of freshwater in the vast arid extension of the country (North and Center Mexico) and b) the population and infrastructure in the Southern region o the country, were heavy rains cause severe flood events. Aquifer overexploitation is also a crescent problem, associated to a fast growing population in the central highlands and to potential pollution in the karstic Yucatan peninsula, where groundwater is the only source of freshwater.

The effects of climate change on Mexican inland waters are mainly related to five processes: 1) changes in the water level of the systems and associated ecological impacts, 2) changes in the thermal structure and mixing regimes of lakes and reservoirs, 3) increased trophic state and intensification of hypoxia, 4) eutrophication and toxic algal blooms, and 5) increased respiration that turns the metabolic balance towards net heterotrophy. In particular, the processes implied in driving system shifts from sinks to sources of atmospheric carbon in tropical inland waters are discussed, although the data to build these analyses are still scarce and heterogeneous. We outline that research on tropical cyanobacteria metabolic treats may provide relevant elements to understand the increasingly threat of noxious phytoplankton blooms.

Here we highlight the research lines that need to be reinforced in order to create the strategies for preservation and management of freshwater in a sustainable way: 1) carbon, nitrogen and phosphorus fluxes should be estimated in ecosystemic to basin scales, and should be incorporated into long term studies of water quality, 2) pollutant assessment as well as water treatment programs must increase significantly (only 37% of the Mexican municipalities have water treatment plants), and 3) systematic monitoring programs should be included in country-scale planning.

Diverse social issues (e.g. inequity, corruption, security and drug dealing) threaten the possibility of coping with the challenges that climate change involve for continental aquatic systems in Mexico.

P-2212a-20

Analysis of groundwater level historical data to detect climate change impact in France

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The level of groundwater bodies depends for many of them on the infiltration of meteoric water and will therefore be necessarily impacted by climate change if it causes a change in the infiltration system (intensity, period). To assess and monitor the impact of this change, a dedicated groundwater monitoring network is necessary. As this impact is currently unclear, the implementation of such a network involves an analysis of existing groundwater level data series.

The study was based on Mann-Kendall trend detection tests from groundwater level data and a comparison of trends between groundwater level data and climate data (precipitation, temperature, potential evapotranspiration). Trend detection tests were carried out on 377 piezometers of the french national groundwater quantitative monitoring network for which we had a data series of at least 25 years. In the end, 70 have a significant trend, 44 down and 26 up. Piezometers showing significant trend mostly concern aquifers with predominant annual hydrologic cycle. But most of aquifers in France have longer hydrologic cycles and statistical tests are not relevant because the data are autocorrelated and we do not have at our disposal long time series which are required for such tests. A sketch of spatial structuring trends has been identified, with rising levels for chalk aquifer in the Artois-Picardie basin and the center of the Seine-Normandy Basin and lower levels for chalk and Jurassic limestones aquifers in eastern Seine Normandy basin. Trends upward or downward may in some cases be influenced by groundwater pumping without that one can be demonstrated. The break tests show that the behavior change corresponds to the years in which water levels are significantly higher or lower than average or to the years that precede or follow these events. Finally, a tool for lumped hydrological modelling (Gardenia) was used to test the sensitivity of the groundwater level variations to potential evapotranspiration (PET). The results show that these variations have a relatively small impact on the groundwater levels, especially compared with model uncertainties.

In conclusion, this study shows that we cannot demonstrate a significant impact of climate change on groundwater levels because of too short time series but it reinforces the need to set up a monitoring network dedicated to the impact of climate change on groundwater. In order to set up that network, about 40 aquifers were selected with following creteria : unconfined aquifer, recharge likely to be impacted by climate change, large piezometric fluctuations, aquifer weakly impacted by withdrawals, aquifer to preserve for the future. To select piezometers for each aquifer, the main criteria was a low anthropogenic impact.

P-2212a-21

The Management of Traditional Hand Dug Wells

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The population of Cameroon is about 22 millions of habitants. The country has at least 120 billion m3 of useable groundwater resources unevenly distributed. The proportion of Cameroon's population with access to clean water was estimated at 57.8 per cent in 2005. It was 40 per cent for rural areas.Groundwater Management provides information on the distribution of groundwater resources and the feasibility of the water supply technology through the building of traditional Hand Dug Wells (HDWs).Our objectives are to show how a successful management of HDWs are economically-viable for the water supply and for the sustainable development of communities.

The methodology of fieldwork involves three stages: the decision to establish a new, or renovate and existing Hand Dug Wells (HDWs) in the village, the construction/installation of the HDWs and Its management.The materials required:- Guided interviews/seminars/workshops with key informers (officers of the administration and NGOs, builders of HDW's technology, representatives of farmers and pastoral associations, professional diggers of HDWs, land committees, farmers, rural councilors and village chiefs).- Group discussions (focus groups to help identify key issues for field work and for the discussion of the preliminary results of research).

The analysis are:

The idea of common ownership of the HDW is a reality for more impactful stakeholders' engagement:

1) In local municipalities:

-the economical development of rural areas;- the availability of potable water for the population;- the reduction of water diseases;- the improvement of the hygiene and sanitation within the population;-the development of agriculture/irrigation/breeding

2) In associations of women interested in the management of HDWs:

-the availability of potable water to reduce the burden of fetching water dedicated to women and children;-the improvement of the hygiene and sanitation in houses;-the development of agriculture/irrigation/breeding;

3) In associations of youth interested in the management of HDWs:

-the learning of the duplication of the construction/management of Hand Dug Wells for the future and for the sustainable development of the locality;-the availability of job opportunities in the construction/management of Hand Dug Wells

The results are:

-the monitoring and the management of the HDWs by the rural communities;-the training of diggers, builders and users of HDWs;-the sustainability of HDWs;-the availability of water;-the supply of remote/ rural areas with water

Conclusion

Our conclusion includes the village subsistence -level cropping- with groundwater use for the cultivation of vegetable gardens and seedlings to the improvement of food security at local scale.

Recommendation

We recommend that the technology of building HDWs been developed further in many countries in Africa to improve the availability of water because significant findings and outcomes of the management of HDWs are in its replication:-by the learning of the construction/ management of Hand Dug Wells in primarily/secondary schools/associations of youth/universities;-by organizing workshops to train many trainees/teachers/diggers/ builders in the construction/management/technology of Hand Dug Wells(HDWs).

P-2212a-22

Glacier retreat from a regional point of view: Characterization of glacier area changes over the Southern Central Andes Region

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In the region known as the southern central Andes of Argentina and Chile (between 30° and 37°S), some of the highest peaks are found. Glaciers are present in the high Andes from which originate several of the main rivers that flow through Chile to the Pacific and through Argentina to the Atlantic. Because of the temperate climate in the foothills on both sides of the Andes, this region is inhabited by the majority of the Chilean population as well as the largest fraction of the population in western Argentina. It is located in the transition between the region where the maximum precipitation over the Andes is observed and the desert regions of northern Chile. In this transition region, winter precipitation (mainly snow) associated with extratropical systems is sporadic in space and time and the melting of the yearly snowpack is the main source of summer river flow. Under these circumstances, mountain glaciers play an important role in the hydrological system of the region as they serve as a natural reservoir that can buffer the impact of dry seasons on socioeconomic activities in the region. Under a climate change context, the consequences of this phenomenon over glaciers are well observed at a global scale. Nevertheless a regional study of glacier variations over the Southern Central Andes Region has not yet been carried out.

We have selected images from the Landsat satellite from different years in the period 1989-2014. These images were obtained from the United States Geological Survey website. They have a spatial resolution of 30x30 m and they are ortorectified and georreferenced with the global reference system WGS84 and projected with the projection system UTM (Universal Transversal Mercator). All the images were obtained during the end of the ablation season, from the end of March to the beginning of April, when the seasonal snow has already melted. A false color composition that distinguishes ice surfaces was used. A supervised classification was applied with the purpose of making glacier evolution maps of the entire region. Changes are studied in terms of total glaciated areas and in individual glacier area.

Although some years have shown small advances, a general decrease in the total glaciated area was found. Both the altitudinal and latitudinal dependence was explored. Every latitudinal band has shown different rates of changes which imply that environmental factors other than latitude may play key role in determining the difference in the observed changes. Futherthermore, a number of glaciers were identified and studied as independent units which allows to consider other environmental factors, such as morphological characteristics of the different glaciers. As an example, the glacier Juncal del Sur (33°06'S, 70°07'W) situated in the Aconcagua river basin near the metropolitan area of Santiago de Chile has lost more than 25% of its total area between 1989 and 2014. Another glacier with accumulation zone at similar altitude, the Maipo volcano glacier (34°09'S-69°48'W) has reduced its total area by less than 20% in the same period. Even though the glaciers are situated within the same region, the second glacier belongs to a protected area. These factors are key when analyzing different behaviors within the same region.

2212b - Climate change and freshwater – 2: Shaping the Future

ORAL PRESENTATIONS

K-2212b-01

Water security: Global challenges, global responses?

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Röckstrom et al. (2009) suggest using consumptive water run-off (or blue water use) as a proxy for global freshwater use. Assuming an upper limit of ~12 500-15 000 km3 year-1 of accessible blue water resources, they suggest that consumptive uses above a threshold of 4000-6000 km3 year-1 would represent a significant risk to ecosystems, moisture feedbacks and freshwater/ocean mixing. Given that consumptive use is now at about 2600 km3 year-1 the authors conclude that there appears to be some room for manoeuvre, although there continues to be a trend of rapidly growing consumptive water use at the global scale. An Anthropocene or planetary boundaries framing of global sustainable development problems suggests a global governance of planetary boundaries. But there are questions about whether the planetary (or global) scale is really the appropriate scale at which to govern many of critical global resources and environmental services, including water. Water is typically governed at the level of the river basin and ecosystem. Moreover, while for some global environmental problems, like stratospheric ozone depletion, global governance appears to have been, in large part, successful, there are questions about whether such global coordination can be achieved in other cases. While global governance regimes now exist in many environmental domains, including climate change, achieving an alignment of interests leading to a common understanding of the problem and effective action at the global scale has often proven elusive. Water security emerges at many different and connected scales, from the local to the global. There are important legal, regulatory and voluntary dimensions of global water governance that contribute to water security across these scales. These include norms about rights to water, trade in virtual water, technical and other standards for water use and quality, as well as international transfers of knowledge, technology and finance to support water security. The paper argues that much of the task of governance will need to be focused on fostering transitions in water use, starting at the local level.

K-2212b-02

Shaping the future of freshwater: towards a collective effort to enhance our understanding and capacity to model change

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A large part of the Earth surface may still be in pristine condition, but humans have already had significant impacts on many hydrological processes relevant to society.

Humans have changed the face of the Earth dramatically over time and in doing so introduced substantial changes in the water cycle. Climatic change is one of these impacts, but effects of land use change on: erosion, the character of floods, droughts, and the partitioning and distribution of moisture fluxes are often more strongly noticeable at human scales.

In fact, the limited transferability of water in space and time implies that water withdrawals from natural resources take place where and when water is needed, thereby causing a direct perturbation to all water bodies relevant to society, and therefore to society itself. The current trend of population dynamics and the current status of water systems are such that this impact will not be sustainable in the near future. Therefore mitigation actions are urgently needed, and planning thereof needs to be based on improved interpretations of the impact.

Until recently, hydrologists mainly concentrated on catchments where human perturbation was limited, so as to improve the understanding of pristine hydrology. Nowadays, the urgency to mitigate the global water crisis through improved water management calls for research that attempts to bridge water and social sciences. To reach this target, new science is needed aimed at improved interpretation and modeling of the integrated human and water system. The question is how to build operational models that fully account for the interactions and feedbacks between water resources systems and society. This scientific challenge and the ambition to improve freshwater management in a changing environment together form the pillars of the science initiative «Panta Rhei», promoted by the International Association of Hydrological Sciences. Panta Rhei focuses on three targets, namely: to improve understanding; to enhance predictive capabilities; and to support societal planning. Two years since its inception, Panta Rhei already counts 30 working groups, involving about 300 scientists, who are developing innovative theories and modeling approaches to address the above challenges. In doing so, Panta Rhei is catalyzing a global and collective effort to assist societies to mitigate the global water crisis.

K-2212b-03

Prospective approach for assessing change in water resources management for large river basins in France

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Water management planning is influenced by many natural and human factors that interact at basin scale. A multidisciplinary approach is therefore required to both understand and well represent the main characteristics of the water system before analysing its sustainability under global change and suggesting efficient adaptation measures. The complexity of the interactions and thus the challenge in modelling increase with the size of the river basin. This talk presents the main results of the research project R2D2-2050 "Risk, water Resources and sustainable Development within the Durance river basin in 2050" (Sauquet et al., 2014). The Durance River, one of the major rivers located in the Southern part of the French Alps, supplies water for competing human uses (irrigation, hydropower, drinking water, industries and more recently tourism and ecological services) within and out of the drainage area through an extended open channel network. The project R2D2-2050 aimed to assess whether the current water management - especially operating rules for the three main reservoirs - would need changing under future conditions taking into account evolutions in both climate and socio-economy.A multi-model approach was carried out to simulate regional climate, water resources, irrigation needs, water supply for domestic purposes, water transfers and reservoir operations. A model of water management similar to the operational tool used by the French hydropower producer EDF was also developed to simulate water released from the reservoirs on present-day conditions under constraints imposed by ecological flows and water levels in summer for recreational purposes. Four territorial socio-economic scenarios have been also elaborated with the help of stake holders to project water needs in the 2050s for the area supplied with water from the Durance River basin.

Results suggest:

- an increase in pressure on diminished water resources,
- a decrease in energy produced by the main dams mainly due to reduced annual inflows,
- a decrease in biological richness for intermittent rivers,
- a full compliance with water needs for priority uses downstream from the reservoir but less flexibility for hydropower management during winter peak energy demand if current water management rules are unchanged,
- more frequent restrictions on water abstraction reducing the demand to be met for sub-basins with no reservoir,
- socio economic scenarios as the most important source of uncertainty influencing the sustainability of the present-day allocation rules.

Those conclusions will be compared with previous findings from similar impact studies on other large French river basins (Seine (Habets et al., 2013); Garonne (Hendrickx and Sauquet, 2013)).

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O-2212b-01

A citizen science approach to managing freshwater resources in the tropical Andes

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The tropical Andes are a hotspot of environmental change. The combination of global climate change, local land-use change, demographic growth, and increasing water demand is putting extreme pressures on water resources. This is of particular concern to rural upland communities. They are facing a double challenge of maintaining their own livelihoods with dwindling natural resources, and at the same time supporting downstream ecosystem services such as a well buffered stream flow and good water quality.

This challenge is complicated further by the acute lack of data on the hydrological functioning of Andean catchments. The factors that control their hydrological response are extremely variable in space and time, including meteorological forcing, land cover types, soil properties and geology. This makes it very difficult to predict accurately the impact of human activities such as land use, and watershed investments. Such predictions are essential for policy-making and sustainable ecosystem management.

In order to tackle the issue of hydrological data scarcity in the tropical Andes, we set up a citizen science initiative, implementing a network of hydrological monitoring of upland catchments in a pairwise fashion. Using a trading-space-for-time approach, the initiative aims to use these data to improve predictions about the impact of land-use changes and other ecosystem management practices on the hydrological response. Currently, over 25 catchments

are being monitored for precipitation and stream flow in 9 sites located in Venezuela, Ecuador, Peru, and Bolivia. The sites are supported by local stakeholders and communities in a participatory approach that otherwise would be impractical or prohibitively expensive.

Because of the technical challenges of monitoring hydrological variables in remote mountain areas, we set up a web-based infrastructure to support local technicians and stakeholders. Additionally, using open data standards such as those of the Open Geospatial Consortium, the data can be pooled efficiently for regional-scale analysis, as well as processed and visualized efficiently. Lastly, the datasets can be coupled to web-based hydrological models using rich and interactive interfaces. Such setups, which we refer to as "environmental virtual observatories", can support water and land users at different scales of decision-making, from community level to national governance entities, and at different levels of technical and scientific skills.

In our presentation, we will report on the effort of setting up a citizen science approach to monitoring freshwater resources in the tropical Andes, and how this can be used to support local management efforts. We will discuss our successes, as well as the remaining challenges in the technological, hydrological, and social science domains.

O-2212b-02

Science-policy interface to foster scientific development and uptake by policy makers for the purpose of water management in the context of climate change and climate change adaptation strategies development

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Water resources challenges exacerbated by global change including climate variability can affect water security and human well-being. To globally face this situation, there is a need to develop evidence-based policy incorporating accurate information related to predicted global changes.

But water and climate change research outputs are insufficiently reaching water managers today. And there's a lack of places where water managers can express the scientific information they need to develop their adaptation strategies.

A science-policy interface (SPI) answers this challenge by enhancing science-based policy development and fostering dialogue between researchers and water managers. It first facilitates the expression of policy requirements of scientific knowledge for specific management decisions, and a common understanding of these needs. It identifies existing scientific knowledge fulfilling policy needs and influences development of research agendas to match future policy needs. It finally allows a mutual understanding and long-lasting dialogue between scientists and policy makers.

Three science-policy interface experiences studied at international, European and national levels led to identify some recommendations to set a sustainable science-policy interface helping to face the challenges of water and climate change.

The 6th World water forum recommended initiating an international networking platform for researchers and water managers in order to facilitate communications in relation to the IPCC and other UN conventions. The objective of such a water SPI is to provide relevant scientific inputs to help governments and water managers develop effective decisions and climate change adaptation strategies, considering the uncertainty related to the impact of climate change on water resources. A mapping of existing SPI mechanisms over the world initiated this investigation.

From 2010 to 2012 a science-policy interface for the water framework directive (WFD) has been operated by the European commission and France. This SPI intended to support WFD implementation by helping provide and if needed produce adequate scientific information.

With a view to improving the uptake of science by policy makers involved in water management decisions in the context of climate change, and conversely the comprehension by scientists of the needs of policy makers, Onema organized on 3 February 2015 a seminar between scientists and policy makers. This event allowed them to share their knowledge and views on scientific needs, and raise recommendations on science-policy dialogue enhancement.

Those three experiences led to consolidate some main principles to set and maintain a science-policy interface which allows a better evidence-based water policy development under climate change.

Establish a sustainable Community of practices (CoP). The CoP is a consistent group of stakeholders of the water sector: scientists, water managers, knowledge brokers, politicians, journalists, civil society, ensuring a multidisciplinary approach. It should engage stakeholders from all the scales of the water management (and around the world). It ensures the operating of the SPI.

Appoint Knowledge Brokers and form them. They are skilled experts dedicated, trained, and resourced to engage in the SPI. They assist policy makers in formulating scientific and technical questions, enhance the scientific knowledge transfer to the policy makers and contribute to keep research aligned with policy needs.

Improve Communication and Tools. Communication may be encouraged and improved at all levels through the creation of a platform in which the CoP can share information and network. Recent research findings and request for collaborators with particular expertise for future research projects can be shared there. Policy makers can there access scientific information digested into policy briefs and other publications, seek experts' scientific opinion, and communicate their research needs to scientists.

O-2212b-03

"Water crisis and tensions in Europe and in the Mediterranean by 2050: future scenarios?"

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All around the world, water resources management is facing numerous challenges. The predicted effects of greenhouse gas emissions are of particular concern with regard to future droughts, which frequency and intensity are expected to increase. Despite the many uncertainties reflected in various future studies conducted in France, a general trend of decline emerges in the long term (2050-2070) with a 10 to 40 % decrease of the annual average river flows. Due to the decrease in snowy surfaces, rivers could also evolve from a nival (snowmelt dominated) regime to a pluvial (rainfall) regime, with lower flows during the summer - when crop evapotranspiration is at its maximum. Studies carried out on aquifers, suggest, under a business-as-usual scenario, an acceleration and intensification of the level of exploitation or of the degradation of the quality of many of them. Challenges and risks are particularly high in the Mediterranean countries, with a tendency towards an increased concentration of their population along coasts or within deltas, having direct and significant implications for drinking water supply and sanitation.

Foresight studies on water - related issues. The issue of scale is usually not discussed as such when conducting foresight studies. The watershed is certainly a relevant unit for surface hydrology. It does not, however, necessarily allow grasping groundwater, nor the territorial basis upon which public action is deployed. Greater emphasis should also be given to other scales such as water supply and water demands. On one hand, quantification is important in order to ensure the consistency of a given scenario, but it must be done a posteriori and not a priori. On the other hand, possible disruptions are difficult to model. Their probability of occurrence can certainly be quite well modeled, as long as a wide range of temporal uncertainty is acknowledged. What happens after any type of disruption is, instead, often qualitatively and quantitatively unpredictable.

Issues related to the status of global change. Climate

change is usually represented as a "driving force" of the system at stake, that legitimizes foresight debates, since it should lead to a decrease of water resources (on an annual or seasonal average),that could be very intense locally, and to a greater variability of the resource in space and time. While the water and climate nexus was brought to the international political agenda, the concept of adaptation also emerged, a concept to be differentiated from mitigation. Water issues are also to be framed in terms of adaptation, while having in mind that mitigation measures can significantly reduce adaptation costs.

Future issues. In Europe and in the Mediterranean basin, major issues are related to future tensions over water resources management and to likely induced disruptions. Possible answers to this should take into account the relations between climate change and the evolution of water uses, at an adequate time horizon (2050); it should also integrate hydrological and climate studies as well as social sciences approaches or results. Such is the aim of the international conference «Water Tensions in Europe and in the Mediterranean basin: water crisis by 2050?» organized by SHF, AFEID, the Water Academy and UISF, to be held at Paris (7-9 October 2015). Three cardinal themes have been identified: 1/Analysis of past and present "crises" and tensions on water resources. How, by whom and when, these past events have been classified as «crises» of «tensions»...? How were they governed, evaluated, explained? How may these analyses help in managing the future? 2/Forecast of the evolution of surface water and groundwater regime by 2050, and consequences associated in terms of water scarcity and water quality deterioration. The issue of uncertainty linked to the identified spatial scales shall be studied as well. 3/Methodological issues for prospective studies. How to build relevant analysis scales in prospective studies, how to relate them to water flows and territories? How to recognize and clarify uncertainties related to prospective studies and how to make more explicit the social and political dimensions that are inherent to prospective analysis? How to tackle water crises and their consequences? What kind of ruptures are to be considered? What can be expected from "new" technologies?

O-2212b-04

The importance of protecting and restore freshwater ecosystems for sustainable development and building resilience to climate change

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According to OECD (2012), the global demand for freshwater is projected to increase by 55 % between 2000 and 2050. Freshwater ecosystems such as wetlands, lakes and peatlands are the most essential of ecosystem services providing for food security, income, health and resilience to climate change induced impacts. Safely managed water resources are necessary for human wellbeing, for protecting communities from climate induced vulnerability and risk. (Millennium Ecosystem Assessment 2005) Stress on already exposed water recourses has implications on local communities relying on the sources for their human security and livelihood; it will impair the ability to overcome inequalities, and enhance economic development (UN Water 2014). Women are at a higher risk of being negatively affected by hydro-climatic disasters, and to the exposure of water- and sanitation related diseases. Freshwater interlinks sustainable development strategies with effective mitigation action. Wisely managed water strengthens climate adaptation capacities and protects livelihoods. Freshwater ecosystems harness the potential for reduced climate vulnerability, while being vital for resilient, prosperous communities, and this should be acknowledged in global policies. Further, bridging the gap between policy and practice; facilitating the integration and application of local expertise from indigenous communities, is necessary in order to build relevant capacity.

2212b-POSTER PRESENTATIONS

P-2212b-01

Climatic Change in the Amazon Estuary: perception of changes and impact on production by traditional population

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The studies on climate change in Amazonia have focused on the impact of changes on the regional climate (Coe et al 2002, Costa et al., 2013, Costa et al, 2007, Sampaio et al., 2007, Oliveira et al 2013) or on the relationship of climate change and reduction of biomass (Phillips et al. 2013) and more recently on the interactions between human activities (such as deforestation), climate change and the water system (Melack et al 2013). This paper aims to analyze the perception of traditional estuarine population in relation to climatic events in the Amazon and assess the potential for adaptation to climate change in this population.A semi-structured questionnaire was applied with 239 families in two communities in the municipality of the state of Pará Abaetetuba Perceptions of climate impacts vary according to the activity and the type of weather event to be evaluated. In general the product dries on the tree or fall and, according to the interviewees, can reduce yields by up to 46%. Regarding the fishing activity the answers were not as uniform as for the acai. In general, 54-58% report that high temperature affects the shrimp and fish (respectively) reducing their catch. The shrimp seem to be more susceptible to temperature and most of the informants said that the reduction occurs in the range 10-20% of production. The perception that temperature affects fishing fish is low (23% of total). The impact of rain, however, was remarkable for fishing. Most of the respondents say that increased rainfall and reduces fish and shrimp production (78% and 81%, respectively). In this case, around 50% said that production is reduced between 10-20% while 20% say that the reduction is around 50%. The tide seems to have huge impact on fisheries. In this case, the respondents said that when the tides were higher there was a large reduction in fish and shrimp production (92 and 95%, respectively). Surprisingly while 65% of respondents said that there was no way to reduce the impact of high temperatures on shrimp farming and fishing, the rest (45%), for the most part, believed that reducing deforestation would be a way to alleviate the impact. The population of the estuary is subject to a continuous process of adaptation. The cycle of the sugar cane mills encouraged the planting of sugar cane (from 1920 to 1987, Anderson 1991) resulting in deforestation of lowland forest. In 1987 in end of the cycle, the population began the cycle of palm hearts, cutting down much of the native palm heart trees and finally with the rising price of açaí fruit they began a process or maintenance of forest with enrichment of açaí forests or replanting açaí trees in areas previously cleared. In 1984 with the construction of Tucuruí hydroelectric dam, there were huge drop in fish catch (Juras et al., 2007) downstream of the dam to which the population also had to adapt. These experiences resulted in a higher capacity of adaptation by local population. However, with the major limitations of possible activities in the várzea and the high dependence on fishing and açaí this population need to be aware of the impacts.

P-2212b-02

WEBRESNAT: A Geoenvironmental Tool of GHG Emissions on Natural and Anthropogenic Aquatic Environments

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Concentration of natural greenhouse gases (GHG) in the

atmosphere have increased because of anthropogenic activities, but information on their emissions are still scattered in the scientific community. Hydroelectric dams have become the subject of speculation that their reservoirs are contributing to the intensification of the GHG effect. In 2006, IPCC decided to discuss a specific section to the issue of artificial wetlands where hydroelectric reservoirs are totally relevant. Research conducted primarily by COPPE / UFRJ in Brazil have shown that these systems have emissions, particularly CO2 and CH4. However, studies show that depending on the construction, operation, climate, soil and wetland biome type, hydropower reservoirs emit less or similar to various natural environments (wetlands, peat, rivers and estuaries). Thus, owning a GHG emissions database hydroelectric reservoirs and natural aquatic environment (wetlands, rivers, lakes, estuaries, etc.) are essential so that we can have a review of this issue and to make comparative studies. However, by 2012 it had no information about the existence of a database with this focus. As a result, the IVIG/COPPE from Brazil created WebRESNAT (http://webresnat.ivig.coppe.ufrj.br), in order to make available to researchers information about greenhouse gas emissions (CH4 and CO2) in hydroelectric reservoirs and natural aquatic environments worldwide. The study consisted of developing a database system based on GIS (Geographic Information Systems), whose objective was to collect, develop and disseminate information to assist in the analysis of the GHG and various geo-environmental parameters in hydroelectric reservoirs and natural environments through an online portal. The next steps will be oriented to the expansion, refinement and further details of the portal, using interactive maps that allow the user to view different aspects of specific areas and phenomena in question, as well as the lines of your interest, the different scales and varying degrees of detail. After its development, will become a very useful tool for the research community, because with it you can promote interactions, intercomparisons, collaborations and joint analyzes.

P-2212b-03

Integrated Modeling in support of Transboundary Water Cooperation in Central Asia: Ili-Balkhash watershed

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There is a concern that the Lake Balkhash can repeat the fate of the Aral Sea. Balkhash is the second largest lake in Central Asia and it has environmental, social and economic value for Kazakhstan. The loss of the Lake will lead to the deterioration of the climate change consequences in the region. An increase of the average air temperature by 1.3°C during the century that country is already facing is two times higher than the global warming value. This results in massive desertification and soil degradation, which will negatively impact on economy and living conditions in the region.

In order to verify this assertion an integrated model of the transboundary Ili - Balkhash watershed was done. Climate change and socio-economical changes were assessed for the level of influence on the lake system. Climate Change analysis was processed in Astana with the support of Laboratory of Energy, Ecology and Climate of Nazarbayev University Research and Innovation System. A Bayesian statistical model was used in order to make probabilistic forecast of climate change in the regional scale (Tebaldi et al. 2005). The analysis of socio-economical changes was based on the use of GIS techniques and remote sensing as well as literature review. Nine main scenarios were developed including climatic, economic and combined sets. An initial scenario showed that the Lake Balkhash is actually drying and current system is unstable. The best or 4.5 scenario that provided favorable conditions for the water regime has showed the only positive result and increase of water level. But this scenario is not realistic as finding of this study indicated the rapid economic growth in the near future due to population increase. Therefore combined p4.5 scenario was found more feasible. Under this scenario lake volume gradually fell but did not exceed the minimum level. The worst scenario (r8.5) showed the complete loss of the lake in fifteen years. Despite the fact that this last scenario is based on the maximum values and implies dramatic changes in the climate conditions and economic activities it is still possible to happen. Therefore countries were recommended not only to examine current watershed management strategy and come to consensus on the Ili river water use limits but also to reconsider energy strategy and consumer behavior of the local population.

P-2212b-04

Comparison of climate change impacts on the recharge of two karst systems computing different modelling approaches

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Karst systems constitute aquifers in which infiltration and groundwater flows are generally complex processes and are characterized by limited knowledge in terms of geometry and structure. Nonetheless, they often represent interesting groundwater resources, some of them being subjected to intensive exploitation and others non exploited due to their poor understanding. In the future, it is likely that climate change impact on water resources will increase the interest for such a kind of aquifers due to their strong infiltration and storage capacity, in a broad context of higher water scarcity.

The Lez and the Lison karst systems in Southern and Eastern France, respectively, provide 2 examples of such systems of several km² under two contrasted climate conditions, the first one being heavily exploited. This study presents a comparative climate change assessment on both karst systems. Nine climate scenarios corresponding to the Fourth assessment report of the IPCC (SRES A1B scenario), downscaled using weather-type methods by the CERFACS, have been applied to various recharge modelling approaches, as standard analytical solutions of recharge estimation and soil-water balance models. Results are compared and discussed in order to assess the influence on climate change impacts of i) the climate conditions (geographic location), ii) the groundwater exploitation and iii) the modelling approach.

P-2212b-05

Balancing water uses and availability under human- and climate-induced changes at the 2050 horizon

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Over the past decades, human and climatic pressures on water resources have been increasing in the Mediterranean region, and the area could experience higher water stress over the 21st century. This study aims to assess water stress by 2050 in Mediterranean river basins facing increasing human and climatic pressures, and to compare the impacts of a wide range of possible future socio-economic and climate trends.

A modeling framework integrating human and hydro-climatic dynamics and accounting for interactions between resource and demand at a 10-day time step was developed and applied in two basins of different scales and with contrasted water uses: the Herault (2 500 km2, France) and the Ebro (85 000 km2, Spain) basins. Natural streamflow was evaluated using a conceptual hydrological model. A demand-driven reservoir management model was designed to account for streamflow regulations from the main dams. Urban water demand was estimated from time series of population and monthly unit water consumption data. Agricultural water demand was computed from time series of irrigated area, crop and soil data, and climate forcing. Environmental flows were accounted for by defining streamflow thresholds under which withdrawals were strictly limited. Indicators comparing water supply to demand at strategic resource and demand nodes were computed. This framework was calibrated and validated under non-stationary human and hydro-climatic conditions over the last 40 years before being applied under four combinations of water use and climatic scenarios to differentiate the impacts of human- and climate-induced changes on streamflow and water

balance. Climate simulations from the CMIP5 exercise were used to generate 18 climate scenarios at the 2050 horizon (from nine climate models and two Representative Concentration Pathways). Two water use scenarios were considered: water uses of the 2000s and a trend water use scenario at the 2050 horizon, based on demographic and local socio-economic trends. The sensitivity of water stress to variations in the main drivers of water demand and availability under the trend water use and climate change scenarios was tested to assess the efficiency of potential adaptation measures.

Temperature projections show a clear increasing trend, particularly marked in the summer. Projections for precipitation are more uncertain and differ among the 18 scenarios considered. However, a decrease in spring and summer precipitation is expected in both basins. These climatic trends should result in changes in natural discharge: while scenarios diverge in fall, winter and spring, all 18 scenarios result in a decrease in summer low flows. Simulations revealed a significant increase in total water demand under anthropogenic and climate trends in 2050 in both basins. Results also show that projected water uses are not sustainable under climate change scenarios. While anthropogenic drivers could influence variations in water demand more than climate change, in the Herault basin the impact of climate change could be more determining than water use changes for the balance between water uses and availability. In some areas of the Ebro basin water use changes could have a larger impact than climate change on water stress. The combination of the trend water use scenario and climate change scenarios could also have a high impact on the respect of minimum environmental flows in both basins. Finally, water stress showed little sensitivity to individual variations in the drivers of water demand.

This study points out the areas most vulnerable to human- and/or climate-induced changes by 2050 in two Mediterranean basins. In both basins a combination of adaptation measures leading to a large decrease in water demand and an optimized management of water availability will be necessary in order to supply enough water to satisfy demand while limiting anthropogenic pressure on water resources to sustainable levels.

P-2212b-06

Revising the planetary boundary for freshwater use

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The nine planetary boundaries represent thresholds for key earth system processes which, if crossed due to collective anthropogenic activities, may move the earth out of the Holocene status with potentially desastrous consequences for human societies. While the concept and quantitative basis of planetary boundaries has recently undergone a comprehensive update (Steffen et al., Science, 2015), some boundaries still require a more robust quantification, especially in terms of the upscaling of regional patterns to the planetary scale.

This presentation shows a way to improve the assessment of the planetary boundary for human freshwater use, and the proximity to this boundary given current and potential future water demand and use. Our core concept is to account for the environmental flow requirements of riverine ecosystems as local limitations to human water use, which serve as a basis for a geographically explicit 'bottom-up' estimation of the planetary boundary. Our pilot assessment indicates that respecting the environmental flow requirements yields a planetary boundary value that is potentially lower than suggested earlier. Different estimation methods to assess environmental flows suggest a boundary between 1,100 and 4,500 km3 consumptive water use per year (original estimate from Rockström et al., Nature 2009: 4,000 km3 per year). Thus, humanity's current consumptive water use (~1,600 km3/year, ~90% of which are for irrigation), let alone water withdrawal (~3,600 km3/year), already exceeds the lower end of this range that reflects strict rules on environmental flows. Moreover, local tolerance limits (specified in terms of the ecological flow requirements) are already exceeded in many places, such as in parts of southern Europe, southern Asia, the Near and Middle East, and in the western USA. Our assessment is based primarily on high-resolution simulations with a dynamic global vegetation and water balance model, LPJmL.

Building upon these results, the presentation also elaborates on how the definition and quantification of the freshwater boundary can be improved further, for example by including «green» water conributions, process linkages with the planetary boundary for land-system change, and also water ethical considerations.

P-2212b-07

"Garonne 2050": an innovative participatory prospective study on the base of a strategy of adaptation to global changes for the Garonne river basin

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With its "Garonne 2050" study, the Adour-Garonne Water Agency, which covers the south-west quarter of France, carried out a forward-looking analysis of needs and resources, primarily taking into account the impact of climatic change. Although there remain considerable uncertainties about precipitation, by 2050, rising temperatures will result in a substantial increase in evapotranspiration in this region, what means less available water.

The study took place over a period of three years (2010 to 2013) combining a forward-looking methodology with the participation of the stakeholders (mainly water users) and simulations used to calculate the approximate amounts of water to be mobilised and costs involved for the agency managing the river basin .

The principal challenge for 2050 is that natural flow will be halved during the low-water period which itself will be earlier and longer (May to November). At the heart of possible scenarios for adapting to such changes, the key factor is the societal choice that will be made in response to the two-pronged question: what flow of water do we want in our rivers in the summer? And what are we able to do about it? Thus, the result of the simulation indicated that if we wanted, by 2050, to compensate for this natural hydrological reduction to maintain today's Target Low Water Flows (DOE) and preserve uses, biodiversity, aquatic recreational activities and landscapes during the summer period, then the total deficit, to be made good over the year, is around 760 Mm3/year (or to be more precise, a value between 480 and 1,200 Mm^3 given uncertainties). As a comparison, summer surface water usage for irrigated agriculture in this basin currently amounts to around 400 Mm3 and water stored in hydroelectric reserves in this same area amounts to 1,200 Mm3.

Models of five initial exploratory scenarios were created and submitted for consultation. In this way, it was possible to reduce the scope of the strategic debate to three main water management scenarios.

One of the important conclusions of this study is that in a region that is both highly agricultural and attractive from a demographic point of view, it will be extremely difficult to secure uses and maintain a low-water flow as it is today with the natural hydrological context of the future.

However, without impacting the management of energy or completely sacrificing an activity like irrigated agriculture, it is almost impossible to maintain an acceptable low-water flow, without relying on additional storage. Other problems connected with the quantitative management of the water resource have not been sufficiently detailed in this study, which may lead to an under-estimation of the tensions at stake and the problems to come. These include pollution, of course, but also soil erosion and effects on biodiversity, river morphology and so on; all essential factors impacted and impacting the volumes of water available for various uses. Finally, since the study did not specifically look into questions of governance, its main aim is to highlight the scope of the debate, which can no longer be avoided in the Adour-Garonne basin. In addition to the efforts that are now necessary for each sector of activity, the study picks up on an important question: the way we arbitrate and reconcile between different uses and, therefore, the question of access, which will be increasingly strategic, to the water resource, an essential asset of a region of over 65,000 km2 which will accommodate over 5 million inhabitants in 2050.

That is why the Adour-Garonne water agency organizes in continuation of this study, a regional conference with controversies, beyond the river basin committee, by integrating questions of choices of lifestyle of the citizens...

P-2212b-08

Combined effect of climate change and groundwater abstraction on multi-layer and alluvial aquifers in France

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Although nowadays groundwater resources are mostly affected by increasing water abstraction, they will have to face the impact of climate change. Even in a temperate climate as the one in northern France these two drivers will have strong impact on the aquifers. Evolution of groundwater resource is most often studied based on evolution of the rainfall infiltration that is assumed to be the aquifer recharge, although river-aquifer and multi-layer aquifer exchanges are also part of the recharge and can only be estimated using a hydrogeological model. Moreover, providing a change of the piezometric level is usually not found to be meaningful by stakeholder as a 1 meter variation can have different impact depending on the hydrogeological context. Therefore, in this study, to provide greater insight into the impact of groundwater, two new indicators are used: the evolution of the extension of groundwater-fed wetlands and the frequency with which a crisis piezometric head is exceeded. The crisis piezometric levels are used locally by stakeholders and as soon as the observed piezometric heads fall below these levels, actions are taken to preserve the water resource.

For the present study, the local crisis piezometric heads were extended to the whole studied basins, the Seine and Upper Rhine Graben basins.

The results show that the two basins under study are not affected in the same way by climate and groundwater abstraction changes. The Seine multi-layer aquifers are projected to suffer from

a substantial decrease in rainfall infiltration (about 20%), while the decrease is lower in the Upper Rhine Graben aquifer (about 6%).

In 2050, the extension of groundwater-fed wetlands is expected to lose about 900m2/km2, while the crisis piezometric heads are expected to be exceeded about 40% and 26% of the time on average on the Seine and Upper Rhine Graben aquifers, respectively. The reduction of the groundwater abstraction has a large impact locally but is not efficient enough to overcome the impact of climate change, although the impact is more sensitive on the Upper Rhine Graben than on the Seine,

and particularly on the extension of wetlands and low flow. Sensitivity to the parameters that drive the river-aquifer exchange was found to be second order compared to the uncertainty due to the

climate model in the Upper Rhine Graben, although these parameters have a considerable impact on present-day estimation of the aquifer balance. The two indicators are found to be highly useful to discuss the impact of climate change on groundwater with stakeholders.

In order to be able to extent such studies to the whole aquifers of France, and to have a survey of such impact as soon as new downscaled projections are available, the AquiFR project is bringing together hydrogeological applications used by stakeholder in a common plateform that will be based at Météo-France.

P-2212b-09

Monitoring and Evaluation of water of Quality of Taal lake, Philippines

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The study is an update on the physico-chemical properties of Taal Lake for local and government officials and non-government organizations to determine if there is a change in the quality of water in relation to climate change and environmental effects. A total of nine (9) water quality parameters were monitored and analyzed. The study shows that Taal Lake's surface temperature, pH, total dissolved solids, total suspended solids, color, and dissolved oxygen content conform to the standards set by the DENR while phosphate, chlorine, and 5-Day 20°C BOD are below the standard. T-test result shows that there is no significant difference in the overall average of the two sites at Taal Lake ($P > 0.05$). Based on the data, the lake is safe for primary contact recreation such as bathing, swimming, and skin diving and can be used for aqua culture purposes.

P-2212b-10

Integrated Climate and Land Use Change on Downstream Ecosystem Service in the Ta Chin River Basin, Thailand

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Ecosystem provides goods and services that sustain all life on planet earth. The services provided by ecosystem and their components are highly crucial for human well-beings such as provisioning of food, water and habitat, regulating carbon sequestration and providing recreational resources. Economies and livelihoods in developing countries heavily depend on ecosystem service. Climate change is expected to be major cause for changing in ecosystem services in variety of ways. Land-use and land-cover change (LULCC) involves several processes that are central to the estimation of climate change and its impact on ecosystem. It is, therefore, very important that integrated climate and LULCC change framework scenarios will enhance the current and future knowledge of ecosystem services. The area of study is located in downstream portions of the Ta Chin river basin where the river Ta Chin passes through the heart of province and flows into gulf of Thailand. It consists of many tributaries networks which connecting the ecosystem of lands and seas make it as a suitable place for fishery and aquaculture.

This paper aims at exploring potential impact of climate and LULCC change on ecosystem services in downstream areas of the river basin. Three Land-use change scenarios were developed; business as usual scenarios (BAU), high economic growth (HEG) and green growth (GG) scenarios and integrated to different climate scenarios (RCP 4.5 and RCP 6.0). For a case study, downstream ecosystem service in a changing climate and LULCC will be quantified baseline and projected change in provisioning of habitat and water supply. The interaction of socioeconomic development and changing climate on runoff, streamflow and precipitation will be studied. The scenarios shows that habitat loss is expected to occur in a basin in according to urban/resident sprawl (HEG scenario). Projection also reveals the increase in extreme precipitation in rainy season that might dominate runoff than recharge. Altered service of ecosystem leads to substantial effect on local livelihood. The results found that integrate climate smart land-use planning needs to be taken into consideration. It will reduce vulnerability and increase more efficient in water resource planning and resilience of local communities.

P-2212b-11

Salinity intrusion in the Mekong delta of Vietnam: Challenges and Solutions

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Mekong delta is located in the South of Vietnam, where salinity intrusion has been observed for many decades (Nguyen et al, 1999). As with many deltas, the Mekong delta is a□ected by both river floods and tidal inflows. Before 1980, salinity impacted 1.7–2.1 million ha of a total 3.5 million ha of agricultural areas of the Mekong delta every year during the dry season. In the 1980s and 1990s, a number of salinity control projects were implemented, including the construction of closure dams and sluice gates in the navigation canals connecting the branches of the delta. However, fresh water intakes along key estuary branches are a□ected each year by high salinity (Nguyen, 1999; Le A. T., 2006; Chu, T. H., 2012). As a result, these intakes have to be closed for anywhere from a few weeks to two months each year to prevent salt intrusion. (Nguyen and Savenije, 2006; Chu, T. H., 2012).

In recent years, stronger ocean tides and saline intrusion as a result of sea level rise are changing Mekong river flow in the dry season. Saline intrusion has started to influence river water near Can Tho city which is 65km far from the costal line and it impact to almost of sectors such as agriculture, aquaculture, infrastructure, water supply and local livelihood (ISET, 2013). According to the climate change scenario of the Ministry of Environment and Natural resource of Vietnam, the Mekong delta will be impacted significantly by sea level rise and salinity intrusion in the future (MONRE, 2012). The close proximity of measured saline intrusion to the cities and provinces in the Mekong delta and the vulnerability of residents to that intrusion have made this an issue of concern for people in the region. The combination of land subsidence, sea level rise, upstream dams and extractions, and tidal flows are projected to produce rapidly increasing salinity levels. With an unusually high reliance on surface water for industrial, residential, and agricultural use, the regional stakeholders quickly recognized the need to respond to the situation. To further complicate matters, daily fluctuations provided a strong impetus to monitor levels as could provide real-time data to ensure that citizens, water utilities, public health agencies, farmers, and local industries were informed.

This paper introduces a new model of real-time salinity monitoring system, which has been installed, and maintaining in the Mekong delta. Without the ability to halt the salinization process, the paper presented a strong example of resilience planning. It enabled adaptive management at a household and institutional level. It brought multiple stakeholders together, including city and national departments within government, and also involved collaboration with telephone companies to deliver SMS alerts. In addition, it focused on a pressing, but not immediate challenge, a category for which it's difficult to generate interest or commitment. This paper also reviews scientific information related to salinity intrusion as well as the perspectives of scientists, key local stakeholders, and local communities in order to assess the likelihood for salinity intrusion in the Mekong delta and, based on that, review possible options for the next steps of planning and decision making.

P-2212b-12

Impacts of climate change in the Bolivian Altiplano

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Introduction
The biggest impacts of global climate change will be felt mostly in developing countries, specifically smallholder farmers like in the case of the Bolivian Altiplano. The vulnerability of the people living in the Bolivian Altiplano comes in various ways; one is the location, the high altitude given semi-arid climatic conditions and the recurrence of ENSO natural phenomena.

The impacts of climate change on water resources in the Altiplano will have consequences on the availability of the resource and its growing demand to meet the requirements of drinking water and irrigation for agriculture.

The focus of the study is the Mauri and Desaguadero river basin, located in the Bolivian highlands part of the binational (Bolivia-Peru) TDPS hydrological system (Titicaca, Desaguadero, Poopó and Coipasa salt lake). The Mauri and Desaguadero rivers provide irrigation water to more than 24.000 ha. of crops.

The aim of this study is to assess the impact of climate change on the historical availability and requirements of water in a basin of the Bolivian Altiplano as a base line to build future scenarios to construct a participatory integrated adaptation Plan for the basin.

Methods
For this topic, three specific studies (water availability, water rights and water requirements) are considered combining field work with participation of stakeholders in the area and office work to process the data acquired.

Water availability
This procedure implies the collection and process of hydrological data (1965-2012), defining the curves of discharge of hydrometric stations in the basins Mauri – Desaguadero and Lake Titicaca, and obtaining series of daily flows, monthly averages and annual averages validated.

Water Rights
To have a view of the local management of water in the basin, a mapping rights study was developed, it allows to spatially visualize the water rights in relation with the customary rules applied to the social organizations of users. The methodology consists on interviews to stakeholders, workshops with communities and processing work. The most important tool is the GIS to process the information (Villarroel et al., 2014).

Water requirements
The water requirements methodology for crops and wetlands begins with the collection of productive information, weather information and the information about social management of water.

The main irrigated crops in the area are alfalfa (Medicago sativa), potato (Solanum tuborsum), barley (Hordeum vulgare), oats (Avena sativa), wheat (Triticum aestivum), native grasses, introduced grasses and quinoa (Chenopodium quinoa). A considerable area of wetlands is also important for the requirements in the basin.

Results and discussions
A hydrological database (1965-2012) of 21 stations located throughout the TDPS system was generated to use it in flow calculation. The results in the model showed that during the period 1990 – 2012 a significant reduction of the annual average flow is observed for the stations in the Mauri and Desaguadero Rivers. The reduction on the average flow of the Desaguadero river is caused by the contributions of Titicaca Lake, rainfall reduction and increased water usage in the upper side of the watershed (Molina et. Al. 2014).

The common law is that, in practice, grants, regulates and guarantees the rights of access to water for the residents of the area. Likewise, customary law is backed by positive law in different standards starting with the new Constitution of Bolivia that recognizes the habits and customs in water management.

After looking at the results of this study, it is important to consider that if the availability of water decreases and the water requirements increases, a deficit of water will be a fact.

P-2212b-13

Influences of Climate Change on Freshwater Water Resources Availability in a Basin Located in Asian Monsoon Region

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The influences of climate change on fresh water resources availability in Chinese Jinjiang Basin located in Asian monsoon region were assessed using the Block-wise use of the TOPmodel with the Muskingum-Cunge routing method (BTOPMC) distributed hydrological model. The ensemble average of downscaled output from sixteen GCMs (General Circulation Models) for the medium CO2 emission scenario in the 2050s was adopted to build regional climate change scenario. The projected precipitation and temperature data were used to drive BTOPMC for predicting hydrological changes in the 2050s. Results show that evapotranspiration will increase in most time of a year. Runoff in summer to early autumn exhibits an increasing trend, while in the rest period runoff shows a decreasing trend, especially in spring season. From the viewpoint of fresh water resource availability, it is indicated that it has the possibility that water resources may not be sufficient to fulfill irrigation water demand in the spring season and one possible solution is to store more water in the reservoir in previous summer.

P-2212b-14

Uncertainties in establishing hydrological impacts of climate change: what do we really know?

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The success of climate impact assessment studies is partly dependent upon the uncertainties in the reliability of the future climate estimates derived from one or more GCMs or RCMs but also depend upon the ability of the hydrological model to represent the catchment responses to climate variations and change. Thus, both hydrological and climate model uncertainties propagate through the entire assessment process and are not always easy to isolate. This study of the Great Ruaha River basin in Tanzania is based on the use of regional estimates of mean runoff, groundwater recharge and three flow points on flow duration curves (FDCs) to constrain ensemble outputs from the Pitman monthly model using Monte Carlo parameter sampling. The constraint bounds were quantified from gauged data available for 26 sub-basins together with assumptions about the spatial variations in hydrological response using limited physical sub-basin property and climate data. The results are encouraging in that the simulated FDC ranges bracket the observed curves at two gauging stations downstream of many ungauged sub-basins that are important sites for water resources development decision making. The established hydrological model (GW-PITMAN) with behavioural parameter sets has been utilized to simulate the effects of climate change projections on stream flow as given by three (3) GCM/RCM combinations using the RCP 4.5 emission scenario for the near future period 2031-2060. The RCM projections of change in monthly precipitation and potential evapotranspiration were estimated using the delta change approach where future climate conditions are compared to a reference period 1976-2005. Preliminary results based on three GCM_RCM combinations (NCC_RCA4, MPI-ESM_CRCM5 and MIROC5_RCA4) clearly indicate a shift in mean discharge. There are notable changes in both high and low flows. In all three GCM-RCM combinations, low flows are lower than the historical flow conditions, while high flows are higher than historical flow conditions. The high flows correspond to the projected increase in precipitation where initial results indicate a clear tendency across the RCM to increased precipitation in the wet season and decreased precipitation in the dry season with an overall annual increase in precipitation. A comparison of the uncertainty arising from the hydrological model and GCM-RCMs combination has been established based on the upper and lower bounds of the simulated historical and future stream flows. Figure 8.2 the upper and lower bounds for the three GCM-RCM shows an overlap between the historical and future predicted uncertainty.

2213 - Ecological feedbacks to climate change

ORAL PRESENTATIONS

K-2213-01

How biodiversity mediates feedbacks from terrestrial ecosystems to climate change

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Climate change impacts ecosystems in multiple ways, in interaction with other global change drivers such as land use change, nitrogen deposition or biological invasions. These joint impacts may vary from radical shifts such as switches in vegetation types or loss of top predators to more subtle reorganisation of community composition and interactions across trophic levels. While their understanding has progressed tremendously over the past decades, many uncertainties still remain about their implications for earth system dynamics. This uncertainty is all the more critical as cascading impacts of biodiversity for the earth system have recently been recognised as one of the two highly integrated emergent system-level phenomena that are connected to all other planetary boundaries (Steffen et al. Science 2015).

Biodiversity affects ecosystem functioning and land surface properties through multiple mechanisms. These are often underpinned by so-called functional effects, which reflect the fact that the morphological, structural, biochemical or life history characteristics of organisms directly determine their effects on ecosystem properties, as well as their responses to global change drivers. In this presentation I will first review the diversity of functional mechanisms through which biodiversity affects ecosystem properties, and especially biogeochemical cycling. This review will emphasise the role of interactions among the functional characteristics of organisms and global change drivers, and between the functional characteristics of different groups of organisms that interact as part of ecological networks. Second I will summarise the available evidence across scales for such effects and highlight main uncertainties and gaps in terms of knowledge and data. Lastly I will outline how some recent research terrestrial modelling efforts have started to incorporate functional diversity and its role in the response and effects of vegetation on biogeochemical cycling.

K-2213-02

Responses of marine ecosystems to climate change and ocean acidification

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Changes in temperature, oxygen level, acidity and other ocean properties directly affect marine ecosystems through shifts in biogeography, phenology, productivity and trophic interactions. This paper synthesizes our latest understanding on the extent to which climate change and ocean acidification are affecting global marine ecosystems structure, functions and services and the resulting vulnerability. As shown by analyzing global marine biogeography records and fisheries data, ocean warming has already been altering marine species assemblages in the past four decades. Moreover, mapping of vulnerability of almost 1000 species marine fishes in the global ocean based on their exposure to climate stressors and biological sensitivity and adaptive capacity indicates that most of the studied marine fishes become highly vulnerable to climate change under high greenhouse gas emission scenarios. Such findings corroborate with results from simulation modelling of global shifts in distributions of marine fishes and invertebrates, highlighting the large climate risks of regional ecosystems, particularly in the tropics, in terms of decreases in biodiversity and key ecosystem services such as fisheries. Scope of adaptation to these changes may not be sufficient to substantially reduce these risks, particularly in sensitive ecosystems. These evidence demonstrates the multi-facet responses of marine ecosystems to climate change, identify hotspots of vulnerable ocean regions to climate change, and highlights the need for ongoing interdisciplinary efforts between marine biologists, ecologists, oceanographers are needed to further reveal the multi-scales (spatial, temporal and

organizational) responses of marine ecosystems to climate change, ocean acidification and interactions with other human stressors.

O-2213-01

Ecological emergence of thermal clines in body size

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The unprecedented rate of global warming requires a better understanding of how ecosystems will respond. Organisms often have smaller body sizes under warmer climates (Bergmann's rule and the temperature-size rule), and body size is a major determinant of life histories, demography, population size, nutrient turnover rate, and food-web structure. Therefore, by altering body sizes in whole communities, current warming can potentially disrupt ecosystem function and services. However, the underlying drivers of warming-induced body downsizing remain far from clear. Here, we show that thermal clines in body size are predicted from universal laws of ecology and metabolism, so that size-dependent selection from competition (both intra and interspecific) and predation favours smaller individuals under warmer conditions. We validate this prediction using 4.1 million individual body size measurements from French river fish spanning 29 years and 52 species. Our results suggest that warming-induced body downsizing is an emergent property of size-structured food webs, and highlight the need to consider trophic interactions when predicting biosphere reorganizations under global warming.

O-2213-02

From cut twig to satellite – understanding the full response of phenology to climate change

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Phenology (the timing of seasonal natural events such as plant growth or animal migration) is now commonly used as indicator for evaluating responses of ecosystems to climate change. More than 500 papers are published annually that include 'phenolog*' in their title and many of them are related to anthropogenic change. Recent phenological changes have been reported across the globe, continents, ecosystems, habitats and taxa, predominantly as mean temporal changes ('trends') or as relationships to temperature and other drivers ('responses'); they have been summarized in various meta-analyses as well as in the IPCC WG II contributions to the AR4 and AR5. Although it has been well known during the 20th century that phenological events are triggered predominantly by climate, it was only in the late 1990s that phenology emerged as a key asset in identifying fingerprints of climate change in natural systems, when significantly advancing spring events were identified on larger scales mirroring recent warming.

Since then, phenological research has made considerable advances but is now at a crossroads of understanding its full climate change response and associated variability. Especially, other drivers of phenology than forcing by spring temperature, such as chilling and photoperiod preventing too early spring development and thus damage by late spring frosts, precipitation, snow, nutrients, ambient CO2 concentration or management effects have come to the fore. In addition, more emphasis has been given on reproductive phases and autumn changes in the last decade. The reported variability in observed trends and responses has been related to geno- / phenotypes, microclimate in stands, provenances and origins, species, species traits and phylogeny, regional climates and methodological considerations.

The timing of leaf development strongly regulates earth-atmosphere interactions and thus climate feedbacks, e.g. via biogeochemical cycles and impacts on the global energy balance, as well as biotic processes, such as pollination, agricultural and forestry production, and human health (via allergenic pollen). Thus, a full explanatory understanding of phenological drivers, accurate predictions and development of adaptation options are emerging topics which also need a full acknowledgement of the observed variability in trends and responses. In data-intensive analyses of observations, the inherent variability may facilitate the correct identification of all drivers, whereas in novel experimental approaches, the observed variability may call for a higher number of species, treatments and replicates. Variability may yield to more plasticity and resilience to climate change and thus phenological responses will drive the fitness and adaptation capacities of species. In this review, I summarize the current knowledge and recent insights into observed changes in phenology from satellite data to multispecies records, describe observed spatio-temporal variability linked to species traits and regional climates and highlight the role of additional drivers other than spring climate recently derived from cut twigs. Only a full consideration of variation in these responses will allow a complete understanding of ecological, cultural and socioeconomic consequences of these phenological changes mirroring climate change, driving impacts in the biosphere and feeding back to the climate system.

2213-POSTER PRESENTATIONS

P-2213-01

Effect of climate and site factors on exotic plant invasion in West Virginia, USA

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Global climate change is known to contribute to the proliferation of non-native invasive plants worldwide. Moreover, human-caused soil disturbance favors the growth of invasive plants, which negatively impacts the productivity of forest ecosystems. This study aims to examine the distribution of invasive plants in West Virginia and identify the site and climatic factors that contribute to exotic plant invasion. In 2007-2008, the U.S. Northern Research Station's Forest Inventory Analysis Program (NRS-FIA) surveyed the presence and extent of 20 invasive plants in West Virginia. Approximately 20% of permanent forested plots in 46 of the 55 counties were surveyed. The non-native plants were chosen based on range, invasiveness, and level of landowner interest. We generated maps and performed geospatial analysis using Geographic Information System (ArcGIS v.10). The most abundant invasive species was multiflora rose, (Rosa multiflora) which was present in 48% of the forested plots and 77% of the inventoried counties. Japanese stiltgrass (Microstegium vimineum) occurred in 52% of WV counties and was recorded in 24% of the sample plots. Nearly 25% of the sample plots containing Japanese stiltgrass had 25 to 70% cover. Autumn olive (Elaeagnus umbellata), tree-of-heaven (Ailanthus altissima), and garlic mustard (Alliaria petiolata) were present in 18, 14, and 10% of the forested plots, respectively. Each of West Virginia's ecoregions contains large number of invasive species with the Northern Ridge and Valley and Southern Unglaciated Allegheny Plateau sections containing the highest amount of 85% (n=17). Among the 46 counties, Hardy County contained the largest number of invasive plants surveyed at 65%, while Lewis County held 50%, and Ritchie and Hampshire Counties contained 45%. Logistic regression analysis of site and climatic factors ($p > 0.05$) reveals that the occurrence of Japanese stilt grass and garlic mustard is indirectly related to elevation and temperature while forest cover and road density are directly related to the presence of Japanese stilt grass and tree-of-heaven, respectively. Understanding invasive species and the environments where they exist is essential to gauge their impact and control their spread in West Virginia. Key site factors (elevation, aspect and slope), disturbance regime (land use types, amount of timber removal, degree of urbanization, fire occurrences and road density) and climate factors (temperature and precipitation) contribute to rapid increase in the distribution and abundance of non-native invasive plants.

P-2213-02

How soil microorganisms respond to and feedback climate change under non-extreme to extreme water fluctuations

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The response of soil to water fluctuations is poorly understood which result in high uncertainties about the effects of climate change and the associated feedbacks. Through several French national and regional research programs, different scenarios of drought-wetting (DW) intensities were simulated in microcosms and the dynamics of telluric microbial communities were followed to assess their stability in terms of diversity and function.

Thess studies highlighted a critical minimum moisture threshold below which microbial community stress was induced. Below this threshold, the wetting of dry soils induced (i) a large flux of CO2 (called the 'Birch effect'), which could be finely predicted from the intensity and duration of drought and wetting and (ii) erosion of bacterial diversity, leading to a structural instability in the following DW cycles. Despite an overall functional resilience, bacterial and fungal communities exhibited permanent modifications. Finally, the effects of DW events were also partially modulated by the soil physicochemical characteristics inherited from management practices.

These changes in microbial communities may be related to the size of soil pores, with more intense drying causing usually moist micropores to dry out. The stress of microbial populations less adapted to these disturbances, could result in (i) higher population turnover and intense competition for new available ecological niches and (ii) the establishment of physiological mechanisms such as the synthesis of extracellular protections. Upon wetting, this C would be immediately dissolved and mineralised. This is an alternative explanation for the increase in substrate availability and the CO2 flush that occurs after rewetting.

Taken together, the integration of climate change drivers investigated in this work could improve the modeling of C fluxes in soils undergoing DW cycles that feedback both atmospheric and soil C compartments. It also raises the issue of the existence of a tipping point in the decline of diversity beyond which an erosion or cut-off of the functions and services provided by ecosystems could be induced.

P-2213-03

Influence of climate changes on growth and initial development of tambaqui (Colossoma macropomum) larvae (Characiformes, Serrasalmidae)

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Introduction: The Amazon is the most diverse biome in the planet, hosting a number of plants, animals and microorganisms, being specially subjected to worldwide climate changes due to constant human activities affecting this biome. Amazonian species show important adaptation capacity, allowing them to explore challenging environments throughout the year. Larval development of fish is a very dynamic phase, marked by morpho-physiological changes during the organogenesis of the main systems. Therefore, initial phases are especially critical and the interactions with the environment define the adult individual. The aim of this study was to evaluate the effects of climate changes on the initial development of an important Amazonian fish species, the tambaqui – Colossoma macropomum.

Material and Methods: The predicted scenarios by the IPCC AR4 for climate change (Current CT, Mild B1, Moderate A1B and Drastic A2) were simulated in real time controlled microcosms – at the "Instituto Nacional de Pesquisas da Amazônia", Manaus – AM, Brazil – based on the current climate conditions. Ten 9-L tanks, equipped with recirculation system, containing 300 newly hatched larvae each were positioned in each microcosm. Larvae were kept for 16 days and periodically collected to perform biometrics and yolk consumption analysis. Yolk consumption, notochord length and standard length were analyzed by one-way ANOVA with Tukey post-hoc, and are presented as Means ± SE.

Results: Temperature, CO2 concentration, dissolved oxygen and water pH are shown in Table 1. Yolk consumption was not different among treatments throughout the five lecithotrophic days (mean areas on day 1 and day 5 of 0.7095 ± 0.007 mm2 and 0.2583 ± 0.016 mm2, respectively). Larvae submitted to the CT and A2 scenarios showed, by the end of the experiment, similar standard length (6.764 ± 0.170 mm and 6.877 ± 0.148 mm, respectively), but were significantly smaller ($P < 0.05$) than larvae in B1 and A1B (7.573 ± 0.141 and 7.804 ± 0.247 mm, respectively). During the first two days, high mortality was observed in all treatments (approximately 50%) due to an unknown cause, and by the end of the experiments, survival rates were calculated considering the initial density of the tanks. Survival rate in CT was 29.3 ± 0.3%, significantly higher ($P<0.001$) than in A1B (26.3 ± 0.7%) and in A2 (24.7 ± 1.0%). In the B1 scenario, the survival rate was intermediary (27.5 ± 0.6%).

Discussion: The causes of high mortality in the first two days of the experiment could not be identified. However, the stress of the transportation of the yolk-sac larvae (about 200 km) and the water quality differences from the water of transportation and the water in the microcosms must be considered, despite the use of a rigorous protocol of acclimatization. When exposed to higher temperatures (A2), the larvae energy demand to supply the increased metabolism is also higher. Considering that yolk consumption did not differ among treatments, it is assumed that the efficiency of this initial source of energy in the yolk-sac larvae may have been compromised at higher temperatures, subsequently resulting in smaller larvae and higher mortality. Treatments with intermediate temperatures (B1 and A1B, ranging from 29 to 30.5 °C) allowed better growth.

Conclusions: The predicted scenarios of future climate change by the IPCC for the end of the century, mainly the drastic ones, may affect the initial development of this Neotropical fish species, leading to high mortality rates.

Table 1. Mean values of temperature (temp, °C), CO2 concentration (ppm) in the air and water, pH and dissolved oxygen (DO, mg.L-1) in the tanks installed in each microcosm. Values are presented as Mean ± SE.

	Current	Bland	Moderate	Drastic
Room Temp	26.74 ± 2.08	28.72 ± 2.05	29.68 ± 2.01	31.70 ± 2.07
Water Temp	27.71 ± 1.19	29.23 ± 1.26	30.35 ± 1.07	32.05 ± 0.76
[CO2] Room	486.43 ± 32.69	690.00 ± 36.59	885.37 ± 28.42	1330.75 ±30.49
[CO2] Water	5.26 ± 0.78	7.17 ± 1.35	11.16 ± 3.85	15.20 ± 2.84
Water pH	7.10 ± 0.22	7.03 ± 0.27	6.96 ± 0.22	6.80 ± 0.27
DO	7.02 ± 0.16	6.89 ± 0.26	6.99 ± 0.11	6.85 ± 0.16

P-2213-04

Effects of Climate Change on Bird Migration in Iran

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Climate change can directly affect birds through changes in temperature and precipitation. Drainage of wetlands is from the direct effects of climate change, which can indirectly affect bird's life. Around 70% of wetlands are seriously subject to dry or water loss. Even the rice fields, which defined as a wetland type, and very important for birds, are rapidly decreasing, converting to the other cultivations and uses. Birds in Iran are affected by climate change in various ways, such as distribution, abundance and migration behavior. Statistics and observations suggest that the birds are selected more northern altitude for wintering. As well, they arriving to wintering grounds later and leaving the area a bit earlier. A huge breeding colony of Greater Flamingos are disappeared in Uromiyeh Lake due to serious drainage this international wetland. The Siberian crane is a critically endangered migratory wetland bird numbering 3,000 individuals worldwide, which breed in arctic Russia and Siberia, which recent climatic conditions in these areas have seen rivers and lakes shrinking, causing wetlands to become more accessible to hunters. The western population of this species is dropped to only one single bird. Noting that climate change will put a lot of birds in danger of extinction In the future, we need activities to help birds to mitigate and adapt against changes. One way should be conserve local bird habitats, through the community based and grassroots programs and invested in on-the-ground projects involving Important Bird Areas.

2214 - Climate-ready adaptation for conservation and ecosystem services

ORAL PRESENTATIONS

K-2214-01

The response of species and ecosystems to large and rapid climate changes in the past: information for conservation policy in an uncertain future

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Contrary to the impression given by some recent, high-profile reports, climate changes of similar magnitude and rate to those projected for the 21st century have occurred repeatedly in the geologically recent past, during and at the terminations of glacial periods. The causes and geographic patterns of these natural climate changes were quite different from those of contemporary climate change, which has two additional distinguishing properties: the fact that it is superimposed on a warm (interglacial) rather than a glacial base state, and the fact that it could - in the absence of mitigation - continue longer, and ultimately exceed the bounds of what the biota have experienced during several million years of Earth history.

Nonethless, the palaeoecological record can provide uniquely valuable evidence on how the biotic response to a fast-changing environment. Examination of the last glacial termination yields surprising (and in many ways encouraging) findings. Known extinctions were few, except among large mammals. Among hundreds of tree species known to have existed worldwide at the last glacial maximum, just one became extinct. A variety of responses allowed the great majority of species to persist, either in situ (through toleration or local habitat shifts), or by migration at remarkable velocities. These findings suggest a continuing role for conservation policies that focus on the maintenance and spatial continuity of habitats. They also suggest that the species most vulnerable to climate change may also be those that suffer most from other, non-climatic pressures.

K-2214-02

Enabling transformative adaptation

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The Transformative Adaptation Research Alliance (TARA) has developed an operational framework to study and support transformative adaptation, linking three novel concepts of 'adaptation services', the 'values-rules-knowledge (vrk) perspective' and 'adaptation pathways'. Adaptation services describes future options provided to people by ecosystems, recognising changing societal perspectives on ecosystem management and use. The vrk perspective focuses on the societal system and how we can free up constraints on the decision context for implementation. The adaptation pathways concept provides the means for planning and sequencing the actions required for transformative adaptation. Uniting these concepts allows the exploration of interactions between changing biophysical systems and co-evolving societal systems in order to enable deliberation, choice and decision-making.

K-2214-03

Biodiversity conservation under climate change: do we need a new approach?

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Climate change is predicted to have major implications for species and ecosystems, acting as a driver of biodiversity loss in its own right and amplifying the effects of existing threats. It differs from other pressures, such as land-use change or over-exploitation, in the global extent and pervasive nature of its potential impacts on biodiversity. The potential magnitude of climate change impacts calls for a policy response, but the type of response and the species or regions to be targeted remains unclear. Predictions for wide-scale extinction and disruption of communities and ecosystems has led some to question whether traditional conservation practices, such as protected areas, will continue to be effective. Others have called for radical and interventionist strategies, such as moving species from their current locations to regions that are predicted to be climatically suitable.

We will provide some recommendations for conservation management under climate change based on the emerging science of integrated vulnerability assessment. This uses multiple sources of information, a greater understanding of the mechanisms and drivers of vulnerability, and identifies proxies and predictors for sensitivity and adaptive capacity.

Effective conservation policy and practice will need to embrace some change rather than aiming to preserve existing ecosystems with their component species. Distinctions between native and non-native species may become less relevant as species shift their geographic ranges. Global rather than regional or national targets or criteria for species or habitat protection or designation of protected areas may be more appropriate as species' ranges and abundances change. A focus on ecosystem function and resilience may be more appropriate than on maintaining species community composition. Traditional practices, such as protecting or restoring habitat within reserves, may support function and resilience by allowing existing systems to absorb the impacts of climate change. Improving permeability of the landscape or connectedness between reserves may be required to facilitate range shifts, either through spatial structuring of new reserves of by enhancement of natural linear features, such as rivers and hedgerows.

Uncertainty as to future climate may be, to some extent, irreducible and be incorporated into decision frameworks and interventions though adaptive management and scenario planning. Early applications of integrated vulnerability frameworks suggest that tropical regions may be centres of climate change vulnerability. Climate change, coupled with predicted increased in land-use

change in these regions, suggests that tropical zones may be future centres of biodiversity loss. Stemming loss is likely to require a co-ordinated international response, with transfer of expertise and financial assistance from high-income developed temperate nations to assist low-income tropical nations in increasing their level of human societal development in a sustainable manner.

K-2214-04

Powerful deliberate practices for enabling transformative adaptation

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Anticipatory and transformative adaptation in the face of climate change, including for biodiversity conservation and maintenance of ecosystem services, is an intentional process. It requires the facilitation of the enabling conditions for significant and qualitative societal changes well beyond minor or incremental adjustments. Yet there is currently little understanding about how such deliberate significant changes come about, and at the rates necessary to reduce the threat of climate change. This presentation will therefore examine the nature and role of powerful deliberate practices (the tools, activities and processes) for helping to create the enabling conditions for transformative adaptation and conservation of biodiversity. The presentation will do four things. First, it will explain the concept of transformative adaptation and the challenges involved in facilitating enabling conditions. Second, it will explain the kinds of research that is that can simultaneously help understand transformation while also accelerating transformation in practice. This necessarily involves: (i) integrating existing theory, such as social practice theory and social technical transitions to overcome epistemological and ontological differences; and (ii) the bridging and integration of different kinds of knowledge, including academic (episteme) and that of practitioners (phronesis). Third, it presents a new concept called 'powerful deliberate practices' as a way to overcome some of the challenges of working on transformation. This concept is important because its emphasis on: (i) 'powerful' highlights the need to understand which practices are most useful, for which circumstances, and why for adaptation and biodiversity conservation; (ii) 'deliberate' highlights the need for approaches that can directly contribute to change in the present rather than, for example, looking to poorly suited past cases of change as analogues for the contemporary issues; and (iii) 'practices' highlights the need to understand the complexities and subtleties of interventions for conservation and adaptation as a collection of tools, activities and processes in systems of wider, less conscious social practices. Finally, an example of Three Horizons will be used of a potential powerful deliberate practice. Three Horizons is a process used to facilitate dialogue between individuals with different values and mindsets to map out processes of transition and transformation. The approach is able to both deal with situations of high uncertainty and has been found to create radical transformations in how participants relate to the future and view themselves as credible actors in shaping change, and is thus relevant to diverse circumstances, including transformative adaptation and the management of ecosystem governance and change. In conclusion, a research agenda is needed to develop, integrate and understand the role of a suite of powerful deliberate practices to accelerate learning about the enabling conditions for transformative change. This will necessarily involve new transformative modes of research that are significantly and qualitatively different from many of those already being applied.

O-2214-01

Expanding the horizons of governance for adaptation pathways: illustrations from protected areas management

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The concept of adaptation pathways is expanding our ideas of governance for adaptation to include wider social and institutional dimensions of organisation, decision-making and implementation. This is captured by the "values-rules-knowledge" construct. Drawing on recent work in adaptive governance and long-standing development studies literature and practice, we propose that we can combine this construct with complementary perspectives to develop a more holistic framework for governance in examining transitions to more sustainable and adaptive development pathways. This expanded framework incorporates culture and corruption, power and politics, resources and capacity, and process and vision. We present this framework, and demonstrate its application through retrospective application to research on public land management in Colorado, USA, and prospectively to a pilot study on the Pacific island of Palau, specifically the Protected Areas Network (PAN) Fund. These illustrations suggests that the framework can be used as a device to help us identify 'deeper', more structurally-embedded influences that shape values, rules and knowledge, that support or inhibit transformational change, as well as some of the practical implications. Importantly, it also has the potential to alert us to crucial 'blind spots' in our investigations and analyses of governance for adaptation in the face of global environmental change, as well as to identify opportunities for institutional innovation.

O-2214-02

Global scenarios that achieve multiple sustainability targets: challenges for IPBES and IPCC

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Several global sustainability goals for the 21st century have been agreed upon or are being discussed in the context of global multilateral environmental agreements. These include keeping global warming to 2°C or less for the 21st century (UNFCCC objective under discussion), halting the loss of biodiversity by 2050 (Convention on Biological Diversity) and attaining these while simultaneously meeting human development goals under the UN post-2015 global development goals currently under discussion. Scenarios of future global development suggest that achieving these multiple targets simultaneously will require substantial societal transformations. Many of these transformations have not been fully explored in global scenarios, even though many studies have shown that these can play very large roles in achieving mutliple sustainability targets. This talk will review some of the key challenges facing IPCC and IPBES (International Science-Policy Platform on Biodiversity and Ecosystem Services) in developing the next generation of global scenarios of socio-economic development, using examples from the IPCC SSP scenarios, the Global Biodiversity Outlook 4, the UNEP Green Economy report and a wide range of published studies. This analysis suggests in that transformations of food systems, in terms of marine fisheries, aquaculture, agriculture, food transformation and food consumption can make major contributions to achieving a wide range of sustainability targets.

2214-POSTER PRESENTATIONS

P-2214-01

Guiding Agricultural Expansion to Spare Tropical Forests

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Expanding commodity crop production in the tropics presents the dual challenge of enhancing food production while preserving tropical moist forests (TMF) ecosystems and the carbon that they store. Over the years, biologists

have prioritized biodiversity rich areas and made recommendations on conservation imperatives. Conversely, agricultural imperatives—and especially commodity crops—typically ignore biodiversity and carbon content values when converting new lands for expansion, even though the ecosystem services from the latter are vital to sustain the former. In this analysis we attempt to reconcile biodiversity, carbon storage, and agricultural imperatives by identifying low-carbon density land (LCDL) for large-scale commodity agricultural expansion in the tropical realm. Thereby protecting important and representative biodiversity while minimize CO2 emissions. Our rationale is based on the fact that LCDL are essentially degraded TMF that are usually stripped of the high carbon cover and forest-dependent biodiversity. Because degraded TMF can take decades or even centuries to recover and mature, these lands are of limited conservation value relative to intact forests. With techniques now available to improve soil fertility, drainage, and sustainability these degraded forests can be made suitable for agriculture, and provide opportunities to expand the commodity and industrialized agricultural footprint with minimal loss of biodiversity and CO2 emissions

Here, we propose a transparent approach for shifting agricultural expansion away from biodiversity and carbon rich TMF into degraded, low-carbon density lands, defined as lands holding less than 40 metric tons of Above Ground Carbon (AGC)/ha. Results show about 274 Million ha of low carbon density forests occur in the TMF tropical belt. After applying important safeguards, filtering for areas unsuitable for industrial agriculture, under formal protection, in indigenous reserves, or other biologically sensitive areas, about 125 Million ha are potentially available for tropical agricultural expansion for the next 25-50 years without further destruction of rainforests. About 65 Million ha of this LCDL estate is distributed in contiguous tracts larger than 5,000 ha and lies below 500 meters elevation, meeting the prerequisites for successful commercial-scale oil palm production. Nearly one third of all LCDL occur in Brazil; followed by India, Myanmar, Mozambique, Indonesia, Tanzania, and Democratic Republic of Congo, all holding more than 4 Million ha. The simplicity and transparency of this easily-monitored metric could prove useful to producers, governments, investors, and consumers and enhance good governance in tropical regions.

P-2214-02

Treeline Dynamics with Climate Change in Nepal Himalaya

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The imprints of climate change impacts have evidently been recorded from the natural habitats of the Himalaya. Available climatic data show a rapid increase in the average annual temperature in Nepal Himalaya compared to other regions. Nepal's rich tree diversity emanating from varied climate within a narrow geography of extreme topographic range (Alt. 60 m to >8000 m asl) provides opportunities for multi aspect tree-ring research. The high altitude climatic treelines are sensitive biomonitors and bioindicators of past and recent climate change and variability as well as warning line to the climatic impacts on high altitude biota and livelihood. Science based empirical studies on the impacts of climate change in high-altitude ecosystems and their components are yet new approach in the Himalaya especially in Nepal.

We carried out a dendro-climatological study at the tree-line ecotones of seven high mountain protected areas of Nepal Himalaya from east to west, namely: Kanchenjungha, Sagarmatha (Everest), Langtang, Manaslu, Annapurna, Rara and Api-Nampa, with an aim to assess the impact of climate change in the tree-lines. Two to three sites were selected in each protected area. Vertical transect plots (10-20 m x 100-250 m wide) were laid down in each treeline site covering different aspects of mountain slopes. In addition to ecological details, more than 1200 tree core samples from major treeline species, viz. Abies spectabilis D. Don, Betula utilis D. Don and Rhododendron campanulatum D. Don were collected. Using the ecological and dendrochronological tools, climatic response on radial growth and regeneration, recruitment and dynamics of the these species were analyzed.

The position of tree-line in the east (Lat. 27.7155 N) was higher (Alt. 4150 m asl) in the west (Alt. 3800 m als; Lat. 29.8750 N). The size parameters such as tree density, basal area, diameter at breast height, height and age decreased with increasing elevation revealing dynamic nature of tree-lines though it presented some spatial heterogeneity. High regeneration of A. spectabilis as compared to B. utilis was observed in most of the sites. The population age structure of these species showed both stand densification as well as upward shifting of tree-line in many sites. The tree core analysis showed that in most sites, B. utilis appeared first which was later displaced by A. spectabilis. High regeneration of A. spectabilis in recent years compared to that of B. utilis indicated that the tree-lines in Nepal Himalaya are changing along with the species composition and dominance.

The upward shift of A. spectabilis was clearly observed, the shifting rate ranged from 1.1 m to 3.6 m per year. An invariant positive correlation among the site chronologies was also noted, indicating that there prevailed some common climatic factors limiting the growth and dynamics of the trees. Tree growth-climate and regeneration-climate relationship showed that warm winter and moist summer favoured the regeneration of A. spectabilis, while pre-monsoon (March-May) climate enhanced the radial growth. Growth of B. utilis in most of the sites was mainly limited by moisture stress during pre-monsoon months just before the main growth period. Population structure and climate growth response indicated that both the species had species specific response to climate change. Hence, a wider difference is anticipated in the population attributes of the species as climate continues to change in the future. These shifting also have implications on the poor mountain people whose livelihood depend on marginal rangeland just above the tree-lines.

P-2214-03

A Perspective on Conservation of Sub-Tropical Grassland in Eastern Himalaya

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The matrix of riverine grasslands and grassland-forest mosaics in the Ganges and Brahmaputra river valleys in the eastern Himalayan foothills are some of world's tallest and most productive .These tall grassland forest mosaics are the last remaining examples of subtropical tall grasslands in the Indian subcontinent, and contain some of the highest densities of tigers, rhinos, and ungulates in Asia. These grasslands mosaic are maintained by a suite of disturbance processes including flooding, fire, and grazing. Manas National Park, a world heritage site and a tiger reserve with an area of 519 sq. km, situated in the North bank landscape of Assam. A socio-political change in the North bank landscape led to a disruption of management practices in the Park. These changes lasted over 15 years, and as a result, fire regimes and grazing practices changed. Wild populations of herbivores and carnivores suffered huge declines due to lack of protection. Coupled with changes in river flow, these changes have led to significant alteration in the grassland community in both local and regional level. Recent observations have shown an increase in the spread of species that are dominant in drier ecosystems, as well as occurrence of tree species in areas previously occupied by grasslands, changing savanna grasslands to woodland. This dynamism is probably driven by the interacting effects of environmental variation, changing management regimes, human interactions, and ecosystem feedbacks. The system probably experiences fluctuating species composition and wide variation in population dynamics of plant species, but none of this has been clearly documented.

P-2214-04

Commodifying Nature, Where we were mistaken with Ecosystem Service Classification

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Economic theory driven ecosystem valuation has been the fundamental areas for the Ecosystem Service (ES) and Payment for Ecosytem Services research in the last decade. The Classification of ES by MEA 2005, has diverted the whole research community to think Nature as a Commodity and the research community for this whole decade spend their huge effort in the monetary valuation of Nature, but still we are far away from the solution within nature-human-development nexus. The major problems in this classification was with the cultural service, weighted in similar fashion with other three provisional, supporting and regulating service. Our empirical Study has shown that, with all those three services, cultural service was interconnected and no way can be treated as a separate class. Besides, the complexity of natural process like hydrological cycle, nutient cycle and climate cycle, which were categorized in regulating and supporting services needed research on the long term nature, and it can no way be monitised like other economic goods, and hence resulted in the failure to measure and manage it for the transformative solutions in our societies. The economic theory like utility and welfare theories in no way could justify the interlinkage of nature and economy.

P-2214-05

Maintaining Habitat Connectivity for Vulnerable Ungulate to Mitigate the Impacts of Climate Change in Isfahan Province, Iran

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Climate change is predicted to have substantial negative impacts on biodiversity for a wide variety of taxa across many regions of the world. The combined effects of climate change, habitat fragmentation and land use change is the most important conservation challenge we face. Maintaining connectivity is the most recommended strategy for conserving species in onset of climate change. In this study, we identified and evaluated migration corridors for two vulnerable ungulate species, the wild sheep (Ovis orientalis isphahanica), and the goitered gazelle (Gazella subguterrosa) between Mooteh and Ghamishloo wild life refuges in Isfahan province, Iran. Migration of goitered gazelle and wild sheep between these wildlife refuges is related to seasonal change in environmental conditions. To identify migration corridors, two connectivity models were used, Least-Cost Corridor (LCC), and Circuit Theory. Using LCC, two corridors were selected for each target species. The first least-cost corridors for the species included habitats of highest quality (lowest resistance) which stands for the minimum costs for movement. Theses corridor for giotered gazelle covered about 158 km2 (7.5% of the total area) and the one for Wild sheep covered 151 km2 (7.2% of the total area). Although the identified corridors in this study are currently used for round migrations between Mooteh and Ghamishloo wildlife refuges, they are most likely to be served as one way migration corridors from Ghamishloo to Mooteh protected area assisting the species to shift their ranges in response to climate change in an immediate future. Climatic conditions in Mooteh compared to Ghamishloo in terms of annual rainfall (249.16 mm in Mootieh in compared to 180.9 mm in Ghamishloo) and minimum average temperature (-8.5C in Mooteh compared to -1.6 C in Ghamishloo) indicates that Mooteh wildlife refuge will be used as a refugia to buffer these ungulates from the impacts of drought and climate change in this region.We conclude that protecting and incorporating of the remaining suitable migration corridors into the existing protected areas network of Iran is an urgent need in order to secure the survival of the migratory species. As the study area is not protected at present and is very likely to be developed in near future, it is very important identifying the areas with the easiest movement routes for future conservation which, if conserved, provide the easiest movement routes assisting species in the face of climate change and land use change. Improving connectivity is not only strategically smart, but a proven method of allowing wildlife to move in response to rapid environmental change.

P-2214-06

Impacts of Biodiversity Loss in the Carbon Stock and Evapotranspiration Fluxes Regulation in Brazilian Amazon

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Biodiversity supports many ecosystem services that are very important for climate change mitigation and adaptation, according to the Convention on Biological Diversity (CBD) there are clear interlinkages between biodiversity and climate changes. There is a functional link between the tropical forest ecosystem biodiversity and their capacity for carbon uptake and storage as well as regulation of evapotranspiration flux. Nevertheless, land use changes and agriculture expansion reduce the ecosystems integrity modifying the functions related directly to the ecosystem services. The relationship between biodiversity loss and the ecosystem services in tropical forests, in face of the ongoing global climate change, has been quite accepted by the scientific community, but needs to be better quantified and understood. The objective of this paper is to present the methodological approach and preliminary results on the impact estimation of land use changes and ecosystem biodiversity loss in carbon stock and evapotranspiration fluxes regulation ecosystem services. In order to fulfill that goal, the carbon stock and evapotranspiration spatial models were correlated with an ecosystem integrity model, used as an indicator of biodiversity loss for the Brazilian Amazon. The methodological approach of this work consists in the generation of an "ecosystem biodiversity loss" spatial model based on probability distribution of evidence parameters (Bayesian theory - Lindley 1972). The modeling was based on learning process (dada-driven model) using the Expectation Maximization algorithm (Buntime 1994). Bayesian network has been established from an expert conceptual model that related different spatial data (Thematic maps and Remote Sensing data): (i) Biomass (MODIS/ USGS - NASA); (ii) EVI; (iii) LAI- Leaf Area Index (MODIS/ USGS - NASA); (iv) Tree Cover (MODIS/ USGS - NASA); (v) GPP- Gross Primary Productivity (MODIS/ USGS - NASA). The carbon stock ecosystem service was estimated from aboveground carbon stocks spatial model developed by Baccini et. al. (2004) within the Pantropical National Level Carbon Stocks Project held by the Woods Hole Research Center - WHRC, Boston University and the University of Maryland (MA, USA). The methodology was based on ground data, MODIS 500m imagery and GLAS LiDAR data. The evapotranspiration fluxes ecosystem service was estimated from MODIS Surface Resistance and Evapotranspiration (MOD 16), data developed by Numerical Terradynamic Simulation Group (NTSG), College of Forestry & Conservation - University of Montana (Mu et al., 2007). Preliminary results were promising, allowing the establishment of the probabilistic distribution spatial patterns of biodiversity loss, as well as a preliminary assessment of the relationship with the carbon stocks (aboveground biomass) and evapotranspiration fluxes. This work is part of the ROBIN Project - Role of Biodiversity in Climate Change Mitigation - sponsored by the European Union (FP7 Edict ENV. 2011.2.1.4 -1: Potential of biodiversity and ecosystems for the mitigation of climate change).

Keywords: Spatial modeling; Bayesian networks; Climate changes: Climate mitigation

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P-2214-07

A theoretical analysis of a hypothetical auction program to pay for biodiversity in Peruvian Amazon nuts (Bertholletia excelsa) ecosystems

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Peru is a megadiverse country with the second extension of forests in the Amazon basin. The design of efficient public policies for these territories is challenging due the fragility of public institutions and lack of economic valuation of important ecosystem services provided from old-growth forests.

This paper develops preliminary a dynamic system model and a theoretical analysis from the ecological economics perspective for a key non-timber forest product of the Peruvian Amazon basin: the Amazon nut (Bertholletia excelsa). Specially, we analyse the bioeconomic dimensions of two ecosystem services: pollination and the forest cover to provide habitat for flora and fauna.

The contribution of this paper is to present evidence that support the argument that decision makers from development countries have an excellent investment opportunity for conservation of biodiversity in indigenous lands with Amazon nuts.

P-2214-08

West Africa's most climate change vulnerable species: which, where and why?

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West Africa supports globally high levels of species richness and endemism but this exceptional biodiversity is subject to serious ongoing anthropogenic threats, particularly from land transformation and over-exploitation. Climate change is now recognised as a serious emerging threat to biodiversity due both to its direct impacts on species' health and habitats, and because some human responses are likely to exacerbate historical threats. In order to prepare sound climate change adaptation strategies for West Africa, it's necessary to understand how biological systems will be impacted. To address this need, we carried out climate change vulnerability assessments for almost all of the region's terrestrial and freshwater vertebrates, including mammals, birds, reptiles, amphibians and fishes (2,854 species). Using a trait-based approach, we worked with species experts to identify traits conferring high climate change sensitivity and low adaptive capacity for each taxonomic group, and then scored each species' degree of possession of these. Species' exposure to climate change was estimated using regional projections of future climate across their individual distribution ranges. Combining the resulting sensitivity, exposure and adaptive capacity scores, we categorised each species' overall climate change vulnerability. This allowed us to identify those facing highest risk from climate change, as well as the regions where such species are concentrated. Comparing the patterns of high climate change vulnerability with those of high threat from non-climate related factors allowed us to identify areas of greatest overall concern for West African species. By comparing these priorities with current protected area coverage, we highlight areas that are currently unprotected but in great need of protection, as well as the existing protected areas in which adaptation efforts should be prioritised.

P-2214-09

Pitfalls in reconciling greenhouse gas mitigation and biodiversity conservation

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Current environmental policies urgently call for climate change mitigation strategies. Among these, biological sequestration of carbon (C) in soils through plant and soil management was identified as one of the most promising. Compared to other strategies such as oceanic sequestration or solar radiation management, biological C sequestration is cost effective, ecologically more attractive, relatively easily applicable, and has minimal side effects (Cusack et al. 2014). The potential for biological C sequestration in terrestrial ecosystems at the global scale is estimated between 1.7 and 2.4 GT C per year, which is roughly one fourth of the 9 GT C released annually to the atmosphere through human activity.

Biodiversity is often presented as critical to explain ecosystem processes, because more diverse organisms may exploit more efficiently the resources available in their environment. Yet, altering biodiversity might have strong functional consequences for C sequestration. The few meta-analyses dealing with biodiversity / ecosystem process relationships suggest, however, that protecting biodiversity is not necessarily the best way to optimize C sequestration in soils. Reciprocally, management strategies identified as favorable to C sequestration sometimes cause side effects on habitat structure and biodiversity. Because the conservation of biodiversity is also an internationally recognized priority in environmental policy, the potential for C sequestration management and its application must be assessed intimately with their consequences for biodiversity and sustainable development in the wider sense.

The proposed soil management strategies for increasing C sequestration include afforestation / reduction of deforestation, biofuel energy plantations, no-till or conservative tillage systems, nutrient management and the use of biochar. In this poster, I will present their respective potential for C sequestration, their feedbacks on biodiversity, but also their reliability, ecological risks, and their economic and social acceptance. The literature treating biological C sequestration increasingly referred to it as an 'ecosystem service' in its own right. However, as I will show, C sequestration is a complex process with strong scale dependent properties and interacting with other ecosystem functions in often non-linear ways. Therefore, I will argue that C sequestration cannot be evaluated in isolation of other ecosystem functions and should not be identified as an independent 'ecosystem service'.

Cusack et al. (2014) An interdisciplinary assessment of climate engineering strategies. Frontiers in Ecology.

P-2214-10

Climate change impacts on the fisheries in the Himalayan Kingdom of Nepal

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Besides land locked country, Nepal is home of more than 200 fish species. The resident of these species are rivers and lakes of this country. Rise of temperature with changes in precipitation have been effecting on the Himalayan river flow rate with un- expected floods and runoff. These increased flow rates have been altering the habitat of fish species. These will be affecting on the diversity of fish species in these river and lakes. The bank of rivers and lakes are known to home of many ethnic fishers and livelihood of these ethnic communities depends on its capture fishery. Thus, vulnerability of fisher community due to climate change is at high risk in this country. Proper adaption measures needed to combat the climate change and its hazards.

P-2214-11

Community Forest of Nepal: How it maintains ecosystem services and maintain sustainability?

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Community forestry is a participatory forest management system in Nepal. Till date 17,000 community forest (around 1.2 million ha) forest is managing directly from the 1.5 million people.

Research shows that the environmental services provided by the Community forest such as provisioning services, regulatory services, cultural services, supporting services, biodiversity conservation, water purification and regulation, soil erosion protection, forest recreation and carbon storage are gaining some attention and need to protect the future of the forests linking commercial market and climate change adaptation and mitigation issues activity to conservation objectives from past 30 years. Moreover, selling forest environmental services for the coping with climate change should ensure through the effective payment system in securing forest environmental benefits and their role in effort to eliminate rural poverty and also helps further for climate change mitigation and adaptation. The government of Nepal is developing different policy and management plan how can get more benefit from the community forest such as Payment for ecosystem services, Carbon market, Reducing Emissions from Deforestation and degradation plus, ecotourism, green jobs from the forest etc which can make direct benefit to the community people and helps to cope with climate change.

This research explore how community forest maintains ecosystem services and maintains sustainability, resilience development for community?

P-2214-12

Sectoral contributions to the conservation of biodiversity

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In 2014, governments within the Convention on Biological Diversity (CBD) reviewed progress in the achievement of the goals and targets set in the Strategic Plan on Biodiversity 2010-2020, as a step towards halting the loss of biodiversity as envisioned in the 2050 Biodiversity Vision. Although there has been an increase in responses to stop the further loss of biodiversity, this progress is insufficient to attain most of the Aichi Targets by 2020, nor can under current trends a stabilization of biodiversity loss towards 2050 be expected. This is for a large part due to persistent increases in pressures. To be able to address these, biodiversity policies need to address primary production sectors. Developments in sectors such as food production and agriculture, wood production and forestry, energy production, water management and fisheries largely shape the world's current and future biodiversity, as they exert direct pressures on biodiversity.

Related to the Aichi targets on sustainable use we identify different pathways that could contribute to achieving the 2050 Biodiversity Vision. Pathways are combinations of technological measures and behavioural changes, for food production and wood production and consumption. Biodiversity goals in these pathways are realized as part of a broader set of sustainability objectives, including eradicating hunger, feeding an increased and more wealthy world population, providing universal access to modern energy, preventing dangerous climate change and controlling air pollution. The pathways were evaluated, using the IMAGE-GLOBIO integrated assessment modelling framework. The analysis shows that it is possible to couple improvements in the trend of biodiversity, reduce greenhouse gas emissions and improve the well-being of all people simultaneously, but that this requires substantial transformations in the sectors we researched.

P-2214-13

Climate change impacts on global faunas: the causes and consequences of range shifts

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Anthropogenic climate change has affected Earth's biota on all continental and ocean territories. Global and regional climatic changes affect the world's faunas, causing among others shifts in their geographic ranges, changes in their seasonal activities, species turnover, increasing the risk of extinction, of spread of diseases and of invasive species. Species' range shifts have been the focus of attention of climate change studies, and vast amounts of correlational evidence show that the geographic range of species around the world is shifting either in latitude or elevation in response to climate change. There is no doubt of the importance of correlational studies describing the connection between the range shifts in species and climate change, however a great challenge in ecology is to commute from a simple correlational claim to the understanding of the underlying causal mechanisms. Understanding species' range shifts relative to climate changes entails knowledge of the underlying causal mechanisms of the observed phenomena, to ultimately understand the future directions of global faunas under climatic changes. Mechanistic explanations of animal range shifts - or their absence - should account for ecological traits that strongly influence species' responses to climate change. For example physiological thresholds that determine climatic limits to species distributions, or biotic interactions (e.g., inter and intra-species competition) in which intricate web relations and feedbacks influence the distribution of animal species. Other example is species' dispersal limitations that may compromise their capability to disperse at rate that is sufficient to track the changes in suitable bioclimatic space, causing time lags and thereby leading to novel community structures and novel interactions. We propose a comprehensive framework linking mechanistic explanations to causal claims in explaining range shifts, present and future, under changing climate zones. First, we illustrate the mechanistic explanations underlying animal range shifts driven by climate changes using a series of case studies contrasting the northern and southern hemispheres. We discuss as well the resulting effects exerted by range shifts at different ecological levels, from micro-evolutionary processes through selection of phenotypes, to ecological communities and ecosystems; and identify consequential feedback loops. Our theoretical framework provides a synthetic robust broader approach that links hypotheses and underlying mechanisms to advance our understanding of climate change impacts on global faunas, and provides grounds for generalisations that can direct future research and lead to evidence-based solutions to climate change challenges.

P-2214-14

Biodiversity implications of REDD+ policies: assessments in Brazil and in the Congo Basin

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Brazil and the Congo Basin contain the largest remaining areas of tropical rainforest on earth. In both regions, there is interest in implementing policies to mitigate climate change through the Reduction of Emissions

from Deforestation and forest Degradation plus the conservation, sustainable management and enhancement of forest carbon stocks (REDD+) in order to mitigate climate change. Policies aimed at achieving REDD+ objectives will have major impacts on future land use and resulting land cover, both inside and outside forest areas, which in turn affect biodiversity. Countries in both regions have committed both to supporting the the achievement of the goals of the Convention on Biological Diversity (CBD), including the Aichi Biodiversity Targets in its Strategic Plan, and to addressing and respecting the safeguards developed by the UNFCCC to minimise social and environmental risks and enhance the benefits of REDD+ . Therefore, understanding how different policies may influence land use and biodiversity is essential to informed decision-making and identifying REDD+ policies that can help safeguard biodiversity.

We are assessing the potential impacts of REDD+ policies on biodiversity in Brazil and the Congo Basin by using an economic land use model (GLOBIOM), to project future land use and changes in land cover under different scenarios. The biodiversity impact of the different scenarios is then explored by assessing the locations of projected land use change in relation to ecological regions, nationally and regionally identified priority areas for biodiversity conservation and species ranges. The effect of potential differences between ecoregions in land use policies and their application are explored. The impacts on species depend on both their habitat requirements and their distributions relative to different types of land use change.

The different assessments of impacts on biodiversity can in combination inform both REDD+ and biodiversity policies. In Brazil, both the implementation, and the impacts, of the Forest Code differ between Amazonia and other biomes. This therefore has implications for the species living in the different biomes. Analysis of the impacts on threatened species of different assumptions regarding the implementation of the forest code can inform the classification of species threat status. It also allows an assessment of the compatibility of these different scenarios with achievement of Aichi Biodiversity Target 12 on reducing extinction of threatened species. In the Congo Basin two important future scenarios relate to the contribution of protected areas and forest concessions to reducing deforestation. The assessment results highlight that not only is the current network of protected areas unevenly distributed across the different ecological regions, but also the impact of their enforcement on deforestation varies between ecological regions. Expanding the network and strengthening the effectiveness of existing protected areas to support REDD+ objectives would also contribute to achieving Aichi Biodiversity Target 11.

P-2214-15

Multi-Temporal cover patterns using Landsat TM in the Tapajós National Forest and its surroundings: a case study

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Brazil's Tapajós National Forest (Flona Tapajós) — a designated Conservation Unit (CU) under the Sustainable Use Group created by Decree No. 73,684 (February 1974) — measures approximately 527,000 hectares (ICMBio, 2012). This CU has undergone constant changes in usage patterns and ground cover, especially in its surroundings, due to activities related to agriculture, livestock and timber harvesting. In June 2012, Federal Law No. 12,678 reduced the area of Tapajós Flona by approximately 4% of its original size. These areas began to be called buffer zones. According to Batista et al. (2013), this reduction may lead to possible threats in the maintenance of goods and services that Flona offers, provoking with the passing of years changes in the livelihoods of surrounding communities, thus increasing pressure on the protected area. Therefore, the aim of this work was to identify and map spatial distribution patterns of use and ground cover after the alterations in the landscape using data from spatio-temporal remote sensing sources. Satellite images from the TM sensor and the Landsat-5, from July and August of 1989, 2005 and 2009 were used. Digital processing was performed: atmospheric correction; geometric correction; mosaic; classification, post-classification and definition of use classes and land cover. We used the Geographic Information System (GIS) ArcGIS v.9.3 to construct thematic maps of the study-case, along with the following procedures: conversion of classified images to vector format for calculating the areas of thematic classes adopted this work; assembly and manipulation of geographic database and map algebra to detect changes between the years studied.In Flona Tapajós and its surroundings, between 1989 and 2005, the areas with Native Forest (NF), Regeneration (R), Recent Deforestation (RD) and Exposed soil (ES) that remained unchanged comprised respectively 62, 3, 2 and 2%. The altered areas (17%) underwent their most drastic changes in areas with NF (9%) and in 2005 were identified as R (2%), RD (3%) and ES (4%), while (2%) areas belonging to class RD had not been removed, reaching stage R 2005. The remaining 6% suffered conversion between ES and RD (Table 1). In the period 2005-2009, the areas with NF, R, RD and ES that remained unchanged comprised 61, 6, 3 and 6% (Table 2) respecitvely. It is noteworthy that 11% belonged to Water bodies in both periods. In the period 1989-2005 there was a 11% reduction in NF areas. In the second period, this reduction was approximately 1%. On the other hand, the area (R) made up only 4.4% in 1989 and grew to 7.6% in 2005, reaching about 11% of the area in 2009.Areas with RD represented 5% in 1989 and 7% in 2005 and 2009, indicating that the «Government Programme Zero Deforestation in the Amazon» shows evidence of consolidation in Flona Tapajós and its surroundings. This fits with the trend in ES, which went from 4% in 1989 to 19% in 2005 and 2009. It is noteworthy that, despite the reduced fragments located within Flona Tapajos, its environment, in particular its buffer zone, underwent a robust process of human disturbance. From the results, we concluded: Between 1989 and 2005 there was a higher percentage of loss patterns in the Native Forest than occurred from 2005 to 2009 and the patterns remained stable; the method of assessment of natural and non-natural landscapes can support the understanding of the observed dynamics of use and coverage. In addition, the assessment provides support for analysis of the effects of fragmentation in this landscape. The spatiotemporal dynamics in Flona Tapajós and its surroundings indicates the importance of legally protected areas for the conservation of goods and services offered by the people as part of the Amazon Forest Strategy. In integration with other information and analysis, these dynamics may uncover possible threats to the maintenance of goods and services that sustain the biodiversity of the region.

P-2214-16

Scenario analysis of the main drivers forces threatening the conservation of the Tapajós National Forest, Brazilian Amazon

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Several public policies were released in an attempt to integrate the Amazon to the other regions of Brazil in the 1960s. Amongst the main engagements on infrastructure, the government built ports, hydroelectric facilities, and opened highways such as the Transamazônica (BR 230), Cuiabá-Santarém (BR 163) and Belem-Brasilia (BR 316), triggering an aggressive process of landscape transformation and deforestation. At the same time, however, the government instituted legally protected areas in the region, such as the Tapajos National Forest (FLONA), in 1974. The road was extended in 2012 and is now part of a regional complex, between two major highways in the region. The Tapajós National Forest suffers influence of the Transamazônica highway (BR-230) in the South, and the Cuiabá- Santarém highway (BR-163) located in its Eersten side, which leads to Santarém and Itaituba. Despite all the pressures generated by its surroundings, the protected area has presented suitable conservation indicators. However, it is noteworthy that the west side of Pará concentrates the greatest number of projects, as the seven hydroelectric power plants, the Cargo Transhipment Stations (ETC), and also the paving of highways BR-163 and BR-230. Thus, the spatiotemporal analysis intends, not only to provide a description of changes over time, but also to point out future trends and identify higher-pressure areas. This study addresses efforts to investigate landscape changes in the Tapajós National Forest and its surroundings, which covers a total area of 19,627 km², including the municipalities of Belterra, Santarém, Aveiro, Rurópolis, and Placas. The

literature review supported the selection of change drivers.

Considering the infrastructure, we selected roads, municipal offices, land tenure (settlements, Conservation Units and Indigenous Lands) and localities. Biophysical elements included climate variables such as rainfall and annual water deficit, altimetry and slope. All variables were crossed with land use data made available by the project TerraClass (INPE) for 2008 and 2010. For each municipality was sought information on crop, livestock and plant extraction through production to subsidize economic data provided by the results of spatial analysis process. Data were spatialized by using the geostatistics analysis, modeling and scenario generation were operated in the DINAMICA software that provided a detailed analysis for each vector element of change in the landscape, in addition to its role in the spatial dynamics of the study area.

The results showed that amongst the variables used as landscape transformation vectors, the roads appear to be the main drivers of change in every scenario, which means a change in the forest with different production systems. Taking into account the total area analysed, sites from Rural Settlement present more probability for transitions. The remaining areas with most probability for transitions are those with the lowest declivity values, who use agricultural machinery on the yearly cultivation of soy and corn. The remaining transitions follow the deforestation pattern, known as fishbone, along the Transamazonica highway. Inside the National Forest, the road that connects the São Jorge Community to the Tapajós across the Forest, at the Km 67 on Highway 163, is a major anthropic pressure. The evidence to this fact is that in 2012 this community was no longer under the control of ICMBio. In the map, the yellow and red dots indicate the places with higher chance of changing in the year 2030. According to the map, there are two zones of concern: the South side of FLONA, for the settlements controlled by INCRA (National Institute of Colonization and Agrarian Reform); the West side, where the Santarem-Cuiabá road is being renewed. The South side is a major concern for biological conservation given the intense use of the soil by farmers from the Settlements. The altitude, intense rainfall rates, the areas for settlements, and the predicted scenario for the year 2030 are elements that strengthen the need of Integrated Crop-Livestock-Forestry Systems to relieve the pressure on the south side of the Tapajós National Forest. Based on the results, we conclude that the emancipation of the São Jorge Community entails a further loss in the total area of FLONA for 18 years scenario, therefore leading to a threat for this Conservation Unit. In addition, it is recommended that the ICMBio should have a more strict access control to the Tapajós River.

P-2214-17

On the need to integrate microclimates and thermal limits when forecasting warming tolerance of organisms

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The impact of warming on the persistence and distribution of ectotherms is often forecasted from their warming tolerance—inferred as the difference between their upper thermal limit and habitat temperature, which is usually taken as the macroclimate temperature. Ectotherms, however, are thermally-adapted to their microclimates, which can deviate substantially from macroscale conditions. Ignoring microclimates can therefore bias estimates of warming tolerance. We compared warming tolerance of a leaf miner insect across its ontogeny when calculated from macro- and microclimate temperatures. We used a heat balance model to predict experienced microclimate temperatures from macroclimate, and we measured thermal limits for several life stages (egg, larval stages 4 and 5, and pupae). The model shows a concomitant increase in microclimate temperatures and thermal limits across insect ontogeny despite they all experience the same macroclimate. Consequently, warming tolerance, as estimated from microclimate temperature, remained constant across ontogeny. When calculated from macroclimate temperature, however, warming tolerance was wrong by over 7-10°C depending on the life stage. Therefore, large errors are expected when predicting persistence and distribution shifts of ectotherms in changing climates using macroclimate rather than microclimate.

P-2214-18

Inferring the effect of climate change on dispersal-limited species in the Brazilian Atlantic rainforest with collection data and targeted field sampling

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Inferring the effect of global change is especially difficult in tropical biodiversity hotspots. These places shelter a large and poorly known part of the world's biodiversity, with many species that cannot track environmental changes due to their limited dispersal ability. Tropical hotspots are also submitted to the fastest man-induced environmental changes. Therefore, even strongly targeted field samplings cannot be fast and comprehensive enough to provide knowledge for taking management and conservation decisions. Sampling needs to be completed by data already obtained and accumulated for decades in Museum collections. Better than being simply supplementary, these data are often critically complementary, since they represent the only available information for parts of natural ecosystems that are already largely destroyed, allowing for composing more real models of species requirements and distributions. We carried out a study to understand the effect of climate change on one of the most remarkable hotspots of biodiversity, the Brazilian Atlantic rainforest, fragmented in thousands of remnants, and extending on more than 3000 km from Nordeste to Uruguay. Our goal was to evaluate the ability of dispersal-limited and poorly-known species to survive climate change and also to assess how much collection data from Natural History Museums complement a targeted field sampling. We focused on one model organism, the saprophagous insect genus Monastria Saussure, 1864 (Dictyoptera, Blaberidae) endemic of the whole rainforest hotspot, abundant but still poorly known, dispersal-limited and unable to track climate change.

We conducted a targeted field sampling by visiting 67 locations distributed all over the Atlantic rainforest in geographical and altitudinal extremes and including all forest physiognomies, and by also sampling "secondary" forests and areas with other land uses. This was complemented with specimens from collections from 13 Natural History Museums. We used the Species Distribution Model (SDM) MaxEnt to model present and future potential habitats based on sets of 19 Bioclim climate variables. For current climate, we used the data from 1950-2000 provided by Worldclim. The habitat modeled with collection data nicely overlaps in 89% that obtained with targeted field sampling. It covered almost the entire range of the 19 climate variables assessed with targeted samples, which shows how useful it can be to consider it.

In order to assess the amount of habitat available for Monastria in future climate we used two climatic models for 2050 and 2070, derived from climate surfaces IPCC - HadGEM2-ES and MIROC5 (http://www.worldclim.org, IPCC 2007). For each model applied to pooled data sets, we used two outputs (RCP 4.5 and 8.5), representing roughly a pessimistic and optimistic greenhouse scenario according to CO2 emissions. We already know from previous studies that the Monastria with apterous females is unable to move between remnants of primary forest by using inhospitable matrix (grasslands, diverse plantations) or "secondary" forests where it is never found. We then searched the extent of forest remnants that are capable to host Monastria now and in the projected future climates. Our results point for a critical situation in which a maximum of 4% of the present distribution area will fit Monastria's habitat requirements in the near future. This calls attention to the need for considering the most frequent case of dispersal-limited species in relation to habitat connectivity when evaluating the potential effect of climate

P-2214-19

Agent-Based Modeling of Reasonable Consumption for Grassland Ecosystem Supply Service in Inner Mongolia, China

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Sustainable ecosystem service is of vital importance to the survival and development of human society. How to balance the conflicts between the ecosystem protection and the ecological consumption of local residents has been a serious challenge today especially in ecologically vulnerable area. In order to find out reasonable consumption approaches of the grassland ecosystem supply service and explore the sustainable land management strategies for the local social-ecosystem, taking Hulun Buir, Inner Mongolia Autonomous Region as the case study region, based on the agents' behaviors rules derived from households survey, a Agent-Based Model (ABM) has been developed in this study for simulating the ecosystem consumption pressure under different grassland management scenarios. This model links the supply and consumption of grassland ecosystem service by calculating ecosystem NPP supply and households NPP consumption. The model includes three sub-models: Individual growth status sub-model, Households' land-use decision sub-model, and Ecosystem service consumption pressure sub-model. In accordance with the multi-objective land management practices in case study area, four land management scenarios were modeling in this study, (1) business as usual, (2) aiming at increasing household's living level, (3) aiming at ecosystem protection and (4) aiming at balancing the ecosystem protection and living level improvement. The result indicate that reasonable ecosystem service consumption mode is possible in the research region, under which the indicators including ecosystem pressure, NPP supply, forage consumption of livestock, households incomes and herders' living level could reach a reasonable and sustainable level, This reasonable consumption mode is an improvement of traditional grazing mode, which could stimulate herders to control the livestock marketing rate by rational ecological compensation measurements, so as to ensures the NPP consumption is close to but never beyond the threshold.

2215 - Tropical degraded forests response to global change: current knowledge and cross-cutting research challenges for monitoring and processes understanding

ORAL PRESENTATIONS

K-2215-01

Tropical Forest Degradation in the context of climate change: increasing role and research challenges

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While developed countries in temperate regions faced their forest transition about 100 years ago or more, "tropical forest rich" nations still largely depend on forest resources or land clearing for their development. Hence, tropical forests are retreating at an alarming rate from advancing cash crops, such as oil palm, soybean, or cattle ranching. Beside tropical deforestation, tropical forest degradation resulting mostly from human-induced causes (e.g. predatory or illegal logging, non-timber forest product extraction, fuel wood extraction) significantly contributes to greenhouse gas emissions and loss of biodiversity. If deforestation is an obvious ecosystem change, forest degradation is more difficult to discern and quantify. Degraded forests have become a major component of today's tropical landscapes, representing up to 50 % of all tropical forests. For example, almost half of standing primary tropical forests, up to 400 million ha, are designated by national forest services for timber production. The portion of tropical forests managed for timber extraction, hereafter referred to as "managed forests", will therefore play key roles in the trade-off between provision of goods and maintenance of carbon stocks, biodiversity, and other services. However, so far, most of our understanding of tropical forest arise from studies carried out in old-growth undisturbed forests, or secondary forests (i.e. regrowth forests) while the ecology of degraded forests at the regional and continental scale remains poorly studied and their role to mitigate climate change still very poorly known. However, understanding the functions played by degraded forests in providing goods and environmental services in the context of climate change is crucial. We will first discuss the complex concept of forest degradation in the tropics and then define degraded forests. We will show their importance in providing timber while maintaining high levels of biodiversity and carbon stocks. We will further demonstrate that implementation of sustainable forest management can promote long term provision of ecosystem services. Finally, the potential of tropical degraded forests in mitigating climate change will be discussed along with future research challenges on this issue.

K-2215-02

R&D efforts, coordination, and needs towards operational forest monitoring systems in the context of an increasing Earth observation data availability

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Deforestation is the second largest source of anthropogenic greenhouse gas emissions to the atmosphere, accounting for 15% to 20% of the total emissions. To meet the challenge of climate change in the Agriculture, Forestry and Other Land Use (AFOLU) sector, the United Nations Framework Convention on Climate Change (UNFCCC) has been developing the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism. The UNFCCC recommends the use of remote sensing for forest monitoring in the frame of REDD+. Forest degradation can be monitored by remote sensing technologies using direct methods like forest gap detection, or indirect methods using logging roads as a proxy. International initiatives such as the Global Observation for Forest Cover and Land Dynamics (GOFC-GOLD) and the Global Forest Observations Initiative (GFOI) of the Group on Earth Observations (GEO) foster sustainable availability of Earth observation data to support national forest monitoring and reporting activities compliant with the good practice guidance of the Intergovernmental Panel on Climate Change (IPCC). GOFC-GOLD and GFOI also provide guidance to countries to develop forest monitoring systems, with the REDD Sourcebook and the Method and Guidance Document, respectively. These international initiatives foster also coordinated research and development (R&D) activities encouraging joint projects between research institutions, in collaboration with space agencies.

The launch of Landsat-8 in 2014 ensures the continuity of Landsat missions with an increased ability to collect data compared to the 1980's (about 14 times more images). Joint to the American effort, Europe will increase further Earth observations capabilities with the advent of the Sentinel satellite constellations. Sentinel 1A was launched in 2014 with a Synthetic Aperture Radar C-band sensor. The launch of the Sentinel-2A carrying a superspectral optical sensor is scheduled for June 2015. Sentinel-2A will allow a coverage of the land surface every 10 days. Once Sentinel-2B will be launched, the Sentinel-2 satellites combined with Landsat-8 will allow a revisit time period of 3-4 days. Other national and international satellite missions will also will provide or provide already additional imagery, either in the radar and optical domain (e.g., CBERS-4, SPOT series,

Pleiades, ALOS-2). The increased amount of observations will facilitate the use of time series analysis methods for the monitoring of tropical forests. Such methods are still at the R&D stage however some studies have started to show their potential capabilities to detect deforestation, forest degradation, but also forest regrowth. Challenges still remain to make such methods operational such as data set accessibility, data source interoperability (optical and radar), increase of the robustness, use of recommended practices, and standards. Such R&D efforts can serve other international policy discussions and agreements beyond those from the UNFCCC. The monitoring of habitats and their fragmentation for instance are listed among the Biodiversity Aichi Targets proposed by the United Nations Convention on Biological Diversity (UNCBD).

This presentation will present some foreseeable forest monitoring methods including degradation to become operational in tropical regions within the next decade, in the context of an increasing availability of Earth Observation data. We will present also international efforts to coordinate research, promote robust forest monitoring methods and standards. Finally we will discuss the current knowledge gaps and R&D needs to be met to achieve the objectives of some international policy negotiations and agreements.

K-2215-03

Tropical forests, Earth Observation and REDD+: requirements, research and progress in supporting developing countries

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Tropical forests represent about 45 % of the world forests, are home to over 2/3 of terrestrial living species and play a major role in climate regulation. In 2005, official discussions initiated at the United Framework Convention on Climate Change (UNFCCC) established a process to analyze how reducing greenhouse gas emissions from deforestation and degradation (REDD) in developing countries could contribute to the ultimate goal of the Convention. A basic underpinning requirement is the systematic long-term observation of forests and other land cover characteristics and changes on national and global levels. The European Copernicus programme will guarantee these long term observations by the Sentinel satellites for the next decades. In response to this need several international activities have been established like the REDD working group within the "Global Observation of Forest and Land Cover Dynamics" (GOFC-GOLD) and the "Global Forest Observation Initiative" (GFOI) of GEO. Both initiatives foster a continuous interaction mechanism with the UNFCCC to provide technical contributions to the negotiations and for national-level capacity development for monitoring emphasizing the important role of satellite remote sensing in this context.

The presentation will elaborate the state of play of REDD+ in the political context and discuss the approach and experiences of the Earth Observation and carbon monitoring community with the REDD political discussions. It addresses the research community with open scientific questions to improve methodologies to support REDD early actions and readiness mechanisms for building national REDD monitoring systems. Critical issues on monitoring forest degradation, accuracy assessments, biomass burning and the role of evolving technologies will be discussed.

O-2215-01

Assessment of forest degradation in the Amazon using multi-sensors techniques: the case of Paragominas (Brazil)

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The Amazonian pioneer front region is a mosaic of different forests types and agricultural landscapes resulting from the colonization of the region through forest conversion into pasture and agricultural lands. Fearnside and Guimaraes (1996) showed that 47% of the deforested area is rapidly abandoned. It also appears that logged forests surface is equivalent to deforested areas (Asner et al., 2005).

Consequently a degradation gradient exists from low-impacted logged forests (depending of the logging intensity) to young secondary (regrowth) forests. To obtain more accurate estimation of carbon stocks, it is important today to take into account the degraded forest gradient including all degraded forest stages between mature intact forests and non-forest areas. The first main challenge is to identify and to characterize the various stages.

The identification of forest degradation is still a complex and expansive problem even if it has been focused until now only on logged tropical rainforest (Asner, 2009; Gond and Guitet, 2009; Desclées et al., 2006; Asner et al., 2005; Souza et al., 2003). In parallel estimation of biomass loss in the degraded forest is little-studied. Within temperate and boreal forests some estimation are made by Solberg et al., (2013). The combination of optical remotely sensed data (Landsat-8), radar (Terra-Sar-X) and Lidar (IceSat) have to be studied to analyze the potential of the multi-sensors techniques to characterize the tropical rainforest degradation (Betbeder et al., 2014).

The study presents the first results obtained during the field work at Paragominas (Pará, Brazil) on different forest degradation intensities (Bérenguer et al., 2014). This field database is then compared with multi-sensors remote sensing to better understand multiple interactions and to establish a forest degradation typology.

O-2215-02

The Challenges of Monitoring Forest Degradation: A Case Study from Central India

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Forest degradation, as distinct from deforestation, results in loss of forest biomass within forested ecosystems. Implications for climate include reductions in carbon storage and the reduced ability of forests to provide hydrological services that buffer against climate change. Many factors contribute to anthropogenically-driven forest degradation, including local dependence on forest resources for fodder, fuelwood and other products as well as fire and commercial timber extraction. Monitoring forest degradation with remote sensing is more complex than monitoring deforestation and calls for the use of data from non-optical sensors. An example from central India, where local livelihoods are highly dependent on forests, illustrates the use of optical and radar data to monitor changes in forest biomass associated with human use. Loss of biomass is associated with human use surrounding villages. Reductions in degradation in this context depend on providing livelihood options that reduce dependence on forest resources. The utility of operational systems for monitoring progress towards that goal depends on the involvement of NGOs and other institutions working with local communities. Expanding degradation monitoring over large areas needs to account for the heterogeneity of forest types and varying pressures on forests in different settings.

O-2215-03

Development of EO based national forest cover monitoring systems in the Congo Basin

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Deforestation is currently known to account for up to 20% of global greenhouse gas (GHG) emissions. Therefore, a significant decrease in deforestation can have a direct positive impact on reducing GHG emissions. Initiatives such as the Reduction of Emissions from Deforestation and Degradation (REDD), Low Emission Development Strategies (LEDS) or Zero Deforestation (ZD) aim to provide incentives to reduce deforestation. The Congo Basin represents the

second largest forest area in the world after the Amazon. Deforestation in Congo Basin countries is generally expected to be low. The assessment of forest cover and forest cover change area is essential for the initiatives mentioned above to determine what is referred to as activity data in the Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines on the Agriculture, Forestry and Other Land Use (AFOLU) sector.

Producing estimates of deforestation in tropical countries in relation to greenhouse gas (GHG) emissions often relies on the use of satellite remote sensing in the absence of National Forest Inventories (NFI). A probability sample combined with an appropriate response design can provide forest cover and forest cover change area estimates and their associated uncertainties in the form of confidence intervals at a set probability threshold as required in the IPCC 2006 guidelines and for reporting to the United Nations Framework Convention on Climate Change (UNFCCC). However, wall-to-wall mapping is often required by countries to provide an exhaustive assessment of their forest resources and as input to land use plans for management purposes, but implementing a wall-to-wall approach is expensive requiring specialized equipment and staff. The recent release of the Global Forest Change mapping products could provide an alternative for tropical countries wishing to develop their own wall-to-wall forest monitoring mapping products.

A model assisted regression (MAR) estimator was applied nationally in Gabon and for selected regions in Cameroon and CAR using the combination of both reference data obtained from a probability sample and nationally produced forest cover and forest cover change maps and produced from the Global Forest Change data. The resulting area estimate is potentially more accurate than the direct expansion estimate and provides an estimate of the precision of the estimate which is not available from the map statistics alone.

Results show that the method presented provides a reliable means of producing forest cover and forest cover change area statistics and confirm the low level of deforestation expected in Congo basin countries. It also confirms the high level of forest cover in Gabon with more than 88% of the country covered by forest covering an area of just over 23.5 million hectares. In Cameroon and CAR, forest represents about 72% of the area of the regions selected with a total of over 5 million hectares.

Forest cover estimates for national level maps lead to coefficients of variation less that 0.3% at national level in Gabon and between 1.4 and 1.8% at regional level in Cameroon and CAR thus reducing significantly the level of uncertainty for forest cover area estimates compared with reference data alone.

Deforestation rates are generally low, with less than 0.4% between 1990 and 2000 in Gabon. In CAR, the deforestation rate is about 1.5% between 1990 and 2000 and 0.8% between 2000 and 2010. However, the deforestation in Gabon is not statistically different from 0 between 2000 and 2010. The same is observed for the Centre region of Cameroon. This is because the changes detected are very small and as a result the coefficients of variations of change estimates are greater.

Overall, results based on the global forest change data are not as accurate and precise and substantial post-processing and calibration are required to obtain results of similar quality than that of the national maps. However, it is considered that the level of effort necessary would be considerably less than that for producing the national maps.

O-2215-04

Will tropical forests face slow down with ongoing climate changes?

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In the context of climate changes, identifying and then predicting the impacts of climatic drivers on tropical forest dynamics is becoming a matter of urgency. We used a coupled model of tropical tree growth and mortality, calibrated with forest dynamic data from the 20 year study site of Paracou, French Guiana, in order to introduce and test a set of climatic variables. Three major climatic drivers of the tropical forest dynamics were identified through the variable selection procedure: drought, water saturation and temperature. Drought decreased annual growth and mortality rates, high precipitation increased mortality rates and high temperature decreased growth. Interactions between key functional traits, stature and climatic variables were investigated, showing best resistance to drought for trees with high wood density and for trees with small current diameters. We then used SELVA, an individual-based model to run forest dynamic simulations for the next century using predictions from the IPCC 5AR with 3 different scenarios corresponding to 3 relative concentration pathways. Basal area, above-ground fresh biomass, quadratic diameter, growth and mortality rates exhibited decreasing values as long as the scenario became pessimistic. Temperature is the strongest driver highlighting a drop of 40% in average forest growth for the RCP8.5. Our results highlights the potential slow-down danger that tropical forests will face during the next century.

2215-POSTER PRESENTATIONS

P-2215-01

Amazonia, a tropical forest in transition: from natural biogenic conditions to land use change, large scale biomass burning and urbanization

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Amazonia is a large tropical forest in transition, with strong pressures for agriculture expansion, climate change, urbanization and others. Deforestation rate has decreased dramatically, from 27,700 km² in 2004 to 4,700 km² in 2013, being responsible for a strong reduction in greenhouse gas emissions on the order of 70%. Agricultural expansion and climate variability have become important agents of disturbance in the Amazon basin. Recent studies have demonstrated considerable resilience of Amazonian forests to moderate annual drought, but they also show that interactions between deforestation, fire and drought potentially lead to losses of carbon storage and changes in regional precipitation patterns and river discharge. Although the basin-wide impacts of land use and drought may not yet surpass the magnitude of natural variability of hydrologic and biogeochemical cycles, there are some signs of a transition to a disturbance-dominated regime. These signs include changing energy and water cycles in the southern and eastern portions of the Amazon basin.

Feedbacks in Amazonia are very strong between ecosystem functioning, trace gases and aerosol emissions, cloud cover, precipitation, radiation balance and other key issues. In the wet season, a large portion of the Amazon region constitutes one of the most pristine continental areas, with very low concentrations of atmospheric trace gases and aerosol particles. However, land use change modifies the biosphere-atmosphere interactions in such a way that key processes that maintain the functioning of Amazonia are substantially altered. This study presents long term aerosol and trace gases observations at a preserved forest site in Central Amazonia, with observations from 2008 to 2013. Amazonian aerosols were characterized in detail, including aerosol size distributions, aerosol light absorption and scattering, optical depth and aerosol inorganic and organic composition, among others properties. Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low aerosol concentrations (PM2.5 of 1.3±0.7 μgm-3 and 3.4±2.0 μgm-3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm-3 in the wet season. Aerosol composition shows organic aerosol accounting to 81% to the PM1 aerosol loading. Aerosol light scattering and absorption coefficients were very low during the wet season, increasing by a factor of 5, approximately, in the dry season due to long range transport of biomass burning aerosols reaching the forest site in the dry season.

Remote sensing observations from six AERONET sites and from MODIS from 1999 to 2013, provides a regional and temporal overview of changes in Amazonian atmosphere. Aerosol Optical Depth (AOD) at 550 nm of less than 0.1 is characteristic of natural conditions over Amazonia. At the arc of deforestation region, AOD values greater than 4 were frequently observed in the dry season. Combined analysis of MODIS and CERES showed that the mean direct radiative forcing of aerosols at the top of the atmosphere (TOA) during the biomass burning season was a high −5.6±1.7 Wm−2, averaged over whole Amazon Basin. For high AOD (larger than 1) the maximum daily direct aerosol radiative forcing at the TOA was as high as −20 Wm−2 locally. This change in the radiation balance caused increases in the diffuse radiation flux, with an increase of Net Ecosystem Exchange (NEE) of 18-29% for high values of AOD. Recently the GoAmazon project is analyzing the impacts of urbanization on atmospheric properties, and preliminary results shows important changes in ozone formation, secondary organic aerosol production and cloud properties.

From this analysis, it is clear that land use change in Amazonia shows alterations of many atmospheric properties, and these changes are affecting the functioning of the Amazonian ecosystem in significant ways. The potential impacts on global carbon cycle and on the hydrological cycle are large.

Funded by Instituto Nacional de Ciência e Tecnologia para Mudanças Climáticas - INCT Global Change - CNPq/FAPESP, and FAPESP project 2013/05014-0

P-2215-02

Climatic implications of rainforest transformations in Nigeria: quantitative and qualitative approaches

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This study examines forest transformation in the rainforest of Nigeria, focusing on the drivers of forest change, the climatic and societal implications on the local people. Both quantitative and qualitative approaches were used. Remote sensing was used to perform quantitative analysis while social methods were used as qualitative approached to evaluate the spatial and temporal rate of deforestation. A time series of Landsat data was used over the period from 1984 to 2011. Remote sensing change detection methods were used to assess forest transformation in rainforest reserves in the study area. Two forest reserves, Okomu and Sakponba/Urhonigbe, were examined to have detail case studies of intensified deforestation within forest reserves. The implications of these changes on local climate around the forest reserves were assessed. Social survey data, questionnaires and interviews, were used to assess societal implications of forest transformation on local people in the study area. Ancillary data such as population data, road network data, and climate data were used to assess the drivers of forest transformation and their implications. Correlation analysis was performed to assess the relationship between deforestation and population, road network, and surface temperature (ST) around the forest reserves. The results show that Okomu forest reserve nearly 50% of its area cover while Sakponba/Urhonigbe forest reserves loss about 90%. There are good relationship between deforestation and distance from road (R2= 0.52), also between population and deforestation with a correlation (R2) of 0.48. There appears to be a significant relationship between change forest cover and surface temperature with R2= 0.46. Thus, the major finding of this study is that a major cause of deforestation in the rainforest is a result of increased accessibility created by road network. Forest reserve with high rate of road accessibility has high rate of deforestation compared to the forest reserve with less road network. The results from this study also show that increased population appears to be driving people to access these forest areas, that the relationship between population and deforestation relatively significant. The major implication of deforestation on local climate is that ST tends to increase as the rate of deforestation increases. Area with high forest cover tends to experience low ST while area with high rate of deforestation appears to have high ST. The results from social survey show that the drivers of forest transformation in the rainforest of Nigeria are multifaceted. Such drivers include the influence of human activities such as communal and commercial logging, which are enhanced by high and rapidly increasing population, and accessibility to forest reserves through road transportation network. Corruption, lack of political will and unenforced environmental laws are other major drivers, though these are not easily understood in the study area because of lack of accurate data about them. This study is important to both governments and local people to see the need for better forest conservation.

P-2215-03

Predicting the combined impacts of climate change and selective logging in timber production forests of Central Africa

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In the design and the implementation of current rules of Sustainable Forest Management (SFM), still too little account is taken of the sensitivity of tropical forests to climate change. In the Congo Basin, forests cover 220 million hectares and represent an economic sector of utmost importance for the rural development as well as for national and regional climate strategies. Hence, these forests constitute a major challenge for both adaptation and mitigation.

A prerequisite to ensure the relevance and the effectiveness of SFM recommendations in this region is to elucidate the influence on forest dynamics of both climate change and harvesting pressure. This influence will likely consist of major shifts in structure and floristic composition. By opening the stands and increasing light availability, selective logging fosters the development of light demanding species. Some of these species, particularly the pioneers, are thought to be particularly drought sensitive so that global warming could strongly impact logged forests. The study of forest-climate-logging relationships needs therefore species-level predictions. However, the high diversity of tropical forests, in pair with the scarcity of data, hinders the correct fitting of species-specific models.

To investigate the combined effects of climate and harvesting influence on Central African forests, we conducted long-term simulations of forest dynamics under several scenarios of climate change and timber harvesting. Climate scenarios were based on outputs from simulations of the atmospheric model ARPEGE-Climate of the French National Centre for Meteorological Research (CNRM), performed within the Coupled Model Intercomparison Project Phase 5 (CMIP5) and under several Representative Concentration Pathway (RCP) scenarios of the International Panel on Climate Change (IPCC). We also used outputs fields such as soil water and potential evapotranspiration from the model CARbon Assimilation In the Biosphere (CARAIB) of University of Liège obtained under the same climatic scenarios. Logging scenarios were implemented by considering a wide range of felling intensities.

To carry out this work, we developed an innovative method based on a Mixture of inhomogeneous matrix models (MIMM) that permits to test and simulate the influence of timber harvesting and climate change on forest dynamics. While insuring a satisfactory fitting of vital parameters, such a methodology allowed us to reflect the diversity of tree ecological patterns, notably in response to climate variables. To do this, we simultaneously clustered species into groups according to species-specific ecological responses and identified group-specific explicative environmental and climate variables. To infer and validate model outputs, we used the M'Baïki site, in the Central African Republic (CAR), a unique experimental site that has been monitored for 30 years through a collaborative partnership with various French and CAR institutional and research organizations.

Our methodology is a novel tool to accurately predict long-term ecological consequences in Congo Basin forests under both constraints of climate change and selective logging. One of the main immediate applications would be to check if classical SFM strategies, such as Reduced Impact Logging (RIL), Improved Forest Management (IFM) or post-logging sylviculture, are still valid when the ecological complexity and the climate sensitivity of tropical forests are duly taken into account. As an envisaged development, a coupling with a logging company model could allow to predict climate change impact on the economics of forest-based sectors, including tax revenues and socio-economic local benefits. More generally, our work could contribute to the improvement of climate-smart policies for Central African forests, a critical issue in the current context of deployment of the mechanism of Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+).

P-2215-04

The AmazonFACE research program: assessing the effects of increasing atmospheric CO2 on the ecology and resilience of the Amazon forest

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Despite being suggested, for nearly 20 years now, as a process of utter importance for the resilience of the Amazon forest and maintenance of the global carbon cycle, the existence, magnitude and duration of a supposed "CO2 fertilization" effect in tropical forests remains largely undetermined. Reducing this uncertainty is critical to the future of the Amazon region as well as for global assessments of ecosystem vulnerability to climate change. In this presentation we will introduce the AmazonFACE (Free-Air CO2 Enrichment) research program, an experiment of unprecedented scope and importance in a primary, old-growth forest of the Amazon basin near Manaus, Brazil - the first of this kind in a tropical forest. The experiment will simulate an atmospheric CO2 composition of the future in order to help answer the question: "How will rising atmospheric CO2 affect the resilience of the Amazon forest, the biodiversity it harbors, and the ecosystem services it provides in light of projected climatic changes?" Amazon-FACE is divided in three phases: (I) pre-experimental ecological characterization of the research site (Jun.2014-Nov.2015); (II) pilot experiment comprised of two 30-m diameter plots, being one maintained with atmospheric [CO2] at +200ppmv and the other with ambient CO2 concentration (Dec.2015-Nov.2017); (III) fully-replicated long-term experiment comprised of four pairs of FACE plots maintained at ambient or elevated CO2 concentrations for 10 years (Dec.2017-Nov.2027). The forest inside these plots will be scientifically scrutinized from the top-most canopy leaves to the deepest roots in terms of carbon metabolism and cycling, water use, nutrient cycling, forest community composition, and interactions with environmental stressors. A multi-disciplinary team of scientists namely from Brazil, USA and Europe will employ state-of-the-art tools from deep in the soil to above the forest canopy. The resulting data sets will be valuable resources for a broad community of scientists, especially for ecosystem and climate modelers.

P-2215-05

Evidence of Ecological Resilience Clusters to climate typology in the Amazon Rainforest: a methodological proposal

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Resilience is usually defined as the capacity of an ecosystem to absorb disturbance without shifting to an alternative state and losing function and services. This concept encompasses three distinct processes: resistance, the magnitude of disturbance and the speed of return to the original structure, which are fundamentally different but rarely distinguished. Successfully increasing the resilience of natural systems may therefore have important implications for human welfare in global climate change scenarios. Forest areas contribute in maintaining the moisture due to evapotranspiration exchanges. Severe droughts and periods with diverse anthropogenic pressures are threatening the ecological resilience in the Amazon region. This research intended to identify the areas with a differentiated resilience capacity in the Brazilian Amazon. Some climate data were used in this study, such as: annual rainfall, total rainfall during the less rainy trimester, total rainfall below 100 and 60 mm, minimum air temperature and vapour pressure deficit. We used biophysical data (NDVI, GPP, FPAR and LAI) to assess the temporal response of vegetation in order to express the effects of seasonal conditions and variations in weather and climate conditions. The biophysical data were obtained from the MODIS satellite, and the altitude data was provided by TOPODATA. The data integration was performed based in the correlation analysis for detecting redundancies between variables. Since the original data were highly correlated, we used the Principal Component Analysis (PCA) to identify which variables should be incorporated in the assessments of areas with ecological resilience. The year of 2005 was used due to the strong El Niño as well as the high deforestation records of the year 2004. The year of 2013 was our reference as average climate conditions. The first component to generate the maps was able to clarify 40.5% (2005) and 41.7% (2013). We have considered climate typology and resilience in the Brazilian Amazon as reference in the evaluation of these ecological thresholds by integrating the variables in ArcGIS.We were able to identify 8 zones with ecological features of transitional, which indicates the distinctions in their climate resilience. Analysing the years 2005 and 2013, it is clear that different climate typologies were rebuilt after the 2005 severe drought. The positive values in 2013 indicate that same classes have been recovered in eight years showing zones with differentiated resilience capabilities. These differentiated resilience capabilities may be associated to the effect of anthropogenic land-use change, but overall to natural ecological resilience of the Native Forest. The results indicate that the 17.2% increase in areas with high rainfall in the far west Amazon, in 8 years, indicate the great capacity of recovery of this native forests (with ecological resilience in the range of 0.7 to 0.8). The proposed methodology evidence that the response of biophysical variables from satellite information combined with typological climate conditions allow us to differentiate the diversity in resilience ecological capacity of the Amazon.

P-2215-06

Potential of tropical rainforest microrefugia to sustain tropical biodiversity in Northeast Brazil

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Although the Northeast Brazil is mainly characterized by a semi-arid climate that corresponds to the driest area of Brazil, a sub-humid climate persists in small mountainous areas close to the coast. Such very local climatic conditions enable the development of a highly diversified Neotropical rainforest that represents rainforest microrefugia surrounded by a xeric shrubland and thorn forest. Because these microrefugia are characterized by small areas with specific vegetation and microclimatic conditions, their potentials to sustain tropical biodiversity are generally underestimated within the future scenarios of climate change. In order to characterize the different communities and distributions of these rainforests we analyzed the present-day pollen rain in soil samples along an altitudinal gradient for several microrefugia from Northeast Brazil. We identified several ecological successions characterized by significant changes in rainforest assemblages whose distribution depends on water availability linked to several factors (e.g. elevation, slope, distance from the coast). To test their potential to sustain future tropical biodiversity we compared our calibration of pollen rain with fossil pollen data in one of these microrefugia. Despite the high sensitivity of rainforest to climatic variability evidenced by our study, the rainforest persisted and responded to past climate changes by recruiting key species among its highly diverse stock. Our results suggest that the high plant diversity of the microrefugium could play an important role in allowing the development of specific assemblages in response to different climatic conditions. Consequently, we demonstrate that identification and conservation of such microhabitats in the context of future climate change represent a crucial interest in policing the tropical biodiversity.

P-2215-07

Congo Basin forests under pressure: the role of increasing population and strong international palm oil demand

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The Congo Basin forest is the second largest rainforest area after the Amazon forest but contrary to the latter, it has been relatively preserved up to now. However, pressure on the Congo Basin forests is increasing with high population growth, large economic development needs and new opportunities from global markets, increasing the chances of future emissions from deforestation. Understanding the main drivers of deforestation and their evolution in the next decades can support the development of policies compatible with development objectives and the REDD+ initiative, which many countries of the region have joined. On the one hand, the majority of the population continues to depend on subsistence agriculture and informal natural resources exploitation for their livelihoods and the viability of such practices in the context of higher population density is questioned. On the other hand, large-scale forest and agricultural concessions driven by foreign investments and supported by the States are also flourishing in the region to take opportunity of growing international demand. Global palm oil production has more than doubled over the last decade and ambitious palm oil production targets are now included in the development strategy of the Congo basin countries.

We use the land use economic model CongoBIOM to explore projections of future land use in the Congo Basin, including the role of shifting agriculture and plantation expansion. CongoBIOM is adapted from GLOBIOM which represents land-based activities and land use changes at a 50x50km resolution level. It includes domestic and international demand for crops, livestock products and wood products. In the Congo Basin, the model represents deforestation from forest conversion to both subsistence and intensive agriculture and also from intensive fuel wood harvests. Forest degradation is caused by logging activities. We have built a global oil palm suitability map to improve the model representation of future oil palm expansion. Results are presented for the whole Congo Basin and in more details for three countries -Cameroon, the Republic of Congo and the Democratic Republic of Congo- to illustrate the variety of challenges the region will face to protect its forests and ensure economic development. We compute emissions from future land use change and test their sensitivity to several model parameters including future population and economic growth, and land carbon content from different sources (IPCC, FAO-FRA, NASA and WHRC).

From our results, deforestation over the next decades increases strongly in the Congo Basin: the average annual deforested area is 60% higher over 2010-2020 and 123% higher over 2020-2030 compared to the historical rate 2000-2010. The region doubles its palm oil production over 2000-2030 and also more than double exports but a high share of the total production is used to satisfy rapidly increasing domestic needs. More generally, we observe that future agricultural expansion in the Congo Basin is mainly driven by internal demand. The Democratic Republic of Congo and Cameroon will experience the highest pressures from the agricultural sector while in the Republic of Congo pressures on the forests will mainly come from timber exploitation. Since uncertainties in the carbon content of the forest land are quite important in the region, they lead to significant variations of emissions from deforestation in our computation. The Congo Basin countries represent an important challenge for the REDD+ framework as i) historical deforestation rate is not very informative to set-up Congo Basin countries' reference levels for future emissions from deforestation and ii) REDD+ policies will need to reach scattered and remote subsistence farmers to allow them satisfying their needs without destroying the forest.

P-2215-08

Estimating and Forecasting Carbon Stocks in Indian Tropical Forests using the LiDAR Technology

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Tropical forests play a major role in the cycle of terrestrial carbon, being at the same time both sinks and sources of atmospheric CO2. It is estimated that around 40% of forest carbon is contained in the above-ground biomass of trees, the stock of which, at the global scale, varies mainly through reforestation and deforestation. Monitoring the stocks of forest biomass is therefore a major issue for the reduction of uncertainties associated with the overall assessment of carbon. International political institutions are therefore increasingly demanding for an effective decrease in the uncertainties associated with the estimation of these stocks. The conferences of the United Nations on climate changes, the next one of which will be held in Paris in 2015 (COP21), have as a main objective to reduce greenhouse gas emissions in order to limit global warming. Each country is invited, on a voluntary basis, to quantify the stocks and flows of forest carbons in their territory. In south and south-east Asia, huge progress has been made in this area in the past decade, with good level research and technical competencies. However, the quality of works remains variable, and the efforts are made at the national scale with very little exchanges of knowledge and know-how between institutions of different countries. This isolation considerably limits the emergence of international standards in the monitoring of stocks of forest carbon. Developing new methods for monitoring forest carbon, widening ongoing works and stimulating exchanges of knowledge and know-how with regard to the monitoring of forest carbon stocks in south Asia, are some of the main objectives of the French Institute of Pondicherry (FIP) in South India. The emergence of methodologies that capitalize on the products of remote sensing is a major advance in the mapping of forest biomass at a large spatial scale. The mapping of forest carbon via remote sensing tools is therefore rightly foreseen as a cornerstone of the MRV systems (Measuring, Reporting and Verification) that are promoted by the UN-REDD (United Nations Collaborative Programme on Reducing of Emissions from Deforestation and Forest Degradation in Developing Countries) programme. Yet, the quality of products generated by remote sensing tools depends to a very great extent on the quality of field and remote sensing data that are used. This explains in part the strong inconsistencies that exist between the different forest carbon maps published recently at the world or pantropical scale. For example, in south and south-east Asia, these

inconsistencies are sometimes of the same order of magnitude as the values indicated in the maps. During the past few years, the FIP has invested a great deal in the processing of remote sensing data, and in particular of the data generated by the very promising LiDAR technology (airborne or terrestrial laser). These new technologies allow unprecedented measures of forest structures with a centimetre-level resolution through entire landscapes. Furthermore, the FIP has monitored forest dynamics in permanent forest plots at Uppangala, in the Western Ghats biodiversity hotspot, for more than 20 years. Coupling detailed information on forest dynamics with airbone and terrestrial LiDAR data opens promising perspectives to understand and forecast with high precision the ability of tropical forests to stock carbon.

P-2215-09

GHG emissions and mitigation – a model approach for the Brazilian Amazon

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According to the recent scientific literature on the field, about 70% of the terrestrial sink of CO2 derived from anthropogenic activities resides in tropical forests. Of the tropical belt, the South America Amazon encompasses the largest continuous broadleaf forest in the globe. Estimates accounts more than 50% of the tropical carbon sink to these forests. Tropical deforestation accounts from about 1/10th to 1/5th of the global anthropogenic emissions of carbon and carbon equivalent green house gases. Big uncertainties associated to these estimates rely on the quantification of above and bellow ground living biomass in tropical forests and its spatial distribution. Adding up to the uncertainly on carbon emission estimates, the deforestation is not a linear process, but a patchy activity in the landscape, characterized by dynamic processes in both spatial and temporal dimension. Thereby, studies on carbon sources, sinks and stocks are urgent observational needs for both remote and ground observation in the tropics.

This paper will present recent studies coupling observation, remote and modeling approaches to better estimate green house gases emissions from tropical deforestation, with special focus on the Amazon forest. The result present outcomes of the INPE-EM model, developed at the National Institute for Space Research, in Brazil. This is a spatially explicit modeling framework that incorporates the deforestation dynamics, the biophysical and socioeconomic heterogeneity of the region. As well, we will explore mitigation of greenhouse gases emissions within a sustainable development framework, in special associated to nutrient use and emissions of nitrous oxide.

P-2215-10

Contribution of the analysis of diurnal cycles for understanding the mean seasonal cycle of rainforest photosynthetic activity in Central Africa

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Global carbon, water and energy cycles are substantially driven by vegetation phenology. In particular tropical rainforests have been shown to be a key component of the climate system as they act as major water vapor sources and carbon dioxide sink. For these reasons their evolution in response to both human pressure and climate change is critical. As compared to the Amazonian and Asian rainforests, the rainforest of Central Africa experiences slower deforestation rates, so that its main threat for the next decades might come from climate change. So far, the response and sensitivity of the Central Africa rainforest to the mean seasonal evolution and inter-annual variability of climate has attracted little interest. Indeed, most of the studies focus on its Amazonian counterpart and suggest that solar irradiation is the main driver of the annual and inter-annual variations of rainforest photosynthetic activity, and the Central Africa climate itself is not well documented.

As a first step towards a better understanding of the Central Africa rainforest sensitivity to present-day climate variability and response to climate change, this study performs for a target region located between 0-5°N/12-19°E (thus documenting forest areas from 5 countries) and using space borne observations, a detailed analysis of the rainforest photosynthetic activity mean seasonal cycle comparing it with those of climate variables considered as potential drivers, i.e. rainfall, cloudiness and solar irradiation.

Several key points emerge from our study. First, the seasonal cycles of photosynthetic activity (EVI MODIS) and rainfall over our target region are both bimodal. However, the highest peak of EVI (March-May) coincides with the driest of the two rainy seasons while the lowest peak of EVI (September-October) coincides with the wettest of the two rainy seasons. Second, the two rainy seasons are not associated with two distinct lows in total solar irradiation and two distinct peaks in total cloudiness: the first rainy season (March-May) which is less rainy as compared to the second one (September-October), is also less cloudy and receives more total solar irradiation. This might explain the higher EVI values recorded. Third, the high total cloudiness recorded throughout the seasonal cycle actually hides marked seasonal variations in the frequency of the 5 main types of clouds analyzed. These cloud types have specific diurnal cycles which control those of solar irradiation (thus the daily light and energy available for photosynthesis), but also influence the remote sensed photosynthetic activity data (or index).

Our results clearly show that (1) nor the two dry seasons, nor the two rainy seasons do compare in terms of mean rainfall, cloudiness, solar irradiation and temperature, and (2) water and light availability have a respective weight in the Central Africa rainforest photosynthetic activity which evolves throughout the seasonal cycle. They also suggest that any evolution, due to climate change, of the complex diurnal cycles of rainfall, nebulosity and solar irradiation which characterize the equatorial climate regimes might perturb the rainforest phenology and enhance these ecosystems vulnerability.

P-2215-11

Bhabar Terai Forest Cover Reduction Causes Climate Change in the North Bank of the Brahmaputra Valley increased Severity in Flood

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During the last few decades floods in the Brahmaputra basin had been extremely of large magnitude and high frequency and there were heavy floods in Assam almost every alternate year. The fragile hills of the Himalayan Mountain range are prone to major landslides that are getting aggravated due to wide ranging deforestation, mining in the catchment, rampant construction of embankments and roads and cutting in the Brahmaputra basin.

We have examined the decadal change in the forest cover of the Brahmaputra basin from 1970-80's to 2010 and compared with the increase in the level of flood severity, frequency and increasing level of the rising temperatures from the existing data sources and field survey on the North Bank of the river Brahmaputra.

During the period of the study this has been found that the decreasing forest cover has major role in the rising temperature and flood. On the entire North Bank of the

River Brahmaputra on the foothills of Himalaya there have specialized zone of Bhabar Terai forest. This has been seen that where these Bhabar-Terai zone has been removed from the foothill the severity of the flooding has been increased with the decadal rise of temperature in such areas. The rate of rainfall has been found increasing in the last four decades but the number of the rainy days has been decreasing.

After the 1950 earthquake and following flood in the year 1954 the entire basin of the Brahmaputra river changed forever. With the many fold increase of human population in the Brahmaputra valley the conversion of the forest land into agricultural lands started in a faster rate and continued till the 1996 Supreme Court ban on the timber logging and any such activity. Along with this forest destruction the flood occurrence in the Brahmaputra basin has been observed from the year '54, '62, '66, '72, '74, '77, '78, ' 84, '86, '87, '88, '89, '90, '91,'92, '93, '94, '95, '96, '97, '98, '99, '2000, 2011, 2012 and 2013 and is still continuing. It has been revealed from the present study that the magnitude increased with time and frequency of flood increased which direct positive correlation with the decadal rise in temperature and negative correlation with the decadal forest cover change in the North Bank of the river Brahmaputra in Assam specially the Bhabar and Terai forest which acts as the cushion for the speeding rainwater on the foothills zone of the Himalaya in the basin. It has been evident from the present study that forest cover in the foothills zone are very much necessary for resisting the impact of climate change such as increasing temperature, rainfall and flood. Hence, the forest cover has been necessarily found related with the severity of flood thus helps in curbing climate change impact.

P-2215-12

An Impact of Climate on Tree Species Diversity in Tropical Reserve Forest using Geospatial Domain

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Forest is a tool mentioned for ecological balance and environmental set up. It performs social, ecological and economical functions to the living organisms such as it preserves the natural resources for the sustainable use, lesser soil erosin, preserves the animal habitat etc. Forest degradation in the tropics is of significant concern because of the substantial losses of biomass and habitat fragmentation. Geographic Information System (GIS) has been proven in many studies and experiences to aid in the decision-making process based on Multi-Criteria techniques. The advancement in remote sensing coupled to Geographic information system expedites the adverse changes in forest vegetation and the assessment of impact of various factors such as climatic change or human activities on forests.This study aims to evaluate an assessment of tree species diversity of the Sariska Tiger Reserve using GIS and Multi criteria techniques. Vegetation indices among other methods have been reliable in monitoring vegetation change. One of the most widely used indices for vegetation monitoring is the Normalized Difference Vegetation Index because vegetation differential absorbs visible incident solar radiant and reflected much of the infrared. Data on vegetation biophysical characteristics can be derived from visible and NIR and mid-infrared portions of the electromagnetic spectrum. Four forest types, namely Anogeissus pendula, Boswellia serrata, mixed Anogeissus butea and mixed Acacia zizyphus are mainly dominant in the forest cover of Alwar district. Satellite data of LISS III (2012) give precise information of vegetation through reflectance value.

2216 - Climate smart forestry- Integrating mitigation and adaptation into sustainable development

ORAL PRESENTATIONS

K-2216-01

Forest carbon conservation and management: integration with sustainable forest management for multiple resource values and ecosystem services

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Forest carbon management is an important consideration in temperate forests as well as tropical forests. It is estimated that US forests absorb up to 15 percent of total US carbon emissions, or more than 200 Tg yr -1. Recent research suggests that this net carbon sink is declining, and that US forests could become a net carbon source within the next few decades unless decisive action is taken in the near term to alter this trajectory. Annual per capita carbon emissions in the US are triple those of France, and more than eight times those of Brazil or Indonesia, so many in the US forestry community consider it a moral responsibility to avoid this possible future. This paper will summarize ongoing research to determine whether carbon management is compatible with forest resource sustainability (continued production for a variety of goods and services), and whether forest carbon management enhances or detracts from other ecosystem services such as water and biodiversity. Examples are drawn from private forest lands managed primarily for timber and other economic values, and from public forest lands in which management for specific forest uses, values, and services are mandated by law or policy.

K-2216-02

Title not communicated

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Abstract not communicated

O-2216-01

Understanding and directing small-scale private forest owner behaviour towards climate change adaptation

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Climate change will affect many productive forests across Austria, which may lead to significant economic loss, but also depicts various opportunities for future management. While the Federal Forest Service already takes climate change into account, little is known about adaptation of small-scale private forest owners, who manage 56% of Austria's forests. Consequently, this project will investigate human dimensions of climate change and small-scale forest owners' adaptation strategies. The main focus lies on their climate change perception, ways to influence their implementation of adaptation methods, the rising of their awareness of possible risks of inactivity, and the enhancement of their transition to resilient forests. The key challenge is to "re-interest" this group in their property and to increase the awareness of their required contribution. For this purpose, the project develops innovative concepts for attracting as many forest owners

as possible to implement adaptive measures. The core of the study builds a questionnaire combined with a discrete choice experiment, which aims at acquiring a thorough understanding of the salient factors influencing decision-making processes. This innovative methodologically approach initially combines forest growth modeling and visualization of potential effects within a stated preference method.

O-2216-02

How forests can support adaptation of landscapes systems to mitigate climate change? A landscape approach to sustainable forest management

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The world's forests are in a state of flux due to land-use and climate change, deforestation, afforestation, wildfires, insects and pathogen outbreaks. In the face of both anthropogenic and natural forces there is an increasing need to assess the value of our forests. The incorporation of the ecosystem service (ES) concept into the framework of forest management stems from a need to create a more holistic perception of forests, recognizing not only their economic value, but also their cultural and ecological values including their regulation capability. Thus, requirements of an optimized forest production and an environmental quality improvement represent a true challenge for the years to come. A fast reorganization of the system is needed in order to find the right balance between management within a forest ecosystem services approach at different scales. In particular, we need to consider a valorisation of wood resources and production, thorough knowledge of their vulnerability within an intensification management scenario.

As climate changes, societal demands for goods and services from forests are also changing. The recent decision of European government leaders to increase the share of renewable energy in Europe to 20% by 2020 is expected to result in a much greater demand for forest biomass for bio-energy generation. This higher demand will intensify the competition for resources between forest industry, the energy sector, and nature conservation/other protective functions and services (including biodiversity, protection from natural hazards, landscape aesthetics, recreation and tourism and climate regulation). A comprehensive and integrative approach from the plot level to the landscape level is needed through collaborative tools. Such tools also should inform on what level of spatial scale adaptation measures can be effective: can they just do it by managing the land within their jurisdiction, or are they dependent on changes at broader scales and do they need to collaborate with other land managers around? Scenario analysis and planning options for the future will be also presented based on specific case studies as exemplars. The work opens questions regarding the needs for a comprehensive adaptive forest management under changing environmental conditions to improve forest management in a wide range of territories.

The challenge that lays ahead demands gaining awareness of the increasing pressures on forests and forest resources and concern about the continuous changes in climate conditions that will increase forest degradation for what a holistic approach towards integrative solutions is needed.

O-2216-03

The loop effect: quantifying the mitigation potential of the forest sector when adaptation strategies are also taken into account. A case study for France

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Objectives: (1) quantify the contribution of the French forest-wood product chain in terms of sequestration and substitution of carbon when we account for forest response to climate change and consequent forest managers adaptations; (2) assess the effects of the incertitude of current climate scenarios on the above carbon balance; (3) assess the potential consequences of an early introduction of adaptation measures.

Methodology: We use a spatially-explicit bio-economic Model of the French Forest Sector (FFSM++) that is able to consider and integrate: (a) effects of climate change over forest dynamic; (b) forest investment decisions (among groups of species) according to expected profitability (conditionally to cc); (c) market effects in terms of supply, consumption and trade of wood products depending on the stock of forest resources. Having both forest dynamic and forest products included, we can evaluate the carbon balance considering the following elements: (a) carbon sequestered in live and death biomass in the forest; (b) carbon sequestered in wood products; (c) carbon substituted when wood is used in place of fossil fuels; (d) carbon released by forest operations.

Results: When we run the model for the next century using IPCC A1B scenarios the average sequestration rate is 43.88 Mt CO2 eq. y-1 while the net energy substitution emissions is 13.59 Mt CO2 y-1. Together they form 16% of the French 2010 emissions (361 Mt CO2}). The sequestered carbon is highly due to an increasing forest stock, that however tends to peak in about 100 years. In A2 and B1 scenarios the forest balance decreases by 0.51% and 1.20% respectively. Testing 12 different climatic models for the A1B scenario we obtain a coefficient of variation of 2.47% for the overall carbon balance. Allowing forest managers to have a perfect foresight on future climate favour broadleaved species but has a limited effect on the carbon balance.

2216-POSTER PRESENTATIONS

P-2216-01

Community based Climate Change Adaptation: a Case of Community forestry programme in Nepal

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Community forestry programme is a major community based climate change adaptation (BCCA) and potential mitigation strategy; recognized by climate change policy and National Adaptation Programme of Action (NAPA) of Nepal. In these regards, some community forestry user groups (CFUGs), in the support of donor organizations , are implementing practices of community based adaption plan, establishing fund as well as creating institutions to benefit from REDD (reducing emissions from deforestation and forest degradation) mechanism. However, there are very little evidences about the strength and limitations of such practices and its impacts on wider socio-economic development of vulnerable community.

Based on the paper presenter's 10 years long experience in the issues and the study of six community forest user groups, three from each of DFID/UK and CARE supported groups, the finding shows that the programme is suitable mechanism for planned, decentralized, cost effective, linked and inclusive adaptation strategies. The programme is initiated and groups are formed to address the issues of natural hazards and mal-adaptation practices the local people followed previously in responses to local changes. The groups adopt bottom up planning process to identify vulnerability and prepare adaption plan, collaborative effort to establish matching fund to implement prioritized activities and coordinating mechanism to integrate these activities into wider development programme. These practices increased the livelihoods security of marginal groups through increasing human and food security and forest product availability, building social capitals, use of indigenous knowledge and providing alternative livelihoods to the landless poor members, and deriving benefits from development service providers.

While community forestry policies and practices of Nepal seem climate change friendly exclusions persists and people who are member of the groups have opportunity

to get benefit from the adaptation fund while there are some households/communities are excluded from the groups. Also, limitation on extraction of forest products is in some instances undermining the livelihoods strategies of the forest dependant people limiting their adaptation capacity. There are also issues of resource access with members in particular can be constrained by poorly aligned jurisdiction.

The finding shows that the programme promotes entry points for pro-poor mitigation strategies. The growing stock of forest particularly in hills increased and the community forestry user groups have established resource distribution system based on wealth ranking of the groups, the mitigation strategies specifically the REDD mechanism may benefit to the poor category of the users. However, we find that the executive committees of CFUGs are politicized and the political ideology affects resource distribution. Also, there are high value forest trees, the illegal sale of which offers considerable financial intensives. So, particularly in the Terai, the conservation and management of forest may be competing with very high opportunity costs. Also, there are significant issues of land tenure conflicts between people and Government, VDCs (Village Development Committee), and communities, the result of which does not favor the protection, management and conservation of forest.

The findings suggest that CBCCA approach needs to integrate in rural development policies at landscape level. As the groups are growing as a local adaption funding institutions, the role of CFUGs should be linked with sources of credit and low-interest loans. To increase the community forest for mitigation, climate change sensitive forest management guidelines needs to developed and linked with national forestry activities. In addition, there is value in exploring PES (Payment for environmental services) and carbon markets more broadly than strictly REDD mechanism; Community forestry stakeholders should undertake experiential marketing of forest carbon in a volunteer market.

P-2216-02

Disentangling the climate change contributions of CO2 emissions from global forest bioenergy

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Many future energy and emission scenarios envisage an increase of bioenergy production in the global primary energy mix [1]. Bioenergy is the most important renewable energy option in studies designed to align with future RCP projections, reaching approximately 250 EJ/yr in RCP2.6, 145 EJ/yr in RCP4.5 and 180 EJ/yr in RCP8.5 by the end of the 21st century. However, many questions enveloping the direct carbon cycle and climate response to bioenergy systems remain open and partially unexplored. While the climate change effects of the different greenhouse gases (GHGs) are usually aggregated into common units (e.g., radiative forcing, CO2-equivalents, or °C), for example using emission metrics like the well-known global warming potential (GWP) or Global Temperature change Potential (GTP) [2], emission metrics for CO2 from forest bioenergy are not implemented in global emission scenarios. Bioenergy systems are largely assessed under the default climate neutrality assumption and the time lag between CO2 emissions from biomass combustion and CO2 uptake by vegetation is usually ignored, with integrated assessment models and policy directives mainly focused on the quantification and mitigation of the risks associated with deforestation and land use changes. Whereas recent studies show that the temperature change of CO2 emissions from re-growing biomass is characterized by an initial warming followed by a smaller long term cooling [3], an analysis that disentangles the role of CO2 emissions from bioenergy with a global coverage and within the policy relevant framework linking temperature peak and emissions is still missing [4]. Here, the characteristics of the climate system response to CO2 emissions from forest bioenergy is investigated within the 2 °C target and global spatially explicit maps of emission metrics for the climate impact characterization of CO2 emissions from forest bioenergy are produced. These metrics can be used to unravel the contributions to climate change of CO2 emissions from forest bioenergy, as here exemplified by assessing these emissions under the RCP8.5 scenario. The metrics are correlated with the site-specific turnover times and local climate variables and the characterized results are sensitive to the specific metrics used that inform about different dimensions of the climate system response to forest bioenergy. The temperature peak from bioenergy CO2 emissions is proportional to the maximum rate at which emissions occur and is nearly insensitive to the amount of cumulative emissions. While the transient climate response to cumulative emissions (TCRE) of CO2 from fossil fuels is approximately constant, the TCRE to bioenergy emissions depends on time, biomass turnover times, and emission scenarios. The linearity between temperature peak and bioenergy CO2 emission rates thus resembles the response to short-lived climate forcers. As for the latter, the timing of CO2 emissions from bioenergy matters. Under the international agreement to limit global warming to 2 °C by 2100, early emissions from bioenergy have smaller contributions on the targeted temperature than emissions postponed later into the future. The application of these metrics to CO2 emissions from forest bioenergy in the RCP8.5 scenario shows that emissions in 2015 cause a warming effect that is about 45% (expected range: 38-60%) of the gross emission flows when GWPs are used. On the other hand, the result in 2100 is a net climate cooling if GTPs are applied. A temperature peak about 35% (12-46%) less than that caused by an equal amount of emissions from fossil fuels is found. Without coupling the analysis with global climate models, CO2 emissions from forest bioenergy can thus be assessed under different climate change indicators and across various spatial and temporal scales using the global maps presented in this study.

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P-2216-03

A bioeconomic modelling of logged tropical forests to simulate low-carbon strategies for Central African concessions

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Among the contributions expected from forest sectors in policies of climate mitigation, one consists in increasing forest carbon stocks by changing management practices. This activity, generally referred to as Improved Forest Management (IFM), is of major importance in the Congo Basin forests, where 20 millions of hectares are now managed for timber production. The carbon benefit generated by IFM activities is often obtained by a reduction of harvesting pressures on forest resources. In the case of Extension of Rotation Age/Cutting Cycle (ERA) projects, the reduction of emissions comes from the increase of Minimum Cutting Diameters (MCD) and/or the extension of Felling Cycle Duration (FCD). However, such activities have negative consequences for the profitability of timber companies. Climate instruments such as the mechanism of Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) promote a compensatory approach to cover these income losses by the valuation of avoided carbon emissions.

To determine the feasibility of such a carbon-based compensation, it is necessary to predict over the long term both the dynamics of forest carbon and the time schedule of timber incomes. The two are closely interrelated. Selective logging can alter the structure, the floristic composition, and thus, the carbon stocks of tropical forests. Modelling these forest-logging relationships is challenging. Selective logging implies to deploy a species level representation of timber harvesting but the high diversity of tropical forests, in pair with the scarcity of data, hinders the correct fitting of species-specific models.

We developed a bioeconomic approach coupling a mixture of inhomogeneous matrix models for forest dynamics and an object-oriented model for forest logging companies' operations. For forest dynamics, our methodology addresses the challenge of taking into account the high species richness by simultaneously clustering tree species into groups according to vital rate information and selecting group-specific explicative environmental variables. For the logging operations, the object-oriented approach allows us to precisely describe harvest choices under technical and economic constraints, in a highly configurable manner. In the case of a Central African forest concession managed by a typical sawnwood export-oriented company, we predicted the carbon stock evolution for a wide range of ERA scenarios and for a time scale of 100 years. For several categories of carbon credit, we calculated break-even prices that would enable carbon revenues to compensate logger's loss of timber incomes.

Our simulations are based on data from the M'Baïki site, in the Central African Republic (CAR), which has been monitored for 30 years through a collaborative partnership with various French and CAR institutional and research organizations. Economic data are taken from several forest concessionaires in Central Africa. We predicted that without any logging, carbon stock would increase naturally. When logging was simulated, the carbon stock decreased during the first felling cycle and although carbon recovery could be boosted by logging, this decrease was too sharp to catch up with unlogged levels. To ensure low break-even prices of carbon credits, ERA activities had to involve both FCD and MCD. In this case, we found a little dependence of the private discount rate and the alternative MCD and FCD, but a strong dependence of the way how carbon credits are accounted. Thus, from the perspective of the forest concessionaire, depending of the chosen type of credits, carbon revenues could compensate timber revenues for a large number of ERA projects.

We focused on IFM projects, but our approach remains appropriate for other strategies of forest sustainability improvement such as Reduced Impact Logging techniques or post-logging silvicultural systems. In the current context of REDD+ deployment, our work is a first step to bring some preliminary answers to the question of carbon-based compensation opportunities for industrial forest concessions in Central Africa, on the basis of an accurate modelling of tropical forestry.

P-2216-04

Dynamics of vegetation in Managed forest: the case of Missirah Forest in Senegal

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In the global climate change discussion, forest management has become a major concern because of the significant role of forest in climate change as both pool and source of carbon dioxide. Climate change discussion points out the important role of forest sector in climate change mitigation leading to mechanisms like Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD). The concept of REDD launched in the 11th Conference of the Parties in 2005 became later REDD+ integrating sustainable forest management, forest conservation, and carbon sink enhancement. In Africa, there are only few operational REED+ programs but, the idea behind the concept is not new in African forest sector. There have been many attempts to tackle the issue of deforestation in Africa and in these attempts; agriculture, urban growth and wood extraction were identified as the main drivers. In Senegal the driving factors of deforestation derived from the literature are mostly the same. Nevertheless some factors are more specific to some areas. In the southern part of Senegal namely in Tambacounda and Kolda which are the main charcoal supply areas of the country, deforestation is correlated to wood extraction mainly charcoal production. Charcoal production contributes for more than 30% in deforestation in Senegal. To curb deforestation due to charcoal production, some forests were specifically managed for charcoal production under management plans where rules are set to make the production sustainable. Past studies related to forest management in Senegal focused mainly on the decentralization of forest management process, the effect of the institutional pluralism on the decentralization and the management of forest resources, the function of the forest management plan in the new Senegalese Forest code, the evolution of forest management in Senegal, and the effects of charcoal production on woodland regeneration. However there is a lack of relevant information on the dynamic of vegetation in managed forest comparing vegetation state baseline to the situation after a full rotation period. This information are relevant in the light of the willingness to expand the process in a large number of forests. Therefore this study aims at assessing the dynamic of vegetation in Missirah Forest. Specifically it consists of characterizing vegetation type state in 2013, determining their dynamic through the mapping of the land cover land use types from1990 to 2014, and determining vegetation dynamics in terms of floristic composition and dendrometric parameters between 2002 and 2013

Missirah Forest is one the first 3 managed forests for charcoal production in 2004. A mapping of the land use-land cover types was combined with a tree inventory to characterize the current status of the vegetation in 2013 and its dynamics between 2002 and 2013 using 94 circular plots in table lands and 57circular plots in gallery forest. The mapping of the LULC identifies 6 vegetation types namely tree savannah, shrub savannah, degraded shrub savannah, gallery forest, farmland, and settlement areas. It reveals a decrease of area covered by vegetation at the expense of cropland and the appearance of a new vegetation type resulting from the degradation of the other vegetation type. The result of the tree inventory reveals that the vegetation types and the farmland shelter a total of 54 species belonging to 18 families and 42 genera. Inventory data were analyzed according to land use land cover types. Mean diameter at breast height (dbh), tree density, stem density, mean Lorel height and mean basal area in the different land-use land cover were greater in gallery forest. These dendrometric parameters were also found to be significantly different among vegetation types ($p<0.05$) in 2013. The analysis of variance(ANOVA) conducted on the negative binomial model shows that between 2002 and 2013 from a vegetation type to another the difference in terms of diversity is highly significant ($p<0.05$) while from a year to another it is not significant ($p>0.05$). The K-mean method applied to the IVI of species identifies three classes defining species with increased, decreased, and relative stability IVI. Dendrometric parameters show greater values in 2002 except for stem density in tree savannah. Significant difference was observed for tree density, basal area, and mean Lorey height between 2002 and 2013.

P-2216-05

Population growth and deforestation in the Lake Albert region (Uganda) at the start of oil production

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In the early colonial days, a deep political and demographic crisis hit the eastern shores of Lake Albert, Uganda (Doyle). Large areas were then set aside as forest and game reserves. Later on migratory policies and practices shifted and the area became a land frontier. Migrant settlement was encouraged by government from the 1950s onwards. New settlements were promoted by the Ugandan State in response to international refugee crises, as well as national demand for land. Land patronage led to repeated encroachments on protected areas and severe deforestation. Since the 1990s, both the institutional role of central government, acting through a variety of bodies (the administration, the army, the forestry and wildlife services, etc.), and political patronage have consolidated Museveni's regime in somewhat contradictory ways. These contradictions shape access to land and natural resources locally at the start of a new oil frontier. Through a detailed mapping of population densities and growth and an analysis of qualitative interviews conducted in 2012-2014 in a collaborative research framework (M-PRAM, CPAS - IRD, Makerere University), we highlight increased vulnerability and inequalities as well as potential conflicts. Although climate variability is a factor of change locally, the short term issue shaping resource depletion is governance.

P-2216-06

Community Based Forest Management for Future Climate Change Mitigation and Adaptation – Evidences from Northwestern Mountain Region of Pakistan

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Mountain regions are highly vulnerable to global climate change and people living in these areas are first to be affected because their livelihoods are dependent on natural resources (land, pastures, water and forests). Natural forests are a vital component of the daily lives of the mountain communities and it is well documented that degradation in forest resources has adverse effects on the livelihoods of these communities. Forest protection through sustainable forest management strategies is considered as an alternate strategy to mitigate the negative consequences of climate change but the governments of developing countries face many challenges regarding forest management due to poor top-down governance and corruption. Participatory forest management has emerged as an effective strategy for sustainable forest governance. In this perspective this paper reports the findings of an ongoing research projects regarding community based forest management and its link with climate change in northwestern Khyber Pakhtunkhwa (KP) province of Pakistan. KP province is less developed as compared to other provinces of the country, and its mountain areas are among the least developed regions. This area is regarded as highly vulnerable to climate change impacts. Farming, one of the major livelihood activity and is a main source of food for the local dwellers, is dependent on the climatic and weather conditions. Similarly, forest resources are also important for household income and meeting the needs for fuel for cooking.

In response to very high deforestation in the mountainous regions of KP, the government initiated the process of community based forest management in the province with the objective to reduce forest depletion with the help of community participation.

This paper attempts to analyze the impact of community forest management on climate change mitigation efforts as well as on the livelihoods of local communities. The paper also attempts to answer the question that how the efforts of the state and communities regarding climate change mitigation are augmented (or otherwise) with the change of system. More specifically, the paper addresses the following questions:

1. What are the patterns of climate change in the study area?
2. What is the impact of participatory forest management on livelihoods of local communities?
3. How local livelihoods and farming practices changing with time and what are the coping strategies of farmers in the event of climate extremes?
4. What are the perceptions of local people regarding sustainable forest management and climate change mitigation in the context of participatory forest management?
5. What is the link of participatory forest management with future climate change mitigation and adaptation?

Key-informant interviews and focus group discussion was used to collect information from farmers of selected villages. Life histories of some respondents were also recorded find-out how changes in forest management paradigm are linked with livelihoods and farming practices and climate change.

P-2216-07

Linking adaptation and mitigation in carbon sequestration projects: evidence from Belize

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We develop a multi-dimensional framework to explore the extent to which carbon forestry initiatives integrate adaptation concerns, and use three Belizean projects as case material. We demonstrate that the rhetoric of linking mitigation and adaptation is not easy to hold, because the mandate of forest carbon markets does not incorporate adaptation concerns. Projects' contribution to adaptation relate to unintended forestry and biodiversity aspects while, critically, their mitigation potential is debatable and their livelihood outcomes are limited in scope and relevance. We conclude that integration of adaptation and mitigation in Belize's carbon offset projects remains a laudable but elusive goal.

P-2216-08

Climatic impacts on managed forests: predicting the future from the past

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Forests are one of the most vulnerable ecosystem under the coming climate change and a growing concern arise about their capacity to maintain ecosystem services such as production of timber, fiber and energy, climate and hydrological regulations, or soil and biodiversity protection. Climate effects are significant not only at a short time scale, but also on the temporal horizon of a forest life cycle, e.g. through continuous shifts in atmospheric CO2 concentration, air temperature and precipitation regimes induced by the enhanced greenhouse effect. This will affect not only the functioning of forests in situ but also the range and geographical distribution of forest tree species and therefore the spatial distribution of ecosystem services and production across countries and continents.

The long term sustainable management of European forests must account for these dynamic changes and the interactions between climate and forests. Observations of forest functioning growth and distribution for the last decades provide a rich information about forest response to climatic shifts and extreme events and the way management interplays with these impacts.

We present in this communication how two modeling approaches for predicting the future of managed forest at country scale might optimize past observations to strengthen their likelihood and reduce uncertainty of their projections. In situ observation networks such as flux tower networks (FLUXNET, ICOS), ICP forest network and National Forest Inventories are the main data sources used.

The climate niche modeling predicts the potential distribution of forest species in the geographic domain using past observations of climate and water balance and presence/absence of tree species. Results show an expected poleward shift of forest biomes or species due to global warming and water balance changes that may reach several 10s to 100s of km during the 21st century. Similarly, a process based model can be calibrated and evaluated using past observations to predict forest functioning as forced by climate scenarios. The energy balance and the carbon and water cycles in the soil-plant-atmosphere system are modeled at an hourly scale and integrated over an annual basis. As one of the main disturbance in the temperate forests, management is integrated through practices such as ploughing, thinning or clearcutting.

Long time series of flux measurements in monospecific forest stands are used to calibrate the model while adjusting parameters. In a second step, models have been run in various ecological conditions and we have compared the outputs to long time series of observed data from forest inventories or monitoring networks to model predictions. Last, we use climate projections derived from RCP scenarios until 2100 at 8x8 km grid to force the models.

This work is conducted across the French metropolitan area for 3 of the main European forest species: Maritime Pine, common Beech and Douglas-fir. Our results provide an evaluation of the ecosystem services (carbon sequestration, wood supply, water regulation) taking into account climate change. Based on these results we will

discuss about the way to manage/optimize these French forests in the future. To enhance cooperation between researchers and stakeholders, a panel of managers and decision makers has been involved to implement various forest management scenarios in the model.

P-2216-09

Managing of risks in Agriculture: Benefits of Conservation of forest resources in Anambra State, Nigeria

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Forest management offers a promising alternative to depletion of forest resources. Continuous degradation of the forest reserve base has major effects on other segments of the economy. This includes reduction of forest cover leading to erosion and soil degradation. This study assessed the roles of farmers in conservation of forest resources; benefits of conservation of forest resources in the area and reasons for loss of forest resources in the area. Multi-stage sampling procedure was used to select 120 respondents for the study. Data were analysed with the use of descriptive statistics. Results show that reasons for loss of forest resources in the area included: excessive farming (M=2.8) and rapid urbanisation (M=2.0). Roles of farmers in conserving forest resources were: avoidance of illegal hunting and poaching (M=3.0), practicing continuous forestation (M=3.2) and prevention of bush burning in forest areas (M=3.3). Benefits of Conservation of forest resources in the area included: protection of forest cover (M=2.3), prevention of climate change (M=2.4) and retaining economic benefits from the forest (2.5). Hence it was recommended that there should proper planning for farming and urbanisation for conservation of forest resources in the area.

P-2216-10

Multiple trade-offs in forest management facing climate change

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Forests are able to mitigate climate change through carbon sequestration, storage, and substitution. But these different options are generally conflicting. How should they be combined? This question is a first major challenge for forest management and policy. In parallel, forests are impacted by climate change through trends (beneficial or detrimental) and extreme events. They may adapt and deserve to be adapted to these gradual or brutal phenomena. Integration of trends and extreme events is a second major challenge for forestry. Adaptation and mitigation have to be distinguished because they are very different responses to climate change. In the same time, they are interrelated since mitigation supports carbon regulation as an ecosystem service influenced by forest adaptation. Synergies and trade-offs between forest adaptation and mitigation are a third challenge. Finally, climate change issues are only a part of sustainable forest management and trade-offs also exist between climate change measures and sustainability at large. This presentation will comment these four issues from models running at national and stand levels.

At national scale, the carbon balance of French forests will be projected over the 21st century according to scenarios combining various harvest options with different climate change intensities. At stand level, a micro economic model will combine trends and extreme events, mitigation options and climate change impacts in order to find the best rotation age. The results of these models at two different scales will then be discusses in the frame of sustainable forest management.

P-2216-11

National Strategy for Adaption to Climate Change in Hemiboreal Estonia: Forestry

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Climate change can considerably affect ecosystems and different bioeconomy-sectors. In addition to climate change mitigation it is important to know relevant adaptation options. Many EU states already have national adaptation strategies and action plans. Estonia will have a comprehensive national adaptation strategy and action plan in 2016.

The special project for adaptation policies in Estonia is created in 2015: „Climate change adaptation strategy and measures for thematic fields of natural environment and bioeconomy: BioClim." (http://pk.emu.ee/en/structure/landscapemanagement/projects/bioclim/project/).

There is a chapter about forestry in the National Strategy Plan for Adaptation to Climate Change in Estonia. Also in the Estonian Forestry Development Plan until 2020 the climate change impacts and mitigation is concerned (http://www.envir.ee/sites/default/ files/elfinder/article_files/mak2020vastuvoetud.pdf).

Basic studies about climate change impact on functioning of forest ecosystems are conducted in Estonia in the Free Air Humidity Manipulation Experiment (FAHM, https://sisu.ut.ee/fahm1/main). FAHM experimental facility was created in collaboration with researchers of plant ecophysiology, applied ecology and forestry from University of Tartu and Estonian University of Life Sciences. FAHM is a unique open-air experiment where acclimation and functioning of trees and forest stands under elevated atmospheric humidity conditions is studied. Results of FAHM and their theoretical interpretation is a basis for prognosis of climate change impact on Estonian forest ecosystems and life activities of trees.

Climate change will likely cause significant long-term changes in the entire Estonian forest sector. The main impacts of climate change for hemiboreal forests and forest management in Estonia are:

- The proportions of tree species and balance between coniferous and deciduous forests will change.
- Forest industry must consider with changes in local wood assortment.
- The quality of timber may reduce.
- Extreme weather events may cause considerable and unavoidable damage.
- The risk of wind damages will increase.
- The reduced period of frozen ground makes timber harvesting more difficult.
- Increasing precipitation means more investment into forest roads and ditches.
- One of the most important possible hazards associated with climate change concerns forest pests and diseases, especially outbreaks of invasive diseases and mass production of insect pests.

Novel adaptation methods must be elaborated in forest plant production, tree selection and breeding, tending of forests, forest protection, felling systems and forest pathology.

P-2216-12

Potential Risk of Wildfire under Climate Change in Croatia

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The weather conditions such as a long-lasting dry spell and insolation duration, high air temperature and strong wind essentially increase the potential risk for starting and spreading of wildfires. All these relevant factors are observed on the Croatian Adriatic coast and islands and lead to the conclusion that the Adriatic area is prone to wildfires during summer season. The main goal is to research the regional impact of climate change on the potential greater risk of wildfires in Croatia from May to

September. Monthly and seasonal severity rating (MSR and SSR) are used as indices for the potential risk assessment of forest fires which are one of the products of the Canadian Forest Fire Weather Index System. According to the map presentation of mean long-term seasonal severity ratings for the standard climatic period 1961-1990, the most endangered area is the mid-Adriatic coast with the adjacent islands. Using the secular weather series of Crikvenica and Hvar in the period (1901-2014), which represent the northern and middle Croatian coast and islands respectively, the secular variations of MSR has been estimated. In order to establish the eventual increase in potential wildfire risk on the Croatian mountainous hinterland and lowlands the secular data of Gospic, Zagreb-Gric and Osijek has also been used for the MSR assessment. A significant monthly increase (significant level is 0.05) in the MSR was observed for Crikvenica for all months of the period considered and for Hvar in June and July. This increase is particularly important for June, as it indicates the possibility of the earlier onset of the forest fire season on the Adriatic area. The analysis also showed spreading of high potential risk of wildfire from the mid-Adriatic to the northern, especially in July and August in the last 114 years. However, positive trend of potential risk of wildfire noticed in the eastern part of Croatia in the last 64 years. Tendency of increase the potential risk of wildfires in Croatia is in accordance with the projections of climate change. Thus, forest fire regime in our country fits well into the larger picture of increasing areas of high threat of wildfires in the Mediterranean and Eastern Europe in the summer months in future.

2217 - Global scenarios of land-use change and land-based mitigation, and their importance in the climate system

ORAL PRESENTATIONS

K-2217-01

Robust knowledge on land use change and climate at the science-policy interface

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Land Use, Land Use Change and Forestry (LULUCF) contributed 24% of total greenhouse gas emissions and 11% of CO2 emissions in the 2000-2009 period (IPCC, 2014). Land-based mitigation strategies are essential to achieve the 2oC target, with most current scenario projections invoking substantial negative emissions from afforestation and from bioenergy with carbon capture and storage (BECCS), in addition to Reduced Emissions from Deforestation and Degradation (REDD+) and improved agricultural management. Reporting and accounting of some LULUCF activity is already embedded in international climate policy. Negotiations leading up to adoption of new international policies at the Paris 2015 Climate Summit include further LULUCF activities, particularly REDD+. This reliance on land-based mitigation options necessitates that LULUCF policy is in-line with the latest evidence across the natural, economic and social sciences, and that scientific research reflects policy needs. This presentation will review the importance of LULUCF mitigation options in current and planned policy, indicating mismatches with scientific knowledge, often due to different considerations of spatial and temporal scales. We will also explore time lags between the emerging scientific insights, policy targets and commitments and changes in activity leading to desired changes in physical and ecological systems.

For example, scientific research has long emphasised the importance of REDD+ as a low cost, multiple-benefit near-term mitigation option, although international policy is only just catching up. New analyses of the biophysical climate impacts of land use change from both observations and Earth System Modelling (ESM) further confirm the importance of tropical forests as providing a cooling effect through changes in the surface energy budget and in evapotranspiration rates. The biophysical climate effects of afforestation in temperate and boreal areas can however either amplify the biogeochemical cooling effects (e.g through enhanced evapotranspiration in summer) or dampen them (e.g. through reduced surface albedo in winter). At the global scale, net biophysical effects are small and biogeochemical effects of land sources and sinks of CO2 dominate the climate impacts of LULUCF. The regional nature of the effects and the still large uncertainty in the science imply that the evidence base is not yet sufficient to implicate changes in international mitigation policy, particularly related to afforestation/reforestation activities, although effects are likely be important to consider in regional or national adaptation policy. Biophysical effects should be considered in the current development of land-based mitigation scenarios and modelling capability for the next generation of integrated climate-nature-society-policy projections so the implications can be assessed.

Bioenergy has been one sector where controversies in scientific understanding, socio-economic modelling and policy implementation have been particularly apparent and there is a need for the stronger use of evidence and more joined up approach. Recent studies suggest that in the longer term bioenergy may provide larger offsetting potential than afforestation where contribution is small once forests reach maturity. However, to fully reach the potential it will be important to ensure technological improvements, assessment of full life-cycle costs, and the implementation of sustainability criteria. Given the potential lags in the scientific, technological and uptake steps, more resources needs to be put in place now or soon if BECCS is to be expected to contribute significantly to global mitigation by 2050.

K-2217-02

'Land-Use and Climate, IDentification of robust impacts' (LUCID): What have we learned from this project (2008-2013)? Suggestions / attempts to move forward

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The objectives of the LUCID international project are to qualify and quantify robust biogeophysical and biogeochemical impacts of land-use induced land-cover changes on climate (LULCC), from pre-industrial times to nowadays, and from today till the end of the 21st century. By 'robust' we mean that is above the noise generated by model variability and consistent across multiple climate models.

Two steps were undertaken for the 1st phase: one focused on historical climate (from ~1870 till years 2000), and another looking into the future (outlook and papers may be found on our web site: http://www.lucidproject.org.au/index.html).

Seven modelling groups contributed to the historical part. They all conducted two series of two experiments using

observed interannually and seasonally varying SST and sea ice extent for both present-day and pre-industrial conditions, forced with two sets of land cover distributions reflecting the state of the canopy respectively in ~1870, and ~1992.

We have demonstrated that climate change in large regions of the northern hemisphere may be as much influenced by LULCC than by changes in global quantities (CO2, SSTs, ...), with either amplifying or dampening effects. Moreover extremes (e.g. temperature) simulated in climate models are quite sensitive to LULCC (Pitman et al. 2012). Detection/attribution of local to regional changes in climate/meteorology may therefore be strongly biased if one does not account for changes in local to regional land-uses. Similarly we emphasized that downscaling of global climate simulations must include land-cover (and/or land-use) changes.

We have also shown that the response of individual models to deforestation varies not only in magnitude but also in sign from one model to another for some variables such as latent heat flux. This diversity could certainly be better constrained by a proper evaluation of our land-surface models (or DGVMs) in both an off-line and on-line mode. There is a need to properly evaluate the sensitivity of our LSMs (and then our coupled LSM-GCMs) to land cover changes and to land uses using a wide range of observations as for example was done in Boisier et al. (2013 and 2014).

During the LUCID exercise, we have discovered that going from a set of crops and pasture maps to land-cover maps was not only a difficult task as it involves choices, but was also a mean to increase the dispersion between the models' results. There is therefore a need to harmonize the procedure to go from those maps to land-cover. This is highly important for the biogeophysical effect on climate, and is crucial for the carbon cycle. Moreover, as DGVMs become more complex and start to include better representation of crop function and management, we'll soon be facing the need to better interact upstream IAMs who provide climate modelers with such maps.

The LUCID community also contributed to the fifth Coupled Model Intercomparison Project (CMIP5) and analyzed scenarios of future climate change. Six CMIP5 modeling groups performed additional LUCID-CMIP5 simulations without anthropogenic land-use changes from 2006 to 2100. Those analyses revealed that the effects of land-use changes on mean annual temperature in RCP8.5 and 2.6 scenarios are significant for regions with land-use changes exceeding 10%. Changes in land-surface albedo, available energy, and latent heat fluxes are small but significant for most ESMs in regions affected by land-use change (Brovkin et al., 2013). These climatic effects are relatively small, as land-use changes in the RCP2.6 and RCP8.5 scenarios are small in magnitude and mainly limited to tropical and subtropical regions. Crops tend to warm climate in most areas and models. A causal link between LULCC forcing and the climate impact is found in some models where the presence of pastures tends to induce a local biogeophysical cooling which offsets a biogeochemical warming. Conversion to pastures thus may have a climate change mitigation potential but more detailed and idealized experiments are required.

K-2217-03

Shared Socio-economic Pathways – a framework for assessing potential land use futures –

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Today, land-use and land-use change are responsible for approximately a quarter of global greenhouse gas emissions, largely from tropical deforestation, methane emissions from livestock and rice cultivation, and nitrous oxide emissions from livestock and fertilized soils. But, the land system is also seen to contribute much to climate change mitigation in the future by providing biomass for bioenergy, improved agricultural management and conserving or even enhancing carbon stocks of ecosystems. The degree of both, future emissions but also mitigation potential of the land depend strongly on uncertain trends in population growth, dietary changes, trade, possible demand for non-food products such as bioenergy, future developments in agricultural yields and relevant policies. Over time, these uncertainties may result in very different land-use patterns and associated emissions.

Scenario analysis has been established as a tool to explore and evaluate such extensive uncertainties associated with possible future developments. Recently, new scenarios have been developed that are organized around two important dimensions: The five radiative forcing levels consist of four representative concentration pathways (RCPs) which determines the amount of climate change. The possible future socio-economic conditions that could correspond to individual forcing levels are then described in the shared socio-economic pathways (SSPs). The SSPs provide 5 different stories of future socio-economic development, including possible trends in agriculture and land use. Future emissions and carbon stock dynamics in the land system are a function of complex interaction between all kinds of socio-economic factors, including population dynamics, economic development, technological change, trade, cultural and institutional changes and interaction with other sectors such as bioenergy demand for energy supply and transport. In each of the SSPs, climate policies can be introduced to reduce emissions or to enhance carbon uptake to reach radiative forcing level targets consistent with the RCP scenarios.

In this presentation, we will first present relevant aspects of the SSP framework for the land system. Then, based on a study that applied the scenario matrix approach combining climate forcing and socioeconomic dimensions for so-called integrated assessment models (IAMs) with dedicated land use modules, we will focus on possible future pathways for these drivers and their consequences on the land system, associated emissions and mitigation potential.

O-2217-01

Risk-aversion Behavior in Smallholder Farmers and Climate Change. Evidence from Empirical Work in Zambia

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When the economic effects of climate change are considered, decision-making under uncertainty and risk are arguably at the forefront of the problems that need to be analyzed. The consensus is that, in the developing world, smallholder farmers are among the most vulnerable to the effects of climate change and, especially, to the adverse consequences that derive from more volatile and extreme weather events with which climate change is associated. Further, there is overwhelming empirical evidence that risk considerations affect farmers' land allocation and other input usage decisions as well as their technology adoption choices. However, apart from the body of research on index insurance, an extensive review of the empirical literature that deals with climate change reveals that uncertainty and the role of risk-aversion are notably not taken into account in models that estimate the impacts of climate change on agricultural production, market prices and food security for the poor. In particular, those models do not consider the effects of climate change related increases in yield and price volatility on farm household choices with respect to production strategies that provide adaptation or mitigation services. In fact, farmers and farm households respond to changes in the riskiness of their decision making environments as well as to changes in expected average yields, crop prices and input prices. How they respond depends on many factors, but attitudes to risk are widely viewed as important in many contexts, not least when exogenous shocks such as climate change alter the fundamental nature of the production environment in which farmers operate. We therefore explore the role of risk in the farm household's production decisions by using a widely available household survey of farmers in Zambia to build a theoretically based empirical model of land-use choices. The model accounts for attitudes to risk in analyzing the effects of climate change on farm-level land allocation to crop production. The empirical specification

is based on a relatively simple discrete-choice model (nested logit) augmented by risk variables consistent with a mean-variance utility function. After the system is shocked with changes in temperatures, precipitation, and distribution of crop yields consistent with regional effects of climate change, the household decisions and the resulting production trends are aggregated and evaluated at the country level. Shifts in the geographical pattern of crop production appear evident using this analysis with crops like millet and cassava largely replacing maize production. More importantly, results indicate that in the case of Zambia the aggregate effects of risk-mitigating decisions exacerbate trends driven by the biophysical changes caused by climate change. These decisions represent a form of adaptation of small households to the changing climate. The effects of this form of adaptation, developed in the constraints of smallholder production, appear to be detrimental for the total output from the agricultural sector with important implications for market prices and food security for both the rural and urban poor. Three important conclusions follow from our analysis. First, risk matters; its effects on farmers' production decisions should not be ignored and should be accounted for in empirical models of the impacts of climate change. Second, concentrating on farm-level responses to climate change is not sufficient. It is essential to develop methods of aggregating individual responses to climate-change-related shifts in risk so that they can be reflected in models of regional and national crop and livestock markets. This is required to better understand the implications of climate change for ecosystem services and food and income security. Third, our results suggest that not accounting for farmers' risk attitudes can lead to significant mistakes in policy planning. It is also the case that a more accurate estimate of the effects of climate change on farmers' land-use and production decisions will enable policy makers to more accurately assess the benefits and costs of a wide range of policies intended to mitigate climate change's adverse effects.

O-2217-02

Quantifying the impact of LULCC on bio-geochemical cycles into the future under alternative mitigation and policy scenarios. What are the carbon and water costs of different mitigation options?

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Future impacts of land-use and land-cover changes (LULCC) on the biochemical cycles and biophysics are highly uncertain. Firstly, there are large uncertainties in possible future scenarios due to socio-economic parameters (e.g., food demand, trade liberalisation, technological development). Secondly, there are uncertainties in how cropland, pasture and natural vegetation respond to changes in climate. With a model comparison we address both these uncertainties. Three different future scenarios are run with the Integrated Assessment Models (IAMs) IMAGE and MAgPIE. The socio-economic setting in all scenarios is based on the Shared Socioeconomic Pathways 2 (SSP2), and all scenarios include climate change impacts for RCP2.6, which have direct effects on crop yields and terrestrial carbon stocks, and indirect effects on land-use dynamics. A bio-energy with carbon capture and storage scenario (BECCS) and an afforestation and avoidance of deforestation scenario (AD+AFF) are compared to a reference scenario with no land-based mitigation (REF). The land use changes from these 6 IAM scenarios are subsequently used to run the 4 Dynamic Global Vegetation Models (DGVMs) JULES, LPJ-GUESS, LPJml and ORCHIDEE. This comparison will show the impact of different future mitigation scenarios on the carbon and water balance, the development of natural vegetation and crop yields over the 21st century.

O-2217-03

Understanding the role of land management for carbon and climate mitigation under RCP 4.5 and RCP 8.5 using the Community Earth System Model

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As part of the Coupled Model Intercomparison Project phase 5 (CMIP5), land cover change and wood harvest were prescribed as major climate forcings for historical and future Representative Concentration Pathway (RCP) projections. Lawrence et al. (2012) described how land cover change was prescribed in all of these simulations and how the climate system and carbon cycle responded to the land cover change in concert to other transient forcing in the Community Earth System Model (CESM). The attribution of carbon cycle and climate changes directly due to land cover change however, were not possible due to the design of the CMIP5 experiments. Through a series of new CESM simulations we have attributed the land cover change impacts for the historical time series as well as RCP 4.5 and RCP 8.5 with and without land cover change. These simulations show that the direct land cover change fluxes to the atmosphere found in the CMIP5 simulations did not account for the lost uptake of carbon that would have been possible in the absence of land cover change and wood harvest. Once these losses are taken into account, the historical losses of terrestrial carbon increased from 61.2 PgC to 129.6 PgC, the RCP 4.5 uptake of 62.8 PgC changed to a loss of 5.8 PgC, and the RCP 8.5 loss of 49.0 PgC increased to 168.8 PgC. In order to assess the potential of land management to mitigate carbon and climate consequences we are currently simulating RCP 4.5 and RCP 8.5 with large scale global afforestation scenarios compared to maximum biofuel production through increased crop lands. In this talk we present the differences in all of these experiments for both ecosystem carbon and climate. To conclude this presentation we will provide details on the proposed land use simulations for CMIP6, currently being designed in the Land Use Model Intercomparison Project (LUMIP).

2217-POSTER PRESENTATIONS

P-2217-01

Zero-Tillage lessens soil CO2 emissions the most under arid and sandy soil conditions: results from a meta-analysis

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The management of agroecosystems plays a crucial role in the global C cycle with soil tillage leading to known organic carbon redistributions within soils and changes in soil CO2 emissions. Yet discrepancies exist on the impact of tillage on soil CO2 emissions and on the main soil and environment controls. A meta-analysis was conducted using 46 peered reviewed publications totaling 174 observations comparing CO2 emissions from tilled (T) and no-tilled (NT) soils with the objective to quantify tillage impact on CO2 emissions and to assess the main controls. On average, T soils emitted 21% more CO2 than NT soils, which corresponded to a significant difference at $P<0.05$. The difference increased to 29% in sandy soils from arid climates with low soil organic carbon content (SOCC<1%), but tillage had no impact on CO2 fluxes in clayey soils of high SOCc (>3%). Finally, nitrogen fertilization and crop residue management had little effect on the CO2 responses of soils to tillage. These results on the role of soil and environmental conditions on soil CO2 emissions response to tillage are expected to increase our understanding of carbon outputs from terrestrial ecosystems as well as to set up effective mitigation measures of climate change

mitigation.

P-2217-02

Potential impacts of forestation on the future climate change in Southern Africa

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Many studies have projected the future climate change over Southern Africa, but without including the influence of on-going forestation activities in the region. The present study investigates how the forestation activities may alter the projected climate change. For the study, two regional climate models (RegCM4 and WRF) were applied to simulate the present-day (1970-2005) climate, and the future (2030-2065; IPCC RCP 4.5) climate, with and without forestation. The simulations account for the potential impacts of natural bush encroachment and the commercial forestation over the eastern part of South Africa. The results agree with previous studies in that the elevated greenhouse emissions would induce warming over Southern Africa in the future, but the results further indicate that forestation would enhance the warming over the forested area and induces cooling elsewhere. The additional warming over the forested area is due to the albedo-effect of the forestation, while the cooling is due to the dynamic feedback of the local warming over the forested area. For similar reasons, the forestation would induce both wet and dry conditions over the sub-continent in future. As a result of its combined influences on rainfall and temperature, the forestation would enhance drought frequency over some areas, but reduces it over other areas in Southern Africa. This study suggests that using forestation to mitigate the impacts of global warming may produce unintended climate impacts over some areas in Southern Africa. Hence, the biophysical effects of forestation in Southern Africa should be weighed against the biogeochemical benefits.

P-2217-03

Low-Density Development and the Increasing Greenhouse Emissions in Malaysian Special Economic Zones

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Low-density development is one of the major problems associated with rapid urbanization in the global south. Special economic zones (SEZs) constitute new layers of capital driven urbanization and industrialization in many Asian emerging economies. In many Asian countries, SEZs cause rapid fragmentation of landscapes within and around urban areas. This paper focuses on Iskandar Malaysia, one of the most successful emerging SEZs in Southeast Asia. This economic region has attracted more than US$25 billion so far from the expected US$100 billion investments in housing, education, tourism and infrastructure to be realized by 2025. Recent studies have projected that by 2025, if the business as usual model continues, the region's greenhouse emissions and energy consumption will increase more than 70% and 80% respectively. The paper aims to link and discuss how fragmentation of agricultural landscapes, mangroves, coastal vegetation and other green areas give rise to increasing emissions through new urban development projects. The current study relied heavily on fieldwork, landscape metrics for calculation of landscape change using GIS and FRAGSTATS. The study findings used established examples within the region and beyond, to estimate increases in emissions and carbon storage capacities from fragmented agricultural landscapes, mangroves, new low-density development activities, and expanded roads. The findings clearly showed that landscape change is one of the principal source of carbon emissions that climate scientist underestimate in the Asian emerging economies. The study highlights the critical threats of low-density development in increasing carbon emission.

P-2217-04

Understanding complex networks, trade-offs and synergies within the science-policy domain for land-based climate mitigation

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The agriculture, forestry and other land use sector (AFOLU) is a major contributor to greenhouse gas (GHG) emissions. Mitigation within this sector, as well as the interplay between mitigation and adaptation, are crucial therefore in efforts to address climate change. The highly complex institutional structures of global climate policy and the 'wickedness' of the climate change problem lead to trade-offs and synergies, or overlaps and gaps, across land-based mitigation and adaptation policy. Hence there is a need to investigate and examine the mechanisms surrounding the policy environment. Many scientific studies on mitigation and adaptation claim important policy implications from their findings. Whilst a time-lag between the scientific understanding on both direct and indirect trade-offs and synergies within climate adaptation and (land-based) mitigation and policy may be expected, other gaps within the policy arena are likely to exist.

We map these complex policy and scientific arenas through a content analysis of the global scientific knowledge of climate change (from peer-reviewed literature) and of global policy approaches (using International Environmental Agreements). Overlaps and synergies between relevant topics and sectors that exist across different policy and science themes are identified and analysed through a network analysis approach. This approach enables not only the identification of key topics within the scientific and policy documents, but also the degree of overlap between these topics.

This presentation summarises the findings of a series of research questions which have sought to unpack the complex networks between science and policy, but also within global climate policy itself. These include:

- What are the key trade-offs and synergies within global land-based climate policy?
- How has the science-policy relationship changed historically?
- Is there a current mis-match between the global scientific understanding of land-based mitigation and adaptation and global climate policy?

By mapping the current policy network, we show that opportunities for policies to have triple-wins, supporting adaptation, mitigation and sector specific development. Furthermore, we identify gaps within the political environment to which future policy decisions should seek to contribute in order to deliver resource-efficient, land-based mitigation. Comparing the political network to the mapped network of current scientific understanding, we identify key trade-offs that policy needs to account for, and explore how this has varied over time.

P-2217-05

Land Use Change as Barrier and Enabler for Integrated Climate Change Responses

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Land has a finite supply but is subject to an increasing range and intensity of demands that usually involve complex interactions between climate and socioeconomic factors. We have used detailed land use survey data and interviews to investigate these interactions in Scotland (UK) and how they may shape future landscapes using scenario analysis that combines these data with global drivers. The analysis shows the importance of considering 'path dependency' in the evaluation of both adaptation and mitigation land use options. It also highlights that current separation of adaptation and mitigation strategies can result in them 'competing' for the same area of land.

Biophysical factors that influence land supply, including climate and soils, have been analysed using land capability/suitability concepts to investigate the changing options

available for land managers. Socioeconomic factors have been summarised in terms of the 5 Ps (Policy, Preferences, Prices, Power, Path Dependence) to provide a framework for understanding their relative influence. These influences vary between different localities and regions, and particularly between lowland and upland landscapes. High quality land in the lowlands is currently prioritised for food production and much of the land in the uplands has very limited options therefore is effectively prioritised for nature conservation, tourism and recreation. This leaves an area of land that is currently of intermediate quality ('the Squeezed Middle') which has many competing and increasing demands: food, energy, water, afforestation, flood protection, infrastructure etc.; in particular, this land together with the uplands is identified as crucial for meeting climate mitigation targets for GHG emissions reduction.

However, the changing climate further complicates issues because it is affecting land quality (ie. supply) concurrent with changes in demand due to drivers such as globalisation and new technology. The relative influence of top-down and bottom-up factors are therefore changing temporally and geographically, and are particularly exemplified by reactive adaptation responses to recent anomalous or extreme weather. Scenario analysis shows how these factors may play out in the future and how policy could have a more positive influence by encouraging integrated and planned adaptation in coordination with mitigation objectives.

We find that local preferences and the role of path dependence are currently having a high influence on land use decisions. Although land use options are being modified as climate change modifies land capability, the preferences of land managers are to extend options with which they are already familiar. This is usually due to aversion to the risks involved with uptake of new options and concerns over loss of policy support (particularly from the subsidies of the EU Common Agricultural Policy). As a consequence, adaptation measures tend to be mainly reactive and mitigation measures are extensions of those already in use.

In more marginal locations, the role of subsidy support is crucial in influencing land use choices, and this has resulted in new woodland tending to be marginalised to the poorest quality land despite its potential advantages in delivering both adaptation and mitigation benefits. On both high quality and marginal land, the role of policy in counteracting negative influences could be considerably enhanced through stronger spatial targetting of measures based upon local characteristics.

It is particularly salient to note that most land managers acknowledge that seasonal weather, which influences their planning and activities, is changing (regardless of attribution to anthropogenic cllimate change) and they recognise this as a key challenge that they need to better understand and manage. However, path dependence is often entrenched because to fully adapt to change requires negotation and coordination with other land users over a larger area. Currently, policy is mainly developed sectorally and implemented through individual measures that discourages this coordination.

P-2217-06

Global assessment of the biophysical climate impacts of deforestation

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Deforestation impacts climate in two major ways: affecting the atmospheric CO2 concentration and modulating the land-atmosphere fluxes of energy and water vapor. Given the important role of forests in the global carbon cycle, climate treaties account for land-based mitigation options like afforestation, reforestation and avoided deforestation or forest degradation. On the contrary, predicted climate impacts of biophysical processes, such as the exchange of energy and water vapor, are still uncertain in sign and magnitude, and therefore have not been considered in climate negotiations to date. Direct observations of the biophysical climate effects of forest losses and gains are therefore required to constrain model predictions, reduce the uncertainty of model ensembles, and provide robust recommendations to climate policy.

In this work we report an observation-driven global analysis of the biophysical impacts of forest losses and gains on the local climate, based on a combination of Earth observations of forest cover, surface radiometric temperatures and in-situ air temperatures. Our results document that deforestation causes local changes in air temperature that varies in sign and magnitude according to the climate zone. In addition, forest losses affect the local climate also by altering the diurnal and annual temperature variation at all latitudes. These experimental evidences provide a global and robust quantification of the local climate sensitivities to deforestation and a novel assessment of the mitigation potentials of forests on the diurnal and seasonal temperature variations. Overall, the observation-driven, global quantification of the biophysical signal of deforestation provided in this study may support the inclusion of land biophysics in climate negotiations and the definition of novel protocols for the measurement, reporting, and verification of these relevant effects.

P-2217-07

Quantifying the relative importance of land cover change from climate and land-use in the representative concentration pathways

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Climate change is projected to cause substantial alterations in vegetation distribution, but these have been given little attention in comparison to land-use in the Representative Concentration Pathway (RCP) scenarios. Here we assess the climate-induced land cover changes (CILCC) in the RCPs, and compare them to land-use land cover change (LULCC). To do this, we use an ensemble of simulations with and without LULCC in earth system model HadGEM2-ES for RCP2.6, RCP4.5 and RCP8.5. We find that climate change causes an expansion poleward of vegetation that affects more land area than LULCC in all of the RCPs considered here. The terrestrial carbon changes from CILCC are also larger than for LULCC. When considering only forest, the LULCC is larger, but the CILCC is highly variable with the overall radiative forcing of the scenario. The CILCC forest increase compensates 90% of the global anthropogenic deforestation by 2100 in RCP8.5, but just 3% in RCP2.6. Overall, bigger land cover changes tend to originate from LULCC in the shorter term or lower radiative forcing scenarios, and from CILCC in the longer term and higher radiative forcing scenarios. The extent to which CILCC could compensate for LULCC raises difficult questions regarding global forest and biodiversity offsetting, especially at different timescales. This research shows the importance of considering the relative size of CILCC to LULCC, especially with regard to the ecological effects of the different RCPs.

P-2217-08

Uncertainties of future land use change and the potentials of land-based mitigation - an analysis with the SSP scenarios and the IMAGE 3.0 integrated assessment modelling framework

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Historically, the continuous increase in anthropogenic land use has been an important driver of CO2 emissions and biodiversity loss. The scale and dynamics of future land use change (LUC) are very uncertain. The recently proposed concept of Shared Socio-economic Pathways (SSPs) allows us to systematically analyze some of the uncertainties. Integrated assessment models, like IMAGE, can explore the linkages within these scenarios between socio-economic drivers, technology projections, developments in the energy system, policy assumptions

and implications for future land-use. It can also look at future land use projections which are dynamically coupled to changes in the global climate and carbon cycle. This provides the possibility to determine the potential of land-based mitigation options, and directly assess the climate and carbon effects under different scenarios. In this contribution, we present a recent IMAGE analysis using the SSPs to explore the uncertainty in future land use in relation to mitigation action.

The analysis shows anthropogenic land use (crop and pasture land) could increase by 4 million km2 (SSP3, driven mostly by population growth and dietary changes), but also decrease by 7 million km2 (SSP1, as a result of yield improvements and intensification). Cumulative CO2 emissions from LUC by 2100 range from an increase of 280 Gt CO2 (SSP3) to a decrease of 70 Gt CO2 (SSP1), equivalent to an increase of 36 ppmv and a decrease of 9 ppmv CO2 in the atmosphere respectively.

Land-based mitigation measures are an important component of ambitious climate mitigation scenarios. The implementation of options such as bio-energy, reforestation, REDD, agricultural intensification or dietary change have large potentials. However, the net impact depends highly on the context of implementation. Socio-economic trends and non-land climate mitigation substantially affect the land-based mitigation potential, which is typically very location-dependent. The SSP analyses shows the potential of a range of mitigation options. An example is the implementation of REDD in an SSP1 scenario with ambitious climate mitigation, where areas with large carbon stocks are protected. This results in additional intensification of agricultural land due to limited land availability, and a shift of agricultural expansion to areas with lower carbon stocks. Due to this measure, carbon emissions are reduced by 87 Gt CO2, equivalent to 11 ppmv CO2 in the atmosphere.

Next to biogeochemical climate effects, biophysical climate effects of LUC have a substantial impact. Regionally, the net temperature effect of changes in the land energy balance due to differences in albedo or evapotranspiration can be in the same order of magnitude as projected global warming. The location of change is very important, as deforestation in the tropics can lead to a surface warming of 0.5-1 degrees compared to a surface cooling in the highest latitudes of 3-4 degrees (Davin & Noblet-Ducoudré, 2010). As part of the LUC4C FP7 project, the biophysical effects of the SSP land use projections will be studied in collaboration with earth system models.

P-2217-09

Genetic diversity of perennial grass species in response to temperature during germination

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Grasslands cover more that 40% of earth's surface and at least 30% of the 160 Mha Agricultural Surface Area of Europe. They are among the largest ecosystems on earth and one of the major sources of forage. Further, in the context of climate change, grasslands are considered, similar to forest, as an important sink for atmospheric CO2. The agricultural use-value of grasslands depends on their floristic composition and the structure of their canopy. These two intertwined features directly determine the quality and the quantity of the biomass harvested by grazing or mowing. Perennial ryegrass (Lolium perenne L), tall fescue (Festuca arundinacea Schreb) and coksfoot (Dactylis glomerata L.) are the major perennial grass species in temperate and Mediterranean regions. However, during the lifespan of grassland, both floristic and genetic compositions as well as canopy structure evolve under the influences of environmental factors and the competitive interplay between individual. Floristic and genetic composition evolves because of individuals' mortality and recruitment of new species and genotypes from the soil seed-bank or natural sowing. Temperature is one of the major factors controlling plant development rates (i.e. plant phenology, organogenesis and expansive growth). It is important in controlling seed germination. Indeed, higher plant species, as well as populations, varieties and cultivars within species, respond differently to temperature during the critical period of germination and seedling establishment in the field. Literature is vast on this subject that is always a topical issue. In the context of global change, breeding grasses adapted to new ranges of temperature could be necessary. Knowing the variability of responses to temperature by different accession of germplasm is an unavoidable first step towards such breading. Thus, the objective of the work presented here was to analyse the genetic variability of L. perenne, F. arundinacea and D. glomerata in response to temperature during germination.

Eight populations of L. perenne L., nine populations of F. arundinacea and six populations of D. glomerata were evaluated. Four replicates of one-hundred seeds per population were tested for germination in the dark under eight single temperature regimes between 5 and 40°C with 5 °C. Maximum germination (%), apparent initial time of germination and germination rates were estimated.

The novelty of this work comes from the wide range of temperatures evaluated (5 to 40°C). Striking results show that no germination at all was observed at 40°C for any of the 23 populations under study. However, it was observed that, within each species, the response of populations to temperature shows high variability and statistically significant differences ($P<0.05$). Optimal temperature for germination ranged from less than 10°C to 26°C. Further, it was observed a differential sensitivity to our extreme treatments (5 and 35°C).

Overall, these results demonstrate that genetic variability does exist within the three studied grass species for response to temperature during germination. This should prompt i) physiologist to extend to other processes the analyses of response to temperature, and ii) plant breeders to collect and analyse populations of grasses from sites with extreme environmental conditions. We suggest that seed germination of populations from septentrional and cold sites is enhanced by high temperatures and limited by colder temperatures and vice versa for warm-adapted populations from the South. The variability discovered in this study should serve breeders to create grass varieties for the future.

P-2217-10

Land Degradation and Resource Based Economy – A Case Study in Indian Sunderbans

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The Indian part of Sunderbans is highly vulnerable due to climate change impacts like sea level rise, erosion, salinization of soil and water, cyclones, etc. This study is an attempt to identify the drivers impacting the traditional resource based economy and consequent adaptation. Kultali (21051/N, 88030/E to 21056/N, 88034/E), an administrative area (Block) in the district of South 24 Parganas' within Indian Sunderbans on the Bay of Bengal is a very backward area in terms of poverty ratio and vulnerability index (Human Development Report, Govt. of India, 2009). The villages namely Bhubaneswari, Maipit, Binodpur, Baikunthapur, Kishorimohanpur and Bhubaneswari Char under the Kultali Block are under study, situated between the confluence of River Matla and River Thakuran. This area is highly vulnerable due to their close proximity to Bay of Bengal, frequent cyclones, coastal flooding and subsequent land inundation every year. The inhabitants solely depend on the traditional primary activities depending on natural resources to make their sustenance. In agriculture, mono-cropping is the only way of livelihood for the population, with high level of exposure to climate change and natural hazards. Inland fishing is another practice on subsistence basis, while the more vulnerable section depends on offshore fishing. Increasing salinization in river water and soil resulted from sea level rise and frequent inundation, negatively affects the fertility of soil, yield of crops and fish catch, which in turn affect the local economy. The situation has become worsen after cyclone 'Aila' on 25th may 2009, when extreme level of inundation left behind saline water stagnation for a considerable time causing deposition of salt layer on the productive topsoil, leaving the land unproductive for longer time. Consequently, change in land-use pattern as well as change in occupational structure has observed. Minimal effort to switch over to salt tolerant variety of paddy and other variants of vegetables and fruits traditionally grown are found insufficient. Hence, the workforce in the community finds agriculture as a 'loss business' and lacking any other alternate skill they intend to migrate as a

non-skilled daily labourers. Feasible adaptation measures may be recommended with further to revive this resource dependent subsistence economy.

P-2217-11

Spatial and temporal variabilities of land uses as affected by global change: a focus on Mediterranean agriculture

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At the global level, climate and socio-economic changes determine the patterns of the allocation and trade of resources in all markets. Top-Down computable general equilibrium (CGE) models, using only economics factors of production (capital and labour mostly) and ignoring natural resources constraints, look at the effects of global trends and generate trajectories of socio-economic indicators, such as prices of commodities in the global markets, volumes of trades, gross products per country and sectors. Those models are commonly used to analyse the evolution of global economies, under the pressure of climate change drivers, but their approach impose substantial simplifications in terms of spatial aggregation and limited consideration of temporal variabilities.

When considering adaptation of social and ecological systems to climate change, their inherent complexity and non-linearity and spatial and temporal variabilities put the usefulness of consolidated CGE approaches under question. As a consequence, other methodological approaches are explored, and in particular more and more scholars adopt a Bottom-Up approach, which utilises agent-based models (ABM). ABM's embrace a much finer spatio-temporal detail, in particular, with the ambition to analyse the behavioural diversity of agents, as a consequence of their diverse interactions with the surrounding environment and their bounded perceptions of the changing world.

This work explores the potential for integration of the two approaches, with ABM models being used to simulate land use change dynamics, with consideration of spatial (i.e. territorial) and temporal (i.e. climatic extremes and economic shocks) variabilities, driven by CGE models providing the macro-economic trends under the effects of global change scenarios.

We focus on how global change may affect land-use allocation at the regional level, under the influence of limited natural resources, land and water in particular. We specifically explore how constrains and competition for natural resources may induce non-linearities and discontinuities in agro-ecosystems behaviour.

With the purpose to develop an approach that could be implemented worldwide as a means for zooming down from the global to the regional scale, an ABM prototype was developed and run with readily available global databases in three [VM1] test areas around the Mediterranean Basin, in agricultural regions of Morocco, Italy and Spain[VM2] . Starting with extremely simplified and averaged settings; we sequentially introduce the available information about spatial and temporal variability and simulate the dynamics of water and land-use allocations and their consequences on economic performances. The coherency of the outcomes of ABM simulations with the macro trends provided by the CGE model is discussed in view of possible further developments in terms of improved integrated multi-scale simulation of global change scenarios and economic development.

P-2217-12

Low Emission Development Strategies in Agriculture. An Agriculture, Forestry and Other Land Uses (AFOLU) Perspective

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Resource use in many developing countries, from crop production to deforestation, is responsible for the bulk of greenhouse gasses (GHG) emissions. We also know that there are instances in which the agricultural and forestry sectors can provide low-cost climate change mitigation opportunities. From a technical point of view, reducing expected increases in GHG emissions in agriculture requires the adoption of transformative approaches in the use of resources. A growing body of literature analyzes the effects of alternative agricultural practices; the livestock sector has also been the target of research on mitigation opportunities and the mitigation potential of forests, soil and other biomass, has been amply analyzed as well. However, from a policy-making perspective, the design of low emission development strategies is an example of multi-objective decision making in which policies target the reduction of GHG emissions while other goals such as increasing agricultural productivity and food security or attaining objectives such as export goals or economic growth, are preserved. Furthermore, it is important to consider that all countries are part of a global economic system and it is critical that policies are devised with full recognition of the role of the international economic environment which can significantly affect the long-term viability and the budgetary implications of mitigation policies. The challenge at hand is therefore to reconcile the limited spatial resolution of macro-level economic models that operate at a subnational or national level with models that function at a higher spatial resolution, which allow to properly account for changes in carbon stocks and GHG emissions. To our knowledge there are only a few examples of analyses with similar objectives: Golub et al (2013) examined the impact on food consumption and income of implementing mitigation policies at national and regional levels. Schneider et al (2008) estimated mitigation potentials of U.S. agriculture with regionally disaggregated data and changes in welfare within the agricultural sector. Rutten et al. (2014) evaluated the effects of select climate change and economic growth scenarios on Vietnam's economy. Havlik et al. (2014) estimated the effects of transitioning to more efficient livestock production system on GHG mitigation and the economy. In this work we demonstrate that different models, all widely accessible to the public, can be brought together to help policymakers in their evaluation of trade-offs, opportunities, and repercussions of alternative mitigation policies in the agricultural sector. While the focus of this work is on Colombia, the analytical framework can be applied to any country interested in exploring country-wide effects and economic viability of climate change mitigation policies in agriculture. The approach is based on the use of public and widely accessible data and we believe that the flexibility and transparency of the approach proposed in this study can increase decision-makers' trust in the results. It appears clear from our analysis that policy-makers need substantial support in their decision-making process as the range of options they face can be very diverse and the effects of their decisions have important, and sometimes unexpected, repercussions. The effects of the policies we simulated cover the entire spectrum of potential outcomes. We find win-win policies (reducing land allocated to pasture increase revenues and carbon stock and reduces GHG emissions), policies with tradeoffs (limiting deforestation in the Amazon and a moderate increase in oil palm area increases carbon stock, decreases emissions, but reduces revenues) and policies that seem to generate clearly inferior results (substantial increasing the area allocate to oil palm cultivation reduces carbon stock, increases emissions and reduces revenues). Given the complexity of low emissions development strategies, modeling approaches, frameworks, and tools should be adaptable, open, and transparent. Modeling frameworks should be adaptable so that policy makers can explore the consequences of using different data sets and incorporate new information as it becomes available. Modeling frameworks and tools should be open to the inclusion of input from different models and transparent so that the robustness of the results can be assessed. We believe that the modeling framework proposed in this work fits these characteristics. Stakeholders, from government agencies, to producer and consumers' organizations to farmers, will benefit from policies devised with the support of solid evidence and the effects of which can be investigated and evaluated by all the parties affected.

P-2217-13

Implications of bioenergy production under various future land system pathways

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Bioenergy use in the energy sector, particularly in combination with carbon capture and storage (BECCS), plays a key role for reaching ambitious climate targets. But the large-scale production of bioenergy, which potentially requires considerable amounts of fertile land and water (Bonsch et al., 2014, GCB Bioenergy), can have side effects on land-use dynamics, land-related GHG emissions and food prices. For instance, CO2 emissions from deforestation associated with bioenergy production could lower the mitigation effect of bioenergy use in the energy sector (Popp et al., 2012, Ecol Econ). However, avoiding land use change and associated CO2 emissions due to bioenergy production could result in higher prices for food (Popp et al., 2011, Environ Res Lett) and also bioenergy (Klein et al., 2014, Environ Res Lett). There is a huge body of literature on bioenergy potentials and trade-offs with climate protection, sustainability and food security goals (Creutzig et al., 2014, GCB Bioenergy). However, most of these publications focus on single aspects, while a comprehensive and consistent analysis taking into account various uncertainties of future land system pathways, such as future food demand, development of agricultural yields, and availability of land for agricultural expansion, is still missing.

In this study, we analyze the implications of bioenergy production under various future land system pathways with the global spatially explicit land-use optimization model MAgPIE. Our general scenario setup is based on SSP2 (O'Neill et al., 2015, Glob Environ Chang) and includes global bioenergy demand (2nd generation) that increases linearly to 300 EJ by 2100. We assess the global medium to long-term implications of bioenergy production in terms of land-use dynamics, associated GHG emissions, and bioenergy and food prices. How these environmental and socio-economic indicators evolve under bioenergy production throughout the 21st century depends on key characteristics of the future land system. We test the sensitivity of these indicators to the following land system parameters that directly or indirectly affect bioenergy production: future bioenergy yields (irrigation, feedstock availability), pricing of land-related GHG emissions, forest protection, trade liberalization, future food demand, and productivity increases in the agricultural sector. Finally, we identify trade-offs and synergies related to bioenergy production along the analyzed future land system pathways.

Our results show, for instance, that GHG emission pricing strongly reduces deforestation related to bioenergy production. Consistently, CO2 emissions from land-use change are lower under GHG emission pricing. However, bioenergy as well as food prices considerably increase with GHG emission pricing due to competition for land. Thus, there is a trade-off between land-based mitigation via bioenergy and food security: low CO2 emissions from land-use change coincide with high food prices, while high CO2 emissions from land-use change coincide with low food prices.

P-2217-14

Disturbance climate in Eastern of Democratic Republic of the Congo

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In DR Congo , in South - Kivu province , specifically in the territory of Uvira, Fizi, Mwenga and Shabunda , the influx of Rwandan and Burundian refugees in 1992 and 1994. And the population displacement caused by war 1996 and 1998 were at the base of the massive felling of trees in the forests therein and practice of bushfire. These trees were felled every day to serve as firewood, construction and service to millions of people and bushfire to easily obtain cultivable extended to capture wild animals and pastoral aims. Naturally, this region comprises 5 ecological zones which are the coastal plain, the tray means, the highlands and woodland. The region also has two climatic seasons including the rainy season which extends from September to June and the dry season which lasts 2 months, all the months of July and August of each year. The environment in this part has been degraded due to massive deforestation and practice bushfire. These two negative factors were the basis for the deterioration of the climate in this part of country. These massive cuts uncontrolled wood and unquantified and bushfire caused few years later in 2006 and 2007 climate change ever experienced in the region. This climate change has led to a disruption of the agricultural calendar and a sharp increase in heat. Crop period would normally start with the beginning of the rainy season in September was postponed in December or January. The rain was almost rare throughout the region during this period, and once she fell here and there on bare soil where water carried everything in their path. The flow of many rivers has decreased significantly ways and most of the rivers had dried completely. A kind of temporary drought is established. It was suffocating for lack of water everywhere. Meteorological services of the country gave each time the alert climate of the region where the temperature still ranged between 30 and 35 ° signal Many people have fallen ill and many children died of this climate change. Many wild and domestic animals perished. The plant diseases have been developed, particularly called cassava mosaic disease appeared. This disease has made cassava much less productive while cassava is the staple food most consumed in the middle. The plants were dried by lack of water. Famine is installed around the region. Communities of people, groups of people moved themselves further into the forest in search of more productive and reassuring for survival places. Alarm calls initiated by local leaders , civil society and development organizations on the climatic disturbance in that region has allowed political authorities - administrative and non - governmental organizations of development to get involved to stop all this ecological and climatic catastrophe.

To this effect, the following measures were taken:

- Formal prohibition massive cutting wood
- Priority Reforestation of denuded areas
- Cutting wood on authorization by the competent authorities
- Prohibition of bushfire
- Education and community awareness about the dangers of mass slaughter of trees and the practice of bush fire and their impact on climate change.

Seven years later, despite the efforts, the situation has not yet returned to normal.

P-2217-15

Addressing climate change mitigation and adaptation together: A global assessment of agriculture and forestry projects

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Adaptation and mitigation share the ultimate purpose of reducing climate change impacts. However, they tend to be considered separately in projects and policies because of their different objectives and scales. Agriculture and forestry are related to both adaptation and mitigation: they contribute to greenhouse gas emissions and removals, are vulnerable to climate variations, and form part of adaptive strategies for rural livelihoods. We assessed whether climate change projects in forestry and agriculture integrated adaptation and mitigation, by analyzing 201 projects from adaptation funds (e.g., UNFCCC Adaptation Fund), adaptation plans (e.g., National Adaptation Programmes of Action), mitigation instruments (e.g., Clean Development Mechanism), and project standards (e.g., Climate Community & Biodiversity (CCB)). We analyzed whether projects established for one goal contributed explicitly to the other (i.e., whether mitigation projects contributed to adaptation and vice versa). We also examined whether their activities or expected outcomes allowed for potential contributions to the two goals. Despite the separation between the two goals in international and national institutions, 37% of the project documents explicitly mentioned a contribution to the other

objective, although only half of those substantiated it. In addition, most adaptation (90%) and all mitigation projects could potentially contribute at least partially to the other goal. Some adaptation project developers were interested in mitigation for the prospect of carbon funding, whereas mitigation project developers integrated adaptation to achieve greater long-term sustainability or to attain CCB certification. International and national institutions can provide incentives for projects to harness synergies and avoid trade-offs between adaptation and mitigation.

P-2217-16

Legacy effects of repeated land-use changes in the LPJ-GUESS dynamic vegetation model

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This contribution is aimed at the session «Global scenarios of land-use change and land-based mitigation, and their importance in the climate system"- conveners Arneth/Stehfest/Popp.

Natural terrestrial ecosystems store large amounts of carbon in living biomass and soils. During the last centuries, wood harvest and deforestation of primary forests for pastures and croplands greatly altered carbon, water and nutrient cycles and thereby also affected secondary vegetation dynamics after the cessation of agriculture. Historically most terrestrial biosphere models have only accounted for net changes in land-use aggregated at coarse scales of 0.5° or more. However, the extent to which finer-scale details of land-use change dynamics, particularly the detailed land-use history of a site, influence ecosystem and carbon dynamics is not well understood. In this study we investigate the legacy effects of repeated land cover transitions between natural vegetation, pastures, croplands and managed forests over different time intervals in the LPJ-GUESS dynamic vegetation model. We identify the extent to which land-use transitions are reversible, and quantify lags in system response, finding that these results are strongly dependent on the land-use history. Implications for regional and global scale estimates of land-use change emissions and the feasibility of reforestation projects to sequester carbon are discussed.

P-2217-17

A Cascade Modeling Approach to the Assessment of Climate Induced Land Use Change

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Land use and land use change are inherently related to climate change (Pielke, 2005). Furthermore, they are interconnected as each one is influencing the other. In this study we assess the effects of climate change on human activities, namely agriculture and forestry, and the resulting land use change for France. Our modeling approach combines sector-specific mathematical programming models and statistical tools in a multistage algorithm. As a first step, the effects of climate on agriculture and forestry are captured through a generic crop model (STICS, Brisson et al., 2009) and a statistical model of tree growth and mortality. The results obtained are then used in the second modeling stage. They are exploited as parameters in economic models for the two sectors: the agricultural supply-side model AROPAj (Galko & Jayet, 2011) and the partial equilibrium model of French forestry, FFSM++ (Caurla et al., 2013). These two models allow us to evaluate the potential gains for their corresponding sectors. The final, third, step of our modeling approach consists in an econometric (statistical) land use model where agricultural and forestry rents are approximated by the results from the sector-specific models. Thus, we can estimate land use shares of five major categories: (i) agriculture, (ii) forestry, (iii) urban, (iv) pastures, and (v) other; at the scale of a homogeneous grid with resolution of 8 km x 8 km covering metropolitan France for the period 2000 - 2100. The major advantage of our modeling approach is that it accounts for variation in biological productivity due to climate change and at the same time it can test different socioeconomic scenarios such as new price vectors, management practices and public policies.

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P-2217-18

Geoinformation-based morphometric flood risk and vulnerability analysis of Kubwa settlement, Abuja

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Natural landscapes have profoundly been changed due to human activities. In particular, land use and land management change affect the hydrology that determines flood hazard. In this research, the use of historical remote sensing dataset is used to assess the vulnerability of people and places to potential risk associated to settlements especially from flooding events linked to lowland and floodplains. The motivation for this work is that global trends of disaster occurrences are on the increase in urban cities and peri- urban settlement. Hence there is urgent need to assess the vulnerability of places and people to natural hazards such as flood risk especially in developing countries to improve disaster risk reduction (DRR) programmes in urban areas. In here a geoinformation-based approach is adopted to initially map land cover change of Abuja and environ and to understand settlement morphology, and identify settlement such as Kubwa vulnerable to flooding event. Landsat (TM, ETM+ and OLI) image series from 1986, 2001 and 2014 were used to generate retrospective and contemporary landscape maps using support vector machines (SVM). To unlock changes in plan implementation, result of the remote sensing-based land use maps was compared to the original land use map. It was apparent that residential areas have increased remarkably by more than 50%. To determine built area encroachment into the flood zone and floodplains, identify and classify the area into the different levels of vulnerability, a floodplain morphometric information extraction from public domain satellite-based DEMs geohazard modeling such as flood susceptibility due to landscape as well as climate extreme events. Finally, the assessment revealed that the central part of Kubwa, is largely a lowland which is observed to be densely populated and, is most affected by flood incidences due to soil sealing resulting to poor infiltration. Other characteristics include settlement encroachment into the flood zone and floodplains, clogging of the drains and lack of land use planning. The outlook of this study therefore recommends the need for geospatial land use planning, improved drainage infrastructure in delineated high risk zones, enforcement of standards and codes, community education/ participation, among others.

P-2217-19

Urban Land Use Change Effects on Coastal Forest Ecosystem: A Case of Dar es Salaam, Tanzania

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This study assessed the impacts of coastal urban land use changes and climate change on coastal forests. The study analyzed the impacts of climate change on coastal livelihoods and their implication on coastal forest degradation; the impacts of coastal urban and peri-urban expansion on coastal forest ecosystems; examined existing strategies in addressing coastal forest degradation; and developed strategies for integrated coastal urban and peri-urban land use plans in support of climate change adaptation and coastal forest conservation.

The study applied the Geographical Information System (GIS) to map the changes of land use in Peri Urban Areas of Dar es Salaam, a participatory rural appraisal using questionnaires and key interviews was applied to assess the impacts of land use changes on coastal forest ecosystem surrounding communities particularly impacts on coastal livelihoods.

The study found that change in land cover from vegetation to residential buildings and paved land surfaces due to urban land use alters completely the functional properties of land including its ecosystem services that exists before changing the land use. In addition to the impacts of land use change due to urban development, the growing urban population is directly linked to the surrounding as well as distant forest ecosystem services. The shift in livelihoods of communities from coastal to forest based activities due to impact of climate change on coastal environmental services exacerbates stress on coastal forests. Continued pressure of urban and peri-urban growth and livelihood activities on coastal forests contributes to coastal deforestation and forest degradation.

This study concludes that land use changes in settlements that surround ecosystems have caused changes in ecosystem services. However, change in land uses is highly caused by population growth because when one more person enters a new area, creates demand of an area for shelter and an area for performing activities for livelihood. This agrees with the human ecology theory of succession and invasion. When there is population influx in areas surrounding an ecosystem, such an ecosystem is subject to high pressure of degradation. Therefore, unguided land use development has adverse effects to the ecosystem services. Dar es Salaam watershed ecosystems which were once a home for millions of various biodiversity species have been affected by land use/cover changes in surrounding urban and peri urban areas. The study recommended for an integrated ecosystem approach to mitigate the impacts of land use change on forest ecosystem.

P-2217-20

Significant Contribution of Oil and Gas Industries in Temperature increasing in Northern Coast of the Persian Gulf

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Pars Special Economic Energy Zone (PSEEZ) was established in 1998 for the utilization of South Pars oil and gas resources. The gas resources of PSEEZ is about 9% of all gas reservoirs explored in the world. Since 2002, the operation at the PSEEZ is active. It is planned that the PSEEZ will have about 28 phases of refineries and petrochemical plants. Before coming oil and gas activities to the region, there was a unique landscape as mangrove forests, muddy coasts, wetlands, rangelands, farm lands, etc. Although all the phases are not operating but the landscape totally has been changed. Usually, the industrial activities causes an increasing in the local temperature directly (e.g. stacks and flares) or indirectly (landuse/cover changes). In this paper, we studied the landuse/cover changes as well as the changed in local temperature from 1998 to 2013. To do this, we used the Landsat5 ™ and Landsat8 (OLI) satellite images between May 1998 (Before construction started) and May 2013 (after 10 years operation). We made the temperature maps from Infrared thermal bands (i.e. TM 6 and OLI 10). Our results showed that a 100% increase in industrial zones and flares areas, a decrease of 34.11ha in mangroves cover (mostly in Basatin Bay), and a decrease of 12864 ha in natural rangelands (mostly in mountain-side looking to industrial zones) are the major changes. However, the wastewater releases from Phases 9 and 10 could be a reason to destroy the mangroves. Marine watercourses in our study area have been decreased by 1761.7 ha where 1509 ha has been changed to bare lands and 119 ha to industrial zones. This decrease is because of filling the shallow waters and drying the Mohr River. Moreover, the wet lands have changed from 6683 ha in 1998 to 418 ha in 2013. Comparing the landuse/cover changes with the temperature map revealed a positive correlation. The results showed that the mean temperature increase by 2.86 C from May 1998 to May 2013. The findings showed that temperature ranges are different in two dates where in 1998 is between 24C-55C and for 2013 is between 25C-61C. Moreover, in 1998, temperature class 26C had covered the most area of the studied area by 34224 ha where this has decreased to 24416 ha in 2013. In 1998, in overall, only 7400 ha had the temperature lower than 26C but in 2013 only 5 ha. In 1998, the area of the temperature class 37-44C was 58366 ha which is decreased to 18852 ha in 2013. The area of temperature class of 45C-49C I this time period did not changed and was about 60000ha. Therefore, the major changes in area of temperature class happened in 50C-55C which increased from 10569ha in 1998 to 56760 ha in 2013. In 1998, the latest temperature which is observed in the study area is 55C with 25 ha but in 2013 we observed a new class of temperature 55C-61C with 3824 ha. If we have a closer look at the landuse/cover changes map and temperature map, we could found that changing the shallow waters to bare and industrial lands caused an increase of about 17C in the filled areas. Moreover, making dry the wet lands for industrial lands has been caused an increase of about 5C to 6C where this increase because of the Mohr River is about 14C. Our results revealed that although the industrial development and its activities has a direct impacts on local temperature but the landuse/cover changes coming by the development has also a major impacts.

P-2217-21

Agriculture and livestock under the effects of climate change

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Current practices in agriculture and livestock are closely linked with climate change. Surplus nitrogen use agriculture and intensive livestock production represent a major contribution to the increasing concentrations of various greenhouse gases (GHGs). Moreover, climate change affects crops and farms around the world, due to increased temperatures, weather extremes and incidence of floods and droughts.

Agriculture represents one of the main emitters of nitrous oxide (N2O), methane (CH4) and ammonia (NH3). Farming in the EU now accounts for 7% of global emissions of GHGs. Since the second half of the twentieth century the increased use of nitrogen fertilizers resulted in losses of nitrogen into the water and into the atmosphere. Intensive livestock production contributed to the emissions of methane (CH4).

Rising temperatures, reduction of water resources in many areas, changes in the frequency and distribution of rainfall, droughts and floods, etc., directly affect agriculture. Every one of these changes can lower the agricultural production in certain areas as much as traditional crops are abandoned and lost for future climate adaptation. Increases in temperature will help pests and diseases to proliferate in crops with a consequent reduction in both the quantity and quality of agricultural production.

Furthermore, livestock production is directly affected by climate change too. Under high temperatures herds suffer more illnesses and stress as a consequence of a decrease in grazing and grazing time as less rainfall will disrupt the seasonal availability of pastures. Disturbances over crop forage will reduce the herd livestock production while increasing production costs.

We open the debate on livestock production and their effects on ecosystem metabolism (missions of GHGs) by

discussing the production capacity of traditional practices of livestock management in different protected areas in Spain, where adaptation of the vegetation to both managed grazing (forest burning, intensive pastures, seasonal migration) and severe climate has shaped the landscape. As an applied use of GHGs monitoring from the ClimaDat Project, we will debate the variability in mitigation of greenhouse gases emissions by different options of land use management.

P-2217-22

New global land use under climate change and freshwater restrictions

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Allocation of agriculture commodities and water resources is subject to changes due to climate change, population increase and changes in dietary patterns. This study focused on including global water availability including environmental flow requirements with water withdrawal from irrigation at a monthly time-step in the GLOBIOM model. This model allows re-adjustment of land-use allocation, crop management, consumption and international trade. The GLOBIOM model induces an endogenous change in water price depending on water supply and demand. In this study, the focus was on how the inclusion of water resources affects land-use and, in particular, how global change will influence repartition of irrigated and rainfed lands at global scale. We used the climate change scenario including a radiative forcing of 2.6 W/m2 (RCP8.5), and the environmental flow method based on monthly flow allocation (the Variable Monthly Flow method) with high and low restrictions. Irrigation withdrawals were adjusted to a monthly time-step to account for biophysical water limitations at finer time resolution. Our results show that irrigated land might decrease up to 40% on average depending on the choice of EFR restrictions. Several areas were identified as future hot-spots of water stress such as the Mediterranean and Middle-East regions and parts of South-East Asia where theWater Stress Indicator (WSI) ranges from 0.4 to 1 by 2050. Other countries were identified to be in safe position in terms of water stress such as North-European countries. Some countries such as India expect a significant increase in water demand which might be compensated by an increase in water supply with climate change scenario. Re-allocation of rainfed and irrigated land might be useful information for land-use planners and water managers at an international level to decide on appropriate legislations on climate change mitigation/adaptation when exposure and sensitivity to climate change is high and/or on adaptation measures to face increasing water demand. For example, some countries are likely to adopt measures to increase their water use efficiencies (irrigation system, soil and water conservation practices) to face water shortages, while others might consider improving their trade policy to avoid food shortage.

P-2217-23

Metrics for the net climate effect of land use change in support of land based mitigation and adaptation policies

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Land Use and Land Cover Changes (LULCC) have a recognized effect on climate, both in terms of changes in the carbon cycle due to changes in vegetation and soil carbon (biogeochemical effects) and through variations of the surface energy budget mediated by albedo, evapotranspiration, roughness etc. (biophysical effects). While the increase of greenhouse gas (GHG) concentration in the atmosphere affects the climate in the long term and at global scale, biophysical effects result in short term changes in seasonal and/or annual surface temperatures with a prevalent local to regional effect. In addition, the climate signal of biogeochemical processes are independent to geographical location of the LULCC, whereas biophysical effects vary greatly in sign and magnitude depending on the latitude and ecosystems where they occur. For example, observations and model results suggest that deforestation has a predominantly warming effect in the tropics due to reduced evapotranspiration, exacerbating GHG effects, and a cooling effect in the boreal regions in the winter due to increased albedo, running counter to GHG effects, with some warming effects due to reduced evapotranspiration in the boreal summer.

The international policy process within the United Nation Framework Convention on Climate Change (UNFCCC) focuses entirely on GHG and their global effects. At the local level a combination of the global biogeochemical and local biophysical effects following LULCC are important for local climate, ecosystems, their biodiversity and the water cycle. Policies at the local to regional level that aim to address both mitigation and adaptation objectives will thus be less effective if they ignore the synergies and tradeoffs between biogeochemical and biophysical effects.

The paper presents a tool of practical use in support of assessment of mitigation/adaptation land policies, allowing a straightforward comparison of the estimated climate impacts of different LULCC transitions. Through a meta-analysis of the existing scientific literature, we quantified how the LULCC-climate change interplay affects regional vs. global scale, and biophysical vs. biogeochemical ecosystem-atmosphere exchange, providing a simple climate metric that summarize the changes in temperature and precipitation following LULCC. Compared to alternative approaches proposed so far, our strategy was to focus on the regional climate signals rather than on global average effects, considering that ecosystems and communities are affected and have to adapt to local climates.

P-2217-24

Land use response to the climate change in the Great Hungarian Plain?

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This poster presents the concept of interactions between environmental conditions and the productivity as well as the extension of Hungarian arable lands.

Firstly, a descriptive analysis demonstrates the synchronity of the tide of arable lands and climate change. Hungary lies on the border of hot and warm summer subtypes of the humid continental zone. Its plains were transformed into homogeneous grain-producing regions during the 19th century modernization that linked to river regulations. As I see the humidity of the late and post-Little Ice Age (between the mid1870s and the mid1940s) was an important factor in process of this landscape transformation. On the one hand, the late 19th century Hungary replied to the increasing flood-hazard with the intensification of river regulation. On the other hand, the relative precipitation surplus of the humid cycle palpably reduced the drought-proneness of the Great Hungarian Plain (GHP), thus providing a low risk opportunity to convert wetlands into tillages in tens of thousands of square kilometres. The extension of arable lands reached their saturation level between 1913 and the mid1940s, while the beginning of their decrease overlapped precisely with the end of the humid climatic cycle. This decline has been going on in Hungary since the late 1940s. As a part of this process severe droughts and excess surface water inundations have led to the rapid abandonment of croplands in huge areas (e.g. 1952, 1963, 1999, 2010).

Secondly, the paper presents the results of statistical examinations of seven crops - barley, corn, oats, potato, rye, sunflower, and wheat - losses due to droughts and excess surface water events at a national and a county scale between 1921 and 2010. The relationship between

the Pálfai Drought Index (PaDI), extension of inundated areas and annual crop yields was examined by ANOVA, the differences between crop yields in counties by t-test at a 5% significance level. It is an important methodological aspect that the annual yields of periods with approximately the same technological standards should be compared. Years with extreme yield fluctuations in wartime events (1944-45), technological transition (e.g. 1959-1975), transformation of property and economic structure (1990-1994) were eliminated. Thus, besides 30 years long meteorological periods (1921-1950, 1951-1980, 1981-2010), four homogenized technological periods were created (1921-1938, 1946-1958, 1976-1989, 1991-2010).

The closest relationship appeared between crop yield losses and values of the drought index in periods with high PaDI standard deviation. Deviations within 30-years long periods indicate a long-term trend towards an increasing frequency of extreme droughts since the late 1980s. The last technological period (1991-2010) when the standard deviation of drought indices is the highest in the examined 90 years, the yield losses of five out of seven crops indicate a significant and close relation to PaDI values. These results indicate a major transformation in the meteorological conditions of cropland farming. Over the last one and a half decades extreme droughts and inundations have alternated rapidly. Corn deserves a special attention for several reasons. Besides wheat, it is corn that has the most extensive harvest area in Hungary. In the past decade it covered some 26-28% of Hungarian croplands. Since growing season of corn (June-August) is highly exposed to drought, the fluctuation of corn yields showed a close linear relation to drought indices in three out four technological periods and in the three 30-year long periods (e.g. between 1981 and 2010 R^2=0.78; y = -0,4657x + 8,3674; 30 couples).

The most conspicuous phenomenon is that more extremes happened in the last two decades than in the former seven decades. The impact of the climatic variability on the crop yields has been more and more apparent in the regression coefficients. It is partly for this reason that the average yields of the most drought-prone counties that lies in the GHP and covered the majority of former floodplains fall below the national average. Such a high level of exposure to drought fundamentally queries the economic rationale of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European Water Framework Directive that is the water retention in the former floodplains of the Great Hungarian Plain.

P-2217-25

Carbon emission from land-use change is substantially enhanced by agricultural management

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It is over three decades since a large terrestrial carbon sink was first reported. The magnitude of the net sink is relatively well known, and its importance for dampening atmospheric CO2 accumulation, and hence climate change, widely recognised. But the contributions of underlying processes are not well defined, particularly the role of emissions from land-use change (ELUC) versus the biospheric carbon uptake (SL). In the absence of appropriate global-scale observations, process-based terrestrial biosphere models can facilitate understanding of present-day carbon cycling, whilst also underpinning climate projections in Earth System Models (ESMs). Yet representations of many fundamental processes in these models are neglected or immature, especially regarding land management. Here we quantify the effect of representing agricultural land management in a Dynamic Global Vegetation Model. Accounting for harvest, grazing and tillage resulted in cumulative ELUC since 1850 ca. 70% larger than in simulations ignoring these processes. The vast majority of ESMs in the recent IPCC Fifth Assessment Report omit these processes, suggesting an overestimation in their terrestrial carbon sink, or an underestimation of SL, of up to 1.0 Pg C a-1. Management processes influencing crop productivity per se are important for food supply, but had little influence on ELUC.

P-2217-26

Avoided Economic impacts of climate change on agriculture: integrating a Land Surface Model (CLM) with an Economic Model (iPETS)

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Agricultural systems not only provide food but also are an important part of the economy for many countries. Crop yields are highly dependent on the level and variation of temperature, precipitation, CO2 concentration and extreme events, including heat waves, droughts, and storms, and are therefore vulnerable to the effects of climate change. We will assess the impacts of climate change under two different climate projections (RCP8.5 and RCP4.5) and two different socioeconomic pathways (SSP3 and SSP5) in order to quantify the reduction in impacts on agricultural systems as climate change is reduced, and the dependence of this reduction on the socioeconomic development pathway that is assumed.

Previous studies have investigated climate effects on crop yield as well as implications for agricultural markets, prices, land use, and food security. Regarding the climate effect on yield, studies tend to take two different approaches: process-based crop models (e.g., Yao et al., 2007; Moriondo et al. 2011) or statistical relationships between climate variables and yields (e.g., Lobell et al, 2011; Schlenker and Lobell, 2010). Both approaches show that climate change can have positive or negative impacts on different crop types at different locations and over time. Studies that go beyond impacts on crop yields to investigate effects on agricultural markets (e.g., Nelson et al., 2011) also show that there can be agricultural winners and losers, especially over the next few decades, while over time if the degree of climate change worsens then impacts turn more uniformly negative. Recently, the Agricultural Model Intercomparison and Improvement Project (AgMIP) published a set of studies (Agricultural Economics, vol. 45(1)) examining the effect of climate change relative to a no-climate-impact baseline. Fewer studies have evaluated the benefits of mitigation on agricultural system, i.e., avoided impacts.

In this study, the integrated Population-Economy-Technology-Science (iPETS) model, a global integrated assessment model for projecting future energy use, land use, and emissions, will be used in conjunction with the Community Earth System Model (CESM), and particularly with the Community Land Model (CLM), to evaluate the consequences of reducing climate change from RCP8.5 to RCP4.5. The analysis will be global, with results in iPETS produced at the level of nine world regions, and will span the period 2005-2100. We will employ climate impacts on crop yield calculated with CLM, driven by CESM simulations of these two RCPs from the CMIP5 database. These yield effects will be applied within the iPETS model, imposed on baseline (no climate) scenarios for SSP3 and SSP5. These baseline scenarios will be produced in iPETS by tuning to existing IAM simulations for these scenarios. CLM-based estimates of arable land and yield effects on productivity will be aggregated from the grid cell level to the level of the aggregate economic regions in iPETS, and applied to the respective parameters in the model. By comparing the outcomes from two alternative scenarios, we are able to evaluate the avoided impacts of climate change due to climate effects on agricultural systems. We will measure impacts in terms of yield, food prices, consumption, and GDP.

P-2217-27

Land-use/cover changes in the Uttarakhand Himalaya: assessment and mapping

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Land is a dynamic and complex combination of factors - geology, topography, hydrology, soils, microclimate and communities of plants and animals. Land-use stands for the pattern of man's activity on a piece of land for economic functions and land cover changes denote to the type of feature, changes on the earth's surface. This paper aims to assess the land-use/cover changes in the Uttarakhand Himalaya. It also examines the factors affecting land-use/cover changes. Both qualitative and quantitative approaches were used for conducting this study. Data were obtained from the primary and secondary sources. A case study of 12 villages (Khanda Gad sub-watershed) was carried out and a household level survey was conducted on land-use/cover changes. Secondary data were gathered from the government records i.e. State Economic and Statistical Directorate, Dehradun. Land-use data from 1980 to 2009 were gathered and land cover changes were assessed through using various statistical methods and mapping. Participatory research appraisal was used to elaborate data through rapid field visit of the region. Farmers, extension workers and officials of various departments related to agriculture, horticulture and forest were interviewed to know the present trend of land-use/cover change. Five categories of land-use such as forestland, uncultivable land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; fallow land and net area sown were separately discussed. This study shows that forest covers 61% area followed by sown area (13%). Out of the total area sown, fertile patches of tarai (the plain area comprises Udham Singh Nagar) and Doon valley (comprises by plain area of Dehradun and Pauri districts) occupy above 70% area sown while, the other part of the state, which is known as the mainland of Uttarakhand (comprises 92.6% geographical area) has very less sown area. Other uncultivable land covers 16%, uncultivable land is 8% and fallow land is 2%. Temperate forests - pine, oak and coniferous - constitute forest land-use. In the mainland, the cultivable land is generally found in the valley regions and in the mid-altitudes and it is characterised by the narrow patches of terraced fields. Cultivation of subsistence cereal crops dominates the cropping pattern. Area under cash crops - fruits and vegetable is quite less. The land under cultivable waste, pasture, nurseries, orchards, trees and bushes is also found in the mid-altitudes and the highlands. Land cover changes were assessed. About 1.83% forest land was increased during 1980-2009. In Dehradun District, 10.6% forestland was increased. Meanwhile, area sown was almost stable in the mainland whereas in Dehradun district, about 6.06% area sown was decreased. In a nutshell, changes in all categories of land were noticed from 3.9% in other uncultivable land to 0.9% in area sown. Climate change impact on forest and cropping pattern was noticed. Within forest land-use, area under pine forest was observed increased upto 10% and oak forest cover decreased subsequently. This was occurred mainly due to warming of valleys and mid-altitudes. Similarly, cropping pattern has largely been changed from cultivation of subsistence cereal crops to cultivation of paddy, wheat and cash crops, as the case study shows. The major driving forces of land-use/cover changes were illustrated. State's conservation measures (Forest Act of 1982), People's participation (establishment of 'Van Panchayat) and Chipko movement were observed as the driving forces of increase in forestland. Change in food habits was other driving force that transformed cropping pattern. Even, high population growth rate (about 2%) was registered in the whole Uttarakhand Himalaya, area sown was stabilized. High intensity and frequency in weather induced natural hazards such as cloudburst triggered debris-flow; flashflood, landslide and mass-movement have also changed land-use/cover changes.

P-2217-28

Impacts of changes in land surface processes on the West African Monsoon variability : Results from the LUCID inter-comparison project

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West Africa has been highlighted as a hot spot of land surface-atmosphere interactions. The effect of changes in land surface processes on West African Monsoon (WAM) variability have been found very improtant. In this study, we analyze the outputs of the project Land-Use and Climate, Identification of Robust Impacts (LUCID) over West Africa. LUCID uses seven land-atmosphere models with common experimental configurations to explain the strong and constant impact of the land-use and land cover change (LULCC) between the preindustrial period and present day. Focusing our analysis on Sahel and Guinea zone where the changes in the extent covered of crops and pastures between 1870 and 1992 exceeds 5%. These studies have analyzed the performances of the individual GCMs/LSMs model involved in LUCID to simulate the WAM interannual variability. The results showed that the magnitude of these variability varies significantly from model to model resulting two major 'features' varying from one model to another : the land-cover distribution and the simulated sensitivity to LULCC. Changes in land surface properties in each individual model depend on how these represent and respond to a land-cover perturbation have been shown, as well as their simulated impacts on fluxes, rainfall and surface temperature. Finally, the climatic impacts of LULCC to those resulting from the changes in sea surface temperatures, sea ice extent, and increased greenhouse gases on WAM were evaluated. We found that for a number of variables (available energy, temperature, available water etc..), the amplitude of the impact of LULCC is similar to the impact of increased greenhouse gases and warmer oceans, but with opposite sign.

P-2217-29

Land Use Change, Desertification and Development Nexus in the Thar Desert Region of Rajasthan, India

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Desertification is the persistent degradation of dryland ecosystems due to human activities and variations in climate. Currently, 41 percent of the landmass worldwide is prone to desertification and around two billion people are affected by desertification and degradation of land. The major deserts in the world, particularly in China, Mongolia, Africa and India are expanding at an alarming rate. The expansion of deserts implies lesser availability of land for agriculture and allied activities which provide food and livelihood security to millions of people across the world. The chief drivers of desertification include deforestation, over grazing, over cultivation, logging, pressure of population, industrialization and poor land use practices.

Planning Commission of India has identified 15 resource development regions in the country, also known as the Agro Climatic Zones. Among the various regions, the Western Dry Region covers nine districts of the state of Rajasthan. The huge portion of Rajasthan is desiccated and houses the biggest Indian desert- the Thar Desert. The population in this region has been increasing at a rate faster than national average. This has led to increased pressure on land for food security of the increasing population and fodder security for the livestock. Due to less rainfall, people in this region practice a mixed farming system and livestock forms an integral part of their livelihoods. Some of the districts of this region are also characterised by a livestock density that is even higher than population density. The composition of livestock has also seen a change over the years in this region with the cattle and buffalo population being replaced by small ruminants. This is mainly because of low fodder requirement of the latter as compared to the former. Another important feature of this region which is also important as one of the drivers of desertification is the source of irrigation. In most of the districts of this region

more than 80 percent of the irrigation and in some districts even upto 100 percent of the irrigation is done by wells and tube wells. This has important implication from the view point of desertification and sustainable agricultural practices considering the already low levels of ground water in the desert regions. The forest cover in these nine districts is showing a declining trend owing to the land being diverted to cultivation. Besides forests, the area under other land uses is also being diverted to cultivation. This can have serious implications on sustainability of the livelihoods and extent of poverty of the people in these districts. This in turn has implications on the health and other human development indicators. In this paper, the author has used Markov Chain analysis to see the direction of change in the land use pattern in the districts covered under the Western Dry Region. It was observed that among the various land use patterns, there was a high probability of the land under forest being diverted to cultivation. This could have serious implications in terms of desertification as all the nine districts covered under the Western Dry Region of Rajasthan are already very low in terms of forest area. The author has also examined the linkages between various human development indicators of these districts in light of the changing land use pattern in the districts. For this purpose, using various development and desertification indicators, respective indices were worked out for the nine districts. The districts were then ranked on the basis of both the indices and it was observed that there was a negative correlation between development and desertification. The districts which were relatively better off in terms of development indicators were incidentally the districts having worst desertification indicators. A negative correlation was observed between development and desertification. This leads to a very important question that is development being done at a cost? In light of the various findings of this study the author has also suggested policy prescriptions for arresting desertification in the Thar Desert Region of Rajasthan.

P-2217-30

The Morphology of Urban Risk to Flooding In Metro-Manila, Philippines: Patterns of Exposure and Vulnerability Based on Informality and Land Use/ Cover Change

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The Project, "International Research Initiative on Adaptation to Climate Change-Coastal Cities at Risk (IRIACC-CCAR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities" is on-going from 2011-2016. Canada's International Development Research Centre (IDRC) manages IRIACC-CCAR in collaboration with three main research granting bodies, known as the Tri-Council: The Social Sciences and Humanities Research Council (SSHRC), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canadian Institutes of Health Research (CIHR). Under this transdisciplinary IRIACC-CCAR Project, Metro-Manila is a study site, along with Bangkok, Lagos and Vancouver. A component of this research for Metro-Manila, undertaken by the Manila Observatory with local partners and described below, is the study on the morphology of urban risk to flooding, which applies multi-temporal and multi-resolution remote sensing and geographic information systems (RS-GIS).

The specific objectives of this study are to: (1) Generate historical and updated locations of urban poor settlements, (2) Identify the spatial and temporal characteristics of the said settlements in relation to other land use/ cover and infrastructure, the former especially considering residential areas, commercial and industrial sites as well as vegetation, (3) Describe the patterns of urbanization and physical development, such as by the emergence, growth, spread and even the disappearance of the said human settlements, (4) Study the factors contributing to flood risk, which then need to be addressed.

Part I of the research gives the context of informality and vulnerability to flooding in terms of general land use/ cover change from 1972-2009 (LANDSATs courtesy of NASA). Part II involves change detection of informal settlements, that is, in 1997 and 2000 (SPOT courtesy of NAMRIA) as well as 2010 (ALOS AVNIR and PRISM courtesy of JAXA). Part III then concerns overlaying thematic layers of flood risk, where Risk ≈ f(Hazard, Exposure and Vulnerability) (UNDP 2004 and UNDRO 1979). In terms of hazard, this flood risk is especially attributed to low elevation coastal zones or LECZs, which are continuous areas along shores that are equal to or «less than 10 meters above sea level» (masl) and, as such, are prone to inundation (McGranahan, G., Balk, D. and Anderson, B. April 2007). Moreover and as a reflection of poor drainage, river choke points were also observed and validated (Siringan, F. and Perez, J.E., on-going research).

Resulting maps show an overall increasing trend in expansion or growth and distribution or spread of the informal settlements. These are found in marginal, hazard-prone and compromising locations, such as coasts, riverbanks and landfills but near advantageous sites, like major roads as well as industries and commerce. Also, the 1997 and 2000 clustering of informal settlements around socioeconomic attractors seem to give way to more movements towards the fringes of the metropolis in 2010. Dense and overcrowded formal and informal communities ("mixed" settlements), showing comparatively less signs of structural degradation, initially emerged and then declined. This appears closely associated with income and land tenure, which need to be studied more deeply. Very high resolution (VHR) satellite imageries are then necessary in order to monitor informal housing and livelihood, given their dispersion as small and large agglomerations as well as relatively small and degraded structures or spatial units. Besides poor drainage, factors contributing to flooding are: Haphazard urban expansion, densification, industrialization and commercialization and decline in vegetation. The study of broad and detailed land use/ cover across time may also benefit from hyperspectral satellite imageries. Salient patterns of exposure and vulnerability to flooding then form evidence-based decision-support towards better planning for preparedness and resilience, as by co-beneficial climate change adaptation as well as risk reduction and management (CCA-DRRM).

P-2217-31

The Changes of Crop Distribution and its Water Balance Effects in the West Liaohe River basin, China

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As one of the origins of dry farming in North China, West Liaohe River Basin is located in the districts with high production of maize, which is the main producing area in China and the important commodity grain base. As a sensitive area of global change, West Liaohe River basin is located in the eastern agriculture and animal husbandry edge of the western of Northeast Plain, which showed an obvious warming trend and frequent drought in the recent years. Due to the increase of population, water resources development and utilization activities is increased, and the land desertification, vegetation degradation problems are becoming serious by the interaction of human activity and climate change. This study taking the West Liaohe River basin as a case study area, analyzing of the crops distribution changes and spatial agglomeration situation in 2000, 2005 and 2010, using remote sensing tools and GIS technology. On this base, using the water balance model, quantitatively calculate the different periods of the water balance of the different crop types based on GIS technology and mathematical statistics in the West Liaohe River basin, And then systematically evaluated the water balance effects of crop distribution variations from 2000 to 2010, and scenario simulated the water balance effects of crop layout changes in different climate conditions, by establishing the water balance response statistics model. The study indicates that, (1) Water resources pressure substantially reduced from 2000 to 2005, by 26.71hundred million m3. And increased slowly from 2005 to 2010, by 5.50 hundred million m3. (2) The actual irrigation increase 14.31 hundred million m3, accounting for 26.81% of available water in the West Liaohe River basin from 2000 to 2005, influenced by the main crops area increased substantially. And water resources pressure continue to rise, the actual irrigation increase 0.88 hundred million m3 in the West Liaohe River basin from

2005 to 2010, influenced by the main crops area increased slowly. (3) The pressure of water resources was enhanced significantly in the West Liaohe River basin under different climatic conditions (normal year and dry year), the actual water demand for irrigation were respectively 12.94 hundred million m3 and 16.43 hundred million m3, there was serious contradiction between the water resources supply and demand. (4) Adjusting crop planting structure, developing water-saving agriculture and improving the utilization efficiency of water resources would become the main route of agricultural sustainable development in the West Liaohe River basin.

2218 - Land-based mitigation: agriculture, forests, bioenergy

ORAL PRESENTATIONS

K-2218-01

Emission and mitigation hotspots in the land use sector across the tropics

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Deforestation is the largest net source of GHG emissions in the tropics, and mitigation initiatives such as REDD+ should consider agriculture as it is a key driver of deforestation. Climate-smart agriculture (CSA), so far an agriculture technologies focused exercise, can potentially reduce deforestation as the underlying assumption is that higher yields take pressure off forests. However, this cannot be taken for granted and deserves a closer look from science, policy and investment perspectives. If implemented in the right way, CSA has the potential for win-win outcomes as CSA aims to achieve both mitigation and adaptation goals. This also fits the recent focus in climate debates on agriculture as a driver of deforestation and ecosystem degradation, and can become an integral part of the solution to saving the world's forests.

In this session, we present new scientific findings on how agriculture and REDD+ are linked, how these are addressed in country strategies, and how an integrated perspective can exploit synergies and address conflicts. New data showing where and by how much agriculture is driving deforestation, and the potential emissions reductions from reducing this driver will be discussed. We present a new tropical analysis on the contribution to GHG emissions from the AFOLU sector that offers a spatially explicit view of where the AFOLU hotspots of emissions are located and what is the relative contribution of forests vs non-forests we also analyze the potential to achieve mitigation through CSA. Presentations will be short to allow for a moderated discussion. The presentation and related discussions aim to stimulate an interactive debate around the possible linkages between REDD+ and CSA - both in policy and practice. The results can feed into ongoing discussions and ideas of a broader "land use agreement" incorporating both REDD+ and agriculture that is still high on the UNFCCC agenda. With the new data and results generated by several research partners, we are able to underpin the discussions with better understanding and bring critical issues to the forefront, such as: where and how can land-based mitigation through CSA be successful in reducing GHG emissions?

K-2218-02

Developing a sustainable charcoal sector in Africa

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Charcoal is a vital source of energy for millions of people around the globe and one of the most commercialized resources in sub-Saharan Africa, yet policies to effectively govern the sector are lacking in many countries. Authorities in countries around the world tend to view charcoal production and use as an environmental and health problem. However, if managed properly charcoal provides a low-cost and locally available energy source that has the potential to become sustainable and contribute significantly to poverty alleviation.

This paper discusses the main obstacles to a sustainable charcoal value chain in sub-Saharan Africa and identifies key areas where interventions are required to improve sustainability while ensuring charcoal continues to provide livelihood benefits. It provides evidence of how a sustainable, transparent and properly regulated and governed charcoal sector could be part of the solution to energy access and economic challenges faced by many developing countries.

The paper summarises the most up-to-date literature on the issue at this time. Although the focus is on sub-Saharan Africa, some of the recommendations may be equally applicable to other charcoal-dependent developing countries.

Key recommendations

- Improve sustainability in the charcoal sector, and reduce associated degradation, through exploring community-based forest management options, growing trees outside forests, strengthening tenure and property rights, and implementing guidelines on sustainable harvesting and production.
- Improve governance across the charcoal value chain to create a regulated, transparent and coordinated sector which formally contributes to national economies.
- Invest in capacity development in improved kiln technologies, co-management of public or protected forests, agroforestry, woodlots, small-scale plantations, and financial management and reporting to improve sustainability and governance of the sector.
- Increase participation by disempowered stakeholders in the charcoal sector to encourage greater uptake of more efficient technologies and more sustainable management practices.

Transform the negative image of charcoal, allow sub-national governments to earn charcoal revenues and tap into internationally recognized mechanisms to create incentives for investment in a sustainable charcoal sector.

K-2218-03

ORACLE: Opportunities and Risks of Agro-systems & forests in response to CLimate, socio-economic and policy changEs in France

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Our rapidly changing climate significantly affects production of agricultural and forestry products throughout the world, with potential impacts on land-use practices and land-cover choices. In parallel, socio-economic decisions and environmental policies are evolving as agriculture and forestry are called to play a major role in the cost-effective climate mitigation portfolio. The Common Agricultural Policy for example is moving towards "de-coupling" and "greener" schemes, with increased concern for the environment. There is also growing pressure on scarce resources and increasing competition over soils for the production of food, feed, wood, energy and a broad range

of environmental services.

To provide insights on a) the potential risks and opportunities for agriculture and forestry, and b) possible future patterns of land use, the scientific challenge is to account simultaneously for i) climate change and its expected effects on productivity and more generally on the functioning of agro-ecosystems, and ii) the evolution of the socio-economic and policy environment.

Yet the Intergovernmental Panel on Climate Change reports have reviewed model projections of climate change impacts over Europe but most of those projections did not adequately account for climatic variability (in climate projections and impacts). The potential for risks or benefits have therefore not yet been systematically explored, thus reducing our level of confidence in those projections. It is then imperative to increase our understanding of the range of plausible impacts of climate change on agro-ecosystems and forests to better work on adaptation strategies for these sectors. This can only be done using a combination of a) diverse modelling approaches and observations, b) reliable quantification of uncertainty, and c) syntheses of published results.

The ORACLE project (https://oracle.lsce.ipsl.fr/) tried to systematically explore the potential implications of various scenarios of climate change and changes in socio-economic and policy environment for land-use in France, taking explicitly into account the link between uncertainty on climatic drivers and ecosystem responses on the one hand, and adaptation decisions on the other hand. ORACLE brings together climatologists, agronomists, economists, hydrologists and statisticians with a common goal: better inform the relationships between climate constraints and land uses. We focus on French major anthropogenic ecosystems (crops, pasture and managed forests). We have tried to make the best use of the most recent findings of various projects and available databases, the most relevant literature, and the most up-to-date models of vegetation and economics. Our time scale of interest spans the very recent past (last 30 years), and the future regional climate projections for the 21th century with various horizons of interests (2050 and 2100).

Evaluation of potential risks or opportunities for cropland have been examined via a suite of indicators that are either computed directly from meteorological variables, or from generic biosphere models. Climatic indicators provide information on climate only, but with a selection of those that are relevant for a specific managed system (Graux et al. in prep.). Eco-climatic & Biotechnic indicators are directly computed from meteorological variables but designed to be ecosystem-specific (Caubel et al. in press). Other Eco-climatic & Biotechnic indicators are derived from simulations using generic vegetation models, with a prior definition and calibration of the indicators. The areas where a specific crop type is either at risk or potentially cultivable based on an analysis of the combined changes in all indicators.

O-2218-01

Assessing low emissions development pathways for the agricultural and land use sector

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With a contribution of almost one quarter to total anthropogenic greenhouse gas (GHG) emissions and associated abatement potential, its role as a source of biomass for bioenergy production, and potential for sequestration from afforestation, the agricultural, forestry, and land use sector (AFOLU) has to be an integral part of any global low emissions development strategy for climate change mitigation. Studies have sought to identify the required contribution of the sector to long-term climate stabilization and have evaluated its technical and economical mitigation potential. Detailed yet comprehensive analyses of the low emissions agricultural development pathways that form part and result from climate change mitigation strategies are scant. It is not yet well understood where to set priorities for mitigation efforts, both geographically and sectorally. It is further not clear which role specific technologies aimed at reducing GHG emissions in agricultural production processes will have to play.

Applying the IIASA integrated assessment modelling framework with the Global Biosphere Management Model (GLOBIOM) used for the AFOLU sector we create mitigation scenarios to reduce emissions to levels consistent with attaining a 2-degree climate target. The analysis is carried out for three Shared Socio-economic Development Pathways (SSP) up to the year 2050. A basic set of model simulations is carried out with the existing set of agricultural technologies to create standard mitigation cases for each SSP. An extended set of simulations implements additional assumptions on add-on technologies for mitigation in agricultural production processes.

The extent of agricultural mitigation to limit emissions to levels consistent with a two degree target is 2.1 GtCO2eq/yr, 2.9 GtCO2eq/yr and 3.7 GtCO2eq/yr under SSP1, SSP2, and SSP3, respectively. Abatement of emissions from land use change (LUC) consistently accounts for around 80% of the total. Mitigation potentials of CH 4 and N2O from agricultural production are around 11% to 14% and 7%, respectively.

An assessment of priorities for AFOLU mitigation highlights the fundamental role that developing and emerging economies will have to play. Mitigation efforts should be prioritized to regions with the highest economic abatement potentials at emissions price levels consistent with the two degree target, namely Brazil and the rest of South America, the Congo Basin and Western Africa, Southern Africa, and China. Within those regions and depending on regional emissions patterns and the resulting abatement potentials, either a focus on the reduction of LUC CO2 or on emissions from agricultural production should be prioritized. In the regions with large areas of humid tropical forests mitigation efforts should focus on the reduction of deforestation, hence mitigation of land use change emissions. These include the Congo Basin and Southern Africa, where almost the entire abatement potential relates to LUC. In China, mitigation efforts are required in agricultural production. The reduction of CH4 from enteric fermentation accounts for about 50% of total abatement and CH4 and N2O from crop production, including rice, and manure management contribute another 25%. Brazil and Western Africa have also abatement potential from the reduction of LUC CO2. In both regions, however, the reduction of CH4 from enteric fermentation constitutes an important part of the mitigation portfolio.

Mitigation technologies are found to have an important role to play in particular in regions that should prioritize abatement of agricultural emissions. While mitigation technologies can increase overall global AFOLU abatement only marginally, they can have significant impacts on emissions from crop and livestock production. In China, add-on technologies potentially contribute 4% additional abatement in crop production and 23% in livestock production. In Brazil, mitigation of GHG from livestock production could be raised by up to 34%. Finally, in spite of the currently high importance of land use change and associated emissions, future trends suggest that more priority should be given to mitigation of agricultural emissions and the use of add-on mitigation technologies when moving into the second half of the century.

O-2218-02

Land-based mitigation: a social-ecological positive feedback loop? Some insights from the Global Land Project

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Feeding a growing human population, while at the same time mitigating climate change, is a major challenge of this century. The competing demand for land for providing, among others, food, fiber, energy, ecosystem services and carbon sinks and stocks, makes land-based mitigation a particularly tough task (Smith et al. 2013). Sparing land leads to an important trade-off

between the need to perform agricultural intensification, which increases emissions, and at the same time reduce emissions through the reduction of deforestation and land cover change. While the share of total anthropogenic emissions from land use, land use change and forestry (including deforestation) has been diminishing, emissions from agriculture have continued to grow steadily (Tubiello et al. 2015). Furthermore, new research has found that land management impact on surface temperature are substantial and have been overlooked up to now, stressing the need to integrate land management to improve assessment of human impacts on the climate (Luyssaert et al. 2014). This contribution has the objective to give some insights into possible synergies, trade-offs and feedback loops related to land-based mitigation measures. It builds on different research achievements of the Global Land Project, part of the Future Earth program, which hosts the largest community of active researchers and practitioners in land system science. Insights from two GLP endorsed projects related to REDD+, REDD-PAC in Brazil and the Congo Basin and I-REDD+ in Southeast Asia allow to identify methodological challenges in implementing land-based mitigation measures and assessing their impacts on biodiversity, food security and forest carbon stocks. These challenges include 1) the definition of reference emission levels in highly dynamic land use and management change contexts, 2) the estimation and integration of carbon stocks and sinks in degraded forests, abandoned lands and mosaic landscapes, 3) the need for broader and more complex criteria for forest definition, 4) matching spatially explicit data to assess possible synergies and trade-offs between desired functions of land, like for example carbon sequestration and biodiversity conservation, and 5) the assessment of just benefit distribution and risk of elite capture of incentives related to land-based mitigation. On the base of these challenges, we discuss the potential of new concepts for analyzing and measuring land-use intensity to assess the possible impacts and feedback loops related to land-based mitigation measures.

O-2218-03

Agroecological practices adopted by Malagasy farmers to reduce farms carbon footprint in the Central (Itasy) and East Coast (Analanjirofo) of Madagascar

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For decades, Malagasy farmers have to deal with the low performance of the agricultural system and cope with the threat of food insecurity. This low productivity is caused by various factors including lack of means of production and degradation of natural resources such as loss of soil fertility. In addition, the effects of climate variability constrained farmers to shift constantly cropping calendars. Therefore, agroecology was proposed to farmers on one hand to cope with food insecurity by increasing agricultural production and diversifying crops in order to get more sources of incomes and on another hand to restore the production environment such as watersheds, soil and water availability and to contribute to climate change adaptation. First, this work aimed to estimate the carbon footprint of farms in two regions located in the Central and the East Coast of Madagascar. Secondly, the contribution and influence of the agroecological practices adopted by farmers to carbon footprintsat farm scale was assessed. The annual flux of the three main greenhouse gases encountered in the agricultural sector including the carbon dioxide (CO2), the methane (CH4) and the nitrous oxide (N2O) expressed in CO2 equivalent is considered as the carbon footprint of each farm. Twenty smallholder farms selected from farm typologies per region were studied: twelve for the Central Highlands and eight at the East Coast. Farms located in the central region were characterized by intensification of annual cropping systems using agroecological practices such as intensified rice system which alternates flooding and drying of rice fields, composting organic residues and planting fruit trees in association with annual cropping systems. Agricultural activities of farms located in the East Coast were based on clove plantation associated with annual crops either in simple specie agroforestry or mixed tree species agroforestry and the traditional twice-a-year rice cropping system. Farm resource flow maps were developed in order to represent all of the structures and characteristics of each farm. GHG-source and -sink compartments' inventory was carried out and emission factors adapted to each zone were selected form the literature. A local/specific farm carbon footprint calculator was developed.The results showed that farm carbon footprint average amounted to 3.04 Mg CO2eq ha-1y-1and 7.69 Mg CO2eqha-1y-1 in the central and in the east coast respectively. Farms in the East Coast showed high carbon footprint because of the traditional twice-a-year rice cropping. In the Central Highlands, the intensified rice cropping system reduced the farm carbon footprint by reducing methane emission, composting organic residues reduces also farm carbon footprint up to 30% by improving carbon storage in soils. In the East Coast, agroforestry allowed a farm carbon footprint reduction between 15 to 51% due to carbon storage in woody biomass. These results showed another aspect of the beneficial impacts of agroecological practices when adopted by smallholder farmers in Madagascar, at farm scale, to climate change mitigation.

2218-POSTER PRESENTATIONS

P-2218-01

The contribution of agroforestry systems to climate change mitigation - Assessment of C storage in soils in a Mediterranean context

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Agroforestry is a land use type where crops and trees are grown together in the same place and at the same time. Agroforestry systems have the advantage of providing multiple products (e.g. wood, fruits) or services (e.g. biodiversity enhancement, erosion control) whilst maintaining agricultural production. If they are known to store carbon into the biomass of the trees, they could also increase soil organic carbon (SOC) stocks. However their impact has rarely been studied under temperate or Mediterranean conditions and has mostly concerned superficial soil layers. Our objectives were (i) to quantify and spatialize SOC stocks in an agroforestry system and in an adjacent agricultural plot, (ii) to assess what SOC fractions are responsible for possible additional carbon storage, and (iii) to quantify all organic inputs entering the soil. The trial was established in 1995 in southern France. Hybrid walnut trees are intercropped with durum wheat. SOC stocks were measured on 200 soil cores down to 2 m soil depth, and particle-size fractionation was performed on 64 soil samples. Carbon stocks of trees and of the herbaceous vegetation in the tree rows were also quantified. A trench was dug to 4 m soil depth to quantify tree fine root distribution and biomass. Minirhizotrons were installed at different depths to study tree fine root turnover. Annual additional SOC storage rates were estimated at 259 ± 59 kg C ha-1 yr-1 (0-30 cm) and at 350 ± 88 kg C ha-1 yr-1 (0-100 cm). Additional storage was mainly due to particulate organic matter fractions (> 50 µm) and 10 to 15% was associated to clay particles. When the aboveground biomass of the trees was taken into account, total organic carbon storage rate reached 1.11 ± 0.16 Mg C ha-1 yr-1. High tree root densities were observed at depth, but root turnover decreased with depth. Agroforestry systems provide higher amounts of carbon at depth than other agricultural practices, such as no-till farming, and could therefore provide a more stable C storage in the long-term.

This study was funded by ADEME within the Agripsol project as part of the Reacctif program.

P-2218-02

The contribution of agroforestry systems for climate change mitigation - A systematic analysis

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Climate change mitigation and food security are two of the main challenges of human society. Agroforestry systems, defined as the presence of trees on external and internal boundaries, cropland, homestead plots or on any other available niche of farmland, can provide both climate change mitigation and food. There are several types of agroforestry systems with different rates of above ground and soil carbon (C) sequestration. The amount of carbon sequestered will depend on the type of system, climate and region. We undertook a meta-analysis that included data collection from several studies on carbon sequestration for different agroforestry systems, climates and regions in the world. The objective was to provide information on more types of agroforestry systems than those considered by the IPCC. The results from the meta-analysis show that greater carbon sequestration occurs when the land use change is from cropland to a woodlot system in the case of above ground carbon sequestration, and from fallow to a woodlot system in the case of soil carbon sequestration. Results also show that tropical climates are the most favourable for above ground carbon sequestration in agroforestry systems. Time since the change in land use is another variable to take into account, as soil carbon sequestration is generally negative up until 5 years after the transition to an agroforestry system. Our analysis provides a wider range of options that can inform practitioners in case they also need to base their choice of agroforestry system in relation to the carbon sequestration benefits. Carbon stocks before land use change, the variance and the soil sampling design were the main gaps in the literature reviewed. These gaps should be addressed in future studies if the implementation of agroforestry systems is considered as having an important role for C sequestration.

P-2218-03

Development of a global level decision support tool to reduce agricultural emissions

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The tool described is an Excel-based tool which brings together several empirical models to estimate greenhouse gas emissions (GHG) in rice, cropland and livestock systems, and to provide information about the most effective mitigation options. Greenhouse gas emissions are estimated in terms of total GHG emitted in kg of carbon dioxide equivalent per hectare (kg CO2eq ha-1) and in terms of GHG intensity, i.e., kg of carbon dioxide equivalent per unit of product (kg CO2eq kg-1). This tool allows for management-relevant GHG assessments to be made with relatively little effort. Management practices are chosen by the user and mitigation options are estimated and ranked according to its mitigation potential. The aim of the tool is to accommodate a range of users from an introductory to advanced level, depending on objectives and issues like time, existing knowledge, or data available. This paper describes the methods used to develop a tool to enable policy makers to explore the most appropriate GHG mitigation options available for any region worldwide. Since the target users are policy-makers and policy advisers, this tool was built to be user-friendly, and not time consuming. Apart from these characteristics, the tool differs from other tools available because it provides information about mitigation options according to a variable baseline management and it does not ask for detailed management practices (low input data required).

P-2218-04

Limiting factors on low uptake of Clean Development Mechanism based projects in Africa: Lost opportunities during first commitment period of Kyoto Protocol

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Africa countries like other developing countries in the rest of the world signed and ratified the Kyoto Protocol in order to benefit from the clean development mechanism (CDM) funds aimed at mitigating greenhouse gas emission from land used based activities. A study was conducted in 10 African countries aimed at identifying the main limiting factors on low uptake of CDM forest based projects in Africa. The study was a desk review and focused group discussions during training workshops on rapid forest carbon stock appraisal (RaCSA) for academia, research, staff from relevant government ministries, extension services and civil society organisations. The data collected was analyzed using qualitative research approaches where key themes and frames were generated. Quantitative data was analyzed using appropriate statistical procedures. It was evident from the UNFCCC database, since 2004 to 2014, only 2 % of all registered CDM projects were from Africa as compared to 84 % from Asia and Pacific Ocean, 13 % from Latin America and Carribean and 1 % from Economies in Transition. Of the 2 % from Africa, a very negligible percentage was from biomass as compared to hydro, wind and other GHG gases. This demonstrated very limited number of CDM projects that could have significantly wide scale on investment, improved economy and mitigation of GHG emissions from land based sector.

The major identified limiting factors on low uptake of CDM forest based and other related projects were: complicated processes on developing CDM projects especially on how to initiate project idea note (PIN) and develop project design document (PDD). This was compounded with inadequate capacity from Africa especially on the methodology resulting to heavy transactional costs of hiring international experts to support local communities and African governments to develop and implement CDM projects. The stringent rules on implementation of Kyoto Protocol on afforestation and reforestation programmes also played a significant role. For instance, CDM reforestation activities as per the Kyoto Protocol was to take place if there has been no forest since 31st Dec. 1989 or afforestation activities if there has been no forest for atleast 50 years. These periods specified, most of the African areas were forested. Also a number of African countries have not agreed on clear definition of forest to enable investors participate on forestry based CDM project. The other limiting factor is political instability and war among African states that continuously scared investors. This hindered formulation of forest based policies that will capitalize on emerging payment of ecosystem services. These factors among others constitute lost opportunities during the first commitment period of Kyoto protocol for African countries. Enhanced capacity among forestry stakeholders, formulation of favourable policies and continuous update of Kyoto Protocol to suit emerging circumstances in the African continent will be critical on accelerating the validation, registration and implementation of forest based CDM project in Africa.

P-2218-05

Options for reducing greenhouse gas emissions from the agricultural sector: abatement potential and cost of technical measures

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In Europe, agriculture is responsible for 10.2% of greenhouse gas (GHG) emissions, with concomitant opportunities for mitigation. This sector can contribute to abatement objectives via three levers: a reduction in N2O, CH4 and CO2 emissions, additional carbon storage in soil, and biomass and energy production (substitution effect). The objective of this study was to assess technical measures to reduce GHG emissions at the farm level in a European context without reducing production outputs. France was chosen as a case study with a typical intensive and diversified agriculture.

Ten measures, split into 26 sub-measures, were selected from an initial list of 100 "candidate" measures. The selection process was based on five criteria: the expected effect on production, the GHG abatement potential, the current availability of the technology required to implement the measure and of validated scientific knowledge establishing its efficacy, the applicability of the measure, including its social acceptability, and the potential synergies or antagonisms with other agri-environmental objectives, including adaptation to climate change.

The ten selected measures were linked to 1) nitrogen management in the field (better adjust fertiliser application rates, introduce more legumes in arable crop rotations and temporary grasslands), 2) management practices which increase carbon storage in soils and biomass (reduced tillage, cover crops and grass buffer strips, agroforestry and hedges, grassland management), 3) livestock diets (unsaturated fats or additive in ruminant diets, better adjust the amount of proteins), and 4) energy production and consumption on farms (methanisation and flares, energy savings). Their abatement potential and cost were accurately calculated and compared, using a marginal abatement cost curve approach (Moran et al., 2011).

Results showed that the overall abatement potential can be broken down into three groups. One third of the cumulated abatement potential corresponds to sub-measures with a negative technical cost. These sub-measures are based on an improved efficiency of inputs like N fertilizers, animal feed and energy, thus reducing GHG emissions and costs, with no negative effect on production (win-win measures). Moreover, these sub-measures have a positive expected effect on water and air quality and no antagonism exists with the objective of adaptation to climate change.

The second group corresponds to sub-measures with a moderate cost (<€25 per metric ton of CO2e avoided). These sub-measures require specific investments (e.g. methanisation) or modifying the cropping system slightly more (reduced tillage, legumes, agroforestry). However, these additional costs or lower incomes are partially compensated for by a reduction in other costs (fuels) or additional marketable products (biogas, electricity, wood).

The third group corresponds to sub-measures with a high cost (>€25 per metric ton of CO2e avoided). These sub-measures require investment with no direct financial return (flares), the purchase of specific inputs (nitrification inhibitors, unsaturated fats or additives incorporated into the diet of ruminants), dedicated labour time (cover crops, hedges) or involve greater production losses (grass buffer strips reducing the cultivated surface area for example).

When calculated under current national inventory rules, the overall annual abatement of all these measures represents 10% of annual emissions from agriculture. This percentage is higher when calculations are based on higher tier approaches.

It is concluded that cost-effective technical levers exist for agriculture to support greenhouse gas mitigation without hampering production and adaptation goals.

P-2218-06

Land Use Emissions Abatement and Consequences for Food Prices

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Considerable emission cuts of greenhouse gases (GHG) are required in order to prevent further warming of the planet and to reduce the risk of severe impacts attributed to climate change (Meinshausen et al., 2009, Nature 458: 1158-1162). The agricultural, forestry and other land use sector (AFOLU) is one of the central players in such mitigation efforts as it itself contributes with 20-25% to overall GHG emissions, but also allows for negative emissions by removing GHGs, mainly carbon-dioxide (CO_2), from the atmosphere (IPCC AR5, 2014). To this end, climate mitigation policies need to take AFOLU options into account, but science needs to understand and highlight possible trade-offs and socio-economic impacts of AFOLU-based climate mitigation. For instance, large scale land use change can have adverse impacts on various ecosystem services, such as conservation of biodiversity, water retention, food provision etc. Similarly, a direct pricing of GHG emission could affect commodity prices from the agricultural sector through increased cost of agricultural production and further compromise food security. Using an agro-economic, spatially explicit model (MAgPIE; Lotze-Campen et al., 2008, Agric. Econ. 39: 325-338; Popp et al., 2014 Nat. Clim. Change 4: 1095-1098) that estimates cost-optimal land use patterns of global agricultural production, we show that mitigation measure both at the supply or demand side of the AFOLU sector can strongly reduce major GHG emissions in form of carbon-dioxide from land use change, and nitrous-oxide (N_2O) and methane (CH_4) stemming from agricultural production activities. However, supply side emission reduction measures, such as avoided deforestation and less polluting agricultural management and practice incentivized by a GHG emission tax, lead to strong increases of food prices (~250% of price index under a reference scenario, BAU, at the end of the century), which are mostly driven by the pricing of CH_4 emissions stemming from the livestock production sector. On the contrary, measure that target demand side management, including better food waste management and a "demitarian" diet with halved livestock calorie demand in daily food intake compared to present day livestock product consumption in developed countries, allow for additional potential for carbon uptake on abandoned agricultural land and even decreases the prices throughout the 21st century. However, in order to further eliminate residual emissions, especially the cumbersome CH_4 gas, a synergy of the two emission reduction strategies is required. This combined strategy curbs the non-CO_2 emissions further, cutting down N_2O and CH_4 to 50% and 40% respectively, relative to BAU. A stringent abatement of CH_4 emissions (by 60%) through combination of the demand and supply side policies demonstrates generally lower food prices over the century than is the case with only supply side mitigation policy. In conclusion, our study demonstrates the considerable potential of food demand management in reducing GHG emissions from the AFOLU sector without jeopardizing food security and beneficial to the environment.

P-2218-07

Terrestrial carbon sinks: the critical role in deep greenhouse gas reduction scenarios and ecological limits to large scale carbon dioxide removal

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Pathways to achieving deep greenhouse (GHG) reductions (such as 80% reductions by 2050) have implications for carbon cycle science. This talk will highlight the critical role that terrestrial carbon sinks and mitigation of non-energy GHGs have in reading deep decarbonization goals.

In addition, many climate change mitigation scenarios include terrestrial atmospheric carbon dioxide removal (BCDR) or carbon neutral bioenergy production through bioenergy with carbon capture and storage (BECS) or afforestation/reforestation. Very high sequestration potentials for these strategies have been reported, and

we evaluate the potential ecological limits (e.g., land and resource requirements) to implementation at the 1 Pg C y-1 scale relevant to climate change mitigation for U.S. and global scenarios. We estimate that removing 1 Pg C y-1 via tropical afforestation would require at least 7×106 ha y-1 of land, 0.09 Tg y-1 of nitrogen, and 0.2 Tg y-1 of phosphorous, and would increase evapotranspiration from those lands by almost 50%. Because of improved carbon capture technologies, we are updating (and reducing) our previous estimates for switchgrass BECS (previous estimate was 2×108 ha land and 20 Tg y-1 of nitrogen (20 % of global fertilizer nitrogen production)). Miscanthus could meet the same biomass production with much lower N demand. Moreover, transitioning the U.S land currently under corn- ethanol production to no-till perennial grasses for bioenergy would meet U.S. needs and have additional environmental benefits (such as improved wildlife habitat and soil restoration). Therefore, there are important ecological limits to BCDR and carbon-neutral bioenergy production as well as significant potential benefits depending on implementation.

P-2218-08

An assessment of Brazilian biofuels expansion from a climate-resilient pathways framework

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Climate change's impact on society, health, and nature is a global challenge with local effects and needs for response. One of the upmost concerns about climate change is the possibility that its impacts can offset any gains we have accomplished thus far in terms of human and sustainable development, particularly in less developed regions (World Bank, 2010). A highly promising means to achieve desirable future states is the development of climate resilient pathways (CRPs) (Denton et al., 2014) which are "… development trajectories that combine adaptation and mitigation to realize the goal of sustainable development" with the explicit target to simultaneously seek to maximize synergies and minimize trade-offs among those three pillars.

Biofuel development certainly entails a combination of climate mitigation and sustainable development needs, but also adaptation in agriculture and water resources. Originally seen as a solution for climate change mitigation, energy independence, and rural development (Sachs, 2005; Hazell and Pachauri, 2006), recent research has linked biofuels production to biodiversity loss, depletion of water resources, food insecurity, and, contrary to earlier studies, increases in GHGs emissions due to indirect deforestation and nitrogen fertilizer application (Fargione et al., 2008; Gibbs et al., 2008). In this context, Brazil, one of the world's largest biofuel producers, is largely considered a success story given low per ha GHG emissions, availability of land for energy crops, low induced deforestation and social inclusion targets for family farmers (Goldemberg et al., 2008; Nassar et al., 2010; Schaffel et al., 2012).

However, sustainable production of Brazilian biofuels is now put to a test as both national and international demand for domestically produced biofuels is rising, including export of sustainably produced biofuels, thus driving biofuels production into new lands and microclimates. Furthermore, climate change is now predicted to affect agricultural productivity and water resources availability in Brazil, potentially increasing conflicts between different land uses, including those of food versus fuel (Lapola et al., 2010; Assad et al., 2010; La Rovere et al., 2011).

Understanding the interrelationships between different land uses, water demand and supply, and energy production is thus imperative in order to identify potential medium to long-term consequences of current biofuel policies, the potential options to mitigate these impacts, and to take advantage of potential opportunities for sustainable development and adaptation in agriculture, including export of sustainably produced biofuels.

In this context, assessing Brazilian biofuels under a under a CRP framework may thus provide important policy contributions for planning of climate change and development. Considerable efforts have been made in order to identify and analyse key challenges for sustainable production of biofuels in Brazil. However, existing studies (e.g., Goldemberg et al., 2008; Fargione et al., 2008; Lapola et al., 2010; La Rovere et al., 2011) have focused on isolated impacts of biofuel production or case studies, rather than providing integrated assessments of policy-relevant (including climate policy) energy, land use, and water issues. In this context, our presentation aims to inform policymakers and stakeholders on potential biofuels expansion scenarios in Brazil under climate change until 2030 in order to enable sound policymaking that mitigates adverse impacts on land use, water resources, and food security, while simultaneously promoting sustainable production of biofuels. We do so through a multi-institutional modelling effort (carried out by three research centers from Brazil and US) that integrates basin-scale water resources impact assessment, land-use change analysis, and energy-economy-wide modelling of socioeconomic and GHG impacts due to biofuels use. Our presentation will focus on explaining our methodological framework for CRP assessment and present first results obtained in the areas of water resources and land use management.

P-2218-09

Planetary limits to Bio-Energy Carbon Capture and Storage (BECCS) negative emissions

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Most but not all IPCC WG3 emission scenarios stabilising climate at low levels, such as the 2 degree C climate target require large scale deployment of Bio-Energy Carbon Capture and Storage (BECCS). BECCS allows for negative emissions, which is the artificial removal of carbon dioxide from the atmosphere (CDR). BECCS can therefore offset anthropogenic emissions, and even lead to overall net negative emissions. In this study we consider three alternative scenarios of BECCS deployment ranging from the conversion of existing agricultural areas, moderate levels of land conversion and an extreme level of tropical land conversion to maximise yields. These scenarios are used in combination with simulations from the HadGEM2-ES earth system model to consider the implications of climate change on yield and the emissions associated with deforestation, as well as the biophysical effect on climate associated with the land-use change. These are combined to assess the net climate effects of large-scale BECCS deployment. Overall, in our assessment we find the contribution of BECCS is unlikely to exceed cooling of 0.7 deg C by 2100. The median estimate of total negative emissions in the IPCC WG3 database compatible with the 2C target is 166 GtC. The highest estimates presented here is 130GtC.

P-2218-10

Assessment of options for land use in a post-2020 world

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Agriculture, forestry and other land use (AFOLU) account for nearly 25% of global GHG emissions while also absorbing a significant amount of emissions according to IPCC AR5. In this light, IUCN and a group of leading organizations focused on UNFCCC negotiations have been reaching out to Parties to discuss the role of the forest and land sectors in the new climate agreement.

Expert workshops over the last 18 months in Bonn and Lima, as well as an expert panel at the Global Landscapes Forum, advanced discussions and identified solutions for this important issue. All of those events included the REDD+, LULUCF, and agriculture negotiators, in order to ensure the discussions covered the full scope of land-use issues. These discussions highlighted risks to the integrity of a new climate regime if the role of the land sector is not adequately or appropriately reflected in the Paris agreement.

Taking stock of recent publications on the subject and the current status of land use, land-use change and forestry (LULUCF), REDD+, degradation and land-related CDM discussions in the UNFCCC, the relative strengths and weaknesses of options for how the land sector might be addressed in a post-2020 ADP agreement, will be highlighted. This set of options will have been discussed at a targeted workshop the month before amongst ADP lead negotiators.

Based on recent research, key questions that to be addressed will focus on:

- What specific attributes are needed in a framework to promote ambitious emission reductions from the land sector?
- Based on summaries of the INDC submissions to date and beyond, what are Parties to the UNFCCC already preparing domestically to recognize the importance of the land use into their post-2020 contributions?

Beyond global agreement in Paris at COP21, what can the international scientific community and both international & domestic organizations do to support permanence in any future gains on the emission gap via ambitious action within the land sector?

2219 - Politics and numbers: Political and technical challenges in reducing emissions from forests with REDD+

ORAL PRESENTATIONS

K-2219-01

The REDD+ policy arena and the politics of numbers and information sharing

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Forests are an integral part of the international climate mitigation agenda. Transformational change beyond the forestry sector is required to realize the mitigation potential from avoided deforestation and forest degradation (REDD+). In the envisioned REDD+ architecture, payments will be made for carbon and non-carbon results, which need to be measured, reported and verified (MRV). Highly technical information needs to be translated into financial action. Information and information sharing are key features in REDD+ far beyond the MRV of carbon and co-benefits. In addition, dense webs of political actors and economic interests come to the forefront as countries become «ready for REDD+».

Evidence-based policy design and formulation aims at devising policies based on rigorous and objective information (Petrosino et al. 2001). While a factual basis is crucial, decision making is inherently a political process, and the outcome of procedural and technical policy solutions are affected by power relation in the relevant policy arena. Multiple actors, both governmental and non-governmental, with their multiple interests, bargain and negotiate to formulate public policies, often in network structures formed around their interests. Such a process may not produce optimal outcomes (Peskett and Brockhaus 2009, Moog et al 2012 conference paper, Brockhaus and Angelsen 2012). National REDD+ policy processes should be understood as negotiated political processes, with politics and political economy aspects being critical for the outcomes. Effective, efficient and equitable (3E) outcomes are then constrained or enabled by the political conditions which are contextual to the specific country and REDD+ policy domain. To understand the constraints and opportunities in policy processes, design and implementation, we have to recognize the political nature on these processes.

This paper deals with a particular aspect of the politics of numbers in REDD+, namely how information, measures and numbers are produced and used to support specific views on what REDD+ should look like. In particular, we investigate: (1) what are existing procedures for information sharing, (2) who holds information and has to be consulted in REDD+ policy design and implementation, and (3) which institutional and actor-related factors enable or hamper evidence-driven definition, measurement and reporting as well as diffusion of numbers and information across the REDD+ policy arena.

We draw on the "4I" framework developed in Brockhaus and Angelsen (2012), and investigate how institutional stickiness, as well as actors' ideas and interests interact with the fourth I in the REDD+ arena, information, and how this affects the potential for transformational change required to realise REDD+ outcomes. We present results from a global comparative research project (GCS) undertaken by the Center for International Forestry Research (CIFOR) since 2009 in 14 countries in Africa (Burkina Faso, Cameroon, DRC, Ethiopia, Mozambique, and Tanzania), Latin America (Brazil, Bolivia, and Peru), and Asia-Pacific (Indonesia, Nepal, Laos, Papua New Guinea, and Vietnam). The comparative analysis is based among other elements on country-level analyses of the drivers of deforestation, and the institutional and political economy context in which REDD+ policies are being designed, a media based discourse analysis, a policy network analysis, and a content analysis of REDD+ policy documents. All these elements were designed for comparative analysis through the development of extensive guidelines (for an overview on methods and specific guidelines see Brockhaus and Di Gregorio 2012; Brockhaus et al 2012; Di Gregorio et al 2012).

Our findings indicate that despite the increasing levels of investments in countries' MRV systems, as well as analysis, knowledge and early lessons from ongoing REDD+ policy processes, there is still limited understanding and in consequence, limited action for curtailing the impact of politics on numbers and information on effectiveness, efficiency and equity of a REDD+ mechanism, and what factors would enable effective information sharing. In addition, our evidence indicates limited political will and interest in "getting the numbers right", and that data insecurity and lack of clarity may serve then as a justification for inaction.

K-2219-02

Politics of numbers in REDD+: the case of reference levels

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Designing and implementing REDD+ assumes quantification of past and current carbon emissions, constructing a counterfactual future scenario for emissions (i.e. the reference level - RL), as well as indicators for (change in) non-carbon benefits. Most REDD+ countries are characterized by a poor data foundation for undertaking such quantifications, resulting in high uncertainties. In addition, choices have to be made related to what exactly should be measured (including the definition of what constitute a "forest"), the approach to measuring the selected variables (e.g. scope, quality standards), and how the data should be independently verified.

This lack and uncertainty of relevant data creates a fertile ground for "gaming", defined as the manipulation of data for own benefits. "Gaming" does not imply fabricating data (although that might happen too), but rather processes where the unavoidable choices in data generation are heavily influenced by self-interests. Different stakeholders

have different interests in what to be measured, the magnitude of the selected variables, and how the variables should be measured and verified. The most obvious example is how to set the RL in a result-based system: a high RL will give higher estimated emissions reductions and thereby higher payments to those assigned the rights to sell emission reductions. Even without payments, the RL provides a benchmark for measuring the performance of projects and policies, with the credibility and reputation of NGOs, donors and governments being at stake. More generally, what is being measured shapes the political agenda and how different interests are being balanced in the political process. What is being counted counts.

We hypothesize that the degree and nature of gaming with numbers depends on both the underlying uncertainty, the extent and quality of the existing data base, the stakes at play, the informal constraints set by the political environment (e.g. transparent and critical debates), and the formal process for generation and verification of data. We use the RLs in REDD+ as our empirical case, and review RL proposals submitted to UNFCCC by key REDD+ countries. While UNFCCC provides general guidelines for setting RLs, scope for systematic biases of RL exist in the definition of forest, reference period for historical deforestation, adjustments for national circumstances, activities included, pools included, and the emission factors applied.

K-2219-03

Operational approaches for mapping tropical forest biomass and degradation patterns using optical and radar satellite data

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Tropical forest mapping is a basic need for a wide range of users, from fields as diverse as forestry, mining and conservation or for gaining carbon credits under practices related to the Reduced Emissions from Deforestation and forest Degradation (REDD+) framework. Technical difficulties to validate cost-effective procedures to monitor forest structure from space are a hindrance to the increase in number and impacts of REDD+ projects, especially those that aim tackling forest degradation (i.e. REDD's second D). Even punctual logging operations (e.g. selective logging) can lead to a persistent decline in forest goods and thus be a precursor to forest degradation. For projects quantifying and mapping dense tropical forest structure and dynamics at region to country level is a challenging, yet pressing need, notably but not exclusively for assessing carbon stocks and fluxes. The 'Forest' project, funded by EIT - Climate KIC (UE) aims at providing state-of-the-art mapping products for stakeholders requiring a reliable monitoring of tropical forest structure and derived variables. It is built on Airbus satellite fleet bearing optical and radar sensors. It refers to ground and airborne LiDAR data from Central Africa and South America as to calibrate signal inversion under high standards of quality control. The present contribution gathers the results of sensitivity studies carried out by the project team, using very high resolution optical data, as well as synthetic aperture radar data. We present the potential of these two complementary sources of data for assessing critical forest parameters such as above ground biomass density, canopy height and degradation levels.

Despite their broad availability, medium to high resolution optical imagery (e.g. Modis, Landsat 8 or Spot 5) exhibit important limitations when it comes to quantify forest structure variation in high biomass density environments. In contrast to the deforestation phenomena, signals over tropical forests are known to saturate early after canopy closure, bluring the measurement of degradation or biomass. Moreover, instrumental noise (BRDF, atmospheric pollution) is often higher than signal. It is therefore necessary to turn to other spaceborne biophysical observables to monitor forest parameters. In the optical domain, Fourier texture features obtained from very high spatial resolution (e.g. Pléiades) optical data provide non-saturating proxies for stand parameters, including above-ground biomass, within the highest standards of precision (RMSE < 15%) and accuracy achieved to date from remotely sensed data. The influence of acquisition geometry (sun-view angles), that usually hamper regional or multi-temporal studies combining multiple acquisitions can be handled as to avoid biases. These results, and the increasing availability of large swath VHR sensors (Spot 6-7), open the way to applications requiring operational large scale forest structure and degradation monitoring and mapping, except in very cloudy contexts.

Weather-independent TerraSAR-X / TanDEM-X radar satellite data offer an interesting alternative for degradation monitoring, especially when observation frequency is critical. Amplitude change detection of radar time series can indeed be used to automatically detect small scale selective logging or other disturbances. Interferometric SAR features (coherence and INSAR height) derived from TanDEM-X mission data have proved to be correlated to forest structure parameters, enabling consistent estimates of forest height and biomass for large areas at high resolution. In regions where accurate external terrain models are available, e.g. from airborne lidar LiDAR campaigns, the approach using INSAR heights can achieve high accuracies in tree height (LE90 of 7.5m) and biomass (RMSE below 10%) estimation.

Both SPOT6/7 and TanDEM-X data allow producing accurate LULUCF maps compliant with the six land categories mandatory for GHG Reporting as specified by IPCC guidelines. Thanks to information on forest structure, further stratification of the forest area into a range of forest types, including intact and degraded forests, can be achieved. These classes will represent the state of forests as a result of forest disturbance history and can be used to measure the performance and effectiveness of a wide array of mitigation actions as part of MRV schemes.

O-2219-01

Are REDD+ subnational initiatives protecting and improving the wellbeing of local stakeholders?

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REDD+ aims to restrict forest-based greenhouse gas emissions and increase removals. In REDD+ subnational initiatives, this is to be achieved in part by restricting forest access and conversion (negative incentive) and by protecting and improving the wellbeing of local stakeholders (positive incentive). One of the main means to achieve the latter is to produce a reward stream large enough to compensate the opportunity cost of forgone forest conversion, and to deliver it to stakeholders on condition that they successfully protect and enhance local forests (performance-based mechanism). Success in protecting and improving wellbeing is not a foregone conclusion, among other reasons because the most forest-dependent households are those most vulnerable to restrictions on access and conversion, because it has been challenging to produce the large and reliable stream of funding initially envisioned for REDD+, because (for lack of a strong performance-based mechanism) subnational initiatives have been placing strong reliance on non-conditional incentives, because organizations establishing REDD+ on the ground have found it difficult to create an appropriate tenure foundation that reinforces or stimulates forest stewardship while providing effective rights of exclusion to protect forests against outside claims, and because of the technical challenge of establishing effective MRV systems.

This presentation examines the performance of REDD+ in protecting and improving the wellbeing of local stakeholders on the basis of evidence in six countries, encompassing 22 subnational initiatives, 150 villages, and 4,200 households. Half the villages and households are inside and half are outside REDD+ initiatives, enabling robust comparison. Socioeconomic household data were collected at two points in time (2010-2011 and then 2013-2014) enabling longitudinal comparison of the effects of various kinds of interventions. The household data are both objective (e.g. income, assets) and subjective (respondent perception of the causes of wellbeing change over time). Data were collected on the full range of REDD+ interventions, including restrictions on forest access and conversion, forest enhancement, tenure clarification, environmental education, conditional and non-conditional livelihood incentives, and others.

Among the findings are that REDD+ negative incentives have a noticeable effect on forest-dependent households. This is because of high average dependence on agriculture and on clearing forests through shifting cultivation to maintain soil fertility and create new farmlands. Given the high dependence on agriculture, the perceived reasons for improved and worsening wellbeing relate strongly to the covariate fortunes and misfortunes of weather (sufficiency of rain, drought, etc.) and crop and livestock abundance and survival. REDD+ (with considerable variation among initiatives) does have a measurable effect on wellbeing - both negative and positive - but perhaps less than one might have anticipated given that REDD+ has been underway for seven years.

Indeed, REDD+ has had many challenges getting off the ground, and has a long way to go before realizing its objectives. Among the chief obstacles are political and economic interests (at all scales of governance) tied to the conversion of forests to non-forest uses, the difficulties in producing a sufficiently large and stable stream of rewards, and considerable difficulties in establishing an appropriate tenure foundation.

O-2219-02

Calibrating carbon cycle models to determine tropical ecosystem biomass stocks: A Tier 3 certification approach

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According to the latest IPCC report land use and land-use change contributes to 9-11% of total anthropogenic greenhouse gas emissions each year and thus changes in land management could provide short-term solution to mitigating climate change.

Initiatives to protect and enhance carbon stored in forests are meant to be enhanced through the implementation of the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism and countries are supposed to take an active role in its implementation. REDD+ requires biomass to be accurately measured, reported and monitored so that carbon can be protected and efforts are remunerated through a result-based principle.

One key challenge is related to how to measure biomass with sufficient accuracy for reporting and in a cost-effective manner related to the pricing of carbon. Taking these constraints into consideration, REDD+ reporting of biomass has been categorized into:

- high uncertainty estimates, i.e. Tier 1 using global biomass density estimates,
- to moderate uncertainty, i.e. Tier 2 using country-level biomass densities,
- and to low uncertainty, i.e. Tier 3, using carbon cycle models calibrated with forest inventory data.

Here we discuss a pathway for estimating Tier 3 carbon stocks in tropical regions using a carbon cycle model, ORCHIDEE, that is calibrated with forest inventory data and constrained by remote sensing data, to estimate project-level carbon stocks and fluxes in above- and belowground biomass pools. ORCHIDEE is in a class of ecosystem models known as Dynamic Global Vegetation Models, and simulates the establishment, growth, and mortality of trees using principles from eco-physiology.

Using tropical forest inventory data, the ORCHIDEE model is calibrated to reproduce growth rates of over and understory trees, and mortality, resulting in estimates of carbon and their change over time in biomass and in soil carbon pools. For project-level implementation, forest canopy height measured from either airborne LIDAR or space-based RADAR is assimilated to ORCHIDEE to extract corresponding carbon values.

Consequently, gridded maps of aboveground biomass, belowground biomass, soil carbon, leaf area index, net primary production, and net ecosystem exchange, at the corresponding spatial resolution, or mapping unit, to that of the canopy information, can be provided for REDD+ programs fulfilling the Tier 3 criteria. We demonstrate this processing chain for sites in French Guiana, Gabon and Cameroon.

O-2219-03

Expert perceptions on cost of increasing biospheric carbon in landscapes in Finland, Indonesia, Peru and Tanzania

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Good understanding of global variation in prices of adding biospheric carbon to landscapes could lead to a better allocation of scarce funding. Unfortunately, comparisons have been complicated by variability in ways to quantify cost and carbon benefits and how complications such as unsecure land tenure have been taken into account. Our objective was to quantify expert perceptions on cost of increasing biospheric carbon in Finland, Indonesia, Peru and Tanzania by conducting face-to-face interviews. For this purpose we developed a simple carbon bookkeeping tool with a spreadsheet and a more user friendly versions. We applied this future scenario carbon calculator, "CarboScen", in 64 interviews on 8 landscapes in 4 countries. The experts represented governments, NGOs, private sector and research and had their focus in national, subnational or local level. Prior to the interviews we parameterized CarboScen with best available local data on carbon densities and global understanding on speed of carbon density changes after a transition in land use. Instead of the normal, cost per sequestered unit of carbon, we asked the experts to imagine a payment of 1 USD and 10 USD paid annual for every extra ton of carbon stored in the landscape relative to a reference, business-as-usual, scenario. We then asked what kind of land use changes these payments could cause by showing carbon implications of numerous land use changes suggested by the interviewee with CarboScen. According to the perceptions of the experts of land use, marginal costs of adding carbon increased rapidly as the tenfold hypothetical payment of 10 USD lead to only a two or three fold additional carbon store relative to a 1 USD payment. The perceptions on the quantity of carbon added with a given payment were roughly proportional to carbon density of the landscape. Therefore adding carbon to the extremely carbon dense landscapes dominated by tropical peatlands in Indonesia was approximately ten times more efficient than in landscapes in Finland and Peru and the difference to landscapes Tanzania was even greater. Based on the reasoning of the interviewees, these large differences in cost of increasing carbon were caused mainly by differences in technically maximal mitigation potential, income from alternative land-uses and the understanding of the assumed "good governance and efficient distribution of the funding". It is likely that these perceptions reflect actual differences in cost of increasing carbon, and therefore should be taken into account when designing global climate change mitigation strategies.

O-2219-04

Pathways for sustainable REDD+ policies in Brazil

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Brazil's forests constitute 13% of the global forest area and almost 30% of the tropical forest area. They account for

a significant proportion of global terrestrial biodiversity and store about 20% of global above ground forest carbon. At the same time, Brazil's has a vigorous and dynamic agribusiness, being the world's largest producer and exporter of coffee, sugar, and orange juice, and is highly ranked in the production and export of soybean, corn, ethanol, pork, beef, and poultry chicken. Reconciling these two realities presents a major challenge to scientists and policy makers that will require up-to-date and accurate land cover/land use data and modeling tools. Within this context, the REDD-PAC project aims at providing a global forum for sharing and improving global data on forests and deforestation drivers and developing best practices for national REDD+ and land-use planning (see http://www.redd-pac.org). One of the main outcomes of the REDD-PAC project is the development of the GLOBIOM-Brazil model, a partial equilibrium, spatially explicit global land-use model for Brazil's agricultural, forestry and bioenergy sectors, over a 0.5 by 0.5 degrees spatial grid, adapted from IIASA's GLOBIOM. Among other refinements, validated with 2010 IBGE agriculture census data and PRODES/INPE deforestation data, the model includes a detailed and up-to-date representation of Brazil's land cover/land use data together with the main regulations of Brazil's new Forest Code (FC).

Here we present GLOBIOM-Brazil simulation results in the assessment of the economic and environmental impacts, over the period of 2020-2050, of FC's key new policies, namely, the restoration obligation (RO) of illegally deforested areas, the small farms amnesty (SFA) and the environment debt offset mechanism based on the CRA, a tradable legal title of forest surpluses. When compared to the non-additional policies scenario (NAPS), the FC has an overall positive impact on land cover changes and corresponding carbon emissions, with an increase of Brazil's forested area. This is accomplished without much impact in food production, which continues to grow during the coming decades, but, mostly, by conversion of abandoned land and low productivity pastures, mainly in the Amazon. We also observe that the RO policy is effective only to the extent that the ban on illegal deforestation is fully enforced, in order to avoid the trading between pristine and restored forests. As expected, both the SFA and the CRA mechanism have deleterious environmental impact, since they sensibly reduce the total forest deficit area to be restored by landowners. On the other hand, our simulations indicate that the CRA mechanism is effective in protecting areas of pristine forests, still rich in biodiversity, in regions subject to high economic and demographic pressure, such as the Atlantic Forest and the deforestation arch in the Legal Amazon.

O-2219-05

Addressing uncertainty upstream and downstream of emissions reductions accounting from deforestation and forest degradation: examples from Panama and Zambia

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Uncertainty in emissions and emission changes estimates constitutes an unresolved issue for a future international climate agreement. Uncertainty can be addressed 'upstream' through improvements in the technologies or techniques used to measure, report, and verify (MRV) emission reductions, or 'downstream' through the application of discount factors to more uncertain reductions. Uncertainties is an important consideration in the REDD+ context since 1) the land-use/cover change and forestry (LULUCF) sector is identified as the sector where uncertainties are the largest, 2) many developing countries still lack capabilities for estimating stocks and flows from forests, 3) the financial mechanism planned for compensating developing countries in their successful efforts to slow, halt or revert forest cover change could include the use of offsets. The integration of REDD+ in the climate regime is providing a new impetus to deal with uncertainty as the offsetting of more certain emissions from fossil fuel with uncertain ER (Emission Reductions) from REDD+ remains an open question with possibly large consequences.

In the context of Reducing Emissions from Deforestation and forest Degradation (REDD+), we provide a diagnosis of the main sources of error to greenhouse gas estimation from land-cover change and overall error using Monte Carlo analysis, using data from Panama, in Central America, and from Zambia, in Southern Africa. For Zambia, we estimate the overall error in emissions from land-cover change and partition the different sources of error starting from national forest inventories. For Panama, we look at the effects of forest monitoring improvements on reductions in uncertainty. We also test five downstream proposals for discounting uncertainty of the potential credits received for reducing emissions. We compare the potential compensation received for these emission reductions to the cost of alternative upstream investments in forest monitoring capabilities.

We show that upstream improvements can noticeably reduce the overall uncertainty in emission reductions. Furthermore, the costs of upstream investments in improved forest monitoring are relatively low compared to the potential benefits from carbon payments; they would allow Panama to receive higher financial compensation from more certain emission reductions. When uncertainty is discounted downstream, we find that the degree of conservativeness applied downstream has a major influence on both overall creditable emission reductions and on incentives for upstream forest monitoring improvements. Of the five downstream approaches that we analyze, only the Conservativeness Approach and the Risk Charge Approach provided consistent financial incentives to reduce uncertainty upstream. We provide policy relevant inputs for those countries to reduce uncertainty in estimates, taking into account natural variability and measurement errors. More generally, we provide recommendations on approaches to be use to address uncertainty upstream and downstream of accounting, especially relevant if REDD+ emission reductions are to be traded for emission reductions from other sectors.

O-2219-06

Addressing emissions from agriculture and agriculture-driven deforestation: opportunities for land-sparing and climate-smart agriculture

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Deforestation and forest degradation are major contributors of global greenhouse gas (GHG) emissions, accounting for a large proportion of many developing countries' GHG emission budgets (Baumert et al., 2005). According to Hosonuma et al (2012), in 13 countries agricultural expansion is responsible for 100% of deforestation. In this study we consider both emissions from agriculture-driven deforestation, and emissions from existing agricultural land to assess the mitigation potential of the agriculture sector. The inclusion of emissions from agriculture-driven deforestation aligns with recent interest in including agriculture in REDD+ strategies, which aim to directly address the driver of deforestation.

Emissions from agriculture are available at the national level however despite recent efforts to map and quantify land use and land cover change (ESA, 2013; FAO & JRC, 2012; FAO, 2014; Hansen et al., 2013), we consider that these are not suitable to determine agriculture-driven deforestation. This is because deforestation in this case has a focus on land-use changes (from forest to agriculture), so deforestation data based on a forest land-use definition is required. Gross change data are required since, in the cases of China, India and Vietnam for example, large-scale afforestation projects will mean that gains to forest area will underestimate deforestation (FAO 2010). Differences in data coverage, spatial resolution of datasets and in particular definitions of agriculture and forests make comparisons and integration difficult. A new approach combining available datasets of deforestation will be presented which estimates that agriculture-driven deforestation results in 4.3 GtCO2e y-1 from loss of above and below-ground biomass. We use empirical data on forest loss and use data on deforestation drivers to convert this to area of agriculture-driven deforestation.

Using our data on emissions from both agriculture and agriculture-driven deforestation, we consider at the national level the mitigation potential. We demonstrate the use of a systematic framework, which considers sequentially (1) the level and main source of emissions, (2) mitigation potential, (3) enabling environment and (4) risks. The level and source of emissions (1) considers the main source of emissions from either agriculture or agriculture-driven deforestation. Mitigation potential (2) assesses the potential for using climate-smart interventions in the agriculture sector or land-sparing options to address agriculture-driven deforestation. Land-sparing options are supply side interventions which reduce the need for the expansion of agriculture land. The enabling environment (3) is assessed by considering the governance, or engagement in REDD+ which can support the implementation of interventions. Risk (4) assessments identify the potential vulnerability of communities to changes to the agricultural system, and we use food insecurity as an indicator. Findings estimate the mitigation potential of existing agricultural land can be up to 1 GtCO2e y-1. Land-sparing interventions which close the yield-gap, or rehabilitate degraded land offer opportunities to mitigate up to 1.3 GtCO2e y-1 in the tropics where there is potential to close the yield gap or utilize available land and there is a good enabling environment. We highlight countries which are likely to require increased support to implement mitigation initiatives and where safeguarding is required to avoid risks to livelihoods.

This research supports discussions on REDD+ which acknowledge the inherent link between REDD+ and agriculture due to competition for land. We draw on recent debates on land-sparing, and discuss supporting policies which will be required to ensure that negative feedbacks are not realized. Although there is a need to look beyond the interventions covered in this study, we find a large potential for mitigation from these options. This study gives a comprehensive overview of national emissions and mitigation priorities within the forest and agriculture sectors, which can guide decision making and investments at the international level.

O-2219-07

The Warsaw Framework for REDD+: Implications for national implementation

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The adoption of the Warsaw Framework for REDD+ (WFR) [1] in 2013 has to a large extent concluded negotiations on REDD+ under the UNFCCC. Together with previous decisions, the WFR sets the requirements for developing countries to access results-based finance for mitigation actions in the forest sector, while attributing to the Green Climate Fund a «key role» among the entities channeling results-based finance to REDD+.

This article describes the WFR and indicates some of its implications for the implementation of REDD+ in developing countries. Rather than a commentary of each decision, it outlines the WFR from the perspective of measuring, reporting and verification (MRV) processes for REDD+ actions and access to results-based payments. The WFR has further centralized these processes. Such centralization has implications for the implementation of REDD+, in particular for those actors who favored a decentralized and/or subnational approach.

Centralization in this context means a concentration of procedures under the accountability of a national authority - one of the main innovations generated by the WFR. By linking the REDD+ MRV process to national reporting obligations under the UNFCCC and related procedures, it is the national government (i.e. the UNFCCC Party) that ultimately assumes accountability for REDD+ results to the international community.

Furthermore, by creating a national entity or national focal point, the WFR attributes to developing countries the prerogative to determine who is authorized to obtain and receive results-based payments on their behalf. The centralization under the WFR, therefore, goes considerably beyond the national, "border-to-border" approach to implementation and MRV of REDD+ activities. Centralization may, in fact, lead to increased accountability as it implies that there is a responsible national entity and that implementation and results of REDD+ activities will be/should be aligned with other obligations under the UNFCCC, such as national communications and inventories. This, in turn, requires increasing the level of inter-agency coordination and collaboration among the multiple stakeholders involved with implementing REDD+ activities.

Such an approach also increases transparency and coordination of actions and support through the use of an info hub and the application of the same guidelines and methodologies for all activities seeking results-based finance for REDD+ activities.

The objective of this paper is to stress that the UNFCCC has adopted a centralized approach at the national level. This may require adjusting national strategies and the relationship among actors at the national level in order to obtain results-based finance. This message, we believe, has not yet reached many stakeholders implementing REDD+, resulting in several initiatives currently being labeled as REDD+ which may not be in accordance with the multilaterally agreed rules.

The oral presentation will be structured in the following way:

1. Brief introduction to the WFR

2. Results-based finance for REDD+ activities and the requirements to obtain such

3. The MRV process

4. The roles of the National Entity/National Focal Point and the Green Climate Fund in accessing results based payments

5. The importance of the WFR for national implementation: identification of (actual/potential) effects and implications

[1] The WFR consists of decisions 9-15/CP.19.

2219-POSTER PRESENTATIONS

P-2219-01

Framework for Assessing Proximate Drivers, Agents, and Underlying Causes of Deforestation and Forest Degradation in REDD-plus Demonstration Sites in the Philippines

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International negotiations on REDD+ under the UNFCCC led to the COP-19 agreement to encourage countries to take action to reduce the drivers of deforestation and forest degradation. In order to define specific strategies for REDD+ and related measures, an analysis of drivers of deforestation and forest degradation is required for the DENR-GIZ project National REDD+ System Philippines. The study used the ASEAN Regional Knowledge Network's Decision Support Tool for identifying drivers of deforestation and forest degradation in two REDD+ demonstration sites in Eastern Samar and Davao Oriental, Philippines. An analysis of the forest cover change between 2003 and 2010 using available maps and official statistics was made. Carbon stock change analysis was done to determine the carbon stocks and emissions of identified land uses. The agents, proximate drivers and underlying causes of deforestation and forest degradation were identified through key informant interviews and focus group discussions. A participatory discussion and identification of priority proximate drivers through stakeholder-identified criteria resulted in a relative ranking of the drivers that need to be addressed by the project. Results of the field data gathered were subjected to further analysis to come up with opportunity costs of converting natural forest to other land uses. The results of this study will serve as inputs in the planning of strategies to address the drivers of deforestation and forest degradation in the REDD-plus demonstration sites.

P-2219-02

An Algorithm to Harmonize Different Sources of Land Use Information: Building a New Land Use Map for Brazil

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The last decades have witnessed an increasing use of land use models for several purposes, including policy evaluation and land use prediction. In general, these models try to capture the dynamics of different land cover and use classes, on a geographic grid, over sequential periods. Having a good input base map, with well estimated starting areas for the considered land use and cover classes, is important for the models to properly represent future shifts in land use dynamics. On the other hand, building a good land use input map involves combining information from different sources. In many situations, it is necessary to combine data from satellite images and data from property surveys. This is the case when one builds land use models for Brazil: in general, it is necessary to take into account information collected by the Institute of Geography and Statistics (IBGE), and combine this data to satellite images for land use, and to vector maps for protected areas.

Combining information from different sources may not be straightforward, because of inconsistencies caused by measurement errors, remote sensing image precision, and discrepancies for when information was collected, for example. In this paper, we present an innovative methodology, named Minimum Distance Allocation Method (MDAM), to help build a consistent map, based on the combination of different sources of data. The proposed algorithm is based on a minimization problem, according to which property survey data can be allocated to overlapping or surrounding model geographic units. Optimization restrictions are specified so as to avoid assigning crop, pasture or planted forest area to a model geographic unit located completely inside a preserved park, for example. Based on the proposed methodology, we constructed a new base map for Brazil, to be an input into the GLOBIOM land use model. In the end, we obtained estimates for number of animals (bovines), pasture area, planted forest area, area and production for different crops, per simulation unit. Although the exercise was performed to prepare inputs for GLOBIOM, the reader will find the MDAM general enough, so that it can be employed to prepare consistent input base maps for any land use model.

P-2219-03

Land use changes and emissions from deforestation in Guatemala: advances and challenges to prepare this Central American country for REDD+

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In spite of the fact that Guatemala is consistently listed as one of the most vulnerable countries to climate change, adaptation needs and gaps have not been the focus of governmental and non-governmental organizations dealing with climate change issues. Rather, most of the work on climate change for the last 15 years has focused on capitalizing on the potential for income from international sources derived from carbon-offset projects, first as part of the Clean Develop Mechanism CDM and more recently as part of avoided deforestation initiatives.

Our research group has accompanied this process for the last 15 years and this paper will present the most important advances in terms of producing the hard data needed to show recent deforestation and reforestation trends in the country, as well as advances in defining the governance system required to implement the National Strategy Against Deforestation which is the basis for REDD+ initiatives in the country.

We first discuss forest cover change information for Guatemala, where we observe a steady drop in the net deforestation rate from a high value of 1.7% measured for the period 1991-2001, to 1.3% for 2001-2006, to 1.0% for 2006-2010. This drop is not a result of a drop in the gross amount of cleared forest. Rather, it is a result of an increase in the forest regenerated, which includes new plantations and forest regenerating after disturbances such as fires and as secondary growth in abandoned agricultural fields. This is in part the result of a successful incentive program by the central government both for large and small holders (PINFOR and PINPEP), which provides monetary incentives for people and communities who plant new forests or preserve existing forest cover. Ironically, these programs have not been able to generate a single carbon credit because of problems demonstrating additionality.

In terms of the governance needed to reduce deforestation and to generate marketable carbon credits, this paper describes various significant advances in recent years. A climate change law was passed in 2013, which mandates the implementation of a series of policies to reduce and compensate emissions from sectors such as energy, industry and transportation. It includes some provisions to create a national registry for carbon-offset projects, which could set the basis for the development of an internal carbon trading system.

Beyond these national initiatives, many sectors within the country, including several government offices, are very actively pursuing the development and implementation of REDD+ initiatives to attract international investments. We will describe some of the governing issues under discussion, particularly the intergovernmental coordination needed to implement a proper Monitoring, Reporting and Verification (MRV) system and the discussions around the fair distribution of potential income from avoided deforestation projects in protected areas between the communities implementing the activities to reduce deforestation and the central government who is the legal owner of the land and therefore of the carbon credits to be generated. This of course has been a difficult issue to negotiate, which has resulted in tension between the communities and the central government.

Many of these issues and challenges are typical of situations encountered in developing countries around the world that have been pursuing the elusive goal of bringing in enough funding to reduce or stop their deforestation problems. Unfortunately, even after many years of work, international markets for carbon credits appear to be unreachable to communities in need of funds to improve their adapting capacites. National carbon markets may prove to be a more feasible solution.

P-2219-04

Agriculture-charcoal interactions as determinants of deforestation rates and forest degradation: Implications for REDD+ design in Zambia

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This paper simulates the relative contribution to deforestation and forest degradation of the two largest proximate drivers of deforestation in Zambia, which are charcoal production and agriculture, under different scenarios over the period 2015-2022. Different options to reduce land use change are examined using a computable general equilibrium model capturing Zambia's different agroecological zones (AEZs). The model assumes that forests used for unsustainable charcoal production are degraded, or can also be in part converted to land for agriculture use. However, land can also be deforested directly for agricultural use without going through charcoal production.

Results highlight how the interplay between charcoal and agriculture is important in determining deforestation rates and forest degradation in Zambia. For example, measures addressing exclusively charcoal drivers, such as decreasing its demand through improved stove

efficiency or improving sustainability of production reduce forest degradation, but are ineffective in reducing deforestation rates because land is cleared anyways due to demand for agricultural land. Conversely, measures addressing agricultural drivers, such as better reducing fertilizer subsidies in a targeted manner, or reducing land degradation through increased adoption of SLM measures, manage to considerably reduce deforestation rates, but have little impact on forest degradation.

Table 1. Predicted cumulative impact on forests in Zambia under different scenarios for the period 2015–2022: area deforested directly for agriculture, attributable to charcoal, and forest degaradation (million hectares).

	Deforestation directly for Agriculture	Deforestation through Charcoal	Forest Degradation	Total: deforestation + degradation
Business-as-usual	1.03	1.37	2.06	4.46
Stove efficiency (+30%)	1.44	0.97	1.46	3.87
Charcoal sustainability	1.69	0.71	1.06	3.46
Reducing fertilizer subsidies	0.65	1.38	2.06	4.08
Reducing land degradation	0.69	1.37	2.06	4.11
Potential REDD+ package	0.68	0.71	1.06	2.45

Simulations indicate that with a potential REDD+ package proposing a reduction of fertilizer subsidies in agroecological zones (AEZs) I and IIa, reducing land degradation through sustainable land management practices, combined with making charcoal production more sustainable and improving stove efficiency, approximately 1 million hectares of deforestation could be avoided in the period 2015–2022, and forest degradation reduced in an area of 1.06 million hectares.

We also report on welfare effects on small and large farm rural households in different Agro-ecological zones. The Business-as-usual scenario, as assumed in our simulations, is one where incomes grow over a period of 8 years by 120% to 150% among rural households. In AEZs I, IIa1, IIb, and III these gains are reduced only marginally (-1%to -4%) by the implementation of the REDD+ package envisaged in these simulations. Conversely, both small and large farm households in AEZ IIa2 are considerably negatively affected by the REDD+ package (-15% relative to BAU). These results would indicate that financial resources available under REDD+ may need to be allocated asymmetrically so that households in AEZ IIa2 are provided with appropriate incentives for losses incurred due to constraints associated with a REDD+ package. This would be particularly important because of the 990,000 hectares of reduction in deforestation, 400,000 are in AEZ IIa2.

P-2219-05

Drivers of deforestation in REDD+ countries: Results from a pan-tropical remote sensing analysis

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Within the United Nations Framework Convention on Climate Change (UNFCCC), negotiations are ongoing to build a framework for reducing emissions from deforestation and forest degradation, and to enhance forest carbon stocks in (sub)tropical non-annex I countries (REDD+). The UNFCCC considers addressing the drivers of deforestation and degradation crucial for the development and implementation of national REDD+ strategies and action plans, and encourages REDD+ countries to identify drivers and activities causing forest carbon emissions. Monitoring and tracking human activities that result in forest carbon change (e.g. deforestation by agricultural expansion, mining etc.) is crucial. Earth Observation data can be used to derive information on follow-up land use which generates understanding about proximate causes and drivers of deforestation. This research assesses and quantifies deforestation drivers in South America, Africa and Southeast Asia in a systematic manner, building on the 2010 global Remote Sensing Survey of the FAO Forest Resource Assessment. Deforestation drivers are assessed by visual interpretation of forest change patches depicted from satellite imagery to derive follow-up land use of deforestation from 1990 to 2005. This allows to quantify the proportion of deforestation drivers which are then used to assess forest carbon emissions per driver. The focus for this conference will be on presenting the spatial distribution, trends and trajectories of regionally specific drivers of deforestation and associated carbon emissions.

P-2219-06

The action of indigenous peoples of the Amazon and the political economy of environmental change

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This communication aims to analyse the attempts to reform land and resources management policies that emanate from the global climate regime and concern the Upper Amazon region. It examines some of the coalitions, alliances, and negotiation strategies that have accompanied and shaped the process of climate change politics from the preparation of COP 15 in Copenhagen (2009) to the preparation of COP 21 in Paris (2015). Using a form of multi-sited ethnography, it compares and contrasts the involvement in REDD+ (reducing emissions from deforestation and forest degradation in developing countries) negotiations of two transnational movements: the indigenous peoples movement, and the forest conservation coalitions. How do indigenous peoples of the Amazon region have occupied the political space created by climate change negotiations? Have they succeeded in gainning recognition and better access to resources and services within national boundaries? Do states, environmental organizations and indigenous peoples have found ways to avoid deforestation?

By following key mobilization processes of indigenous peoples during the period studied (2010-2014) in Peru, Colombia and Bolivia this paper aims to show the impact that indigenous peoples already have as political actors in the conservation of Amazonia. This comunications aims to contribute to the understanding of the role of indigenous social movements in normative global orders by focusing on the way this political realm transforms the relationship between the «human» and «the environment» engaging non state actors on this task.

P-2219-07

Do REDD+ social safeguards reach the 'right' people?

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There is extensive debate about the potential impact of the climate mechanism REDD+ on the livelihoods and welfare of forest-dwelling people. To provide carbon credits, a forest carbon scheme must slow the rate of emissions. If this is achieved by slowing the expansion of agricultural land there is clearly a local cost. Madagascar has attracted significant investment in REDD+ and has a number of pilot projects with World Bank support. We focus on one such REDD+ pilot - the Ankeniheny Zahamena Corridor (CAZ). Some 2500 households around the corridor have been identified under World Bank safeguards as containing 'project affected people (PAPs)' and are receiving individual income generation projects as compensation. There has been controversy as to how such people are identified. We carried out intensive field work in one administrative unit, mapping the location of each household and selected

a random sample stratified by location for detailed household interviews about livelihoods, food security, and assets. We compared the characteristics of households identified as eligible for compensation with those not identified as eligible. We found that people living closest to the forest, with livelihoods most dependent on the forest, were less likely to be identified as PAPs while those living closest to the village centre and with powerful social positions were more likely. We interpret this as evidence of elite capture of the benefits being distributed. Given the extremely poor information available on local populations (even the location of quite significant villages is not available from maps), and the unwillingness of people's whose livelihood depends on illegal agricultural expansion to self-identify, it is unsurprising that the official process faced challenges. We question whether the approach of identifying and compensating particular households is practical in such settings and discuss what this means for ensuring that REDD+ can be implemented without harming local people's livelihood.

P-2219-08

Forest Degradation, Regeneration, and Farmers' Income: Evidence from Smallholders' Decisions in Vietnam

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The interactions between agricultural production, forest conservation, and economic development are complex. Higher agricultural output prices and technologies that increase yield are expected to increase farmers' income and stimulate forest clearing, while higher agricultural input prices have mixed effects. On the one hand, an increase in the opportunity costs of labor makes agriculture less profitable and can reduce pressures on forests. On the other hand, raising costs associated fertilizer price may induce shift to extensive production systems that use more land and less fertilizer. This study presents new evidence about these relationships by focusing on forest degradation, regeneration, and farmers' income in Vietnam.

Vietnam has recently experienced forest transitions from net deforestation to net reforestation as many European countries and the United States underwent in the past. From 2000 to 2010, approximately 1.6 million hectares of timber forests were restored in the country. Reforestation, however, coincided with a net reduction of rich and medium timber forests, the area of which declined by 0.16 million hectares and 0.27 million hectares, respectively. In the meantime, the area of agricultural land increased by almost 2 million hectares, due largely to the expansion of permanent crops. Thus, understanding how agricultural sector affects forest resources and how these changes in turn affect rural economy have important implications for policy making.

The purpose of this study is to empirically examine the impacts of agriculture production on forest degradation and regeneration in Vietnam in the 2000-2010 decade. We compile highly detailed forest data for two years 2000 and 2010, which are derived from fine-scale vector data of land use developed by the International Center for Research in Agroforestry (ICRAF). The forest data are merged with ~40,000 household-level observations in ~ 3,000 communes from the 2008 Vietnam Household Living Standards Survey, which provides extensive information about farmers' income and expenditure. Using the data set, we address three questions: (1) How did agricultural output prices, input prices, and off-farm wage affect forest degradation and regeneration? (2) How did these changes subsequently influence farmers' income? (3) How did these influences vary with intensive agricultural production regions and frontier agricultural production regions?

Our study makes two contributions to the literature. First, the coexistence of forest degradation and regeneration in Vietnam provides an opportunity to study the influence of small farmers' decisions on forest resources at the micro level. The detailed forest data allow identifying changes in forest species, which helps to distinguish forest degradation from restoration. This is particularly important because to assess the impact of forest resource change on climate change, it is necessary to understand how forest carbon density changes. An oversight of the spatial pattern of forest species may cause misleading estimates.

Second, this study provides empirical evidence of the interactions between agricultural production, forest conservation, and economic development. Land use change is arguably the most pervasive socioeconomic forces affecting economic and environmental systems. These forces drive a large portion of global economic and environmental problems. Solving these problems requires a renewed focus on these interactions.

P-2219-09

Under-estimation of forest biomass loss with REDD+ standard reporting method

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Tropical deforestation is estimated to total approximately 13 million hectares per year in the period 2000-2010. Tropical deforestation, resulting from different causes, is thought to be a major contributor to GHG emissions, leading to emissions of CO2 and, if the biomass is burnt during the clearing process, additional non CO2 gases. Emissions from tropical deforestation, forest and peat degradation are currently estimated to be 15% of the world's anthropogenic GHG emissions, mainly through CO2 emissions (in the range of 8-20%). In response to the evidence by the scientists of the value of protecting forests in tackling climate change, policymakers have developed a family of policies, collectively known as Reducing Emissions from Deforestation and Degradation (REDD+) to provide a financial incentive to governments, agribusinesses and communities to maintain rather than reduce forest cover. A key question for REDD+ measurement reporting and verification (MRV), is how much aboveground biomass (AGB) or carbon has been released. The standard method for REDD+ MRV consists in using earth observation optical data to assess change in forest cover, together with a priori knowledge of values of forest carbon per unit area. The shortcoming of the method is the lack of reliable distributed forest carbon density (biomass). In addition, current MRV results using optical remote sensing are dependent on the retained UNFCCC forest definitions, which are characterized by threshold values of tree crown cover, tree height, and minimum area. Synthetic Aperture Radar (SAR) data are sensitive to forest AGB; thus an adequate SAR system, with long wavelength, could provide mapping of AGB and its change over time to be used for estimating carbon emissions. The available long wavelength SARs are 25 centimetres wavelength (L-band). Whereas AGB of dense tropical forest cannot be retrieved from L-band SAR data, biomass mapping of low AGB forests using spaceborne ALOS-PALSAR data has been object to several studies. Recently, mapping of savanna forest AGB has been achieved at 100 m resolution over Sub-Saharan Africa [1]. In this paper, the focus is on the assessment of African tropical AGB over the so-called 'non forest' class, which is not taken into account into REDD+ processes. To do so, the AGB map from [1] has been improved and AGB from this map has been assessed in various countries over areas from the Landsat tree cover benchmark map [2] that are not considered as forests. The AGB map from [1] at 100 m resolution results from an inverse model based on the empirical regression derived from insitu data and 2007 ALOS PALSAR data. A collection of AGB estimates over 81 plots (mean plot size is 0.98 hectare) from 7 African countries was used in this study to improve the AGB map. The mean AGB is computed over tree crown cover values lower than 30%, the most widely used threshold. The results show that biomass loss estimation is clearly under-estimated when using standard methods such as changes in forest cover using spaceborne optical data. For example, the biomass stocks of non forest class in Zambia, a UN-REDD partner country, is 1,509Mt in this study and represent 31% of total biomass stock in Zambia (4,914 Mt), where fires make a significant contribution to greenhouse gas emissions in miombo woodlands that cover almost half of the country. The biomass stocks of non forest class in Zimbabwe, another UN-REDD partner country, is 1,078Mt in this study and represent almost the total biomass stock in the entire Zimbabwe (1,086 Mt). Such a high AGB value associated to the non forest class leads to a significant underestimation of the carbon emissions associated to deforestation and degradation of savanna woodland. Within higher latitudes, mean AGB in non forest class was found to be logically lower but far from negligible. Therefore, SAR data could support REDD+

MRV, especially with the launch of BIOMASS satellite in 2020.

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P-2219-10

Large scale agrofuels projects in the Tana River Delta, Kenya: an assessment of their purported climate benefits and their impact on ecosystem service delivery for the local population

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Over the past decade, the Tana River Delta in Kenya has attracted a lot of interest from foreign investors aiming to start large-scale development projects for agro-fuel production. Most of these projects have failed either to commence or to thrive but others are continuously coming up. From 2010, Bedford Biofuels a Canadian company acquired 160 000 ha of Land on the terraces surrounding the delta with the plan to convert it to a vast Jatropha curcas plantation. The rationale behind the investment was that the delta lands are unproductive and could be used to produce cheap and climate-friendly agro-fuels.In order to check this assumption a survey was conducted in May 2012 on the project area, assessing its woody vegetation and standing carbon stocks in order to compare their potential for REDD+ schemes with the proposed direct land use change by conversion to agro-fuel farms. This carbon stock assessment, combined with a wider analysis of the ecosystem services provided by the delta terraces, have shown that there are more opportunities for the local communities in their current use of the Tana Delta land than in the option of the conversion to a vast Jatropha field. In this presentation we put emphasis on the risk of developing large scale agro-fuels projects without properly taking into account the various values of the ecosystem to the local users and without considering the existing customary land tenure rights.Resilience to climate change is more likely to improve when land rights are secured for traditional semi-nomadic livestock keeping and participatory land use planning with all use planning with all users.

P-2219-11

The development of FOREST: a Fully Optimised and Reliable EmissionS Tool

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The objective of this poster is to present the different scientific components of the FOREST (Fully Optimised and Reliable EmissionS Tool) project that gathers since 2014 the expertise of seven European institutions working together thanks to funding provided by the project funded by the EIT- Climate KIC.

The FOREST project aims to positively respond to the growing demand of forest carbon stakeholders for trusted, fully integrated and cost effective Measuring Reporting Verification (MRV) service components, enabling forest carbon projects and initiatives to achieve carbon goals, i.e. emission reduction and/or stock enhancement. It brings essential building blocks for such services including the observations from space, the local in-situ ground measurements to calibrate these observations, the forest maps and the theoretical model needed to estimate and manage the carbon sequestrated in forested areas. By providing cost effective capacities driven by market and end users, the project will improve the process of MRV for forest carbon at project/national scale.

Remote sensing by satellite is a practical way to get large geographical and ideally global information about forests, especially in remote regions that are difficult to access. Satellite imagery, optical and radar, is used to basically determine land cover/use and land cover/use changes and to map forests. It provides essential information that is used:

- to establish historical forest maps
- to feed carbon model
- to design / optimize sampling scheme
- to understand drivers of deforestation & degradation
- to measure performance of projects and effectiveness of public policies

Although pre-operational solutions exist, some issues such as the lack of standardization, the overall cost (transaction and implementation) or the overall achievable quality & reliability can hamper the development of the forest projects and undermine market attractiveness. There is considerable room for improving existing methods and to design innovative solutions, for developing solutions that bring effective value to money, for tackling pending issues that are key priorities in the international negotiations such as degradation monitoring.

The FOREST partners are currently working on developing 'forest mapping' and 'carbon modelling' services relying on:

- Provision and processing of Earth Observation (EO) data (optical and radar) for deriving primary products required in the assessment of forest cover and change,
- Determining canopy texture features at local and regional scales based on these EO data for a better characterization of forest structure
- Developing the ORCHIDEE carbon flux model which is already recognized by the scientific community towards its operational implementation in national and regional REDD+ MRV systems.
- Quality Assurance, calibration and validation strategies for each step supported by existing ground based in situ measurements or products accuracy assessment already established through robust metrological practices will allow to provide an uncertainty for the overall services.

In order to assess the market size for this technology and to evaluate the potential savings for project developers a market analysis will be performed.

The poster will present the technical approach of this project as well as the different outcomes that can be achieved through this interdisciplinary collaboration.

P-2219-12

Conservativeness and technical corrections foster broad participation and advanced reporting standards for REDD+

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The proposed presentation deals with one of the main issues for scientists and policy makers regarding the combat against global climate change in the realm of tropical forests: the realization of a credible mechanism to reduce emissions from deforestation and forest degradation (REDD+).

One of the major topics within building the framework for REDD+ are uncertainties associated to estimating reduced emissions via a measurement, reporting and verification (MRV) system. IPCC requires applying the principle of conservativeness to address these uncertainties (IPCC 2006) by constructing a reliability interval around a carbon stock estimate and utilize the lower bound of the interval for reporting. This, however, can have severe consequences to countries that are willing to participate in the REDD+. Despite successfully reducing emissions, some countries may have little to no chance of achieving benefits from REDD+ due to high uncertainties and the application of the principle of conservativeness (Köhl et al. 2009, Plugge and Köhl 2012, Plugge et al. 2013). In consequence, this would preclude many countries from participating in REDD+. Broad participation is, however, one important prerequisite to make the mechanism a success, e.g. to reduce undesired displacement of emissions (leakage) as explicitly mentioned in the safeguards (UNFCCC 2011) or to achieve the overall 2°C goal. Consequently, to be able to participate in REDD+, countries need to implement higher MRV and reporting systems standards (Tier 2 or Tier 3). At the moment most countries are not in a situation to meet these high standards due to (among others) capacity or costs constraints.

In this study we identify a way of how to overcome the consequences that uncertainties and the principle of conservativeness may have with regard to the participation of countries in the mechanism. To lower the entry threshold for countries interested in REDD+, recent discussions (Grassi et al. 2013) involve the option of temporarily reducing the strictness of reporting and applying a discount for uncertainties. The study analyzes the effectiveness of this proposal for two accounting periods. Our results confirm that by lowering the entry threshold participation is fostered and benefits from reducing emissions are achieved by the countries. However, at the same time our results show that countries would make a profit by maintaining low reporting standards with associated high uncertainty. Nevertheless, continuously advancing in the MRV and reporting standards is a prerequisite for participation in REDD+. To overcome this discrepancy we propose to allow for adopting technical corrections implemented in the Kyoto Protocol also for REDD+ reporting. Technical corrections are used for a backward recalculation of reported values when the MRV and reporting standards have been improved towards higher standards. We show that by including technical corrections countries profit more than by maintaining low standards. Therefore, the combination of conservativeness and technical corrections represents a coherent solution to promote reliable and advanced reporting, foster broad participation, and achieve benefits from REDD+.

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P-2219-13

Land-use protection for climate change mitigation

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Land-use change, mainly the conversion of tropical forests to agricultural land, is a massive source of carbon emissions and contributes substantially to global warming [1]. The future development of forest area is uncertain, but deforestation is projected to persist as a significant emission source in the absence of new forest conservation policies, especially under increasing demand for agricultural commodities. Despite the general scientific agreement on environmental benefits of forest conservation, and although the United Nations Framework Convention on Climate Change (UNFCCC) has affirmed the potential role of forests in stabilizing the global climate, no global action has yet emerged to conserve natural forests. One key issue for the implementation of REDD (Reduced Emissions from Deforestation and Degradation) is how to address leakage of emissions [2]. Without full participation of all countries in a forest conservation scheme, emission reductions in one location could result in increased emissions elsewhere, as agricultural expansion, the main driver for deforestation, could just be displaced rather than avoided (international leakage). However, carbon leakage is not only relevant in the context of regionalized forest protection efforts. Another risk associated with a global REDD scheme that so far has not been quantified in the literature is the shift of land-use pressures to non-forest ecosystems (non-forest leakage), simply because they are the only remaining resource for agricultural expansion. Such ecosystems may also be rich in carbon. First, areas under natural vegetation other than forests, such as shrublands and savannas, can also store considerable amounts of aboveground carbon. Second, carbon-rich soils also play a major part in the terrestrial carbon balance and have to be taken into consideration. For this reason, carbon stocks decline strongly after land is converted from grasslands and pastures to cropland. Finally, agricultural activity can reduce carbon sequestration by preventing regrowth of natural vegetation on abandoned agricultural land.

In this study, we estimate land-use and associated carbon stock dynamics for different global terrestrial carbon policies at global and regional scale using the land-use optimization model MAgPIE (Model of Agricultural Production and its Impacts on the Environment) [3, 4]. We show that a global forest policy could reduce carbon emissions by 77 Gt CO2, but would still allow for decreases in carbon stocks of non-forest land by 96 Gt CO2 until 2100 due to non-forest leakage effects. Furthermore, abandonment of agricultural land and associated carbon uptake through vegetation regrowth is hindered. Effective mitigation measures thus require financing structures and conservation investments that cover the full range of carbon-rich ecosystems. However, our analysis indicates that greater agricultural productivity increases would be needed to compensate for such restrictions on agricultural expansion.

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P-2219-14

Ensuring community benefits; case study of REDD+ in Ghana

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In the last decade, United Nations negotiations have been on going on using forests to mitigate climate change via the mechanism known as Reduced Emissions from Deforestation and Forest Degradation plus the added value of conservation, enhancement of forest carbon stocks and sustainable forest management (REDD+). With support from organisations like the World Bank and the collaborative efforts of UNDP, UNEP and FAO, forest countries across the globe have started to get REDD+ ready. Getting REDD+ ready includes running pilot projects and implementing other readiness initiatives to feed into the systems and strategies countries are laying out for REDD+ and to reform already existing climate and forest governance institutions. The purpose of this research is to understand how local communities harness such new carbon economy opportunities (or not). The study is a multi-sited case study approach in Ghana employing systematic literature review, semi-structured interviews, actor mapping, focus groups and document analysis as the main methods of identifying what can be learnt at the international level from the local level implementation of such carbon mechanisms.

P-2219-15

Future scenarios for the north of Amapá State considering REDD+ as a conservation tool

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The ecosystem services provided by forests are important for ecosystem maintenance, and support, protect or affect the activities and human well-being. Much of the forests in the north region of Eastern Amazon are under some type of protection, being one of the most pristine areas of the Amazon. In Amapá these forests may be threatened by being in an area of the border with French Guiana, where the current political development of the State is being targeted, resulting in actions that modify the current scenario and pressure on natural resources in the region.

This study assessed how the provision and maintenance of ecosystem services such as carbon stocks can contribute to local and regional sustainable development. This study allowed creating development scenarios for the northern region of Amapa to 2030. These results contribute to the discussion of a policy to subsidize programs aiming at reduction of emissions from deforestation and degradation (REDD) and payment for ecosystem services (PES) implementation, by defining priority areas in the border region between Amapa and French Guiana.

This study was conducted in the northern region of the State of Amapa across the municipalities of Calçoene and Oiapoque. This area lays within the Guyana Shield, which is characterized by a low population density, difficult access to remote forest areas and for being a geological and biological unit where high levels of endemism and biodiversity exists.

The opportunity cost of avoiding forest conversion was generated using information of the net present value (NPV) of four land use activities (forest, cattle ranching, and gold mining) and the average carbon stock values of these land use categories. This latter data was associated with a land transition matrix, processed using the REDD Abacus SP software. The output was the differences derived from the returns of the forest and those land uses that will replace it, with differences in carbon stocks of the emissions avoided by not converting the forest to other uses. Three opportunity cost scenarios were modelled to which a sensitivity analysis was done and, based on these results, scenarios were simulated.

The cumulative reduction of forest cover in 2030 was higher in the pessimistic scenario compared to the other two simulated scenarios. In the optimistic scenario, we observed a clear effect in reducing deforestation by implementing a program of PES-REDD+, which resulted in a level of deforestation close to the historical projection.

The opportunity cost of avoiding the conversion of land use at the current per ton of carbon price (R$ 14.6/tCO2e = $ 7.5/tCO2e) varied between R$ 3.00/tCO2e and R$ 2410.00/tCO2e, corresponding to a potential annual reduction of emissions between 0.14 and 0.02 tCO2e per hectare. The largest potential abatement of emissions derived from avoiding forest conversion to cattle ranching activities (0.14 tCO2e.ha-1.year-1) at a cost of R$ 3.00/tCO2e. Included variations in profitability (NPV) of land uses associated with the three scenarios of deforestation, livestock continue to be the most attractive activity for the implementation of a REDD + project.

In modeling the opportunity cost in terms of the three scenarios of deforestation, we found that the pastures activities remained as the most attractive activity for developing REDD+ projects, with an average cost of R $ 4.93 ± 2.73/tCO2e for the three scenarios, at the current average price per ton of carbon. This shows the potential of establishing a program of payment for environmental services with small cattle ranching producers who practice a low-productivity activity.

The balance between the implementation of conservation policies and economic development will give the state alternatives for successfully implement REDD+ mechanism. However, this success will depend on strengthening of institutional capacities and land regularization measures, which will provide the necessary information to the construction of the policies and the REDD+ strategy of the state. This study gives various elements to support the construction of such a policy, especially for the construction of its baseline.

2220 - Landscape level adaptation and mitigation: integrating science, policy and practice

ORAL PRESENTATIONS

K-2220-01

Adaptation Services : How biodiversity can support climate adaptation pathways

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This abstract is a submission to parallel session N° 2220 of theme 21: Landscape & ecosystems adaptation, with the title «Landscape level adaptation and mitigation: integrating science, policy and practice»

The IPPC Climate Change 2014 Synthesis Report states it is very likely that surface temperature and sea levels will continue to rise and that extreme weather events become more frequent and severe. The interaction of climate change with other drivers of global change amplifies existing risks to social-ecological systems, and creates new ones. Adaptation to climate change should therefore

be acknowledged as a long-term driver of economic, social, political and cultural transformations.

Ecosystem services are often valued for their immediate material or cultural benefits to human well-being, although in the medium- to long-term ecosystem services that sustain such benefits (referred to as regulating and supporting services in the Millennium Ecosystem Assessment terminology) must be considered. In the context of climate change and its expected dramatic and likely abrupt impacts on ecosystems and on societies, an additional role for ecosystems towards human well-being has been considered, and referred to as Ecosystem-based Adaptation. Going one step further, a broader framework can be proposed for the identification, understanding and management of so-called adaptation services. Adaptation services are defined as the benefits people derive from the capacity of ecosystems to moderate and adapt to the effects of climate change.

Adaptation services differ from ecosystem services by formally recognising the intrinsic ability of ecosystems to provide valuable services for societal adaptation by (i) buffering risks, (ii) providing options and (ii) transforming. In contrast to ecosystem-based adaptation, which has been addressed under decision-making status quo, for adaptation services to emerge and inform effective adaptation, new decision contexts that incorporate the integrated transformation of values, rules and knowledge are required. In particular, new transdisciplinary knowledge will be required to drive such social changes, and to achieve consensus on decisions and actions.

As a first step, the uptake of the concept of adaptation services by scientists, managers and policy makers requires proof of the concept and identification of key underpinning mechanisms so as to move beyond a conceptual definition and iconic story lines, and to develop innovative management solutions. In this presentation we will demonstrate such a proof of concept by means of a common methodological framework applied to ecosystems from a range of latitudes and with key roles in ecosystem-based adaptation to climate change.

This framework facilitates implementation of an adaptation services approach and enables synthesis across case studies. In particular, using such a comparative approach we propose hypotheses on functional mechanisms underpinning adaptation services required to support transition and transformation of socio-ecological systems, such as the role of keystone species and keystone functional groups or the role of different types of response diversity. Landscape connectivity already does, and is expected to play a key role for transition and/or transformation of fragmented systems.

We then identify initial principles for the management of adaptation services that range from the management of pre-existing adaptation services that will support autonomous adaptation, to planned adaptation by steering new adaptation services, and to the restoration of adaptation services in degraded ecosystems. Lastly we discuss alternative adaptation pathways that could meet multiple objectives of nature conservation and human well-being.

K-2220-02

Ecosystem services in forest conservation for climate change mitigation: a cross-site analysis of REDD+ projects

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This presentation is part of parallel session 2220 «Landscape & ecosystems adaptation» with the title «Landscape level adaptation and mitigation: integrating science, policy and practice».

The presentation provides insights into the role of ecosystem services in projects for reducing emissions from deforestation and forest degradation (REDD+). The role of ecosystem services in the design of 39 REDD+ projects was analysed in a cross-site comparison, revealing opportunities and trade-offs in delivering climate change mitigation, adaptation and sustainable development at the landscape level.

REDD+ has become a well-established building block of climate change policies under the UNFCCC. Policies require REDD+ projects to comply with safeguards for maintaining and enhancing forest ecosystem services. This cross-site analysis of REDD+ projects indicates, that the majority of REDD+ projects do address multiple ecosystem services relevant to climate change mitigation, adaptation and sustainable development, with benefits to local communities. However, the analysis also reveals challenges when it comes to the effectiveness of REDD+ projects in mitigating carbon emissions and at the same time providing benefits to local communities.

The findings of this analysis inform on 1) how REDD+ projects comply with safeguards defined in UNFCCC policies, and 2) how REDD+ projects contribute to mitigation and adaptation at a landscape level.

K-2220-03

REDD+ delivery models at landscape level: the crucial role of private sector, for session «N° 2220 -¬□ Landscape & ecosystems adaptation» with the title «Landscape level adaptation and mitigation: integrating science, policy and practice»

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Addressing REDD+ requires interventions at scale to address the drivers of deforestation and forest degradation within large landscapes where competing users and land uses provide an opportunity and a challenge in reducing emissions. IIED has been conducting research to understand the role and risks of private sector in REDD+ as well as the institutional and policy frameworks that govern their involvement in implementation of REDD+ – particular focus was on carbon rights and benefit hsaring. A database of 115 REDD+ initiatives in Africa, Asia and Latin America was constructed. Case studies from DRC, Mozambique and Tanzania provided for detailed analysis of the legislations and institutional arrangement in place at national and local level. This presentation will share some of the key findings related to issues of carbon rights and benefit sharing as clarity on this is core to REDD+ delivery models that are inclusive, equitable and sustainable. In addition, IIED is conducting research and testing REDD+ at the Beira Landscape Corridor in Mozambique including three provinces (Manica, Sofala and Zambezia) in which four models were identified to address key drivers in agriculture, biomass energy, timber and non-timber harvesting practices. The role of private sector in implementing sustainable land use changes to reduce emissions is important. However, it has been equally acknowledged that public finance for REDD+ can only do so much. Private capital is needed to provide the impetus for large scale and sustainable investment required for meaningful and measurable emissions reduction. There are questions however: what is the formulae for this private capital and who are the winners and loosers? Is the model economically viable as well as socialy and environmentally sound? Are the local small scale enterprises requiring the capital to invest in sustainable land uses likely to be a conduit for generating profits for financiers alone or they stand to gain as well? What safeguards need to be in place to secure win-win solutions?

O-2220-01

The role of ecosystems in Disaster Risk reduction

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Ecosystems have the capacity to play an important role in disaster risk reduction (DRR) as well as in climate change

adaptation (CCA). In the context of DRR, ecosystems contribute to hazard mitigation as well as to the reduction of the so called "underlying risk" as outlined in the Hyogo Framework of Action (HFA, 2005). Although engineered structures are still preferred and promoted by planning authorities dealing with disaster risk reduction in many cases, there is an increasing number of applications of ecosystem based solutions in disaster risk reduction worldwide. Similarly ecosystem based adaptation (EbA) measures in CCA are gaining recognition. Examples of such measures are wave dampening by willow or mangrove forests, functional green infrastructure in urban areas or sustainable land management in drylands. The ESP working group on Ecosystem Services and Disaster Risk reduction aims to integrate the concept of ecosystem services into DRR and CCA and provides a platform for research investigating the potential of ecosystem-based approaches for Disaster Risk Reduction (DRR). After discussing relevant concepts and identifying potential synergies, this presentation will showcase a number of applications in a range of contexts based on the existing research activities within the working group. For some selected cases, the role of ecosystem services and how they contribute to reducing risks and vulnerabilities and/or contribute to climate change adaptation will be presented. The presentation will also highlight linkages to other ESP working groups that provide solutions for disaster risk reduction from specific ecosystems perspective, such as for fresh water and marine environments.

O-2220-02

A Community Forestry-landscape based approach to climate change adaptation

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International debate on the role of forests in climate change has thus far mainly focused on their potential to mitigate Greenhouse Gas emissions (GHGs), particularly through the REDD+ mechanism. However, the role of forests in contributing to climate change adaptation has been gaining recognition. In addition to the efficiencies in linking adaptation and mitigation funding and project activities, a key rationale for focusing on forest landscapes for adaptation is the reliance of approximately 450 million people on forests in the Asia Pacific region alone. The contributions of forests to the livelihoods of these local communities is significantly higher than previously thought and thus a major contributor to their adaptive capacity. Conversely, local communities may prove to be critical in on the ground implementation of activities to support ecosystem resilience. Community forestry (CF) in this context is of particular importance as a modality for providing multiple benefits to local communities, and the various assets required for adaptive capacity in a context of climate change. The focus of this research article is to present a CF based climate change adaptation framework, which is grounded in 10 case studies in Cambodia, Indonesia, Nepal, Thailand, and Vietnam, and the recent piloting of this framework in the Terai of Nepal.

2220-POSTER PRESENTATIONS

P-2220-01

Ecosystem services as determinants of social-ecological system transformations: Dojran Lake, Macedonia

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Global environmental change often triggers abrupt and irreversible ecosystem shifts resulting in transformations of social-ecological systems. The capacity to adapt to such variable and uncertain conditions is a unique learning opportunity to better understand factors underpinning system's resilience to shocks. This study examines a social-ecological system through the lens of ecosystem services and their role as determinants of a transformation. The project Integrated Water Resource Management (IWRM) at Dojran lake in Macedonia applied the ecosystem services framework to examine the impacts of sudden natural disasters affecting Dojran Lake in Macedonia. Once a significant site in the Balkan peninsula, known for its water health benefits, fisheries, and abundant hydrological resources for agriculture and surrounding settlements, the lake has experienced two extreme shocks resulting in flood (1955 – 1956) and drought (1989). The shocks were detrimental for the small, mesotrophic -eutrophic lake of 42.5 km2 and with the maximum depth of 10 m. The research is focused on the latter, anthropologically driven, event, which lead to a 60 cm drop in water level of the lake, a recession of lake's margins up to 100 m from the main settlement, the disappearance of much of the western littoral zone, and significant biodiversity loss. All these resulted in long-term impacts on the social-ecological system and overall economic downturn associated with collapse of the local fisheries industry and decreased tourism.

In the attempt to better understand how did the abrupt transformation affect ecosystem services and human wellbeing, we collected and analysed information through the following activities:

1. identification of main stakeholders at Dojran lake and analysis of their relevant role in the process of transformation;
2. analysis of social, ecological, and economic factors defining the current state of the system;
3. identification and prioritization of ecosystem services and their current conditions;
4. exploration of the stakeholders' visions about desired future social-ecological pathways and consultation of the development strategies of the local government.

The collected information contributed to the development of a holistic picture of the actors and components necessary to understand the resilience of the system, emphasizing the dynamic character of the internal transformation processes.

The research was further guided by the principal question of how the listed information can provide insights for the management and conservation of the altered social-ecological system. Results show that the state of ecosystem services provision has dramatically decreased; nevertheless they continue to be determinant for local communities' wellbeing and an indicator for their adaptive capacity. We identified recreational services, fisheries and agricultural production as the key ecosystem services. Their intensified exploitation, however, is guided by past livelihood patterns, which can hardly be supported by the current state of the ecosystem and which can be exposed to further risks in the perspective of climatic changes. Although the visions about the prospects of development in the area were rather heterogeneous, there is a common shared awareness of the need to preserve and valorise key ecosystem services.

The analysis of past sudden social-ecological transitions through an ecosystem services approach provides a comprehensive framework for the research of adaptive and coping capacities inherent in the system and the identification of its main vulnerabilities. These results represent a step forward towards identifying enabling factors to incorporate ecosystem services in the development process of the area, while strengthening the capacities for adaptive management of social and ecological systems in view of possible future shocks.

P-2220-02

Impacts of land cover changes on ecosystem service delivery using remote sensing, GIS and social innovation tools at Duiwenhoks catchment

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Historic spatial land cover databases consisting of maps and land use patterns are important tools for monitoring impacts of land cover change. Such a database was constructed for Duiwenhoks catchment in the Western

Cape, South Africa from 1940 to 2010 in order to assess land cover dynamics at a long scale (70 years). This, coupled with attribute climatic data and streamflow dynamics will be useful in modelling future hydrologic patterns, ecosystem services sustenance and resilience to natural and anthropogenic impacts such as floods and increased vegetation clearing for agricultural purposes respectively in the 21st half century (2050) using ACRU. To achieve this, black and white Aerial Photographs (AP's) were used to build the land cover maps roughly in a decadal series (1940, 1950, 1960, 1970, 1990 and 2010) with the exception of 1980 due to bad raw datasets which was technically deemed impractical to be used for this study. Research tools for the project were advanced software in GIS (ArcGIS 10.1) and Remote Sensing (ERDAS Intergraph 2014 and ENVI 4.4) to perform desktop applications like geo-referencing, image cropping, mosaicking, projection and post classification. The project used remote sensing tools for textural analysis, Principal Component Analysis (PCA), supervised and unsupervised classification to build the spatial land cover maps. An error matrix using 80 sampling points per land cover class and ground truthing was used to quantify the degree of correctness resulting in a 60% overall classification and 58% Kappa index. Furthermore, interviews with the farmers, long-standing residents, private land owners, and the Duiwenhoks Water User Association and conservation planners were used to assess trends and the effectiveness of environmental policy and ecosystem based adaptation mechanisms that are rolled out by different organisations in the study area. Findings of the study show a loss of natural vegetation from the 1940's especially in riparian zones of the middle catchment. An observed increase in dam construction also indicate the increase in demand for irrigation water for both crops and livestock production. With good national and international policies in place to promote environmental sustainability in South African Water Catchment Management Areas, there is great potential for rehabilitation and conservation of ecosystems and the physical environment. However, the limitation of application of policy at a local fine scale level is one of the reasons which appear to lead to failure of preventing unsustainable land cover change such as in riparian zones. Firstly, catchments differ in their heterogeneous statuses signalling a need to structure locally developed environmental adaptation tools. Other studies indicate that the hierarchical list of planning documents and environmental issues become diluted in terms of their relevance to local development due to a weak alignment of policies and legislation (Sitas et al. 2013). The on-going gabion construction project (Duiwenhoks Goukou Wetland Rehabilitation project) is one of the success adaptation mechanisms being rolled out in the Duiwenhoks catchment because prior to its conclusion, several of the objectives like maintaining streamflow and halting river bank erosion appear to have been achieved. Additional to the gabion construction adaptation response, the alien vegetation clearing exercise has also proved to be yielding substantial results in the middle catchment. However, at the upper catchment below the Langeberg Mountains, the alien clearing programme should have immediately followed up the clearing exercise by planting endemic plants that will protect the soil from further erosion due to its looseness and exposure to runoff. Therefore, alien clearing should take note of the seasons in which to act on because performing the exercise in mid-winter makes the exposed soil erosion debris which waits to be washed into the main river and other feeding streams.

P-2220-03

Traditional plant-phenological observations at the Hungarian Meteorological Service

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The relationship of the vegetation and climate is obvious from the first observations of the nature. Climate change has a strong impact on the flora of each country, which can be followed by the study of phenology. The task of plant-phenology is to observe and analyse the periodically recurring biological processes such as budburst, flowering, fruit ripening, and leaf fall. This is the scientific discipline, which is able to link vegetation dynamics with climate variables.

Phenological observations in Hungary started in 1871. The observation system of the Hungarian Meteorological Service (OMSZ) collapsed and revived time by time, until it was closed because of financial problems in 2000. Due to the reorganization of the institute, unfortunately, a part of the datasets were destroyed. Between 2009 and 2014 within the framework of a scientific research fund we had an opportunity - beside the main tasks of the project - to study the archive records.

In the last two years we collected detailed statistics about the digitalized and the only-paper datasets and tried to methodize the whole available digitalized and paper-based database. The paper will present the archive phenological data collection of the Hungarian Meteorological Service between 1871 and 2000.

P-2220-04

Economic Contribution of Communal Land Restoration to Rural Livelihood; a Case Study in Ethiopia

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Restoration of natural capital in areas with conservation interest has significant potential in the conservation of biodiversity and thereby increasing the economics of the area. Despite such qualitative assertions, quantitative accounting of restoration areas is hardly ever assessed in Ethiopia. Therefore, this study attempted to quantify the economic net benefits of the restoration of degraded community conservation area by comparing the cost of restoration inputs; with the income generated from the restoration outputs. The restored conservation area cost and benefit are projected temporally to 2025 the time when the restoration outputs yield maximum and spatially to the large-scale communal land holdings in the study region. The study findings indicated that not all economically valued restoration outputs contribute to conservation area community incomes. The present net benefit from the study area generated an income of USD 158, which is almost half the national per capita income during the study. After the restoration outputs yielded maximum, net benefit expected from this study area increased incomes of beneficiaries six times more. Whereas restoring all the communal land in the study area would increase incomes to USD 4,526, which is way over what the government aims to achieve with its acclaimed 2025 Growth and Transformation Plan. However, to realize this it will require thorough research for the development of markets for different bio-geographic zones and evolving appropriate working plan prescriptions. Moreover, the possibilities of linking these services to international protocols in conservation of natural resources, global warming, and world trade have to be explored.

ORAL PRESENTATIONS

O-2222-01

Adaptation Research in Semi Arid Regions of South Asia

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Faced with high climate variability and a multitude of development challenges, people in the semi-arid regions of Africa and Asia are particularly vulnerable to climate-related risks. Interventions to date have focused mainly on short-term solutions, leaving large gaps in our understanding of which responses will enable widespread, effective and sustained adaptation over longer time horizons.

The Adaptation at Scale in Semi-Arid Regions (ASSAR) project aims to fill the above knowledge gap. Central to the ASSAR project is a focus on multi-stakeholder processes, which help in identifying key adaptation and development-related vulnerabilities, and determining responses that can yield tangible and lasting benefits to society.

Key insights are emerging from South Asia's multi-institutional team's research and interaction with a range of stakeholders. Over the past year, policy makers, senior government officials, community members, academics as well as practitioners were engaged through a variety of formats including key informant interviews, participatory workshops and research validation events.

Initial research findings suggest that the welfare cost of climate change impacts in India varies across geographies and sectors. Given the high prevalence of natural resource based livelihoods, high incidence of poverty and inherent socio-economic inequalities, a significant section of the population is ill-equipped to adapt to current and projected climate variability. While households dependent on agriculture are directly affected, those living in urban areas are also affected by declining agricultural productivity. At the same time, rapid and largely unplanned urbanization manifests in an intense competition for resources and land. Quality of life for marginalized groups in urban areas is characterized by lack of access to social capital, poor quality of jobs and exclusion from public services. This begs the question whether migration for livelihood diversification or improved well-being actually translates into a reduction in vulnerability, or simply into a differently characterized vulnerability.

Practitioners working with urban dwellers and rural households over decades carry unique tacit knowledge of local barriers to effective adaptation, mal-adaptive practices and the unintended outcomes of current institutional, policy and governance structures. As part of ASSAR, climate scientists aim to generate climate messages with the intention to test whether improved climate information heightens adaptive capacity, for those whose lives and livelihoods are directly exposed to climate-related risk. Social scientists are poised to study local governance structures that control the sharing of common resources such as water and forests, as well as patterns of migration across a rural to urban continuum. Research across different domains is driven by the need to produce knowledge which is useful to vulnerable people living in semi-arid regions, either directly or through policy influence.

Using a collaborative research approach, while drawing upon the experiences of practitioners, ASSAR aims to inform climate change adaptation policy and practice in ways that strengthen livelihoods and sustain the well-being of the most vulnerable. Conducting and aligning such research is a complex task, requiring at all levels, leaders who can converse in several disciplinary discourses, becoming conduits of scientific and practical knowledge across different communities. At the same time, the project generates valuable lessons for future research initiatives aspiring to contribute to climate change adaptation.

O-2222-02

Famine, climate, agriculture and desertification in Northeastern Brazil : from historical reconstruction to future adaptation

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The previsions say that the semiarid regions in the world are between the most impacted by the global climate change. In Northeastern Brazil, among the environmental (lost of biodiversity, extreme droughts), social (migrations, diseases exposition) and economics (reduction on income generation, in employment rates, and in the Gross Domestic Product) of global warming, it is affirmed strong pressures specially over the environment, the agriculture and livestock because of the increase of the rain irregularity and increase of evaporation. During the last century Northeastern Brazil and more particularly the state of Ceara, was submitted to successive catastrophic droughts that enhanced severe famine and massive migrations towards the big urban centers in southeastern Brazil. Land use in this semi arid area has increased the size of degraded areas and the intensity of degradation and desertification. Overgrazing by livestock is the main origin for the degradation process. However, with the climate warming and the drastic decrease of livestock production, farmers were forced to revert to more primitive forms of subsistence farming with a land rotation system (nomadic farming) that relies on fire for vegetation clearing during the dry season. With the increase in human population density and the partitioning of the large landlord farms, the interval between each land use cycle has been decreasing.

The IPCC 2014 report shows that increase in temperature change in seasonality and decrease in precipitation will strongly affect this region although a large uncertainty due to the scarcity of environmental datas that prevents a good precision in most of the reconstruction models.

The multidisciplinary project developped at the UFC in the frame of a cooperation with IRD aimed to reconstruct the climate and landscape changes during the 20th century. The project is multidisciplinary and is using an historical reconstruction of land use based on microfossil data, the current state of vegetation cover and the genetic diversity of key indicator species.

Modern landscapes are described in different types of degradated areas, from well preserved to very degraded, through botanical surveys and remote sensing analyses. The evolution of the landscape during the last century is analysed on the base of paleo ecological methods adapted to shorter time scales. Short sediment cores were collected in selected dams within the different ecosystems and changes in landscape are reconstructed on the base of bio indicators and microcharcoal analyses. These changes are compared with observed climate datas. Climate and man influence and impact on the desertication processes are defined at fine scale and analysed separately. We aim to answer the following questions: (i) what is the history of land use and diversity loss in areas under a degradation/desertification process in the last century?(ii) What is the quality of the biodiversity in the surrounding area of the degraded areas ? iii) How the defined ecosystem services could be used for natural or induced restoration/recovery of the degraded areas?(iv) what will be the resilience of the remaining Caatinga areas for the next century ?

This project started in 2014 and is carried out by researchers at the Federal University of Ceará, Brazil – UFC and the Institute of Evolutionary Sciences of the Montpellier 2 University, France.

O-2222-03

Adaptive Capacity and Risk management: Evidence from household-level data from semi-arid tropical villages in India

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Objective
This paper attempts to provide evidence on how households respond to climatic variability and extreme events such as droughts/floods in the semi-arid regions villages of India. It looks at how vulnerabilities inherent in farming households and the risks faced by them, which shape and affect local adaptive capacity. Two key questions which this paper would be address are - the impact of climate change on food production and the extent of climate induced migration. The paper focusses on semi-arid regions since this region is highly vulnerable to several socio-economic risks apart from rainfall-related production risk.

Background
Semi-arid regions constitute almost 53 percent of India's land cover, where agriculture is the primary source of livelihood. In addition to being drought-prone and being vulnerable to rainfall-related production risks, semi-arid regions are characterized by higher levels of poverty, poorer asset ownership, higher indebtedness, smaller land holdings, and lower levels of land productivity. Poor performance of agriculture and lack of other livelihoods options further limit their capacities to anticipate and respond to climatic variability.

Data
Household level panel data for 17 villages in India has been collected by the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) which is used for the analysis here. This is a unique dataset in the sense that it provides an opportunity to track the economic status of households over time along with the information whether they faced droughts/floods during the period and the response adopted by them.

Relevance of the Research
This research would enable a deeper understanding of the conditions under which household vulnerabilities in semi-arid regions are shaped. This has direct implications for their current and future ability to adapt to climate change. The uniqueness of the data helps us identify which households are vulnerable to climate change, measure the impact of climate change on household assets and production patterns, and measure adaptation responses to climate shocks. In a nutshell, this paper aims to answer questions related to vulnerability, impacts and adaptation within the context of climate change in semi-arid villages in India.

O-2222-04

Tropical warm semi-arid regions expanding over temperate latitudes in the projected next century

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Two billion people today live in so-called dry lands (Millenium Ecosystem Assessment, 2005), where extreme climatic conditions prevail, and natural resources are limited. The future of those drylands is therefore challenging for many human beings. Drylands are expected to expand under several scenarios of climatic change (e.g. Feng and Fu, Atmos. Chem. Phys, 2013). However, no study focuses specifically on the evolution of strictly climatically defined semi-arid zones. These represent the frontier areas where intermediate conditions might shift either towards fully arid (desert), or less water-limited (favorable to rainforests), climate.

Climatic transformations of today's and future warm semi-arid regions raise the following two issues: 1) will these regions expand and thus widen the area where specific water-limited development issues must be addressed? 2) How will climatic conditions evolve in today's semi-arid regions, and what does it imply for development programs?

To address these, we adopted a bioclimatological approach based on the Koppen climate classification (e.g. Rubel and Kottek, Meteorol. Z., 2010). Monthly surface air temperature and precipitation are combined to identify bioclimatic regions. Geographical migration of these regions can thus be followed over time. We focus on the warm semi-arid class, characterized by a mean annual temperature exceeding 18°C and water-limitation criteria calculated from the seasonal distribution of rainfall and temperature.

A multi-model ensemble of CMIP5 projections was selected to draw and analyze the evolution of current and future warm semi-arid regions according to 3 representative concentration pathways of increasing emissions (RCPs 2.6, 4.5 and 8.5). The Koppen climate classification was first applied to key-periods - beginning, middle and end of the 20th and 21st centuries - to localize past and future warm semi-arid regions. Then time-series for the classification were built using a 15-year running average climatology from 1901-1915 to 2086-2100, in order to characterize trends and variability in the evolution of those regions. Averages over a 15-year interval allow to buffer the large interannual variability.

According to the CRU datasets, global expansion of the warm semi-arid area has already started, following the global warming trend since the beginning of the 20th century (~+13%). Climate models are able to capture this trend albeit with a delayed increasing trend. This expansion will continue according to all projections, especially for the most severe scenarios, reaching ~19% and 51% respectively for RCP2.6 and RCP8.5 (multi-model mean). This will be most significant outside the actual tropical belt towards the North Pole. This poleward migration is of ~1°, 7° and 10° for respectively RCP2.6, 4.5, and 8.5.

Two processes mainly explain this expansion: warming and drying. Drying is mostly responsible for the conversion from equatorial, subhumid climates within the tropical belt. Beyond 30° of latitude, warming is directly responsible for the conversion of cold semi-arid towards warm semi-arid climates; particularly so in RCP8.5. A third category concerns the conversion of temperate climates to warm semi-arid, outside of the tropics. In this case, both warming and drying processes are at stake, as drying effects are amplified in warmer conditions.

Those various transitions may have drastic but also very distinct ecological and sociological impacts. We therefore stress that many of the warm semi-areas that will appear in the future may need to be dealt with differently than tropical semi-arid regions in the past.

O-2222-05

(Re)conceptualising maladaptation in policy and practice: towards an evaluative user-focused framework for semi-arid regions

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Maladaptation is a concept that has received notable policy attention in recent years, but has yet to be fully explored in both conceptual and practical terms. As a consequence it suffers from a lack of consensus around its definition and application in policy and programming. While there is general agreement that maladaptation involves action to adapt to change that increases vulnerabilities or reduces adaptive capacity, there is disagreement over what causes such action.

One of the reasons why maladaptation is such a powerful term is that it encourages practitioners and policy-makers to recognise that the decisions they take now to address climate change can backfire and inadvertently make people more vulnerable in the longer-term. However, a lack of consensus and clarity on how to characterise maladaptation currently prevents decision makers from

being able to apply the concept in practice.

In the context of semi-arid regions, the immediacy of many development challenges, the susceptibility of these areas to existing climate variability and the inherent non-linearity of these systems contribute to a higher risk of maladaptive outcomes arising from development or adaptation strategies.

We outline five areas of conceptual clarity needed in understanding and evaluating maladaptation in semi-arid regions and elsewhere.

First, deliberate non-action should, if contributing to increased climate risks and negative outcomes for people and communities, be considered as maladaptation. The semi-arid lands of East Africa, for example, have long been actively marginalised from the economy and politics. Over the past decades, a lack of development in these regions over long periods has contributed to high levels of vulnerability.

Second, a strategy that has not considered the impacts of climate change should constitute maladaptation. For example, many pastoralist communities have been encouraged to diversify livelihoods as a result of persistent drought. But moving away from semi-nomadic pastoralism can erode existing adaptive capacity, leading to greater vulnerability.

Third, a fundamental component of maladaptation is time. It is only with time that the success or failure of interventions will become evident. This trait is well illustrated in the context of groundwater abstraction for adaptation in semi-arid regions, which may be maladaptive in the longer term.

Fourth, semi-arid ecosystems, livelihoods and economies are not static. Moreover, under climate change, climate risks and vulnerabilities to particular climate variables are likely to shift. Semi-arid systems are characterised by non-linear and unpredictable dynamics in both their socio-economic and ecological components.

Fifth, distributional aspects of adaptation are important because climate change is likely to affect segments of the population differently, both in terms of direct impacts as well as influences on wider drivers of development, and the act of implementing (or choosing not to implement) an adaptation strategy can fail to uniformly reduce climate risks across all social groups. For example, strategies to enhance and diversify livelihoods for adaptation to climate change and variability can reinforce inequalities in terms of gender, or livelihood types.

Building on this reconceptualisation of maladaptation, we present the groundwork for a framework that can lend itself to qualitative and quantitative assessment of adaptation strategies, and clarify the differences between four distinct types of adaptation outcomes - ranging from optimal adaptation to maladaptation. Most importantly, we have used the framework to highlight a number of different 'symptoms' that can act as early warnings for maladaptive outcomes, hoping to guide policy makers in achieving early-diagnosis.

In doing so, our aim has been to make this onerous concept more tractable and applicable to planners and practitioners so as to diagnose strategies likely to lead to maladaptation. It is our hope that this work will stimulate debate and galvanise interest in advancing efforts to understand, and critically, to avoid maladaptation in semi-arid regions in the face of increasing climate risks in the coming decades.

2222-POSTER PRESENTATIONS

P-2222-01

Innovative strategies to adapt climate change impact on traditional rain fed agriculture in semi arid regions: A case of North Kordofan in Sudan

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The purpose of this paper is to develop agricultural and water management strategies to help poor traditional rain fed farmers to adapt climate change impact on agriculture in North Kordofan region in Sudan. Historic climate data from the study area were collected and analyzed using CROPWAT model version 8.0. Reference Evapotranspiration (ETo), effective rainfall and irrigation requirements to develop different sowing dates strategys were also measured using CROPWAT model. Field visits observations and discussion with farmers also helped the author in results justifications. The study found that early sowing dates is better than late sowing in traditional rain fed sector in North Kordofan. Early sowing date secured water for almost 70 days of the crop cycle. Also under early sowing dates, soil moisture can maintain the crop at a later stage of growth. The paper investigated that drought tolerant Sesame crop replaced the millet crop for climate adaptation purposes in North Kordofan. This research study is considered the first to develop agricultural and water management strategies to cope with climate change impact on traditional rain fed agriculture in North Kordofan, Sudan. The paper highlights innovations farmers are making to adjust to the changes they observe.

P-2222-02

Understanding agricultural vulnerability: An approach to identify and understand vulnerability of an agrarian based livelihood system in a watershed area

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Epistemological understanding of vulnerability and its assessment methods follow two main schools of thought: (1) the 'contextual vulnerability', where vulnerability (or inversely resilience) is seen as an inherent characteristic of the system (in our case a socio-ecological system), these confound the manner in which the system responds to external stressors; and (2) the 'outcome vulnerability', where the primary focus is on the impacts of a hazard (which is a process in itself driven by some other primary drivers). Indicator based vulnerability studies have gained increasing importance in the last decade, particularly within dominant framing of the climate change along with other structural variables. Within this methodology, indicators are used as proxies in order to quantify components contributing to vulnerability. This is done at either household or community level, or both essentially depending on its intent to identify points of interventions. The primary weakness of these methods lies in arriving at meaningful weights for the sub-components and the indicators. The assumption of direct causal linkages between indicators and vulnerability is another pertinent factor in these methodologies.

We discuss these weaknesses in the methods while applying the conventional indicator approach to an empirical case in semi-arid Karnataka. We compared the effectiveness and usability of indicators to study structural drivers of vulnerability. Household and community scale analysis was carried out in semi-arid region of Karnataka. The agrarian based livelihood in this area is primarily dependent on ground water resources. We used adapted versions of three indicator based vulnerability assessments; Livelihood Vulnerability Index (LVI), LVI IPCC and the Livelihood Effect Index (LEI). These methods highlighted the main variables driving vulnerability of farming communities in this region. Results indicated that financial sub-components were the largest contributor to both household and community level vulnerability. The LVI-IPCC method indicated that exposure to climatic events was greater than the adaptive capacity and this significantly contributed to vulnerability of the community. Results from the LEI, suggests that individual households in this area will be more affected by climate change than communities.

This study demonstrated the inability of indicator-based methodologies to represent intricate ground realities, which indexes tend to over simplify. Assumptions of linear two dimensional relationships can inaccurately attribute vulnerability to a particular causal factor. Moreover these methodologies largely ignore the requirement of minimum threshold capitals that determine the functioning state of a system.Based on the results and analysis of this study we suggest a framework for developing methodologies for vulnerability assessment suitable for a particular agro

climatic zone. In this framework vulnerability is treated as a dynamic concept moderated by socio economic, socio political processes and human-environment relationships. The framework incorporates the concept of minimum threshold in the capitals ,a concept widely used in "Law of Minimum", (Justus von Liebig, 1840), which propounds that there are capitals that govern the state of a system and growth is determined by the scarcest resource required by the system. We suggest that there are certain key parameters particular to a specific agro climatic zone that defines the vulnerability of the system. This framework is aimed at providing a pragmatic methodology for comparison of vulnerability across regions in similar agro climatic zones. The framework attempts to map the impacts of coping and adaptive strategies on components of a socio ecological system, through analysis of drivers and enablers of vulnerability within a particular spatial scale, having explicit links to other scales. This can contribute towards developing appropriate policy intervention strategies to facilitate adaptation processes for particular agro climatic zones.

P-2222-03

Studies of Long Term Changes in Climate and Environment in South-East Georgia – A Key for Sustainable Development

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Recognizing the fact that we are living in a constantly changing world became actual during the last decades, and promoted numerous studies related to environmental consequences of climate change and human impact. In this sense, study of past changes in environment and, its effect on human society coupled with better understanding of current state of the environment delivers key information to project future changes and their effect.

South-East Georgia represents natural polygon of long term changes in the environment to be caused by combination of natural and anthropogenic factors. In the convention adopted by UN in 1994 on 12th of September – A/AC.241/27, among the regions which are under the risk of desertification and draught Trans Caucasus is also mentioned. On the map developed in 1998 by natural resources and conservation service of US Department of Agriculture Iori upland is situated in the area of moderate, high and very high risk. The semi-arid Iori and Shiraqi highlands in South-East Georgia are characterized with annual precipitation <600mm and shows open steppic landscape today. However archaeological studies deliver evidences of well-developed bronze and early Iron Age settlements in the areas almost devoid of water resources today. Archaeo-Botanic studies also assume that the region was covered by forests instead of steppes.

The goal of current study is: to shed light on historic changes in the environment of the region, its natural and anthropogenic factors and consequently response of human society on these changes; to assess rate and scale of ongoing desertification process during the past decades; to project future possible changes in the environment and based on past experience elaborate adaptation and mitigation policy.

The proposed investigation is focused on identifying the source of modern changes to the environment in South-East Georgia and to discern the relationships of this environmental change to current and past actions of the human population. Long-term, sub-regional records of these changes will be constructed in terms of: 1) physical changes of vegetation; 2) changing patterns of land use/land cover, and settlement; and 3) changing aspects of land quality in relation to agriculture.

Climate change is a serious challenge to sustainable development. Historical study of desertification, as one of the main consequences of climate change coupled with anthropogenic stress, can provide valuable materials for understanding the mechanisms of climate change. Research and understanding of these mechanisms are very important in order to come up with the solutions for sustainable development; therefore the present research (project) will ultimately contribute to developing long term mitigation and resilient strategies and policies for sustainable development of the region.

P-2222-04

Water Crises in a Semi Arid District of Haryana: Trends, Concerns and Alternatives

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Water problems in Asia today are severe—one out of five people (700 million) does not have access to safe drinking water. The stress on Asia's water resources is likely to intensify in future. According to the IPCC, by 2050, more than one billion people in Asia alone are projected to experience negative impacts on water resources as a result of climate change. In India the average per capita availability of water, estimated at 1,600 cubic meters per year, is expected to fall to around 1,000 cubic meters per year by 2050 based on current population projections. District Mahendergarh of North-western state of Haryana and selected for the study falls in semi-arid zone. Mahendergarh has serious water deficit due to absence of perennial rivers, deep water aquifers (about 40 meters in some blocks), scanty & irregular rainfall etc. The mean annual rainfall in Mahendergarh district is less than 300 mm which is also highly erratic. People receive water in much less quantity than their requirements. The agriculture, forestry and horticulture are affected badly due to unavailability of irrigation water which affects the availability of food grains, vegetables and fruits etc. The desertification is visible in the district. The poor water quality is another serious concern as ground water in many parts of the district is brackish. The paper, based on ongoing research by the authors, tries to explore trends, concerns and alternatives in water crises in District Mahendergarh, Haryana, India.

P-2222-05

Lake Chad : present situation and possible future water management

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Lake Chad lies in an endoreic basin located in the centre of Africa, on the southern margin of the Sahara in the semi-arid Sahel belt. The lake has varied at different time scales according to changes in the rainfall over its basin. In the recent past, after a rather wet period (1950-1970), the lake size has decreased sharply with the Sahel droughts (1970-1995) with occasional drying out of the northern basin of the lake, before a partial recovery (1995-2015).

Most of the pessimistic declarations in the media about the future of Lake Chad originate from the dry 1980 situation. The present state of the lake, since the beginning of the 2000s, has been that of a moderately low water level, with large marshes and abundant natural resources (fisheries, recession cultivation and cattle breeding) for an estimated population of 2 million people living on the lake and its shores (2013), and exporting food in the surrounding region. Endogenous innovations in family agriculture have been the key for the adaptation of the local people to the lake's variability.

The lake recession in the period 1970-1990, concomitant with droughts over the lake's basin, triggered the decision of the Heads of State of the riparian countries (Nigeria, Chad, Cameroon and Niger) to study the possibility to transfer water from the Congo basin to the Chad basin in order to increase the level in Lake Chad. The project presently supported by the Lake Chad Basin Commission (LCBC) aims at transferring about 6.2 billion cubic metres per year from the Ubangui River, a tributary of the Congo River with a cost estimated at 14.5 billion US dollars.

This transfer would avoid a drying out of the northern part of the lake (about 0.6 million inhabitants) in case of drought over its basin. But it would not allow for a mitigation of the drought impact over the whole Chari basin, the main tributary to the lake, presently home to 35 to 40 million people but foreseen to reach 80 million in 2040.

The question is whether the climatic change underway may increase or not the probability of a drought over

the Lake Chad basin. The recent IPCC- AR5 report has concluded that the rainfall trends should be moderate over the Chari basin, but with a great uncertainty and no clear indication on the direction of the change. In the short term and as a first step, the ongoing and projected LCBC basin wide programmes aiming at increasing agricultural water productivity and resilience to climate change may be usefully developed and increased.

P-2222-06

The role of cactus pear (Opuntia ficus-indica (L.) Mill.) in the conservation of water and soil in the Skhour Rhamna drylands (Province of Rhamna, Morocco)

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Seasonal and annual fluctuations in rainfall, and drought, are quite common phenomena in arid lands of Morocco. In addition to anthropogenic activities, these phenomena generate soil erosion, which in turn cause desertification.

The conservation of soil and water in these environments relies on adaptive measures, which are necessary to rehabilitate and prevent soil erosion. Therefore, the choice of drought resistant species and the ones having low demands on edaphic conditions is required. In this regard, cactus (Opuntia ficus-indica), can be one of the best choices.

This work was carried out in the rural town of Skhour-Rhamna, an arid area of the province of Rhamna in southern Morocco. We aim to evaluate the effect of planting cactus on the conservation of water and soil. Therefore, we set to study the effects of cactus plantations on the physicochemical properties of soil and vegetation. We used a comparative approach holding cactus plantation in plots with different ages and planting densities and a control plot without planting cactus. Two experimental plots were selected, one with plantation of 3 years of age having a density of 5000 plants / ha, and an older one (6 years) with a planting density of 6700 plants / ha.

We collected soil samples from each plot at different depths, which then were analyzed for organic matter and particle size determination. In parallel, we measured the infiltration rate. We also assessed the vegetation parameters such as the plant cover, the species diversity and abundance.

The results showed that planting cactus has a statistically significant effect on the organic matter content and the plant cover. Plots under cactus plantations showed the best water infiltration rates. So planting cactus in arid zones could conserve soil by reducing runoff and minimizing soil loss by erosion.

P-2222-07

Analysis of Rainfall Characteristics Relevant to Agricultural Planning in Narok County, Kenya

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Climatic factors play an important role in determining the production of food crops in the semi-arid regions of Africa. This is a region characterized by a low and highly variable distribution of rainfall spatially and over time, which constitutes a limiting potential for crop yields. Both short and long rainy periods experience dry spells that substantially influence agriculture. There are also spells where rainfall is excessive in these regions resulting in floods and excessive erosion. Understanding of the behaviour of the wet and dry spells could improve management of the agricultural activities by farmers. The objectives of this study were explore the characteristics of annual and seasonal rainfall and to simulate stochastically the dry and wet spells using Markov models. In-depth interviews were conducted with 120 small-scale farmers to establish what constitutes agriculturally relevant rainfall characteristics for small-scale farmers. Famers' perceptions reflected seasonality, distribution and intensity. Half of the respondents felt there had been a change in seasonality. Ninety percent of the farmers' claimed that the amount of rain throughout the first season had decreased with 98% of the respondents having the same sentiments for the second season. A significance test that there is no change in annual rainfall over time resulted in a t-value of 1.7033. The significance level of this t-test is 0.3044; hence there was no statistically significant change in annual rainfall within the study period. The number of days of rainfall shows a significant decrease within the study period for both long and short rain seasons. The risk of suffering losses when crops that are sensitive to dry spells of up to 10 days are planted in March 1st is therefore more than 75 percent. Long dry spells at sensitive times of plant development (germination, flowering, seeding) could spell disaster for farmers. The risk of dry spells after planting have increased over the decades making farming for small-scale agriculturalists even more risky. The findings of the study suggests the need for the development of a comprehensive agricultural and climate change and variability policy that takes into account the mounting risks associated with agricultural production among small holder farmers.

P-2222-08

The impact of Climate change to agricultural production of the coastal to reservoirs areas and creation of adaptation mechanisms

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The food products manufacture in Tajikistan already faces many serious difficulties caused mainly prompt growth of the population, mountain topography, limitation of farmlands accessible to grain crops and livestock because of abrupt inclinations both high eminences and improper microclimates. The average mean arable land on the person makes 0.14 ha/person who at comparison with global average 0.26 ha/person is low enough.

Researches of dynamics of change of climatic parameters in three agricultural areas adjoining to the Nurek reservoir in Tajikistan have shown that the mid-annual temperature for 20 years (1968-2000) has raised 1.0-1.5 oC that has led to decrease in relative humidity on 3-6 % and to increase potential evaporation on 10-26 % in annually. For example, in the Yavan valley of the Republic of Tajikistan recommended irrigation regimes are connected with the over-expenditure of water resources. Last specifications on irrigation modes to take the Yavan valley on mean annual value of humidity (0.35) to the category of droughty areas. But as show the obtained data, for last 20 years evaporation in a valley has decreased almost on 300 mm (17 %) and the amount of precipitation has risen on 70 mm (11 %). As a result, value of humidity has risen to 0.45. Hence present irrigating norms for cultivation of cotton in the Yavan valley -1100 m3/ha and 3000 m3/ha for a Lucerne are overestimated. Calculations show that unproductive losses of water only on two valleys make more than 60 Mln.m3.

In present paper results of researches on creation scientifically reasonable the scenario and recommendations for cultivation of crops with high value of efficiency and steady against climatic and stressful situations and also increase in efficiency of units of irrigation water and the irrigated lands are presented.

P-2222-09

Strategies of sustainability, green building and climate change in Brazil

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The project Strategies of sustainability, green building and climate change in Brazil has the following general aim: diagnose and provide the development of sustainability strategies of coexistence with the climate change in Brazil.

In Brazil, the project Strategies of sustainability and climate change in South Africa and Brazil will be operationalized in

the state of Rio Grande do Norte, in the city of Caiçara do Rio do Vento (means Fisher of Wind's River). The city has a population of 3,400 inhabitants and is located in the northeastern semi-arid region. The region has an average annual rainfall of 520 mm.

Global warming has generated greater interaction of human beings difficulties with the land. The main difficulties are related to water supply, thermal discomfort and the difficulty of undertaking agricultural crops that provide subsistence activity to the population. Thus, sustainability strategies are needed to address global warming.

Was identified that the global warming can be handle with a strategy of sustainable construction. In this case, the sustainable construction is the starting point to create the individual's living condition in the environment that suffers with the warming. The habitat is the starting point for the individual to undertake adequate transformations and living with the weather phenomenon.

Were developed activities of sustainable construction with natives and students, trying to present and share some sustainable technologies and practices.

The application of sustainability strategies to a Sustainable Construction is characterized by the following pillars-fundamentals: 1 - Construction and sustainable energy; 2 - Waste management; 3 - Preservation of biodiversity and the ecosystem; 4 - water resources management; 5 - Education, involvement of child and youth in cultural, creativite, environmental, social, inclusive and participatory activities; 6 - Formulation and participation in public policies; 7 - Self / Empowerment / Entrepreneurship; 8 - Tourism; 9 - Agriculture; and 10 - Cultural and Historical rescue and cultural economy.

Intervention activities was also important to the culture and the development of the cultural economy (music, art, crafts, dance, festivities), also important to sustainability strategies developed in order to deal with climate warming.

The project Sustainability Strategies and Climate Change in Brazil, from the proposed methodology seeks to accomplish through action-research methodology to collect information and the creation of knowledge about sustainability strategies to deal with global warming. The project will provide the realization of sustainable buildings in the communities served, as well as the transfer of knowledge to local staff, as well as the construction of a collective knowledge of other sustainability strategies that can be developed for better association with global warming.

It stands out on the farm the adoption of a sustainable management model, a kind of sustainability philosophy was very important to rural properties. The management philosophy was based on an opening to absorb various learnings and openness to volunteering.

The importance of recycling PET bottle is the fact that the polyethylene terephthalate is a thermoplastic polymer that takes the environment about 400 years to degrade. Given the argument justifies the importance of the activity of researching the recycling and reuse of PET bottles. It's been developed strategies by the Brazilian university Universidade Federal do Rio Grande do Norte (UFRN) to share the findings between rural communities affected by climate warming. The social impacts of the project in the communities was documented in documents, photos and videos. The social impacts provide skills development focused on sustainability. The design of the house with PET was presented in some meetings in order to receive suggestions to improve the construction process proposed. Sustainable building experience in UFRN is also being developed.

The project presents waste management mechanisms to guide communities, municipalities, organisations and businesses regarding the type of sustainability management models to implement and explore innovative methods to improve the relationship with climate change.

P-2222-10

Are Smart Policies Really Smart? Analyzing the Implications of Smart Policies on Risk Management in India

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Since the new government's ascent into power in India, there has been much focus on creating 'smart' policies. Two such 'smart' discourses are smart cities in urban areas and climate smart agriculture (CSA) in rural areas, both of which focus on addressing development deficits and planning for climatic risks in India. This paper critically analyses these discourses to understand their implications on negotiating inherent socio-economic vulnerabilities and existing inequalities, and managing current and future climate risks.

Smart cities have been vigorously projected as the Prime Minister's pet project with $1.2 billion allocated for developing 100 smart cities in India. The idea of smart cities has been greeted in India with an equal measure of hype and skepticism. Although there is still no clear consensus on what a smart city means, it is generally agreed that 'smart' refers to using technology to solve urban problems. In a country that still lacks basic housing, water, and energy infrastructure, as well as access to health and education services, there is much debate about whether smart cities will be able to address these pressing issues. Moreover, apart from a draft concept note, India lacks a national policy on smart cities. The recent budget avoided the term 'smart city', allocating funds to the Delhi-Mumbai corridor and Gujarat International Finance Tec-City (GIFT), India's first smart city, instead. In the absence of a well-defined policy, there are concerns over how the $1.2 billion will be utilized for urban development and whether it will mainstream climate risk management. It is also unclear how cities in already stressed environments such as in semi-arid regions, will evolve to negotiate development and climate risk management goals.

In rural landscapes, agriculture is constrained by various non-climatic dynamics such as deteriorating soil fertility, depleting groundwater levels, market dynamics tied in with global price fluctuations, and migration towards urban centres. Increasing climatic variability and projected climate change, especially in resource-constrained areas such as semi-arid regions in India, are expected to interact with existing vulnerabilities, exacerbating them and potentially making agriculture an unsustainable livelihood. To address this growing concern, climate smart agriculture (CSA) has emerged as a way to mainstream a suite of mitigation and adaptation strategies that can help make agriculture and agricultural livelihoods more resilient to climatic changes. In 2011, the Government of India set up the National Institute for Climate Resilient Agriculture (NICRA) with a budgetary allocation of $64.81 million. With a core mandate of long-term strategic research on the impacts of projected climate change on Indian agriculture and demonstration of existing best practices to help farmers cope with current climate variability, NICRA is a crucial actor in India's CSA discourse.

In light of these developments, this paper traces the evolution of the smart policy discourse in India by examining the evolution of smart cities in urban areas and CSA in rural areas as well as the key actors and organizations shaping these discourses. By doing so we contribute to the larger smart city discourse that has begun to shun the term 'smart city' and questions whether it has become a term that has reached the end of its usefulness. We also argue that while CSA forefronts vulnerability to climate change, it potentially obscures larger development issues and inherent vulnerabilities. There is also the danger of old wine in a new bottle where existing agroecological techniques that have been practised by farmers traditionally, are being repackaged to make their livelihoods 'smart'. While the investment such a discursive shift attracts is useful, we argue that it is important to understand how such policy trajectories create winners and losers.

In conclusion, while the term smart invokes a variety of desirable visions of a utopia where technology is used to operate infrastructure achieving efficiency and sustainability, we argue that it is important to question whether 'smart' policies truly makes rural and urban living and livelihoods more resilient to current and future climatic risks.

P-2222-11

Investigating climate trends and impacts in semi-arid regions of Africa and South Asia: implications for climate change adaptation and development

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Semi-arid regions, such as the African Sahel, are typically located in the boundary between extremely dry (e.g. arid) and much wetter (e.g. humid subtropical) climate zones. The semi-arid regions of Africa and South Asia are subject to high year-to-year rainfall variability and people living in these regions are particularly exposed to the impacts of climate variability and climate change; the success of the seasonal rains can be critical to people's survival and their livelihoods. As the Earth warms, trends towards harsher or more productive climatic conditions will therefore have significant consequences for how people in semi-arid regions live with the environment and sustain their livelihoods.

The Adaptation at Scale in Semi-Arid Regions (ASSAR) project is one of four projects being funded through the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA). We will present the latest evidence and understanding of climate-related variability and trends, in the semi-arid regions of Africa and South Asia, gathered by scientists working in the Climate and Biophysical Impact (CBI) team of ASSAR. In general, the weight of evidence suggests that climate change is having largely adverse effects on natural systems supporting people's livelihoods in semi-arid regions of Africa and South Asia. Temperatures in these regions are rising at above global average rates and in some locations this is leading to measurable impacts on human and natural systems. However, significant year-to-year and longer-term variability in rainfall patterns means that any attribution of rainfall trends to global climate change is complicated. Also, future projections show large disagreements in the direction of rainfall changes and climate models are subject to large uncertainties that complicate any interpretation of climate messages. Ultimately the impacts of climate change on human and biophysical systems will manifest themselves through the combined effect of changes in temperature, rainfall, humidity and other climate-related variables. Moreover, it is only by understanding specific system sensitivities and adaptive capacities that useful information can be derived to support adaptation research and practice. Examples of how climate variability and change is impacting socio-ecological systems in semi-arid regions of Africa and south Asia will be provided.

The CBI team is made up of climate scientists, crop modellers, hydrologists, ecologists and social scientists. In the first year of the project the team developed a series of "Regional Climate Messages" documents that were produced for the four regions under investigation, namely Southern Africa, East Africa, West Africa and India. The documents provide information about historical and future climate aimed at informing policymakers, practitioners and researchers working in these regions - key results will be shared. In addition, the team is continuing to work alongside colleagues in the ASSAR project to provide tailored information that can directly feed into the adaptation-focused research. Ultimately the wider ASSAR project research aims to both generate transferable knowledge related to issues of adaptation across multiple scales of governance and to develop transformative scenarios that influence adaptation and development planning in the focus regions.

P-2222-12

Analysis of Desertification Process and Impact of Climate Change by using Satellite data in the Algerian Steppe

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The degradation of natural resources in arid and semi-arid areas was highlighted dramatically during this century due to population growth and transformation of land use systems. The Algerian steppe has undergone a regression over the past decade due to drought cycle, the extension of areas cultivated in marginal lands, population growth and overgrazing. These phenomena have led to different degradation processes, such as the destruction of vegetation, soil erosion, and deterioration of the physical environment. In this study, the work is mainly based on the criteria for classification and identification of physical parameters for spatial analysis and multi-sources to determine the vulnerability of major steppe formations and their impact on desertification. To do this, we used satellite images Alsat-1 (2009) (IRS 2009) and LANDSAT TM (2001). These cross-sectional data with exogenous information could reduce the impact of climate change in the semi arid ecological diversity of steppe formations. This longitudinal study based on the use of remote sensing data is to analyze the evolution of steppe ecosystems. The application, through specific processes, including the supervised classification was used to characterize the main steppe formations. An analysis of the vulnerability of plant communities was conducted to assign weights and identify areas most susceptible to desertification. Vegetation indices are used to characterize the forest and steppe formations to determine changes in land use.

This study will map the different components of the steppe, highlighting the magnitude of the degradation pathways, which affects the steppe environment, allowing an analysis of the process of desertification in the region.

P-2222-13

Crop supplemental irrigation experiences in Burkina Faso

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This study assesses the impact of supplemental irrigation from small man-made basins on cereal production in climate variability and change context marked by dry spells in the Sahelian zone of Burkina Faso. After two years, the experiments showed that this innovation in family farms increases maize yield and allows growing a second crop with the surplus of water available in the basin. At the end of the 2012-2013 campaign, the average maize yield was estimated 2.5t/ha on experimental plots (EP) and 1.7t/ha on control plots (CP). The average yield of the 2013-2014 campaign was evaluated as 3.3T/ha and 0.9t/ha for EP and CP respectively. Increase in yield is 0.8t/ha for the 2012-2013 campaign and 2.4t/ha during 2013-2014. It appears as well as the yield obtained on EP in 2012-2013 and 2013-2014 for bridging cereal need of 2 and 6 additional persons respectively in agricultural households compared to the CP. The review of the Net present value, internal rate of return and the Net benefits increase ratio show that the profitability to practice supplemental irrigation depends on the types of basins.

2223 - Modeling Our Agricultural Future

ORAL PRESENTATIONS

K-2223-01

The Agricultural Model Intercomparison and Improvement Project: Transdisciplinary and Multi-scale Agricultural Projections of Climate Change Impacts

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The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

Currently, AgMIP has over 700 participants from more than 45 countries contributing their expertise to over 30 projects and activities. The goals of AgMIP are to improve substantially the characterization of world food security due to climate change and to enhance adaptation capacity in both developing and developed countries.

Since 2010, AgMIP has engaged stakeholders and researchers to assess climate impacts on food security and plan for a more resilient future. AgMIP has built a cutting-edge assessment framework on both global and regional scales, which links climate, crops, livestock, and economics to help decision-makers better understand how climate change will reverberate through complex agricultural systems and markets.

AgMIP initiatives include regional integrated assessments, global economic assessments and global crop modeling activities, data and tools to facilitate multi-model and multi-discipline assessments, and cross-cutting themes to help interpret agricultural model results for decision-making. Results from these initiatives contributed to the Intergovernmental Panel on Climate Change Fifth Assessment Report, provide important context for national and regional stakeholders interpreting climate change risks, further state-of-the-art global food security assessments and agricultural models, and deliver key inputs, such as commodity prices, into regional integrated assessments.

AgMIP is now planning a coordinated global and regional assessment of future food securtiy under changing climate.

K-2223-02

Projecting grassland sensitivity to climate change from an ensemble of models

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The grassland biome covers about one-quarter of the earth's land area and contributes to the livelihoods of ca. 800 million people. Increased aridity and persistent droughts are projected in the twenty-first century for most of Africa, southern Europe and the Middle East, most of the Americas, Australia and South East Asia. A number of these regions have a large fraction of their land use covered by grasslands and rangelands. Grasslands are the ecosystems that respond most rapidly to precipitation variability. However, global projections of climate change impacts on grasslands are still lacking in the scientific literature. Within AgMIP, based on the C3MP protocol initially developed for crops, we have explored the sensitivity of temperate grasslands to climate change drivers with an ensemble of models. Site calibrated models are used to provide projections under probabilistic climate change scenarios, which are defined by a combination of air temperature, precipitation and atmospheric CO2 changes resulting in 99 runs for each model times site combination. This design provides a test of grassland production, GHG (N2O and CH4) emissions and soil carbon sensitivity to climate change drivers. This integrated approach has been tested for 12 grassland simulation models applied to 19 sites over three continents. We show here that a single polynomial emulator can be fitted with high significance to the results of all models and sites, when these are expressed as relative changes from the optimal combination of climate drivers. This polynomial emulator shows that elevated atmospheric CO2 expands the thermal and hydric range which allows for the development of temperate grasslands. Moreover, we calculate the climatic response surface of GHG emissions per unit grassland production and we show that this surface varies with elevated CO2. From these results we provide first estimates of the impacts of climate change on temperate grasslands based on a range of climate scenarios.

K-2223-03

Impacts and implications of global and regional climate change for agriculture

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Agriculture faces severe challenges from increasing demand for agricultural food and non-food products, the need to decrease its environmental burden and to build resilience against climate change impacts. While impacts and adaptation measures need to be assessed and understood at local scales, much of their cross-interaction and societal implications can only be understood at regional to global scale analyses. The Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intersectoral Impact Model Intercomparison (ISI-MIP) have conducted comprehensive global-scale assessments of climate change impacts on agricultural productivity and related sectors (e.g. water, markets) that allows for understanding the scope of the climate challenge for agriculture and food security, including an assessment of associated uncertainties. Climate change under the RCP8.5 emission scenario has the potential to reduce global crop production of the 4 major crops by 24 to 43%, which may be amended by positive effects of carbon dioxide fertilization to losses of 8 to 24%. Climate-driven reductions in availability of irrigation water could lead to a loss of 20-60Mha of irrigated cropland. Associated adaptation responses in land-use patterns, trade and consumption are able to compensate for climate-driven impacts but lead to higher food prices (20% on average). Challenges that need to be addressed at the global scale are the increasing disparity between high- and low productivity countries, which often reflects the disparity in development. Also, increasing variability under climate change is a robust finding across the board of scenarios and will require adequate measures to avoid devastating effects, especially for the poor.

O-2223-01

FACCE MACSUR: Modelling Agriculture with Climate Change for Food Security

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FACCE MACSUR (http://macsur.eu) is a network of currently 270 scientists from 18 European and associated countries for improving the European capacity of modelling the effects of climate change and socio-economic changes on agriculture. This concerns crop and grassland production, livestock production, farm management related to adaptation and mitigation measures, and development of price relations on national to global markets. The emphasis is on the linking of models and data across scientific disciplines. We will present an overview of achievements in the network. Collaborative efforts in the network include the advancement of modelling methodologies, agreement on common modelling scenarios for joint evaluation, comparison of model performance, development of new research projects, organization of training courses and workshops, and interactions with decision-makers, farmers, and other stakeholders. MACSUR collaborates internationally with AgMIP and MACSUR members are engaged in many other international projects and networks.

In the field of crop modelling, MACSUR has set-up and performed a comprehensive, unique model comparison study on simulating crop rotations using long term trial

data from various locations in Europe and looking at various output variables; also an inventory has been made on the available crop models and modelled cropping systems for Europe by the MACSUR CropM partners. MACSUR developed extensive databases on important ongoing and future modelling studies in Europe and it also embarked on developing a centralized system for data storage, distribution and visualization of model results. The knowledge hub systematically analysed scaling methods with focus of scaling up weather and soil information for regional and (supra-) national climate change (CC) impact assessments and related uncertainties for a range of crop models. A large ensemble of 26 crop models has been used for a systematic climate sensitivity analysis based on impact response surface. New CC scenario data was developed for selected locations and regional case studies in Europe and use was made of agroclimatic indicator approaches to indicate shifts in (multiple) risks to wheat production in the EU. Five PhD courses have been organized, dealing with various issues of generating data and applying modelling techniques for assessing CC impacts and adaptations to CC.

In the field of modelling of permanent grasslands, livestock and farms, the main focus across these diverse disciplines was to bring together specialists on a common subject. MACSUR established a performance comparison across several prominent models. Modelling of livestock productivity focused on the impacts of changing climatic conditions on dairy cow health, mortality and milk quantity and quality, and provided contributions to regional case study research. Datasets were identified relating to animal health and disease, and gaps in knowledge were explored at a broad level.

In socio-economic modelling, MACSUR focused on the soft-linking of crop production models to economic models at national and global levels and on comparisons of projections of crop price changes considering global trends in populations, politics, and climate.

Regional case studies constitute opportunities for linking models with less spatial heterogeneity and a longer tradition of model linkage across scientific disciplines. They also allow studying practical effects of the impacts of climate change and discussing them with stakeholders. Our case studies in Finland, Austria, and Italy suggest that a simple climate envelope approach (moving production zones of crops northward) neglects important interactions with soils (water holding capacity) and effects on landscape function/ecosystem services and rural livelihoods.

In the next two years, MACSUR will improve modelling the impacts of weather extremes and consider variations in farm management, cross- and multi-scale issues, uncertainty and error propagation. Exploration of techniques to improve the characterisation (e.g. quality) of feed sources in farm-scale models will also be addressed. Understanding the reasons for the difference between optimal and realised grassland and crop yields and finding solutions for linking these economic models at national to global scales remains a challenge for the next years. Furthermore, we will include more regional case studies and intensify our interactions with stakeholders.

O-2223-02

How accurately do crop models simulate the impact of CO2 atmospheric concentration on maize yield and water use ?

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Methods and Results
Given the incertitudes on the climate change impacts on C4 crops, projections of regional maize production remain speculative. Assessment of the impacts of atmospheric CO2 concentration ([CO2]) on crop yield and resources uses using mechanistic models becomes increasingly important. Free Air [CO2] Enrichment (FACE) studies offer data to test and improve model quality. The objective of this work by the AgMIP Maize group was (i) to test multiple maize models for [CO2] responses against data gathered from a FACE study under two water regimes carried out in Germany during 2007 and 2008, and (ii) to pave the way to potential model modifications so as to improve their simulations of crop responses to [CO2]. The Experiment combined two [CO2] levels with two watering regimes. Yield, leaf area, soil water content and [CO2] levels were recorded both years, 2008 only exhibiting significant water deficit. After a preliminary calibration based on non limiting water conditions and under ambient [CO2] treatments of both years, a blind simulation was undertaken for the other treatments: High [CO2] (550 ppm) 2007 and 2008, both watering regimes, and DRY AMBIENT 2007 and 2008. Secondly, with full growth and yield data along with soil moisture data of all treatments, improvements of simulation results were attempted. Changes made to the models have been documented and submitted for further analysis. The results revealed: minimal [CO2] impacts with low variations among « uncalibrated » models except for the dry season of 2008 where the observed drought impact was simulated by the majority of models; most models caught but underestimated the CO2 impact on crop water status, leaf area, grain number and yield; the CO2 effect on transpiration was generally properly simulated, transpiration per leaf area decreasing but green leaf area duration increasing at 550 ppm [CO2]. As more data from FACE experiments become available, it will be highly desirable to replicate this exercise in order to come up with more robust conclusions on these responses and to improve model response to CO2.

2223-POSTER PRESENTATIONS

P-2223-01

Bayesian Inference for the Ricardian Model

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The Ricardian model is one of the most widely used models to analyze the impact of climate change on agriculture. This paper seeks to empirically extend the

model by showing how one can explore the relationship between temperature, rainfall and land values/farm net revenue via non-parametric approach and characterizing model uncertainty on the impact of variables such as soil fertility measurement and water flow on net farm revenue. We use our derived methodology to investigate the impact of climate change on cropland in Africa using an 11-country survey of over 9000 farmers administered as part of a Global Environment Facility (GEF) project. We find that the relationship between rainfall and farm net revenue exhibits some nonlinearities in Africa but not that strong for temperature. Climate change scenarios from Atmospheric Oceanic General Circulation Models (AOGCMs) is also carried out.

Evaluating the impact of climate change on the agricultural sector is important to assess vulnerability of an economy to climate change and feeds into planning decisions. Current and future impacts on agriculture, magnitude of the impact and distribution of the impact are important questions that needs to be answered for effective planning and policy. Traditional models of crop agriculture such as crop-growth simulation models, agronomic economic models and integrated assessment models are based mainly on climate-crop physiology and development models' parameters that are generated from experimental research. They are typically calibrated into field situations using daily crop development responses to a combination of climate and weather variables and input factors such as soil, water and fertilizer. These models can handle some adaptation and crop management responses through variety selection, incorporating fertilizer use as an adaptation response or changing planting dates. While these adaptation measures can be interesting, they do not adequately capture farmer behavior in reality. We are more interested in models that incorporates farmer's responses to economic factors such as prices (substitution of inputs based on prices) and the ability of farmers to switch crops and plant multiple crops based on responses to climate.

The contribution of this paper is in presenting the Ricardian Model in a Bayesian framework, that relaxes the assumption of linear relationship between climate and agricultural performance through the use of semi-parametric approach and also characterizes model uncertainty in the choice of variables to be included in the model by integrating the variable selection process into the Ricardian model estimation that reflects the uncertainty surrounding the "correct" specification which becomes valuable for predicting the impact of climate change on agriculture. Specifically, we will describe a Bayesian posterior simulator that combines the literature on semi-parametric estimation, Bayesian variable selection and data augmentation. Our underlying mod- eling framework is the same as the Ricardian model. However, the Gibbs sampler algorithm builds upon the simulator in Koop and Poirier (2004) and incorporates the stochastic search variable selection (SSVS) method described in George and McCulloch (1993) to determine the posterior probability that climate and soil characteristics have an influence on agricultural productivity. As in Abidoye and Herriges (2013), we will argue that the model incorporating SSVS presents a form of Bayesian model averaging integrating competing models into a single structure that can be more valuable in predicting the impact of climate change under different climate scenarios. The model is applied using data from a survey of over 9000 farmers administered as part of a Global Environment Facility (GEF) project in 11 African countries in 2003.

P-2223-02

Exhibiting model elasticities to facilitate model intercomparison: an example with a simple land-use model

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In the coming decades, agriculture is projected to experience both demand and supply shocks originating from climate change, growing food needs or increasing demand for bioenergy. This specific context prompts a need for numerical assessments to anticipate the economic and environmental consequences of possible futures. Studies, however, disagree in the extent and direction of the impact of shocks on agriculture. If some progress has been made to reduce the overall variability across models (Nelson et al., 2014), the nature of some discrepancies remains unclear.

To get at the root of these discrepancies, this study applies a simple methodology to explicit the yield, area and demand responses to price. These parameters picture the core mechanisms of models and are critical in estimating the impact of shocks on agriculture (Hertel, 2009).

We present here the results of this methodology for the NLU model (Souty et al. 2012). NLU is a partial equilibrium that simulates changes in agricultural intensification at the global level under various assumptions regarding biomass demand. In this model, yield and area elasticities are not parametrized, but are derived from a cost minimization program taking into account spatial biophysical constraints. We focus here on the supply side as the demand for biomass products is exogenous in our model and thus inelastic to price.

First, changes in yields and areas are computed in response to a +1% p.y. exogenous price shock to 2050. To facilitate the comparison with available econometric estimates, we undertake a similar analysis in the past. Elasticities are then calculated according to a range of food prices relative to those of inputs (land and fertilizer). We show that these functions sum up the core model dynamics and can facilitate the model diagnostic. Finally, we show how our results can be used for the assessment of a biofuel promotion policy.

P-2223-03

Projected global crop yield variability under ENSO and the NAO

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Future food supplies under a changing climate hinge on our ability to understand and adapt to changing precipitation and temperature patterns, which fuel global agriculture supplies. Projections suggest that potential yields of many crops will decrease as temperatures rise. Few studies, however, have addressed the predictability of the spatial and temporal variations over interannual to decadal timescales. In many regions the climate over such periods can be described in terms of large-scale climate indices such as the El Nino/Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO) index. These climate teleconnections result in semi-periodic global patterns of precipitation and temperature, which can alter growing season conditions over large geographical areas and have been shown to directly impact the regional and national yields of several crops. By analyzing the frequency and duration of such patterns in global climate model projections and the effects of each phase on potential agriculture yield, it may be possible to better project global yield variability. Here we present such an analysis of the global yield patterns of three major cereal crops (maize, rice and wheat) and soy on a 0.5 x 0.5 degree grid generated within ISI-MIP. Potential crop yields are simulated using climate projections for four RCPs from HadGEM2-ES. The combined crop model ensemble indicates regional yield averages differ from neutral years by up to 10% during opposing phases of ENSO and the NAO. Furthermore, average ENSO phase responses are not perfectly symmetric and are linked to yield decreases for some regions under both warm and cool phases. In general, the major cereal crops show the strongest ensemble response to ENSO, particularly in the northern U.S. and Europe. The effects of NAO phase are significant over a smaller geographical area than ENSO, but with similar or slightly higher magnitudes. The spatial patterns associated with each phase are further supported in many highly agriculturally productive regions by significant time series correlations between annual yield and NAO or ENSO indices. By linking agriculture yields to climate teleconnection indices we increase the predictability of decadal yields. In addition the association may be extended to impacts from other sectors, allowing for projections of exposure to coincident regional effects.

P-2223-04

Evaluation of Agro-Climatic Index in Korean Peninsular Using Multi-Model Ensemble Downscaled Climate Prediction of CMIP5

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The agro-climatic index is one of the ways to assess the climate resources of particular agricultural areas on the prospect of agricultural production; it can be a key indicator of agricultural productivity by providing the basic information required for the implementation of different and various farming techniques and practicalities to estimate the growth and yield of crops from the climate resources such as air temperature, solar radiation, and precipitation. However, the distribution of agricultural climate resources varies depending on the climate change, and the agro-climate index can always be changed because the index is not an absolute. Recently, many studies which are related the uncertainty of future climate change have been being actively conducted with multiple ensemble approach by developing and improving dynamic downscaling of climate information as well as statistical downscaling. RCP (representative concentration pathways) future scenarios of the Fifth Assessment Report of IPCC (intergovernmental panel on climate change) have been used in many recent studies. In this study, the agro-climatic index of Korean Peninsula, such as plant and crop period based on each base temperature, growing degree day, frost free day, and heating and cooling degree day were calculated for assessment of the indices' temporal and spatial variations and uncertainties of the indices on climate change; the downscaled historical climate (1976-2005) and RCP future climate sceneries of AR5 (2011-2040) were applied to the calculation of the index. Additionally in the study, the assessments of the agro-climatic index and multi-model ensemble were considered for the practicability of the agricultural digital climate map of RDA (rural development administration).

The result showed each average of six agro-climatic indices of nine individual global climate models, as well as multi-model ensembles agreed with agro-climatic indices which were calculated by the observed data. It was confirmed that multi-model ensembles, as well as each individual global climate model emulated well on past climate in the four major Rivers of South Korea (Han, Nakdong, Geum, and Yeoungsan and Seumjin). The six agro-climatic indices of the Korean Peninsula were estimated to increase in nine individual global climate models and multi-model ensembles in future climate scenarios. However, spatial downscaling still needs further improvement since the agro-climatic indices of some individual global climate models showed different variations with the observed indices at the change of spatial distribution of four Rivers. The differences and uncertainties of the agro-climatic indices have not been reduced on the unlimited coupling of multi-model ensembles. Further research is still required; however, the differences started to improve when combining of three or four individual global climate models in the study. The agro-climatic indices which were derived and evaluated in the study will be the baseline for the assessment of agro-climatic abnormal indices and agro-productivity indices of the next research work. For example, if we assume that the temperature of winter will decrease in some areas of Nakdong, Yeongsan and Seumjin Rivers since frost free day has been estimated to increase in those regions in future climate projections, the assessment of frost free day of the regions will be able to take advantage of the assessment of the increasing uncertainty of agro-productivity of the winter crop or agricultural cropping system (e.g., double cropping system) by analyzing agro-climatic abnormal index (e.g., frequency of frost).

P-2223-05

Coffea arabica yields decline in Tanzania due to climate change: global implications

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Coffee is the world's most valuable tropical export crop. Recent studies predict severe climate change impacts on Coffea arabica (C. arabica) production. However, quantitative production figures are necessary to provide coffee stakeholders and policy makers with evidence to justify immediate action. Using data from the northern Tanzanian highlands, we demonstrate for the first time that increasing night time (Tmin) temperature is the most significant climatic variable responsible for diminishing C. arabica yields between 1961-2012. Projecting this forward, every 1°C rise in Tmin will result in annual yield losses of 137 ± 16.87 KgHa-1 (P= 1.80e-10). According to our ARIMA model, average coffee production will drop to 145 ± 41 KgHa-1 (P=8.45e-09) by 2060. Consequently, without adequate adaptation strategies and/or substantial external inputs, coffee production will be severely reduced in the Tanzanian highlands in the near future. Attention should also be drawn to the arabica growing regions of Brazil, Colombia, Costa Rica, Ethiopia and Kenya, as substantiated time series evidence shows these areas have followed strikingly similar minimum temperature trends. This is the first study on coffee, globally, providing essential time series evidence that climate change has already had a negative impact on C. arabica yields.

P-2223-06

Global crop yield response to extreme heat stress under multiple climate change futures

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Extreme heat stress during the crop reproductive period can be critical for crop productivity. Projected changes in the frequency and severity of extreme climatic events are expected to negatively impact crop yields and global food production. This study applies the global crop model PEGASUS to quantify, for the first time at the global scale, impacts of extreme heat stress on maize, spring wheat and soybean yields resulting from 72 climate change scenarios for the 21st century. Our results project maize to face progressively worse impacts under a range of RCPs but spring wheat and soybean to improve globally through to the 2080s due to CO2 fertilization effects, even though parts of the tropic and sub-tropic regions could face substantial yield declines. We find extreme heat stress at anthesis (HSA) by the 2080s (relative to the 1980s) under RCP 8.5, taking into account CO2 fertilization effects, could double global losses of maize yield (□Y = −12.8 ± 6.7% versus −7.0 ± 5.3% without HSA), reduce projected gains in spring wheat yield by half (□Y = 34.3 ± 13.5% versus 72.0 ± 10.9% without HSA) and in soybean yield by a quarter (□Y = 15.3 ± 26.5% versus 20.4 ± 22.1% without HSA). The range reflects uncertainty due to differences between climate model scenarios; soybean exhibits both positive and negative impacts, maize is generally negative and spring wheat generally positive. Furthermore, when assuming CO2 fertilization effects to be negligible, we observe drastic climate mitigation policy as in RCP 2.6 could avoid more than 80% of the global average yield losses otherwise expected by the 2080s under RCP 8.5. We show large disparities in climate impacts across regions and find extreme heat stress adversely affects major producing regions and lower income countries.

P-2223-07

Rising CO2 emissions benefit global crop water productivity

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Climate change threatens global water and food security, especially in arid regions where water availability is already a critical limiting factor of agricultural productivity. Yet, increasing atmospheric carbon dioxide (CO2) concentrations are expected to raise rates of crop photosynthesis whilst also increasing the ratio of crop yield to water use, or crop water productivity (CWP). The potentially large positive effects of rising CO2 on CWP will have major implications for increasing crop yields and reducing pressure on freshwater resources. However, to date there has been no systematic evaluation of global crop model simulation of CWP response to CO2 and climate change, and estimates of carbon fertilisation effects on crops based on observations continue to be controversial.

Our study addresses these gaps; by providing the first comprehensive global scale assessment of the combined effects of climate change and CO2 on global CWP using a large multi-model ensemble (originating from the Agricultural Modelling Intercomparison and Improvement Project (AgMIP), and by directly comparing model results with observations. Our modelling results suggest combined effects of climate change and CO2 are substantial, leading to increase in CWP by up to 13-27% globally (ensemble median, with a range of different crop types) by the 2080s relative to the 1980s. The range increases to 17-35% in water scarce arid regions. This suggests significant alleviation of negative effects of climate change on crop yield and pressure on water use in these regions. Yet, the spread of CWP results doubles when considering climate and CO2 effects, reflecting uncertainty in modelling methodology and assumptions about CO2 response, which are large due to the lack of experimental observations globally. We show the spatial distribution in the impacts on four major crops critical for global food security: maize, wheat, rice and soybean. Our results indicate CO2 fertilisation effects play a key role in future agricultural production and water management and emphasise the importance of extending experimental observation, especially in arid and semi-arid regions.

Our study addresses global scale modelling of an important dimension of agricultural production that is intimately connected with water resources. The effects of CO2 are shown to be large, key uncertainties are highlighted and needs for modelling and empirical research identified. These results demonstrate the need to diagnose further reasons for differences between crop model simulations of CWP and promote wider incorporation of CO2 effects in global food and water resource assessments.

P-2223-08

Options for a sustainable food future and agricultural sector greenhouse gases mitigation

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By 2050, the agricultural sector should produce food to feed an increased and wealthier population, while reducing environmental impacts. In particular, conversion of natural ecosystems and greenhouse gas emissions are serious potential impacts of agricultural production.

To take up this challenge, many options exist for the agricultural sector. Some are on the supply side, such as increasing the efficiency of livestock production, increasing the efficiency in crop production inputs, or a sustainable increase of aquaculture. Others are on the demand side, such as changes in diets, reduction of losses and wastes or, more controversially, reduction in population increase. The overall consequences of those options on land-use and greenhouse gas emissions, especially when taken together, are not easy to assess in a transparent and consistent way.

To tackle this challenge, a simple balance model with detailed biophysical modules is developped to assess the consequences in term of greeenhouse gases emissions reductions of various options for the agricultural sector, under the constraint of feeding the world.

The reference year balances are based on FAOSTAT food commodity balances. Demand is set exogenously based on population and diets, trade is based on import dependence and export market shares, and loss coefficients are used. Transformation through livestock sectors and oil crops crushing allows to determine production, and, with exogenously set yields, land-use. In the reference case, yields and demands evolutions are based on FAO projections. Detailed modules of livestock, aquaculture, land-use change emissions, nitrogen cycle and rice methane emissions allow to determine transformation and emission coefficients, as well as the consequences of diverse options. The model integrates those informations at the global scale on several regions, allowing to assess in a transparent way the consequences of the options used together.

The methodology and the model results will be presented for change in livestock efficiency, rice methane emissions mitigation options, changes in diets and increases in nitrogen use efficiency.

P-2223-09

Detecting the early stage of Phaeosphaeria leaf spot infestations in maize hybrid lines under different climate change scenarios using in situ hyperspectral data

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Phaeosphaeria leaf spot (PLS) is considered as one of the major diseases that threat the stability of maize production in tropical and subtropical African regions. PLS is a foliar disease in maize caused by the ascomycete fungus Phaeospharia maydis (Henn.), and has spread widely in areas of high rainfall and moderate temperatures. PLS can result in a considerable reduction in photosynthetic leaf area as the spots coalesce , cause premature leaf drying thus reduce plant cycle and sharp decrease in grain size and weight and result in early plant death. The objective of the present study was to investigate the use of hyperspectral data in detecting the early stage of PLS in tropical maize. Maize ground-based hyperspectral data were collected at the field level from healthy and early stage of PLS over two years (2013 and 2014) using a handheld Spectroradiometer. Leave samples for full biochemical analysis ware collected form the healthy leaves and early stage of PLS to test the impact of PLS on the maize plant properties. An integration of a new developed guided regularized random forest (GRRF) and traditional random forest (RF) was used for feature selection and classification respectively. The 2013 dataset was used to train the model, while the 2014 dataset was used as independent test dataset.

Results show that there were statistically significant different in biochemical between the healthy leaves and early stage of PLS within certain biochemical variables such as nitrogen, phosphorus, calcium and magnesium. The new developed GRRF was able to reduce the high dimensionality of hyperspectral data by selecting key wavelengths with less autocorrelation. These wavelengths are allocated at 420 nm, 795 nm, 779, 1543 nm, 1747, nm and 1010 nm. Using these variable (n = 6), random forest classifier was able to discriminate between the healthy maize and early stage of PLS with and overall accuracy of 88% and kappa value of 0.75. This study demonstrates the potential of hyperspectral data in detecting the early stage of PLS in tropical maize. The study offers insight to the potential of large-scale mapping and monitoring of the

early stage of PLS in tropical maize using space borne and/or airborne hyperspectral data.

P-2223-10

Optimal groundwater extraction for irrigated agriculture in the littoral North of Senegal under climate uncertainty, implications on irrigation water availability

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Recent studies on climate change in West Africa showed climate vulnerability of the agricultural sector in Senegal with future increase of temperatures and variable rainfall patterns (McSweeney et al., 2010; Jalloh et al, 2013). Climate perturbations will probably have an impact on Senegalese agricultural production and farmers' livelihood.

To date, climate related research has mostly focused on rainfed crops specifically cereals and legumes in Senegal (Jalloh et al., 2013; Sène et al., 2006). Irrigated agriculture particularly horticultural crops mostly grown in the littoral north called Niayes, where at least 40% of Senegalese horticultural products are produced, have attracted less attention in terms of climate change or variability studies. In the Niayes, research have been focusing on how climate affects the aquifer recharge and they generally point out the negative effect of climate on aquifer recharge and depth (Aguiar, 2010; DaSylva, 2005, 2009; etc.).

Farmers grow irrigated crops during the dry season from October to June and use exclusively groundwater resource for irrigation needs. Groundwater is also used by other actors like industries, the Senegalese water company, municipalities, and rural populations. As research has shown, climate variability combined with anthropic action may threaten water availability for irrigation and other uses.

In this paper, we evaluate the optimal patterns of groundwater extraction for irrigation under climate uncertainty, and the potential gains from improved groundwater management. We establish a baseline for economic efficiency in resource management, by solving an optimization problem which captures the social planner's decision-making problem under uncertainty and limited foresight. We construct a stochastic dynamic programming model of resource management to maximize the sum of current benefits together with the net present value of future benefits from groundwater extraction for irrigation - which also takes into account groundwater extraction for other usages and the stochastic levels of rainfall that affect aquifer recharge. Results from this forward-looking optimization problem are compared to the myopic optimization behavior that farmers might typically display, under different climate states (normal, wet and dry), in order to assess the gains from improved resource management.

We use an agricultural production model that is calibrated to data from this part of Senegal, using the Positive Mathematical Programming approach of Howitt (1995), and taking into account the costs of water extraction. We use the outputs of the agricultural production model to estimate the demand for water within the agricultural sector, and characterize the climate conditions with data on precipitation from the National agency of meteorology. Last but not least, the data on hydrological aspects are drawn from the literature (Gaye, 1990; Faye, 1995; El Faid, 1999; Tine, 2004; DGPRE, 2005, 2009) and the direction of management and planning of water resources (DGPRE) of Senegal.

Our results illustrate the value of improved groundwater management in the horticultural sector of Niayes, and suggest the importance of including resource management in the plans for adaptation of agriculture to climate change for this region of Senegal.

P-2223-11

Climate change impacts on Apple trees phenology in northeastern parts of Iran

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Apple is one of the most important agricultural products of Iran. Global warming can effects on many sectors especially agricultural products and food security. One direct consequence of a warmer climate is the earlier onset of Bud break and flowering stages of deciduous trees such as apple in spring and earlier ripening in the end of growing season. The main objective of the present work is to assess the climate change impacts on Apple trees phenology, especially beginning of flowering in spring and ripening time of apple in the end of growing season. These two phonological stages are very important because of the sensibility of Apple orchards to early spring and late autumn frost risk. To do this we used historical data of available meteorological stations as well as CCSM4 outputs for the daily maximum and minimum for the upcoming 3 decades (2006-2039).The phonological data was collected from the Golmakan agrometeorological station during 1999-2006. On the base of UTAH model and using the phonological and historic climatic data we estimated the phonological phases of apple during next 3 decades. According to the results obtained by Rcp4.5 and Rcp8.5 outputs, in both scenarios significantly earlier flowering and ripening phenophases over the study area during 2006-2039 periods are estimated.

P-2223-12

High temperature stress on agricultural crops due to climate change

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Temperature variability is an important determinant of the yield of annual crops, particularly when high temperature episodes coincide with flowering. Under climate change an increase in the frequency of such episodes may occur. Hence temperature variability could become a major yield-determining factor for some regions in the decades to come. The magnitude of the impact will depend upon the level of heat stress tolerance in the genotypes grown.

Mean temperature affects yield by determining the duration of developmental stages. The impact of high temperatures, particularly near flowering, is primarily on the setting of fruit or grain. Most crops are currently grown in regions where current temperatures are already close to optimum for crop production. Any further increases in mean temperatures or of short episodes of high temperatures during sensitive stages, may be supra-optimal and reduce grain yield.

In this study, we performed a spatially explicit assessment of heat stress at the global scale, considering these environmental and management aspects, to identify hot-spots of risk for four important food crops (wheat, rice, maize and soybean). We used the Global Agro-Ecological Zones Model (GAEZ v3.0) to simulate the risk of heat stress for these four crops for a 30-year baseline historical climate (1961-1990) and an alternative future climate scenario (2071-2090) considering climate change.

There was a consistent increase in the intensity of heat stress from the baseline climate to the future climate change scenario for all crops. Rice showed high heat stress intensity already for the base climate, particularly in South Asia. The main hot-spots of heat stress occurred in the continental parts of Central Asia, East Asia, South Asia and North America.

In contrast, only little heat stress was predicted for maize under the base climate. However, the intensity increased highly under RCP8.5. Northern India, the Sahel region, Central South America and Eastern North America were hot spots of heat stress for maize.

A moderate heat stress intensity was predicted for soybean for the base climate with a considerable increase in intensity and extension for RCP8.5. Compared with the other crops, there was less change in spatial pattern and intensity of heat stress for wheat from the Base to the RCP8.5.

The percentage of days with heat stress events increased from the base to the RCP8.5 climate scenario. This increase was most evident for rice in suitable areas of Central Asia, South Asia and Central North America where a high prevalence was predicted. On the other hand, wheat had a less pronounced change in the frequency of stress in RCP8.5.

Mainly tropical agriculture will suffer from climate change. Our results indicate that global food supply may also be affected by heat stress in temperate and sub-tropical regions. Without mitigation measures to combat climate change or the implementation of local adaptive technologies, countries with extensive agricultural landsin continental regions at high latitudes may experience significant crop losses.

* This work was supported by the 2015 R&D Project of the Korea Meteorological Administration "Development and application of technology for weather forecast".

P-2223-13

The impact of high temperature on land values in Europe

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In Ricardian studies the relationship between climate and land values is conventionally assumed to be nonlinear. This nonlinearity has traditionally been captured using a quadratic model of temperature and precipitation (Mendelsohn, Nordhaus, and Shaw 1994; Schlenker, Hanemann, and Fisher 2005; Massetti and Mendelsohn 2011; Massetti and Mendelsohn 2012). This assumption has been supported by the data as the squared terms on climate have generally been statistically significant. Schlenker and Roberts (2009) have suggested that the effect of temperature on agricultural productivity may be not captured by a quadratic functional form because it is highly non-linear at the high temperatures. Schlenker and Roberts found a temperature threshold at about 30°C. Beyond this threshold agricultural productivity plummets.

Schlenker and Roberts (2009) limit their analysis to crop yields and use yearly data. Thus, they focus on short-term weather fluctuations and they neglect the possibility that farmers switch crops to avoid the harmful thresholds. Massetti and Mendelsohn (2014) is the first study that uses flexible functional forms to estimate the effect of growing season temperature on American farmland values and crop yields. The paper finds evidence of the hill-shaped response function for both farmland value and crop yields. But there is no evidence of temperature thresholds whether temperature is measured at 3 hour intervals, daily, or for multiple days.

With this paper we test if the relationship between temperature and land values in Europe is characterized by temperature thresholds. This is a relevant research question because if thresholds exist the increase in mean temperature will cause sizeable damages to the European agriculture. Thus, our study has direct policy implications for both mitigation and adaptation policy.

We use a flexible specifications for temperature in a Ricardian setup replicating the method of Massetti and Mendelsohn (2014) and following in spirit the method developed by Schlenker and Roberts (2009). With our method we are able to detect if farmland that is more frequently exposed to the right tail of the temperature distribution is also consistently traded at lower value than other farmland. If the Ricardian relationship is characterized by temperature thresholds we expect to find that the effect of additional warming at the highest temperatures is significantly negative and much larger than at lower temperature levels.

This paper uses a unique dataset obtained by merging farm-level data for more than 37,000 farms derived by van Passel, Massetti, and Mendelsohn (2014) from the Farm Accountancy Data (FADN) with daily temperature data from the ERA-INTERIM dataset over 1981-2010. The rest of the paper is structured as follows. Section 2 illustrates the method used for the analysis. Section 3 describes the dataset used. Section 4 illustrates results and presents robustness tests. Conclusions follow.

P-2223-14

Building a statistical emulator for prediction of crop yield response to climate change: A global gridded panel data set approach

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There is widespread concern that trends and variability in weather induced by climate change will detrimentally affect global agricultural productivity and food supplies. Reliable quantification of the risks of negative impacts at regional and global scales is a critical research need, which has so far been met by forcing state-of-the-art global gridded crop models with outputs of global climate model (GCM) simulations in exercises such as the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP)-Fastrack.

Notwithstanding such progress, it remains challenging to use these simulation-based projections to assess agricultural risk because their gridded fields of crop yields are fundamentally denominated as discrete combinations of warming scenarios, GCMs and crop models, and not as model-specific or model-averaged yield response functions of meteorological shifts, which may have their own independent probability of occurrence. By contrast, the empirical climate economics literature has adeptly represented agricultural responses to meteorological variables as reduced-form statistical response surfaces which identify the crop productivity impacts of additional exposure to different intervals of temperature and precipitation [cf Schlenker and Roberts, 2009]. This raises several important questions: (1) what do the equivalent reduced-form statistical response surfaces look like for crop model outputs, (2) do they exhibit systematic variation over space (e.g., crop suitability zones) or across crop models with different characteristics, (3) how do they compare to estimates based on historical observations, and (4) what are the implications for the characterization of climate risks?

We address these questions by estimating statistical yield response functions for four major crops (maize, rice, wheat and soybeans) over the historical period (1971-2004) as well as future climate change scenarios (2005-2099) using ISIMIP-Fastrack data for five GCMs and seven crop models under rain-fed and irrigated management regimes. Our approach, which is patterned after Lobell and Burke [2010], is a novel application of cross-section/time-series statistical techniques from the climate economics literature to large, high-dimension, multi-model datasets, and holds considerable promise as a diagnostic methodology to elucidate uncertainties in the processes simulated by crop models, and to support the development of climate impact intercomparison exercises.

P-2223-15

Climate Sensitivity of Rice Yields: An Agro Climatic Zone Analysis in Andhra Pradesh, India

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Observational data confirm that there have been significant regional variations in climate change patterns across India. This paper examines the effect of rainfall and temperature on rice yields of different climatic zones in Andhra Pradesh using district level panel data from 1981-2010. Analysis of data shows that the degree of impact of climate on yield of rice is varied across different climatic zones. Climatic zones which have traditionally higher temperature and less rainfall are more susceptible to variations in climate. Similarly impact of irrigation is more significant in traditionally drier zones than others.

P-2223-16

Widespread vulnerability of current crop production to climate change demonstrated using a data-driven approach

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The projected increase in global population suggests that, among a range of measures, an increase in food production will likely be necessary to achieve food security. A great deal of effort has been focused on the so-called "yield gap", the difference between actual and potential yields. The closing of this yield gap would bring about massive increases in production. Intensification actions such as irrigation, fertilisation, and better farming practices can bring the actual yield closer to the potential yield, although such actions may not be practical everywhere. Yet climate change greatly complicates this picture; crops are sensitive to their growing environment, and it is therefore inevitable that climate change will impact upon potential crop yields, changing the target for which intensification measures are aiming, and meaning that significant intensification may be required just to hold actual yields constant. Global crop models give some insight into such changes, but huge uncertainties in their process representations make even the direction of future change uncertain. We demonstrate a complementary data-driven approach, based on observations of current potential yield and climate analogues, to assess the vulnerability of yields of the three major cereal crops, wheat, maize and rice, to climate change. We find that huge swathes of current cropland show strong reductions in their potential yields of major cereal crops by the mid 21st century, indicating a large vulnerability of crop production in these areas to climate change, and greatly reducing the capacity for intensification of yields. These reductions are predominately in tropical or arid areas, and include current high-productivity areas like the North American corn-belt. Conversely, however, we also find large areas where potential yields increase substantially under climate change. These areas are most prominent in the northern temperate zone, and include areas not currently under cropland. Our approach is independent of the crop modelling methodologies previously used for future yield projections, however we find our results to be consistent with those from an ensemble of process-based global crop models, providing an important additional constraint on projections of future yield under climate change. Adaptation measures based on intensification of yields must consider the change in productive potential due to climate change.

P-2223-17

Biophysical modeling of climate change impacts on crop yields in Europe by 2030-2050 and socio-economic implications

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An impact assessment of climate change scenarios on agriculture was run covering the EU-28 region and focusing on 2030 and 2050 time horizons. To assess the impact of model uncertainties, three model realizations of the Intergovernmental Panel on Climate Change (IPCC) climate scenarios were used as the input of the analysis, based upon the Representative Concentration Pathway (RCP) 8.5 from the runs of global circulation models (GCM) HADGEM2-ES, IPSL-CM5A-LR and MIROC-ESM-CHEM, all bias-corrected at 0.5°x0.5° resolution.

The WOFOST (World Food Studies) model has been used within the BioMA (Biophysical Model Application) platform to simulate the impacts of climate change on crop yields at EU-level. The crop yield simulations were performed at 25x25 km resolution using the soil and crop parametrization of the MARS Crop Yield Forecasting System (MCYFS) that provides the European Commission operational seasonal forecasts of crop yields in Europe. The crops covered by this study were wheat, maize, barley, rye, rice, field beans, rapeseed, sunflower, sugar beet and potato. For each of these ten crops, simulations were performed under water limited (rainfed) and potential (fully irrigated) conditions. Uncertainties are associated with the effect of CO2 on plant growth which were assessed by simulations considering or not the CO2 fertilization effect. The simulated yields were aggregated at regional, national and EU28 levels, using regional statistics on crop areas.

The crop growth simulations show in most of the cases a stagnation or a moderate increase in the potential yields of most of the crops with the notable exception of maize, sunflower and at a lesser extent potato. Under water limited conditions the picture is slightly different with more pronounced negative effects for maize and sunflower. The greatest decreases in the water limited yields occur with HADGEM2-ES GCM that simulates a drier future climate than the two other GCMs. The actual crop yields, estimated by a weighted average of potential and water limited yields using data on European irrigation shares (EUROSTAT), show an overall moderate increase for the three climate models under RCP 8.5 scenario when the CO2 effect is taken into account but a decrease when it is not.

The spatial distribution of the yield changes is crop specific with for instance an overall increase in winter wheat yields for most of the EU 28 regions and an overall decrease of maize (summer crop) yields, with in both cases a reversed result for northern Europe.

Focusing on the year 2030, a bio-economic approach was proposed to jointly assess biophysical and socio-economic effects of climate change on agriculture, providing both global level analysis as well as regionalised for the EU. The global agro-economic model CAPRI (Common Agricultural Policy Regionalised Impact) has been used to assess the effects of climate induced yield changes on agricultural production and prices. The future quantitative societal developments were introduces in the model by means of an intermediate Shared Socioeconomic Pathway (SSP2).

The results suggest that agriculture markets projections to 2030 are sensitive to changes in crop productivity and, therefore, to the uncertainties linked to climate change. They show as well that market forces can reverse the effects of climate induced yield changes with a decrease (increase) in production when yields increase (decrease). The price changes will induce adjustments both on the intensity of production and on crop areas. A sectorial analysis indicates that the regional variability in prices and areas is greater for oilseeds than for cereals. Overall the modelling exercise estimates a moderate decrease of the EU agricultural income for all the scenarios with the CO2 fertilization effect simulated and a moderate increase when the CO2 fertilization effect is ignored. The limitations of these conclusions will be explored.

P-2223-18

Interactions of Mean Climate Change and Climate Variability on Food Security Extremes

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The Coordinated Climate-Crop Modeling Project (C3MP) has conducted a common set of sensitivity tests on more than 1100 simulation sets representing different farm systems in more than 50 countries, with carbon dioxide, temperature, and precipitation change sensitivities gauged for ~20 crop species and ~20 crop models. Here we present an analysis of C3MP results indicating how mean climate changes are likely to affect variability and extreme events within future time periods.

Recognizing that climate change will affect agricultural systems both through mean changes and through shifts in climate variability and associated extreme events, C3MP can elucidate several aspects of these changes. First, mean climate changes can affect yields across an entire time period. Second, extreme events (when they do occur) may be more sensitive to climate changes than a year with normal climate. Third, mean climate changes can alter the likelihood of climate extremes exceeding critical biophysical thresholds, leading to more food security extremes. Finally, shifts in climate variability can result in an increase or reduction of mean yield, as extreme climate events tend to have lower yield than years with normal

climate. This presentation will demonstrate each of these effects and illustrate the potential implications for future food production and associated agricultural economies under climate change.

P-2223-19

Past and future changes in climate of rice-wheat cropping zone in Punjab, Pakistan

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Agriculture is ranked Pakistan's top among economic sectors vulnerable to the potential impacts of climate change. The agricultural production system is directly affected by weather inputs (temperature, solar radiation, and rainfall) that are projected to change in the future (following increases in carbon dioxide and other greenhouse gases). Climatic extremes such as drought, floods and heat waves, are expected to increase with detrimental consequences for agriculture and livestock production, but changes in mean climates also pose challenges to sustainable development. This study presents climate change results for five districts within the major rice-wheat productivity zone of Punjab province in Pakistan. The results are focused on RCP8.5 mid century (2040-2069) scenarios derived from five global climate models (GCMs) output and the Kharif (June-October) and Rabi (November-April) seasons. Analysis of recent historical weather data of Sialkot and Sheikhupura districts shows an increase in minimum temperatures and maximum temperatures and a large variation in rainfall. This temperature change and variability in rainfall is expected to enhance further as we approach the 2050s. Mean maximum temperature is projected to increase by 2-2.5°C during rice growing (Kharif) season and 2.4-2.7°C during the wheat growing (Rabi) season. Rainfall during rice growing season is more uncertain, with projections indicating an increase of 25%-35 % in the study region, while a minimal change is expected during the Rabi season. The projected increase in monsoon intensity corresponds with the climax of the rice season, leaving no doubt about the crop water demand satisfaction. However, simultaneous increase in day and night temperature may affect the growth and development at some critical phenological stages.

P-2223-20

Economic Impact of climate change and benefits of adaptation in maize production in Southern Africa: Case study from South Africa, Namibia and Botswana

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The paper applied the Trade-Off Analysis-Multi-Dimensional (TOA-MD) model to evaluate the economic impacts of climate change and benefits of adaptation strategies for maize-based agricultural production systems in Southern Africa. The analysis was based on data collected from three countries, South Africa, Namibia and Botswana. The empirical analyses combined simulated baseline and future simulated yield from the Decision Support Systems for Agro-technology Transfer (DSSAT) crop model, under five different climate scenarios selected from 20 Global Circulation Models (GCMs). The paper focused on analysing three main objectives: (a) the sensitivity of current crop production systems to future climate change, (b) the sensitivity of future crop production systems to future climate change and (c) the benefits of adaptation in the future. The empirical results show that current and future crop production systems in the three study countries are sensitive to future climate change and yields would decline if no adaptation strategies are implemented. The results with the adaptation package show positive gains in yields, farm net returns and marginal reductions in poverty. In addition, the percentage of vulnerable farmers decrease for the scenario with adaptation compared to the other two scenarios without adaptation. Since various assumptions and uncertainties are associated with using the proposed approach, the results should be interpreted with caution. Despite these limitations, the methodology presented in this study shows the potential to yield new insights into the way that realistic adaptation strategies could improve the livelihoods of smallholder farmers.

P-2223-21

Modelling of Climate Change Impact on Maize Yields in Croatia

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Analyzing agricultural systems and modelling the potential impact of climate change on crop production is a very important topic, particularly nowadays as food supplies are becoming scarcer in many parts of the world and the need for all people to have sufficient food. As climate changes of different intensity in various regions were detected, there is a need for researching them at regional and national levels. The main application of the crop models is in climate change impact research on agriculture. Maize, winter wheat and spring barley are very often used for scientific investigations in the central and southeastern Europe using the different crop-weather models. Maize is one of the most important agricultural crops in Croatia and its vegetation period coincides with the warm season, from May to October. Therefore, it was decisive factor in the crop type choice for the research of climatic changes impact on maize yields in Croatia. The meteorological data of the Zagreb-Maksimir station, which is situated in the central Croatia, and pedological data, physiological and morphological data obtained in the field maize experiment in Zagreb have been analyzed. The Decision Support System for the Agrotechnology Transfer (DSSAT) model, as one of the most applied crop model in the world, has been used for the investigation of maize production in the present climate since 1949. The linear trends of model outputs and Mann-Kendall test indicated a significant earlier onset of silking by 1.4 days/10 years and physiological maturity by 4.5 days/10 years in the central Croatia which started in mid-1990s. Moreover, a significant decrease in maize yields by 216 kg/ha in 10 years is also obtained. The yield trend became significant at the beginning of the 21st century. There was a slight decrease in kernel mass (0.01 g/10 years) and aboveground biomass (122 kg/ha in 10 years). A positive trend in evapotranspiration and soil evaporation (around 3 mm/10 years) and in runoff (0.6 mm/10 years) has been noticed during the vegetation period. Thus, significant shortening the vegetation period by 5 days and reduction in maize yield by 2% have been estimated in the present climate. Further investigation involved the generation of synthetic meteorological series representing the changed climate by stochastic weather generator Met&Roll and different climate change scenarios. The climate change scenarios were prepared by the pattern scaling technique using the following global climate models: ECHAM, HadCM and SCIRO. The middle climate sensitivity is a 2.5°C increase in global temperature to equilibrium doubled carbon dioxide. When the three climate change scenarios had been prepared, the stochastic weather generator Met&Roll was applied to generate a 99-years synthetic meteorological series. Using the synthetic meteorological series in the DSSAT model, the indirect effect of increased carbon dioxide on maize yields in the central Croatia has been estimated for different climate change scenarios for years 2050 and 2100. All climate change scenarios for the 21st century projected a shorter growing season and a reduction in maize yields. The maize vegetation period in the central Croatia would be 39 days shorter for ECHAM, 42 days for HadCM and 34 days shorter for CSIRO, which would result in 14%, 25% and 22% smaller yields for maize, respectively, at the end of the 21st century. Both shifting planting date and using hybrids with longer growing season would be beneficial for maize productivity in the changing climate. The experience of farmers and agronomists in the central Croatia shows they have already been adapting maize production to the warmer weather conditions in the last decade. The usual hybrids in the central Croatia were hybrids with a medium growing season, but nowadays hybrids with a longer growing season are increasingly used. In the future, thus, Croatia could belong to the area of decreased maize yields. Some adaptation options like shifting to an earlier sowing date and selecting hybrids with longer growing season and resistant to drought could be an appropriate response to offset the negative effect of an increase in temperature. The present study could help in optimizing and improving agricultural management in order to adapt to changes in

climate and weather conditions in Croatia.

P-2223-22

Two possible future climate scenarios for AgMIP-GGCMI – Sulfate Injection Climate Intervention and Regional Nuclear War

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Climate is one of the most important factors determining crop yields and world food supplies. To be well prepared for possible futures, it is necessary to study yield changes of major crops under different climate scenarios. Here we propose two possible future climate scenarios for the global crop modelling community: stratospheric sulfate climate intervention and regional nuclear war. Although we certainly do not advocate either scenario, we cannot exclude the possibilities: if global warming is getting worse, society might consider deliberately manipulating global temperature; if nuclear weapons still exist, we might face a nuclear war catastrophe. Since in both scenarios there would be reductions of temperature, precipitation, and insolation, which are three controlling factors on crop growth, it is important to study food supply changes under the two cases. There have been 12 general circulation modelling groups participating in the Geoengineering Modeling Intercomparison Project (GeoMIP) and three modeling groups have conducted the same regional nuclear war simulations, with fires from targets injecting 5 Tg soot into the upper troposphere. We are approaching a robust understanding of climate changes under the two scenarios. We have conducted simulations for China, because of its high population and crop production in the world and we have been working on global agriculture impact under those two scenarios using the crop model in the Community Land Model (CLM-crop). Also, we are preparing protocols and datasets for the Gridded Crop Modeling Initiative (GGCMI), which will conduct a multi-crop multi model assessment of crop yields under the above two simulated climate scenarios. Preliminary results indicate significant changes in patterns of global food production, with substantial losses in major bread baskets around the world under the simulated regional nuclear war scenarios. Here, we would like to invite more global crop modelling groups to be involved in this project, and hence to gain a better understanding of global agriculture responses under the two possible but unpleasant future climate scenarios.

2224 - Agrarian and pastoral societies: adaptive strategies and innovations

ORAL PRESENTATIONS

K-2224-01

Climate Compatible Development in Mongolia: analysis of vulnerability and adaptation response to global changes

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INTRODUCTION: Climate change and variability, market and policy changes are shaping pastoral communities' decisions on what pathways their future livelihoods will take and how the steppe landscapes and river basins, are managed. Recent droughts and damaging winter storms (zuds) of the past two decades have exacerbated the situation and undermined the natural capital on which the pastoral livelihoods depend.. River basins are critical natural resources for well-being of the social and ecological systems in Mongolia. River basins provide the ecosystem services which support pastoral communities, and industrial and urban development. Green development strategies are strongly dependent on water resources.

For this study our team worked in nine «sums» (i.e., county level administrative areas) in three river basins in two provinces (aimags) to collect household data from 144 households. We selected three sums in each river basis, representing forest steppe, steppe and desert steppe regions for comparison across river basins and ecological zones. We also collected census data from the «aimags» and national level to understand trends at the level of regions and river basins.

FINDINGS:
Drought management. Unlike for «zud», people report very few sources of help with drought beyond their household and kin relations. By far the most frequently cited strategy for coping with drought is to do «otor» - long distance movements with livestock.

Cooperation. The most frequently listed "best coping strategy" across all ecosystem types was for herders to have better cooperation, both among themselves and with administrators. They frequently expressed the idea that people working alone cannot accomplish much compared to when they work together. Furthermore, one herder said that in the past, "we deeply understood that the most important thing is cooperation during natural disasters." Herders also want improved education and training to cope with climate and market changes.

Protection and management of pastures, and support to do «otor» were next set of important strategies after cooperation. Protection of otor pastures by local governments is an important strategy for protection from mining expansion in addition to improved management of seasonal pastures.

ADAPTATION ACTIONS:
Integrated river basin management plans. Develop cross ministry and cross-sectoral working groups to develop and implement plans and actions which cut across land, water, livelihood resource needs. Incorporate assessment and monitoring of natural resources. Integrate climate change impact analysis, especially droughts on natural capital, ecosystem services, and livelihood needs. Create governance structures which incorporate both technical and stakeholder perspectives.

Monitoring and Assessment. Establish indicator metrics for multiple water, land and livelihood resources and outcomes. Evaluate vulnerability and adaptive capacity taking into account natural capital, ecosystem services, and livelihoods. Provide early warning for zud, based on summer drought and grazing conditions, and also zud forecasting.

Training and capacity building. Provide training for integrated management which provides tools and skills for assessing and monitoring natural capital, ecosystem services and socio-economic conditions across the river basins. The training tools would include geospatial data gathering on climate, natural resource distribution and usage, land use patterns, community-based planning and management practices, sum, bag and other informal boundaries. Provide adaptation and green development courses for local communities and school systems. Also provide training to resource managers on how to access and communicate information on climate change, natural resource management, adaptation and green development opportunities. For example, develop a webinar program to learn and disseminate skills.

K-2224-02

Innovative adaptation of pastoral systems to climate change: - Case study in Mongolia -

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Synergy of scientific, technological, governance and financial dimensions is required for adaptation of pastoral social-ecological systems to climate and global changes.

- Scientific understanding of vulnerability and adaptive capacity of local and regional social-ecological systems is the basis for success of response actions.
- Application of advanced technologies with co-benefits for mitigation and adaptation is one key for responding to climate change;
- Without financial mechanism, which enables application of innovative technology, there will be no technological advancement with improved adaptation and mitigation;
- Governance for sustainable development, integrating environmental, social and economic dimensions, is another key for adaptation towards sustainability;

We will demonstrate a case study in Mongolia, integrating all four dimensions.

Permafrost melting due to global warming impact is likely to be critical slow variable leading towards desertification of rangelands in Mongolia, reducing water availability for plant growth in the spring - critical season for pastoral systems. Pastoral systems are becoming vulnerable because of interacting dynamic factors such as drought, overgrazing and "zud" (severe winter condition for livestock).

Improved early warning systems with ICT technology based on drought/grazing impacts and winter forecasting are critical for early harvesting of livestock and preventing of livestock loss during "zud". Innovative meat storage systems with application of renewable energy-based freezing system is going to be demonstrated in Mongolia which will be co-benefiting mitigation and adaptation.

The Government of Japan and the Government of Mongolia signed the agreement on Low Carbon Development Partnership, using the Joint Credit Mechanism (JCM). The Parliament of Mongolia passed Green Development Policy in June 2013, which serves bases for governance towards sustainability. Climate compatible development, integrating adaptation, mitigation and sustainable development, was a core of the policy document.

It is a challenge to demonstrate and observe how technological, governance, financial and scientific factors will work at local community level. Management of innovative technology as new commons by local pastoral community is critical for strengthening the traditional adaptive capacity and resilience of pastoral systems in Mongolia.

K-2224-03

Coupled Biological and Cultural Systems under Himalayan Climate Change: Perceptions, Adaptations and Mitigations

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Recent, rapid Himalayan climate change includes rising temperatures, increasing and unpredictable precipitation, glacial retreat, glacial lake formation and outburst, and altering natural resources. Our 1500 km transect across the eastern Himalaya, with intensive, longitudinal ecological alpine plant monitoring (4-5000 masl), shows gradually increasing plant richness, biodiversity and endemism, especially at higher elevations. Comparatively, participatory methodologies of mapping, calendars, photographs and interviews with Himalayan peoples indicate their keen perceptions of and dramatic adaptations often based on traditional ecological knowledge both to climate change and to interacting socio-economic changes. Himalayan peoples recount rapid changes in Himalayan environments, agro-pastoralism and cultural adaptations, indicating dramatic tipping points of production and land-use systems, of subsistence and cash/tourist economies, and of traditional and contemporary cultural contexts . New fruit and vegetable crops are grown, but mostly for tourists, while locals retain their traditional diets. Yak herding now takes time from lucrative tourism. Lucrative chung cao (Ophiocordyceps sinensis) harvesting, once traditional, now commercial, dominates the early spring calendar. Both traditional spiritualism and tourism are threatened by snowless mountains, diminished glaciers and the disappearance of sacred cranes. With increased precipitation, traditional mud roofs are collapsing and being replaced by economical corrugated coverings. Traditional yak robes are too warm, while contemporary, light weight hiking gear is nationally produced and inexpensive. Road incursions into the Himalaya bring more tourists, tourism conglomerates and commercial goods, while undermining traditional ways of life and increasing carbon footprints. Traditional ecological knowledge and economic savvy prescribe rival adaptations for Himalayan peoples; traditional culture and economics become competing paradigms for the Himalayan climate change. Local mitigations of climate change are varied and potentially generalizable, but contextually in decline. Systems dynamics between biological and cultural diversity - models of biocultural diversity and interrelatedness - are transforming and potentially threatening the remarkable Himalayan biocultural diversity. While Himalayan plants seem to be adapting slowly to climate change, Himalayan peoples struggle. Climate change policy needs to incorporate indigenous peoples and their knowledge to support sustainable livelihoods and food sovereignty.

K-2224-04

Climate variability as experienced by farmers

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The typical approach of estimating crop response to future climate scenarios may be inappropriate in the case of smallholder multi cropping rain-fed agriculture. Indeed, a crop-by-crop simulation, based on current varieties, cannot take into account the dynamics among crops as well as within crops i.e. among varieties, in time and space. We implemented a comparative study to understand interactions between cropping system dynamics and past climate variations, taking into account the diversity of farmers' experiences and socio-cultural organization.

In Kenya, farmers who adopted maize a few years ago are still cultivating traditional sorghum and pearl millet varieties, while others abandoned them earlier in favour of maize. Farming systems were thus dynamic, with different crop assemblages over time. Thus, retrospectively, farmers' capacity to mitigate crop failure risk due to extreme rainfall events has never been constant. Has the farming system lost part of its capacity to cope with climate variability, as maize is known to be less resistant to drought than sorghum and pearl millet? While this is usually demonstrated using yield parameter, we used seed losses, which is consistent with a multicrop system.

Combining ecological anthropology and climatology, we confronted the results of a retrospective survey of farmers' seed loss reminiscence about the period 1961-2006 and climatic records for three altitudinal levels on the eastern slope of Mount Kenya were analysed. Over the period, 3204 seed loss events were reported independently by 208 farmers, for eight main crops of their rain-fed farming systems. The causes given for these losses according to farmers' experience and knowledge were recorded yearly. We first assessed whether these causes were related to recorded rainfall values, and, second, analysed the proportion of lost seed on a yearly basis, crop by crop and on the whole farming system, using logistic regression.

Drought was mentioned 73.5% of the time whereas 8.5% of the losses were attributed to heavy rainfall. Farmers recalls coincided on drought years associated with crop diversity losses: conditional Chi-square tests based on Monte Carlo

simulation clearly rejected independence (p = 0.001) between climatic reasons given by farmers and recorded rainfall, for both droughts and heavy rainfall. Farmers' retrospective perception of drought corresponds to major droughts reported for Kenya.

By favouring maize at the expense of sorghum and pearl millet, cropping system dynamics have promoted an increasing risk of drought-associated seed loss. The probability to lose sorghum seed (0.056- 0.065) was significantly lower than the probability to lose maize seed (0.071-0.087). All crops were affected more by droughts than by heavy rainfall. Seed loss probability increased for a rainy season shorter than 50 days, with less than 28 rain days, and with a precipitation under 400 mm. Logistic regression confirmed that a change in cropping systems increased the risk of seed losses due to drought over the 46-yr period.

Farmers experienced climate variability differently, with greater negative impact on farmers cultivating maize. Ecological and social components thus cannot be analytically isolated but have to be considered as parts of a socio-ecological system. While usual approaches consider present-day characteristics of agricultural systems to assess their adaptability to hypothetical rainfall variability (projection into the future), our study used farmer experiences to look into the past. In our approach, past rainfall variability is already known, not hypothetical, while farmers' experiences can allow assessment of the evolution of their agricultural systems, which can be monitored over time, and related to climate variability.

The cropping system dynamics, by favouring maize at the expense of sorghum and pearl millet are partly related to agricultural policies that positively valued maize, whereas sorghum and pearl millet were devalued, being perceived as "poor people crops". The current dynamics of agricultural systems thus imply many dimensions, not only economical, political, and agronomical, but also cultural.

K-2224-05

Adaptation of Irrigated agriculture to climate CHAnge: trans-disciplinary modelling of a watershed in South India

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In the context of climate change and of agriculture increasingly relying on groundwater irrigation, it is crucial to develop reliable methods for sustainability assessment of current and alternative agricultural systems. The awareness that prediction of impact of climate change for water resource management must account for interactions and feedbacks between biophysical processes determining movement of water, and human behavior in a given socio-economic context has gained significant recognition among scientists in the past few years, including the recent advocacy for the development of the new science of "socio-hydrology", dedicated at studying the "co-evolution of coupled human-water systems". Recently, "Change in hydrology and society" was proposed by IAHS as the main research theme for the decade 2013-2022.

In this talk, we introduce the Indo-French CEFIPRA project "AICHA" (Adaptation of Irrigated agriculture to climate CHAnge, 2013-2016), based on the analysis of an agricultural watershed in South India, where a long term environmental observatory has been setup. We describe the trans-disciplinary approach that is developed to analyse the agro-hydrological and socio-economic drivers of groundwater sustainability and farmer adaptation, using integrated modelling.

In the studied watershed, spatial heterogeneity in groundwater gradients has resulted from intensive groundwater pumping in the villages in valley that started in the early 1990s. The decline in groundwater level provoked the disconnection between the groundwater and the river bed, and the main permanent rivers turned into ephemeral streams. Wells are being recently drilled in the upland areas and groundwater irrigation is increasing. Our analysis suggests that these contrasted evolutions are closely linked to the spatial distribution of soil types and groundwater availability, besides access to market and knowledge.

We hypothesize that feedbacks between the biophysical-social system and spatial interactions must be accounted for in order to be able to study scenarios of agricultural evolution and water management policies, not only in terms of sustainability at the scale of the watershed but also in terms of spatial variability of both the groundwater resource and the evolution of socio-economic inequity over time. Consequently, we propose to develop a model framework that combines hydrology, agronomy and economy.

We will also insist on one of the critical challenge in implementing such integrated models, which is to develop the human component of this framework to account for farmer decision that occur at different time scales. We propose to base this module on decision rules to allow the representation of farmer adaptation to a changing environment.

K-2224-06

Adaptation of Irrigated agriculture to climate CHAnge: Retrieving relevant information for distributed modelling of impact of Climate Change of water resources

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Developing integrated assessments of the sustainability of irrigated agriculture is critical in the context of ever growing pressure on water resources. A wide variety of models have been developed for simulating future scenarios of land-use change, climate change or ex-ante evaluation of management policies. Such models usually fail to account for feed backs of shrinking water resources on farmer strategies, and tend to neglect the biophysical and socio-economic interactions spatially and temporally within the watershed.

In this talk, we will present innovative approaches that are conceived and tested within the Indo-French CEFIPRA project "AICHA" (Adaptation of Irrigated agriculture to climate CHAnge, 2013-2016) based on a watershed in South India where a long term environmental observatory has been setup.

One of the critical challenge is to implement the integrated agro-hydrological model in a distributed way over the whole watershed. We propose to use methods based on remote-sensing to collect data on land use and soil properties.

One of the challenges of using such models for scenario testing in a distributed way is the need for accurate knowledge, for example for soil and crop parameters (Launay and Guérif, 2005) which are scarcely available for tropical conditions. As an example of the development of innovative methodologies fostered by the project, we present a method to retrieve soil parameters using remote sensing and crop model inversion (Sreelash et al., 2012; 2013).

Further, another challenge is for developing future projections of water balance components based on such an integrated agro-hydrological model would be the choice of the climate model forecasts to drive the model. This is commonly achieved by driving the agro-hydrological model with the bias-corrected precipitation data from the GCMs. The approaches that are being used for disaggregate and bias-correct the precipitation from the GCMs of CMIP3 will be presented.

2224-POSTER PRESENTATIONS

P-2224-01

Strategies of farmers to rainfall variations in the municipality of Zè in Benin

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Current climate change in several parts of the world are real obstacles to the development of agricultural activities. This change is characterized by irregularity and bad distribution of rainfall along the year. Sometimes rainfall occurs in abundance during a short period when crops don't need a lot of water. These difficulties are greater for farmers in developing countries as those in South-Benin practicing for the most part, highly dependent on rainfall agriculture.

Documentary research, observation and investigation in a real area have permitted to collect the necessary data during this research. The surveys were conducted with 202 farmers living and operating in the Municipality of Zè. This area is located in Atlantique department. It is situated between 6° 32 and 6° 87 N latitude and between 2°13 and 2° 26 E longitude. It covers an area of 653km², Zè is the largest municipality in the department represents 19.88% of the territory.

The climate is sub-equatorial and is characterized by rainfall amounts higher or lower, a relatively small annual thermal amplitude (less than 5 ° C) and the succession of four distinct seasons: a long rainy season from mid - March to mid - July; a short dry season from mid - July to August; a small rainy season from September to November and a long dry season from December to mid - March. The frequencies of rainfall and water levels are experiencing more and more disturbances in recent years. The hydrographic system is not dense. Only the northern part of the municipality is watered by the tributaries of the river Oueme mainly Sô River.

It appears from the use of the data collected that people (more than 84% rural) of the Zè municipality develop strategies to cope with climate change. In general, the agricultural calendar is modified to comply with new rainfall rates.

The combination of cultures and multiple or replanting seedlings are practiced in place to reduce the impact of rainfall variations on Agriculture in Zè. Changing the cropping calendar

Crop calendar takes account of the seasonal precipitation. Land preparation takes place in the late dry seasons. From the first rains, the farmers start planting. To the rainy season, sowing takes place from mid-March to mid-April and early rainy season, from mid-August to mid-September for maize. Currently, with late rains, sowing takes place later. Generally, farmers expect three to four rains before planting when they consider soil humidity is sufficient to favor seed germination and seedling emergence. But some farmers take the risk of planting after heavy rain and other precipitation when not following the operation, they resume planting.

In localities of great pineapple productions like municipality of Zè young farmers interested in increasingly pineapple production at the expense of maize production. Pineapple, CAM plant (Crassulacean acid metabolism), tolerates, breaking to sudden stops rain (Degras, 1986). This is not the case of maize which performance may drop drastically when drought occurs in the critical period of 15 days to 20 days during which occurs grain filling (Vieira da Silva, 1984). There is therefore, according to farmers, less likely to produce pineapples to produce maize.

The combination of cultures is to produce two or more crops simultaneously in the same field (Steiner, 1985). It contributes to reduce natural risks that could affect crop yields including breaks rain. Trenbath, (1993) showed that species that grows in association with other cultures is less attacked by pests that in mono culture and improves productivity per unit area (Adjahossou, 2005 and Adjahossou, 2012). According to some farmers, the association of cultures would better conserve soil humidity. This could be explained by the limitation of evapotranspiration due to the microclimate created by the combination of two or more cultures. In the study area, commonly associated crops are maize-cassava, maize-cowpea and corn-pineapple.

It should be noted that these strategies have many limitations and need to be improved significantly.

P-2224-02

Spatial Information Technology (SIT) based Land Sustainability Management through Suitability Analysis in Kansachara Sub-watershed, Bankura and Puruliya district, West Bengal, India

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Soil is one of the most important non renewable natural resources and soil fertility is its crucial component for land sustainability. Now it is being increasingly emphasized for village level planning. Prosperity of agriculture of any region depends on physical and chemical properties of soil. SIT can play a very effective role in soil fertility analysis for land sustainable management.

The study is an attempt to identify the suitability areas of some alternative crops namely Maize, Barley, Millets, Paddy (Upland and Bunded), Potato, Papaya, Sunflower, Groundnut, Sorghum, Pigeon, Chickpea and Sesame etc. The suitable land were identify based on the land capability. Land capability area ware identify proposed by Tejwani et al. (1976) method. The land capability is categorized into two sub class i.e. i) Land fit for cultivation ii) Land not suitable for cultivation. Both the land is management by different ways.

The study concluded that the cultivable land management is done on the basis of knowledge of crop suitability followed by SYS method for maximum benefit of the farmers. On the other hand non cultivable land is management by applying 1. Grass Land, 2. Conservation Forestry, 3. Horticulture and 4. Animal husbandry.

P-2224-03

Develop a web service portfolio to support the adaptation of agriculture, forestry and water management to climate change

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The adaptation to climate change of agriculture and forestry as well as water management requires tools to predict the effect of multiple scenarios combining agronomy, forestry, water management and climatic components in any physical environment, in order to anticipate negative effects of climate change, and to test and choose the most relevant strategies anywhere. A project is currently developed for building integrated tools and delivering services, encouraging midterm and strategic adaptation over France, by coupling agronomy, forestry and hydrology models. This project presents two main aspects: 1) an analysis of stakeholders demands, which has already shown that different spatial levels (territory, hydrological basin and whole France) would have to be considered, that demands are multiple and multiform, declined according to different levels of information (general information on the effect of climate change on agriculture and forestry, site vs. crop rotation modeling, up to totally distributed spatiotemporal agro-hydrologic modeling including economic dimensions); 2) an inventory of the currently available databases and models (climate, soil, crop and hydrology) and an analysis on how to couple them and overcome sectorial vision. The objective of a first step is to elaborate the specifications of one or several detailed integrated model(s), taking into account the demands of the stakeholders. Indeed, they request several innovations for the dissemination of research on adaptation: sharing knowledge and concepts, web mapping tools to display and examine maps or databases computed by modeling coupled water-agriculture-climate, or the making available models online at allowing the user to test by himself adaptation's options. Such a portfolio of services requires calculations

in the past climate, present and future, with combination of emission scenarios, climate models and downscaling methods to achieve a spatial resolution consistent with the decisions of farmers and foresters to adapt production and the corresponding economic sectors. Several crop and forest models should also be used in order to take into account the uncertainty related to the ability of impact models to reproduce all the processes. Such a portfolio of services requires calculations in the past climate, present and future, with the combination of emission scenarios, climate models and downscaling methods to achieve a spatial resolution consistent with the decisions of the farmers and foresters to adapt production and related economic sectors. Several agricultural and forestry models should be proposed to represent the uncertainty due to the vide range of impact models, reproducing more or less processes. Finally, multi-criteria evaluation (economic, social, biotech) adaptation options will be made possible. This project is developed by Inra and partners (Irstea, BRGM, CEA, CNRS, Universities, Météo France, ...) under the umbrella of Allenvi, the National Research Alliance for the Environment.

P-2224-04

The INRA metaprogramme on Adaptation of Agriculture and Forests to Climate Change (AAFCC)

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The metaprogramme on Adaptation of Agriculture and Forests to Climate Change (AAFCC) has been launched by the French Institute for Agricultural Research in 2011. It aims at coordinating, promoting and integrating the research activities to overcome the scientific and societal barriers that could restrict adaptation. This proactive and pluridisciplinary strategy involves cooperation with French and foreign academic and socioprofessional actors. It should ensure rapid results and progress, for example in multi-criteria assessment of adaptation options. Favouring the dialogue between disciplines, AAFCC provides a framework for the various research projects on adaptation of agriculture and forests to climate change. Discipline-related skills in human and social sciences, agronomy, ecology, genetics, ecophysiology, animal sciences, economy and modelling are mobilised to cover the range of questions raised by adaptation to climate change. The chosen strategy focuses on integrated approaches at the sector or territorial level. The issues and general objectives of the programme can globally be ordered according to the increasing response times of the systems, from short- to long-term, and the intensity and 'active' nature of the adaptation: from palliative or support actions, to innovation and technical or collective organisational breakthroughs. Such breakthroughs require strong innovations and a thorough socio-economic assessment.

AAFCC is fully in line with the European Joint Programming Initiative on "Agriculture, food security and climate change", initiated to enhance coordination of national research programmes. Research projects address annual and perennial crops, livestock, forests, biodiversity or water and soil resources. AAFCC has also promoted training of young scientists through PhD grants and postdoctoral fellowships. Since 2011, AAFCC has supported more than 25 national research projects and international actions and networks. It supports various European-level initiatives through funding of some ERA-NETs. It also supports international (for example cooperative projects with India or south Mediterranean countries) or global (for example ensemble crop modelling) projects. International actions increase the range of climate conditions and model species under investigation. Considering the issues at stake, international cooperation is undoubtedly, along with pluridisciplinarity, the most important issue in this domain. This is the reason why AAFCC supports various European-level initiatives and international or global projects in addition to national projects. The general objectives of AAFCC and its main achievements are presented and discussed.

P-2224-05

Adaptation of smallholder farmers to climate change in the tropical Andes

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In recent years, the precarious state of food production systems has become a focus of attention of scientists, policy bodies, and corporations face to a growing number of challenges including uncertainties and risks associated with climate change, unprecedented price hikes for basic food, and agricultural intensification. In the tropical Andes, climate and habitat changes are considered to be one of the most serious threats to sustainable development, with adverse impacts expected on the environment, human health, economic activity and food security. Over the last decade, the Andes have also experience socio-economic and institutional changes that have increased the pressure on natural resources, weakened the internal social organization and caused cultural erosion in the Andean society, reducing the capacities of populations to overcome them.

Global climate change represents a major threat to sustainable farming in the tropical Andes. Farmers have used local ecological knowledge and intricate production systems to cope, adapt and reorganize to meet climate uncertainty and risk, which have always been a fact of life. Those traditional systems are generally highly resilient, but the predicted effects, rates and variability of climate change may push them beyond their range of adaptability.

This presentation summarizes 10 years of studies performed by our group within a transdsciplinary (from social sciences to ecological sciences to earth sciences) and multi-methodology frameworks (from landscape suveys by drones to agent based modeling to participatory research). It examines the extent of actual and potential impacts of climate variability and change on small-scale farmers and describes how climate change impacts agriculture through two main study case: 1) the consequences of deglaciation and changes in hydrology on biodiversity and land users in high altitude pastures (bofedales) of Bolivia (see www.biothaw.ird.fr) and 2) the effect of temperature variability on the control of pest and disease populations in crop lansdcapes of Ecuador (see www.manpest.ird.fr).

The presentation highlights some promising adaptive strategies currently in use by or possible for producers, rural communities and local institutions to mitigate climate change effects while preserving the livelihoods and environmental and social sustainability of the region. In particular, it presents how the concept of adaptive management, «a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices», may provide mechanisms to adjust to change and uncertainty related to climate change.

P-2224-06

Farm level adaptation to drought: the case of maize production in Shanxi province, China

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Changes in temperature and precipitation will impact food production across the global. The latest IPCC AR5 WG1 assessment report states that although there is low confidence in global-scale observed trends in drought, there are regional changes, such as the weakening of the East Asian summer monsoon which in turn has led to increasing drought in northern China. Shanxi province, located in the north of China, is one of the most vulnerable provinces to be impacted by drought, especially impacting maize production.

Within the research programme on climate change and

Chinese agriculture we assess the impacts and costs to agriculture associated with expected change in risk of extreme events on maize production in Shanxi province. We investigate how local adaptation to climate change through the implementation of adaptation options reduces the vulnerability of farmers. Uncertainty about the extent of the impact of climate change on drought risk calls for flexibility regarding the implementation of adaptation options. Where one should avoid over-investment in case damages increase less than expected while at the same time facilitating proportionate adaptation if damages become higher than expected.

The objective of the paper is to show how drought risk affects the decision to invest in adaptation options. We conduct an extended cost-benefit analysis to address adaptation challenges of farmers in Shanxi province by simulating farmer's investment decisions on resources allocation and adaptation options under uncertain climate change impacts in order to maximize income and reduce the impact of an extreme event on crop production. The costs and benefits of three different adaptation options are considered, namely the implementation of drip irrigation, change of crop variety, and change of crop. Our case study of adaptation at the farm level in Shanxi province provides insights into the nexus between economic decision-making, climate change and adaptation in the agricultural sector.

P-2224-07

Increasing within-field diversity to foster agro-ecosystem services and cope with climate change

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During the 20th century, agriculture experienced major gains in productivity via homogenization and intensive use of inputs. This model is jeopardized by the awareness of rapid global change, in particular climate change, and the need for greater agricultural sustainability. Crop genetic diversity should play an essential role in this context, as it could promote various ecosystem services essential for adaptation to climate change. Increasing within field diversity through the use of cultivar mixtures is a timely option, testified by with some significant "success stories" in the past. Despite the abundant bibliography demonstrating the interest of intra-specific crop diversity, cultivar mixtures are poorly developed worldwide. In this context, the WHEATAMIX project studies the interest of mixing wheat genotypes to reinforce the sustainability and resilience of agricultural production and the provision of various ecosystem services. Based on a highly multidisciplinary approach we analyze the interactions among genotypes and with the environment, to develop new methods for breeding and/or combining wheat varieties to obtain performing blends in a global change context. Complementary experimental approaches are being deployed: i) a main diversity experiment (Eighty-eight wheat plots with 1, 2, 4 or 8 varieties, under low input) to quantify over several years the variety diversity effects on ecosystem services; ii) replicates of the same diversity experiment in 4 sites across France, to test the robustness of wheat diversity effects under a wide range of soil and climate conditions; iii) a network of 50 farms, encompassing agro-climatic variability in the Paris basin, to compare the ecological and techno-economic performance of blends with that of monocultures, using direct links with key stakeholders. The first results provide a comprehensive characterization of the multiple ecosystem services provided by genetic diversity (yield stability; regulation of foliar diseases; insect pest and weed biocontrol; maintenance of soil fertility; biodiversity conservation), and the trade-offs and synergies that exist among ecosystem services. The result also guide the selection of variety mixtures and corresponding bundles of functional traits that can deliver particular groups of services to tackle the climate change issue.

P-2224-08

Assessing the determinants of alternative adaptation strategies at farm level: the case of wine growers in South-East France

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Climate change is expected to have a double effect on water resources, directly, by potentially reducing the recharge of water resources and, indirectly, through an increase of water demands and uptakes, mainly through irrigated farming. Understanding the rationale leading farmers to adapt to climate change is thus a major challenge for water management because one of the strategies to adapt to increasing crop water requirement is irrigation. This will induce new water demands, thus understanding the determinants of irrigation choice is a challenge for robust water planification both in terms of water conveyance infrastructure planning and environmental impacts on water resources. It is also a central issue for agricultural economics and policy. One of our main assumptions to this analysis is to state that climate change is just one of the multiple changes farmers are facing together with regulatory changes (right to irrigate on a regular basis since 2006), economic changes linked to the changes in consumers demand and wine market in general, and technical changes. Adaptation must be seen as a response to all the perceived changes and not to a particular one, apriori. Also, adaptation has always been at the core of farmer's experience.

In order to explore these questions, we concentrate on the case of wine growers in South-East France (Languedoc-Roussillon) where the context is changing: irrigation is authorized on a regular basis since 2006 only and a large water conveyance infrastructure is being constructed enabling for new water resources. We surveyed wine growers in Languedoc-Roussillon via a detailed Internet questionnaire sent to more than 3000 winegrowers to understand the determinants of agricultural practices and strategic choices (planting, structural size change, commercialization). The diffusion of the questionnaire was realized via the mail listings of professional organisms (Chambre d'agriculture, cooperatives...). We collected data on current and future practices relative to soil-plant water management, perceptions of past economic, regulatory, technical and climate changes and social and economic characteristics such as objectives that wine growers are pursuing with their activity (improving wine quality, preserving tradition, etc.). For all completed and validated survey variables characterizing the terroir are systematically associated to each farm: rain, temperature, soil water capacity, elevation.

A representative sample of 363 wine growers is used for a descriptive and econometric analysis. 30% of our sample is already irrigating vine while up to 28% is considering this option. When facing a climate change scenario by 2050, 57% of those not currently irrigating say they would implement irrigation. This illustrates the importance of anticipating future demand for water irrigation. We consider two main types of determinants and explore their relative contribution in explaining the adoption of water management practices at farm level. Terroir-like variables and socio-economic variables, including main objectives that vine growers are pursuing with their activity are explored as determinants. The results confirmed that both terroir and socio-economic determinants play a significant role in the implementation of adaptation actions among which irrigation. Perceptions of past changes are determinants of adaptations: for instance perceptions of regulatory changes are determinants of existing irrigation whereas perception of climate change is a determinant of having the project to irrigate in the future. Results suggest that having its own cellar (wine transformation), increasing its size, being part of professional networks, producing wine of good quality and developing commercial strategies are determinants of resilient farms.

P-2224-09

Combining crop physiology, breeding, socioeconomics and modelling to the targeting of genotypes to "wheat hotspots" in Mexico

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Climate change is a global problem but its potential effects on crop production, as well as appropriate adaptation strategies and stakeholders' adaptive capacity, will differ by region. Mexican agriculture is particularly vulnerable to climate change with models projecting a reduction in national productivity of almost 30%. The main cereal crops such as wheat and maize will be particularly affected. Research in Mexico's main wheat production area, the Yaqui Valley, has shown that an increase of minimum temperature by one degree in the crucial growing period reduces yields by 10%. In order to assist crop breeding programs to select and target wheat genotypes, it is important to identify current and future agro-ecological zones for wheat production in Mexico and, subsequently, appropriate wheat genotypes for these zones. Already established networks for multi-environments trial evaluations worldwide (such as the International Wheat Improvement Network IWIN)) can be used to identify widely or specifically adapted wheat genotypes in order to recommend which ones could have greater impact in different agro-ecological zones in Mexico. This is particularly relevant to rain-fed areas of Mexico where scarce information on genotype performance is available. To complement this approach, detailed studies on the same genotypes evaluated for physiological traits during different years can help to determine which specific traits confer to the genotypes an advantage under given environmental conditions.

We focus on appropriate climate adaptation strategies for wheat in rain-fed areas in Mexico. We use a bio-economic modeling framework involving crop, spatial and economic variables to identify "wheat hotspots" i.e. areas in Mexico which are particularly vulnerable to increased drought and heat stress. Drawing on data from international wheat trials at 25 sites worldwide, we identify wheat lines than could be released as varieties most suited to these predicted wheat hotspots. Additionally, combinations of crop simulation models together with geographic information systems (GIS) help us to understand spatial and temporal aspects related with Genotype-by-Environment (GxE) interaction and can be used to support geographic targeting of genotypes to environments. Wheat breeding and seed supply is dominated by the public sector. The socio-economic analysis focuses on the implications of our results for agricultural policies in Mexico to ensure that farmers have access to seed of locally adapted wheat genotypes. Our cross-disciplinary approach that draws on plant physiology, crop breeding and socio-economics, provides a framework for policy-makers, researchers and development practitioner to identify where climate adaptation efforts should be directed. It is a framework that can be adapted to other regions and crops such as maize in sub-Saharan Africa.

P-2224-10

Farming Adaptation to the Impacts of Climate Change and Extreme Events in Pacific Island Countries

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Farmers in Pacific Islands' communities are considered to be most vulnerable to the impacts of increased temperature, sea-level rise, droughts, cyclones, and heavy rainfall. Farmers living on a raised atoll in the Solomon Islands (Bellona) were interviewed to understand their perceptions and experiences on the impacts of climate change and extreme events on their crops. Some examples of damage and impacts according to the farmers included rotting of roots, damage to leaves and branches, and destruction of fruits and valuable yields. Interviews also revealed that the ability of farmers to recover after disasters was dependent on their pre-disaster conditions, number and varieties of crops they had planted, type of cropping system in use, and consistent use of simple, traditional, and innovative adaptive techniques. Such techniques included crop rotation, change of planting and harvesting dates, and the planting of new resilient varieties.

P-2224-11

Agricultural adaptation to climate change-assessing adaptive decision-making of Indian farmers

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Global climate change threatens natural and human systems and is expected to cause food insecurity, rural poverty, malnutrition and dreadful environmental conditions, especially for developing countries like India. Agriculture being the primary economic activity of developing countries, linkages between climate and agriculture are expected to be more prominent and vulnerable to erratic disturbances in near future. In this respect, adaptation is considered as a sustained approach to adjust agricultural system to changing climatic conditions. Agricultural adaptation involves local adjustments to climate variations and helps in reducing the vulnerability of agro-ecosystem to climate variations and extremes and ensures long-term resilience to future climatic turbulences.

Farmers being the key actors in agricultural sector; assessment of farmers' decision making, their willingness to adapt, adaptive capacity and the likely responses to climate stimuli are crucial to ensure sustainable agricultural management. The critical question underlying farmer's responses is how do farmers decide when and how to adapt and what determines their ability to adapt. Farmers usually choose from a set of adaptation strategies such as crop diversification, crop switching, altering area under cultivation, managing crop sowing and harvest timings, increased irrigation and soil and water conservation techniques; best suited to their local agronomic conditions. Farmers' adaptation initially depends on their perception on changes in climatic conditions which are usually based on their past experiences of climate variability and extreme events and their future expectations of climate change which in turn is based on prevailing climate scenario. Although farmer's perception to climate change might be a necessary condition it is not a sufficient condition to adapt as adaptive responses of farmers are finally determined by their incentive and ability to adapt. Farmer's incentive to adapt is driven by their risk taking behavior and their expectations of earning sustained higher economic returns. Farmer's ability to adapt might defer in terms of managerial and entrepreneurial capacities and farmer's household and socio economic characteristics (Bryan et al., 2000; Nhemchena and Hassan, 2007; Deressa et al., 2008; Below et al., 2010; Falco and Veronesi, 2013). Farmer's in developing countries usually try to maximize their net returns subject to their socio economic constraints, access to information and credit availability. Farmer's decision making is often affected by complex set of socio-economic factors such as household size, age, gender, education level, off-farm income, farm size, access to extension services and credit availability etc. which are beyond farmer's control.

Against this background, this study tries to hypothesize the possible effects of key socio economic variables on farmer's ability to adapt and adaptive choices under differing local conditions for Bihar district in India. Agriculture serves to be the chief economic activity of Bihar which lies in the Indo-Gangetic plain of India and is divided into three agro-climatic zones based on soil characteristics, rainfall and temperature. Through quantitative and qualitative analysis of survey data on farmer's responses, the study finds that socio-economic factors are key determinants of farmer's adaptive capacity and adaptation decisions are outcome of interactions between these factors. Large household size can ease farm labor supply and assist in non-farm income. Also, educated farmers with large household size help in creation of intra-household social network which eases flow of information and helps in framing farmer's perception. Young and educated farmers are more ready to adopt new and advanced technology and also ensure usage of appropriate amount and quality of seeds, fertilizers, pesticides and thus increasingly adopt soil and water

conservation through crop switching and mixed farming practices. The magnitude of effects of these interlinked factors is however difficult to assess as it depends on socio-cultural, economic and political status which varies across spatial and regional scales and are often complex in nature especially for developing countries. The results of the study can be helpful in assessing vulnerability of farmer's to climate change in developing countries and help in reducing barriers to climate change adaptation.

P-2224-12

Vulnerability assessment of commercial & small scale farmers to flooding and its impact on biodiversity from 1940 to 2010 in the Duiwenhoks and Goukou catchments Western Cape, South Africa

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South Africa is a water scarce country and the resources are unevenly distributed across the country's landscape. The majority of the exploitable water is found in sparsely populated mountain catchment areas. Demands in terms of quality and quantity of water differ across sectors, water users and ecological requirements. For the Western Cape for example, a strong seasonality and micro-regional differentiation determines the balance between availability of water and the demands from water users. As a result the pressures and the impacts associated with water use are diverse in composition and intensity and affect the resilience of the province's water resource situation and subsequent resource management. Major threats to both commercial and small scale farmers are as a result of water scarcity, which in turn directly affects the delivery of ecosystem services to the poor of the poorest. South Africa's biodiversity and ecosystems are increasingly under pressure from accelerated climate change ranging from temperature increases, changes in rainfall patterns and flooding. In Duiwenhoks and Goukou catchment there is evidence of increased floods from 1940 to 2010. This has resulted to severe catchment degradation which compromises the delivery of ecosystem services that poor people depends on. The large parts of these wetlands are destroyed, and wetlands are good ecosystem services to prevent flooding and ensure good water quality. The major problem currently is the over-extraction of water for various activities within the catchments such as water for vineyard farms, dairy farming as well as other commercial developments. In Goukou the inappropriate development in the estuarine space is hindering the ability of estuaries to buffer the surrounding landscape against floods. Flow reduction is increasing mouth closure and thereby increasing the risk of floods. This study is aiming at conducting thorough vulnerability assessment of both catchment and develops flooding response measures, where we will look at the land management practises using the existing spatial developments plans and integrated development plans and others in order to assess who is hit the hardest by flooding for both commercial and small scale farmers. The vulnerability assessment data will be integrated with spatial data related to ecosystem service delivery and translated to the local level, based on catchment vulnerabilities and needs to inform local adaptation plans.

P-2224-13

Influence of climate change on nitrogen-fixing bacteria and its use as bio-fertilizer for crop production

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Increasing rates of sea level rise in the mainland of the coastal areas of the Bay of Bengal is thought to have one of the many effects of climate change and global warming afflicting developing countries of South Asia. Bangladesh, in particular has already been affected through land erosion and salinity intrusion in its broader coastline, and is expected to suffer further setback in the form of damage to infrastructures, crop failure, fisheries destruction and loss of biodiversity. The coastal area covers about 20% of Bangladesh and over 30% of the net cultivable areas. Such a vast area is feared to be affected with varying degrees of salinity intrusion, with the consequent reduction of normal crop production. This study attempts to isolate and identify agriculturally-important microorganism (AIMO), Azotobacter spp which play a predominant role in maintaining soil arability by fixing atmospheric nitrogen. They are Gram-negative and aerobic soil bacteria which meet about 70% nitrogen demand in soil. In addition to nitrogen fixation, these bacteria are able to solubilize phosphates, produce plant growth hormones and vitamins. Overall, they are renewable, yet a cost-effective source of the major plant nutrient to supplement the nitrogen-containing chemical fertilizer. In the light of Rio+20 earth summit, it can be said that their effective use could ensure sustainable agriculture as they are economically profitable, socially responsible, and environmentally acceptable.

In order to understand how long these bacteria will remain proactive under the climate change effects, soil samples from rice fields were collected in order to isolate and identify Azotobacter spp based on microscopic, cultural and biochemical properties. Sixteen and four strains of Azotobacter spp were isolated from salinity-prone southwest coastal districts, and non-saline midland areas of Bangladesh respectively. Their survival response in selective media, Azotobacter broth, supplemented with varying concentrations of NaCl was studied. Isolates were found to adapt and grow even at 20% salt concentration indicating their phenomenal tolerance to withstand salt stress. As they continue to grow in medium devoid of nitrogen, understandably they fix nitrogen. Most of these isolates harbor single and one very large plasmid (>50kb), as opposed to isolates recovered from non-saline zones. High salt tolerant, Azotobacter spp were then characterized for their drug resistance, and were tested to twenty six antimicrobial drugs, belonging to fifteen different antibiotic groups. Isolates from saline zones showed shear resistance to most of the drugs (estimated 94%), while the isolates from non-saline zones exhibited 39% resistance only. The presence of high molecular weight plasmid therefore is assumed to be correlated with the multidrug resistance pattern of the isolates. Genetic fingerprinting of the studied bacteria revealed that twenty isolates belonged to five different Azotobacter species. Overall, these salt-tolerant species have the ability to counteract salinity stress, yet fixing atmospheric nitrogen; therefore have the potential to be applied as bio-fertilizer in the coastal agriculture.

P-2224-14

Reducing fungal infestaions in growing groundnuts through biocontrol methods that can increase crop safety by deacreasing Aflatoxin content

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Peanut (Arachis hypogaea L.) is an important food crop in sub-Saharan Africa and also an important oilseed and food crop around the world. In most of sub-Saharan Africa, the consumption of peanut and peanut products is high because of their affordability and adaptability to a variety of culinary uses. Peanut consumption has been linked to the reduction of cardiovascular disease including coronary heart disease, Alzheimer's disease, malnutrition as well as cancer. However, peanut is highly susceptible to the growth of mycotoxigenic fungi and hence it is prone to aflatoxin contamination. Pre-harvest infection of groundnuts by Aspergillus spp. is of great food safety concern due to their ability to produce secondary mycotoxins, called aflatoxins. Aflatoxins cannot be readily removed from contaminated foods by detoxification. Members belongs to the genus Asperigillus are most abundant in the tropics and as such, are major food spoilage agent in warm climates. Therefore, there is a need to develop biocontrol methods that will increase crop safety by preventing the infection of the groundnut seeds by these pathogens, and hence to stop the contamination of the seed by these toxins. Prior research in glasshouse trials suggests that this approach works and can increase yields by 50%, as a bonus.

P-2224-15

Sustainable Agriculture a An ecosystem based approach for climate change adaptation for food security- a case study from an African Small island Developing State

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Sustainable Agriculture as an ecosystem based approach for climate change adaptation for food security – case study from an African Small Island Developing State

Climate change is undeniably affecting all spheres of human life including food security. The impacts of climate change are felt more by the Least Developed Countries and Small Island Developing States (SIDS). SIDS are considered as special group of countries as per the United Nations, because their smallness and remoteness makes them more vulnerable to food insecurity issues, which are compounded by the adverse effects of climate change. Livelihoods and food security of small farmers in sub-Saharan Africa are seriously threatened by climate change and this is negatively impacting on agricultural production and productivity. Climate change is not limited only to increasing temperature, rainfall pattern, soil water availability, intensity and frequency of extreme events, but also encompasses overall perturbation of the ecosystem, all of which influence food production.

The ecosystem based adaptation (EBA) approach to food production and food security assumes greater importance in the SIDS, which have very fragile and unique ecosystems. The use of sustainable agricultural technologies represent one such EBA approach, and which includes measures such as mulching, minimum tillage, multiple cropping, use of soil conditioners such as compost, use of agroforestry systems, etc. Adaptation is not to be considered as a stop-action, but rather as a process. Adaptation of agriculture to climate change is adjustments of the agricultural system to reduce vulnerability and increase resilience. The agricultural system has to undergo continuous changes.

This paper discusses the positive effects of a package of sustainable agriculture technologies, composed of mulching, minimum tillage and use of compost as plant nutrient sources, to food production. Three locally available mulches were investigated, namely banana leaves, coconut leaves and vetiver leaves, at three different rates. Minimum tillage, use of compost, and reduced fertiliser application were the other components of the package. The package was tested and validated in farmers' fields in the island of Rodrigues of the Republic of Mauritius. The beneficial effects were increase in soil moisture, a more uniform and stable soil temperature, improvement in soil biodiversity, control of weeds and other pests, increase in the yields of maize and beans. Furthermore, soil health and fertility was enhanced, in terms of properties such as pH, electrical conductivity, organic matter, water holding capacity, porosity, NPK levels, bacterial and fungal counts.

The project also included an important aspect of capacity building. Farmers were trained on compost making from agricultural and kitchen wastes, on the use of cover cropping, for soil moisture, for weed and pest control, minimum tillage (time and frequency), soil and water conservation measures, rainwater and runoff water harvesting. The training also included an understanding of the barriers to EBA, in particular the multiple functions and services of ecosystems, ecosystem goods and services, ecosystem evaluation, as well as a lack of strong policy drivers behind EBA to climate change issues.

A stakeholder participatory approach was used, with the farmers, community leaders, and NGOs being actively involved right from the problem analysis stage. The project data and information was collected together with the farmers, and at the end of the project, all stakeholders exhibited a strong positive sense of ownership of the results. The participants then served as ambassadors for the popularisation of this technology among their peers, and has now been adopted by over 90% of the farmers in the community. This approach has a very high potential for replication in other SIDS as well as in the region.This project was funded by the European Union(EU)under the Decentralised Cooperatiom Programme (DCP)

Keywords : climate change adaptation, ecosystem based approach, mulches, tillage, compost, SIDS.

P-2224-16

Do agroecological practices decrease farmers' vulnerability to climate change? Insights from the Mediterranean wine industry in France and Australia

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This research aimed to determine factors that impact farmers' vulnerability to climate change with a focus on Mediterranean viticulture, a crop particularly sensitive to changes in climatic conditions and increasingly exposed to water stress. Vulnerability was conceptualized here as a function of exposure, sensitivity and adaptive capacity. In particular, we examined the role played by agroecological farming practices on farmers' sensitivity to recent climatic events and on their capacity to adapt to long term climate change. Agroecology can be defined as a set of practices that aim for sustainable productive systems in terms of environment (resource preservation), economy (income improvement) and society (rural development). Such practices are varied and context dependant, and generally include biodiversity preservation, increasing resource-use efficiency, and limiting chemical inputs. We formulated the hypothesis that agroecological practices could be a generic driver to reduce vulnerability, but implemented differently according to socioeconomic, cultural and political contexts. We thus compared two regions with a similar -Mediterranean- climate, Roussillon in France and McLaren Vale in Australia, but with contrasting production backgrounds, and we tested whether agroecological practices had an impact on their sensitivity and adaptive capacity to climate change, and to what extent their impact and implementation was dependent on the local context.

We used a mixed-methods approach combining analyses of discourse and of climate data. Between 2011 and 2013, we led 69 in-depth semi-structured interviews with producers and key regional stakeholders (37 in Roussillon, 32 in McLaren Vale). Interviews were designed to provide insights on the way producers had dealt with droughts and heatwaves in the last two decades, and how they perceived the future of their activity in a context of climate change. Interview results were confronted to climate data obtained from Perpignan (Roussillon) and Adelaide Airport (McLaren Vale) weather stations, and modeled for the future decades by ARPEGE-Météo France (Roussillon, SCRATCH10-RETIC V4 dataset, 8 km resolution) and CSIRO-Mk3.5 (McLaren Vale, 10 km resolution). Agroecological practices were evaluated as a gradient, from those following organic and/or biodynamic principles, with (level 1) or without (level 2) official certification, those applying some principles according to their current objectives (agriculture raisonnée, or low-input agriculture) (level 3), to those applying little of these principles (levels 4 and 5).

We found that the use of agroecological practices was associated with a reduced vulnerability to climate change, through reduced sensitivity and increased adaptive capacity. Practices commonly implemented in the two vineyards studied were: the following of organic/biodynamic principles, the use of compost and tillage, the reduction or stop of herbicide use, and the use of alternative weed control such as sheep. Level 1 and level 2 producers showed a reduced sensitivity to extreme events from the last decade, such as the consecutively hot and dry summers between 2003 and 2009 in Roussillon, and the three heatwaves that hit McLaren Vale in 2008 and 2009. According to models used, such climatic conditions are likely to become the norm until the 2040's, and gain in frequency and magnitude during the second part of the 21st century. Those producers were also more personally involved in the development of their farm, which they tended to perceive as a component of a wider regional productive system. Their implication in transforming practices towards greater sustainability was associated with a long-term vision of regional development and with optimistic entrepreneurship, which often lacked among level 4 and 5 producers. Also, the close attention that levels 1 and 2 gave to their fields seemed to outgrow the fact that coping better with recent extreme events could minimize the motivation to envision climate change as a pressing issue. Despite the fact that agroecological practices tend to maximize the multifunctionality of the two areas studied -a principle valued by the European Union-, their implementation appeared easier in the Australian than in the French region, due a limitative economic, cultural and legislative context in the latter.

P-2224-17

Transhumant management in the context of climate variability in north east of benin

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The W National Park and its surroundings are a privileged and concentration of the national herd where confront all the logical development of the transhumance. In a context where the Benin suffers directly from weather conditions less under control, it is essential to improve knowledge on transhumance, know the current rangeland management and coping techniques. To achieve these goals, 300 breeders were maintained according to the quantitative and qualitative method based on a questionnaire and processed using the Sphinx plus2 software. The results we found that the texts on transhumance are outdated, ambiguous and unknown key stakeholders. Drought, high winds, excessive heat, late and heavy rain are the major weather risks affecting animals. In response to the new climatic conditions, large farmers practicing transhumance pastoralism opportunism traveling great distances.La all surveyed farmers have noticed changes in their course. These changes may be due either to the plant populations on the old lanes (50%), invasion corridors by fields of crops (65%), the drying up a bit faster ponds and streams (32%). The effects of these changes between. It may be noted thereby lengthening the path of periods (65%), insufficient increasingly higher pastures (50%). The results allowed us to identify 12 transhumance routes in the neighboring municipalities of W Park, spatiotemporal dynamics showed that routes have also changed due to conflicts (68%). These changes are reflected in the reduction in grazing areas (58%), longer travel times (25%) and the emergence of new grazing areas (32%). The changes observed in the transhumance routes are part of the coping skills of nomadic herders face the difficulties they face in feeding their animals.

P-2224-18

Agriculture and conservation: agroforestry biodiverse systems as a adaptative strategy to climate change in the brazilian Atlantic Forest

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These analyses are focused on consensus possibilities regarding spatial planning solutions based on a perspective that overcomes the production/environment polarization and dichotomy. This study also found that transition to different agricultural models, which are more sustainable and biodiverse, can help family farmers achieve their goals. Thus, this research project is aimed at analyzing recent mediation strategies for social-environmental conflicts, addressing issues like the access to land, natural resources and life quality in the context of the in the brazilian Atlantic Forest. The objective of this research is to develop an analysis on the technical and methodological improvements and innovations applied to agroecological private and community production systems in these areas. The methodology adopted is based on bibliographic research and on the collection of primary data through field notebooks noting and oral reports gathering in participative spaces for use planning and land occupation in future rural settlements located in the southernmost region of Bahia, that has one of the largest continuous remnants of Atlantic Rainforest of the country. In addition, we are planning semi structured interviews with researchers who are working on themes related to adaptation and resilience in agricultural ecosystems regarding to climate change. The historical context of the region addressed in this research, including its economy cycles and social and environmental conflicts, must be considered. Specifically, the agendas brought up in negotiations between social movements, traditional indigenous populations, the state and forest companies are discussed here, in order to provide perspectives that enable an agricultural model that conserves the biodiversity of a massive part of the Atlantic Forest Biome. This paper also presents reflections regarding different management models designed for protected natural areas. From the data collected it was possible to characterize and interpret the social organization, the history of traditional agricultural production practices, of environmental conflicts related to the land management and intensive agricultural practices in degraded areas. In this context, it was possible to find evidence that the way of life and agricultural production of the area favor local sensitivity in regard of an agroecological transition process. However, the challenges over the implementation of the agroforestry biodiverse systems analyzed in this study, shows that the perspective of nature conservation along with development faces many obstacles to its propagation even though agroecology is in the forefront of the discussion. Even with the impact of successful agroecological experiences at brazilian Atlantic Forest, socio-biodiversity conservation initiatives and cultural valorization of sustainable development of traditional populations are still overlooked at public polices.

P-2224-19

Climate Warming and Rural Poultry Production in Southern Africa - A Review

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Compared to other livestock types, poultry are more likely to be owned by most rural households in developing countries. Rural poultry production is not an occupation per se, but tends to comprise a supplemental household activity, primarily amongst poor rural families, and thus contributes significantly as a source of scarce animal protein and income. Rural poultry is, however, faced with several challenges such as inherent slow growth rates, high rearing mortalities and susceptibility to diseases, poor nutrition, housing, and lack of proper health care, which impede its productivity. At the same time, the unequivocal warming of climate is expected to compound certain of these constraints. The study described here seeks to establish the relationship between climate warming and rural poultry farming in southern Africa. This is envisaged to outline the impact of climate change on rural poultry, and create a platform for developing intervention strategies to improve and sustain rural poultry production. In the current paper, literature on the importance of rural poultry, rural poultry production challenges, and climate warming and poultry production is reviewed, and key knowledge and data gaps identified. Researchable issues on climate warming and rural poultry production are further suggested.

P-2224-20

The Important of Preservations and Distributions of Milk in respect to the Different Weather Changes in Federal Capital Territory Areas of Abuja, Nigeria

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This paper look at the important of the preservation and the distribution of milk in respect to the different weather, during the dry and wet seasons and how does it affect the level of consumption , tastes , marketing strategies , mode of preservation and the different methodology being use in preservation's of the milk products and the various problems being encountered in the process . The research was conducted in two areas council of the Federal Capital Territory namely Gwagwalada and the Municipal . The Findings shows that weather changes have a great impacts in taste level of consumptions of an individuals that consumes it, it have impact in the areas of transportation during the raining seasons most Fulani's women finds it difficult to convey their milk products because of bad roads in most of the rural areas , cost price, the level of milking of animal is high in the raining seasons due to the much of grasses and indirectly affect the rate of measurement, cost reduces in getting ice blocks for preservation of the milk and during the raining seasons ,

less efforts is needed because of the cold weather , which serves as preservation's . Some industries make use of chemical, good bottling technology which they are using in the process and the use of ice block were done when about the point of sales to the people by the Fulani's women who sales to an individual's that consumes it. Oral interview were conducted, group discussion were made with the Different questionnaires which were administer and analyzed to the sellers of milk products and consumables respectively to ascertain the findings and pictures were taken to support.

P-2224-21

Grape growing : a symbolic marker of climate evolution and a model to study adaptation

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Grapevine has been domesticated 8 to 10 000 year ago in Eurasia. From there, grapevine growing and wine making have expanded to the European-Asian-North African continents, and more recently to the so-called "new world". It is still one of the major high value fruit crops in the world. The capacity of this crop to colonize new spaces since ancient periods, facing a full range of climates, demonstrates its ability to adapt to various climatic conditions. In traditional growing zones, cultivars and human practices have been selected in order to take the best benefit from the environment to elaborate specific or unique wines. The balance between environmental conditions, cultivars and management practices within a specific location, referred to as the "terroir" concept (according to OIV definition), is used to market wines and increase their economic value. However current climate change may endanger this equilibrium. Considering these aspects, grape and wine industry may be considered as a model to study adaptation to climate change. It is the scope of a French project, named Laccave reported hereafter.

The close link of grapevine phenology with climate is demonstrated through successful reconstruction of past climate trends from harvest dates. Several studies show that process-based phenological models can accurately be used to calculate past temperatures and detect anomalies. Additional information on cultivars, wine styles and produced wine quality as well as viticultural in different wine regions may help to build more robust models at local scales. Phenological models have also been used to assess the future growing conditions by using climate simulations. For example, these studies show that an advance of 30 to 40 days for major phenological stages may be expected in France at the end of the XXIth century. Consequently, most varieties are expected to ripen at increasingly warmer conditions, impacting fruit composition and wine types elaborated from these grapes.

These changes are already noticeable in existing vineyards with a recorded advance of 2 to 3 weeks for harvest dates over the last 20 years. Increased sugar contents, lower acidity levels and modified aroma and polyphenolic composition have been observed. The suitability of actual growing zones may be seriously affected in the future and new regions may become appropriate. Cultivated areas in Great Britain have more than doubled in 25 years and vines are now grown in Sweden and Poland. Nevertheless the concept of suitability has to be taken with caution and large scale studies can lead to erroneous conclusions for local situations. Local climatic variability, adaptation of cultural and oenological practices and plasticity of cultivars may enlarge the limits of suitability. An international study is on the way to characterize and model thermal variability at local scale within grapevine growing regions in order to define the parameters of climate variability and the most suitable areas for the future.

It is clearly shown that local temperature variability within growing areas can be in the same range as variability between regions or several years and have to be taken into account for defining adaptation strategies. Altitude and exposition are key parameters. In each location, most suitable varieties to new climatic conditions can be chosen among traditional ones, but also within the large diversity existing among Vitis vinifera spp cultivars. Rootstocks bred from a larger range of Vitis spp background may also contribute to adaptation. Cultural practices such as canopy or soil management need to be taken into account as well as local variations in soil types. Irrigation can be an answer to severe water deficits but in the long run competition for water resources and increased soil salinity may become major problems. Alternative water sources, as retreated waste water, can be considered but their impacts on the environment and on wine quality have to be considered. Other disruptive innovations have to be invented. Growers and actors need to be associated to the process of defining strategies of adaptation. Their perception and the organization of innovation dissemination within the industry are key issues in this approach of adaptation. The research conducted within the Laccave project participates to the definition of these strategies and describes the mutual contribution of human and natural resources. It will be presented, based on examples from French vineyards.

P-2224-22

Investigating Climate Variability and Change and their Associated Impacts on Banana Productivity over Uganda

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Climate extremes associated with climate variability and change are on the rise both globally and regionally with far reaching impacts on socio-economic sectors particularly for countries like Uganda whose agriculture is largely rain-fed. Banana is a major crop that provides continuous cycles of harvests making it important for enhancing food security over most parts of East Africa. Studies have reported continuous decline in banana productivity due to biological and environmental factors including climate extremes. This study investigated pattern in climate and the effect of current and future extremes in rainfall and surface air temperature on banana productivity over L. Victoria basin of Uganda.

The study used observed rainfall, surface air temperature and banana productivity records spanning 1971-2009 for central and western regions of Uganda. Future climate change data from four Representative Concentration Pathways (RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5) climate scenarios for the period 2021-2050 were also analysed.

In this study, seasonal climate data were subjected to time series analysis and Mann-Kendall tests for trend and change detection. The study employed correlation and polynomial regression analysis to identify linkage between current rainfall and surface air temperature variability and banana yields. The Food and Agricultural Organisation Crop Water Assessment Tool (FAO-CROPWAT) was used to estimate banana yield changes due to soil moisture variations for different parts of Uganda. The FAO Eco-crop tool and Geo-spatial Information System (GIS) techniques were used to identify suitable rainfall and surface air temperature conditions for banana production to map future (2021-2050) suitability of banana production.

The study results showed no significant trend in seasonal rainfall in most parts of the country except a notable rainfall decrease in the western regions and slight increase for stations around Lake Victoria region. The results indicated significantly increasing trends in surface air temperature. A faster increase is notable over the central than over western parts of Uganda. This is partly attributed to different rates of land-use changes from increasing urbanization and population pressure in characterizing the two regions. Polynomial functions of degree 1 (rainfall) and degree 2 (air temperature) were determined to fit a relationship between banana yield and climate variables. The regression results show that rainfall variability explained 26% and 14% of the variations in banana yields over central and western regions respectively. Variations in minimum (maximum) surface air temperature explained

31% (34%) and 26% (30%) of the variations in banana yields respectively.

The results indicated high likelihood of warming trends (2021-2050) with respect to the climate scenarios except RCP 2.6 simulation cooler (seasonal surface air temperature) and drier (seasonal rainfall) than current observations, seasonal surface air temperature and rainfall simulation of RCP 4.5 are slightly warmer and wetter than RCP 2.6 simulations. The projected seasonal rainfall and surface air temperature is more amplified in RCP6.0 compared with all other scenarios and only cooler than RCP 8.5 surface air temperature simulations (by ≈1.7 oC). Future banana suitability mapping indicate a larger (smaller) area suitable for banana production under RCP 6.0 and RCP 4.5 (RCP 2.6 and RCP 8.5) for the study period.

This study provides critical evidence of climate variability and change, establishes linkages between climate variability and banana productivity over Uganda that can used to develop coping and adaptation strategies to improve banana productivity and enhance food security over the region.

P-2224-23

Medicinal and Aromatic Crops: An alternate proposition for exploiting abiotic stresses

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The demand for herbal drugs, plant based aroma chemicals and natural products is increasing at a speeding pace owing to the uniqueness, diversity and effectiveness of the associated crops used for. The secondary metabolites synthesized in medicinal and aromatic crops (MACs) also protect them from challenging circumstances like defence against certain stresses. In some cases, stress has been shown to bear positive effects on the production of secondary metabolites. The unique features of these MACs are that, many of them have the potential to withstand abiotic stresses to a higher degree as compared to traditional crops. This is also due the fact that, unlike agricultural crops, the MACs are not so sensitive to availability of soil moisture / temperature/ photo-periodism etc. In many cases vegetative parts are the ultimate products. Hence, there are lot of flexibilities in adjusting the planting and harvesting time.

Many of MACs are considered as high value crops presenting higher returns to the growers. However, cultivation of these MACs may not be encouraged at the expense of traditional agricultural crops already growing on well managed fertile lands. While several attempts are being taken up using molecular and modern approaches to fulfil the impeding demands of natural products, yet still the commercial production of related crops under field conditions remains as major option. The attractive proposition, therefore, appears to evaluate and promote these crops on marginal lands which might be facing some kinds of abiotic stress. These crops can manage to improve productivity and economic output compared to traditional crops.

Various possibilities of growing medicinal and aromatic plants under different types of abiotic stresses and their evaluation in terms of imparting benefits over traditional food and agricultural crops being grown in tropical and sub-tropical regions of India will be deliberated at the meeting.

P-2224-24

Fighting food insecurity and alleviating poverty in the face of climate change through rice-growing in Tonga-Cameroon

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This study focused primarily on the different actors involved in the rice production in Tonga (Western Cameroon) and strategies set to boost its cultivation, and it brought up some suggestions to the various problems that tend to weaken the activity. Preserving and enhancing food security requires agricultural production systems to increase productivity and to reduce output variability in the face of climate change and other agro-ecological and socio-economic risks. Cameroon, a low-income food-deficit country (LIFDC), has made agriculture a condition of its development. But the 2007's riots, coupled with the food prices soaring, deeply raise the double problem in the fight against food insecurity and poverty. The objective was to investigate the role played by the rice-growing activity in Tonga in the fight against food insecurity and poverty. Rice production in Tonga is on the rise because of its natural assets and good quality of the rice cultivated in the locality. To test our hypotheses, we used Quivy Campenhoudt and Van (2006) and Thiétart (1999) methods ranging from field investigation (enquiries to relevant stakeholders, on-the-spot assessment), sampling techniques, to data collection and processing. These methods have demonstrated that rice-growing contributes about 80% to the fight against food insecurity and alleviate poverty in Tonga. These findings could contribute to the improvement of the living conditions of rural populations in Tonga. However, to reverse the trend of rice consumption in Cameroon overall, it is necessary to move from family/traditional farming to industrial/modern agriculture on which the population could sustainably rely to improve their living conditions. The Cameroonian government through the Agricultural Sector Development Program (PADFA) provides different supports to farmers to eradicate hunger and poverty, and finally ensure a brighter future for rice growing. New challenges and technological opportunities for rice-based production systems for food security and poverty alleviation are then needed.

P-2224-25

Screening of Blackgram (Vigna mungo (L.) Hepper) genotypes for thermotolerance using Temperature Induction Response (TIR) technique

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Temperature induction response was standardized for blackgram genotypes. A total of nineteen blackgram genotypes were screened and evaluated for thermotolerance. By using standardized optimum induction and challenging temperature, cellular level tolerance using TIR protocol was assessed in all the blackgram genotypes. The challenging lethal temperature was standardized as 50°C at which 98 per cent of the seedling mortality was noticed. The induction temperature was standardized as 36 to 40°C at which 46.4 per cent of growth reduction over control was noticed The Based on root length and shoot height of induced seedlings over control seedlings, the cellular level tolerance in terms of least reduction in growth and highest survival percentage was calculated. Also, the physiological basis of thermotolerance was assessed by measuring the proline content and antioxidant enzyme activities. The genotypes VBG-07-001, VBG-06-010 have intrinsic heat tolerance and they can be explored as donor source in breeding programme aimed for global warming.

P-2224-26

Does diversification in smallholder coffee landscapes help farmers to adapt to climate change? Answers from Nicaragua

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Introduction: The Central American coffee production area is predicted to reduce substantially under progressive climate change. The livelihoods of many smallholders in these landscapes are threatened because they largely depend on coffee production. Despite the growing emphasis on on-farm diversification to manage climate risks and improve food security in coffee landscapes, there

are no criteria developed to quantify the status, need and outreach of diversification.

Objectives: We identified with community representatives and other local stakeholders in two contrasting coffee zones in Nicaragua (dry and humid): 1) the role of on-farm diversification in farmer strategies in climate change adaptation; 2) different dimensions of on-farm diversification; and 3) the need for specific measures to make use of the potential of diversification.

Methods: We carried out a literature review highlighting the different dimensions of diversification, and for each dimension, the benefits and drawbacks of diversification for smallholders of coffee landscapes. We consulted institutions and focal groups from ten communities in two contrasting coffee zones in Nicaragua about: 1) the vulnerability of their livelihoods to climate changes ; 2) existing and desirable strategies to adapt to these changes; 3) existing diversity in coffee farms; 4) what on-farm diversification would represent for them to be an effective way of adapting to climate change. Taken into account the gender issue, we conducted interviews in farm households to understand how actual diversification is related to climate risk management and food security status, and to identify specific needs to enable farmers making use of the potential for diversification. To embed our results in local development and research processes, our activities were linked to existing farmer initiatives and the local university agronomy faculty. In each coffee zone, phenological calendars for the principal crops were developed on the basis of the collected information to support farmers´ crop management under the existing climate variability.

Preliminary results and discussion: Farmer families in both coffee zones indicated crop diversification among adaptation options that they prefer, particularly enrichment with fruit perennials like plantain, banana and citrus. These crops provide cash flow through the year and can be used also for own consumption to enrich the diets of farmer families. Though a large diversity of agricultural species is grown in the landscape, most on-farm activities are concentrated around coffee, maize and common beans and take place between May and August, which coincides with the months of seasonal hunger. This suggests a high potential for diversification which is currently little utilized to improve food security, generate income and to adapt production systems to climate variability. The literature review allows us to draw a first typology of complementarity and competition effects amongst crops. Some farmers have already enriched their coffee farms with fruit perennials and other crops. Because of their experience, they are key persons to share knowledge about benefits and risks of crop diversification with other farmers. At landscape level, farmers stressed the importance of sufficient tree cover to ensure key environmental services like water availability. Restoration and conservation activities at landscape level will require coordination among farmer s and governmental organizations.

Acknowledgements: This study is financed by the PCP Research Platform and CCAFS.

2225 - Climate Smart Agriculture: Propaganda or Paradigm Shift?

ORAL PRESENTATIONS

K-2225-01

From a global science conference towards UNFCCC negotiations: mobilizing science for transitions

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This presentation aims at presenting the main out comes from the 3rd Global Science Conference on Climate Smart Agriculture (CSA) in Montpellier, France, 16-18 March 2015 where more than 600 researchers and 150 stakeholders and policy makers from 75 countries and 5 continents convened. CSA is a framework that mobilizes synergies and can lead to innovative and comprehensive solutions at local, regional and global levels. Delegates also confirmed that CSA solutions exist and can be brought into reality provided favorable conditions.

Agriculture was acknowledged as a sector particularly vulnerable to climate change, which impacts the livelihoods of the world's poorest people. This places increased strain on global food systems, especially since expectations for meeting demand for food will change tremendously within the next 40 years. Agriculture has also a central role in strongly reducing greenhouse gas emissions and lies therefore at the heart of complex challenges to be addressed. CSA invites researchers, practitioners and policy makers to explore solutions combining three pillars, food security, climate change adaptation and mitigation, underpinning sustainable landscapes and food systems. This is essential since the sector is facing unprecedented uncertainty and risks: synergies have to be looked at and trade-offs addressed. Recognizing that agriculture is a pivotal sector for international negotiations on sustainable development and climate change, CSA therefore provides a framework for looking at necessary transitions.

The main recommendations were as follows: (i) agriculture in the future must also address the challenges of sustainable food systems and landscapes; (ii): based upon a renewed research agenda that addresses a more complex set of objectives, researchers and practitioners must engage to build evidence and design the trajectories for multiple transformative transitions of climate-smart agriculture; (iii) the future relies upon policy, institutional and financing decisions and particularly upon the involvement of policy makers, development agencies, civil society and the private sector with researchers and research institutions in innovation platforms.

The strengthening of CSA scientific community must be pursued and better engaged in interfacing with policy makers, promoting scientific diplomacy. Their capacity to develop relevant global research programs and joint initiatives to address as from now questions that will be key in the future should be supported and stimulated through international cooperation platforms.

K-2225-02

Title not communicated

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Abstract not communicated

O-2225-01

Decision-support framework for targeting investment towards climate-smart agriculture practices and programs

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Unprecedented impacts of climate change on agricultural systems around the world coupled with increasing food demand underlie the urgency of building a more productive, resilient, and low-emission agricultural development model – one that is climate-smart. Establishing climate-smart agriculture (CSA) systems requires investment in concrete on-farm practices and broader programs to establish implementation at scales that will transform systems to address food security and development goals in the face of climate change. The

CSA Prioritization Framework (CSA-PF) was designed by scientists at CIAT and CCFAS to guide actors at multiple levels in their effort to identify best-bet CSA investment portfolios through scientific and participatory evaluation of the broad set of applicable practices for a given context. The CSA-PF is a CSA implementation planning and policy support tool aimed at governments, donors, non-governmental organizations, and local actors. The framework explicitly targets investments that diminish trade-offs between productivity increases, gains in adaptive capacity, and lowering emissions contributions from agriculture. Given the various needs of potential users and investment targets, the CS-PF can be adapted to stakeholders' needs and resources. It has been designed as a four phase process, but current pilots has varied this approach, adding additional analyses and decision taking points as needed. The first phase leads the main user of the prioritization process, in collaboration with a team of experts, to identify the objectives, scope of the study based on vulnerable areas and production systems key for food security, and the associated climatic and non-climatic challenges to be addressed through CSA interventions. The process then continues with the development of a long list of CSA practices applicable to the selected region(s) and production systems, and the identification of indicators to assess the practice's impacts on productivity, adaptation and mitigation. In Phase 2, stakeholders validate these results through participatory workshops and select a shorter list of CSA practices for further investigation based on the analyses from the first phase. An economic analysis, most often a cost-benefit analysis, is conducted in Phase 3 for the short-listed practices. A second workshop for data validation is held in Phase 4, where stakeholders discuss strategies to minimize trade-offs, to increase synergies between practices, and to minimize barriers to adoptions. The process results in the collaborative development of CSA investment portfolios. Through a comparative case study approach, this paper also illustrates the results from implementing the CSA-PF in Colombia, Guatemala, and Mali, where the prioritization objectives vary from strengthening current national agricultural and climate change policy (Guatemala), to articulating governmental and non-governmental actors around CSA actions (Mali), to scaling out CSA initiatives with local community groups (Colombia). Opportunities and challenges related to the different approaches to using the framework are discussed and recommendations for down-scaling the CSA-PF and establishing multi-level planning platforms are formulated, thus contributing to the wider goal of informing agriculture and climate change policy and decision-making.

O-2225-02

The adoption of Climate Smart Agriculture innovations: a summary of an EU project

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Agriculture and its supply chains will be profoundly impacted by actions to mitigate against, and adapt to climate change. The emerging concept of Climate Smart Agriculture (CSA) is one response to this challenge, involving the simultaneous increasing of agricultural productivity and incomes, adaptation and the building of resilience, and the reductions of GHG emissions (FAO, 2010).

Whilst heavily advanced within developing country contexts, CSA is also forming a strategic priority within Europe. Technological innovations are signalled as playing a critical role in the transition towards CSA. However, the diffusion and adoption of technological innovations within OECD countries has been slow (del Río González 2005). This is due to the presence of social and economic barriers, including poor market incentives and low levels of awareness.

The development and refinement of appropriate business models for CSA, increasing awareness and the aligning of national and EU policies have been highlighted as responses to enhance the transition to CSA.

Results from a Climate KiC pathfinder project on CSA will be presented during this key note talk. This ongoing project seeks to increase the adoption and diffusion of CSA technological innovations across the EU by stimulating both supply and demand. The presentation will provide an overview of the projects approach and results to date, which will include consideration of:

- The role and form of inhibiting social and economic factors.
- The role of business models in enhancing CSA technologies, and identifying critical issues that shape successful CSA business models.
- Current policy and regulatory impacts, and how these could be altered in the future to further the diffusion of CSA technologies and practices.

The development of services to boost CSA in Europe.

2225-POSTER PRESENTATIONS

P-2225-01

Trends and Spatial Analysis of Temperature and Rainfall Patterns on Rice Yields in Nigeria

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Due to the increasing decline in food especially rice production, a research to access the impact of climate variability on food crop in Nigeria was conducted. Trends and spatial analysis of the effect of temperature and rainfall on rice yield was carried out using 40 years climate and rice yield data. Past trends analysis was conducted with forty years (1971-2010) climate data obtained from the International Institute of tropical agriculture (IITA) Ibadan, Nigeria while rice yield data were obtained from the Food and Agriculture Organization (FAO) of the United Nations and the United States Department of Agriculture (USDA) respectively. Future trends for the next forty years (2011-2050) projections on the climate variability and trends on rice yields were also forecasted. Six cities, one in each of the six agro-ecological zones of Nigeria were selected for the studies which were Calabar in Mangrove forest, Enugu in wooded Savannah, Ikeja in tropical rain forest, Ilorin in Guinea Savannah, Kaduna in Sudan Sahel and Maiduguri in Sahel savannah. . Geographic Information Systems (GIS) software was employed to map out spatial analysis of temperature and rainfall over the entire country using the six cities in each of the six zones as nodal sampling points. Results and predictions were analyzed using Statistical packages such as Mann-Kendall and Sens' tests, multiple linear regression, cross-correlation analysis, Statistical Packages for Social Sciences (SPSS), Analysis of Variance (ANOVA), Duncan's multiple range test (DMRT) and Arc surfer software, all at 95% level of significance. Rainfall showed increasing trends in Enugu, Ilorin, Calabar, Ikeja, and Maiduguri but decreasing trends were observed in Kaduna while temperature showed increasing trends in all the cities considered in the last four decades. The future climate projections showed increasing rainfall trends in Enugu, Calabar, Ikeja, and Maiduguri while decreasing trends were observed in Kaduna and Ilorin while temperature showed increasing trends in all the cities for the next four decades. For annual rainfall, no significant trend was observed in Calabar, Ilorin and Enugu but a statistically significant negative trend was observed in Kaduna. Similarly, statistically significant positive trends of rice yield, rainfall, and temperature were observed in Ikeja and Maiduguri in the last four decades. Rainfall decreased at the rate of 4.706mmyr-1 (P) while rice yield increased at the rate of 0.052t/ha/yr (P) in Kaduna. In Maiduguri, temperature increased at the rate of 0.063°C/yr (P) while rice yield increased at the rate of 0.063t/ha/yr (P. Mann-Kendall tests showed that rice yield and temperature had generally statistically significant positive trends in Calabar, Ilorin, Kaduna, and Enugu. Pearson correlation also showed that the relationship between rainfall and yield is not significant in Calabar, Enugu, Ilorin, and Maiduguri while temperature against yield is significant at 0.01 in Calabar, Enugu, Ikeja, and 0.05 level of significance at Ilorin. The multiple linear regression models also showed that rainfall was insignificant in Calabar, Ikeja, Ilorin, and Kaduna while maximum temperature was insignificant only in Maiduguri. Adaptation strategies such as genetically modifying rice varieties to tolerate projected changes in

rainfall and temperature trends as well as effective water use strategies (supplemental irrigation) in areas of deficit rainfall are recommended to ensure food security and sustianble livelihoods in Nigeria.

P-2225-02

Salinity a Deleterious Impacts of Climate Change: Biochemical and Physiological indicators of adaptation of Vicia faba L. to Salt Stress

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Plant physiological processes are invariably linked to the deleterious influences of climate change. Salinity stress is considered as one of the major abiotic stresses which strongly reduced crop productivity. In order to assess the effect of salinity constraint on some physiological and biochemical traits in broad bean (Vicia faba L.), two cultivars (Extra Hative and Lobab), originated from Morocco, representatives of two climatic zones were evaluated for their response to salt stress. In this study, the biochemical and physiological responses of two salt stresses levels (0 and 150mM NaCl) on V. faba L. and the effect of exogenous salicylic acid (0.5 mM) at 150mM salt stress were investigated. The irrigation with salt water (150 mM of NaCl) was applied after 15 days of sowing for 21 days. The biochemical and physiological characteristics of Vicia faba L. were measured including: leaf water potential, Stomatal conductance, membrane permeability, chlorophyll content and antioxidant activity (PPO, POD and SOD). The results showed that the physiological and biochemical parameters were affected by salt concentration and there were varying responses between varieties. Thus irrigation with saline water significantly reduced all plant biochemical and physiological parameters in comparison to the respective control. Indeed, Salinity affected leaf water potential, Stomatal conductance and perturbation of membrane permeability. However salt stress caused an activation of oxidative enzymes (PPO, POD and SOD). The increasing of the antioxidant activities was significantly ($p<0.05$) correlated with salt stress. These results suggest that antioxidant enzymes play an important role in reducing oxidative stress in the broad bean exposed to salt stress. Nevertheless the protein and chlorophyll content showed an increasing with salt stress. Alleviation of growth arrest was observed with exogenous applications of salicylic acid (SA) under salt stress conditions. Overall, the positive effect of SA towards resistance to the salinity of V.faba L. will provide some practical basis for V.faba L cultivation. Elsewhere comparison between cultivars resulted in significant difference of tolerance where the Extra hative present the better performance under salt stress. From these results, we conclude that High levels of salinity negatively affected growth parameters, although selection of tolerant cultivars is a viable solution as the case of Extra hative in this study.

P-2225-03

Fostering Climate Smart Agriculture : what role for voluntary sustainability standards?

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Greenhouse gas emissions are seen by economists and others as negative externalities of production (and, to a lesser extent, consumption, and trade. In this context, two ways of regulating "environment" are generally considered for public action: "command-and-control" orders (that is to say legislative and/or coercive regulation) and/or "market-based" instruments (for example creating a market for pollution rights). However, a "third wave of regulation" [Tietenberg, 1998, "Disclosure strategies for pollution control", Environmental and Resource Economics, 11, 587-602] has emerged since two or three decades, based on information provision. This is especially the case in agriculture, where smart consumers should be linked to smart producers: Eco-labels (aslo called «voluntary sustainability standards») such as "carbon free" or "environmental-friendly" assertions, which have proliferated since the 1990s are part of this third wave of environmental regulation based on information provision. What can be their role for mitigation and adaptation to climate change? How can we paradoxically solve production externalities through the so-called "responsible" consumption while consumers should be rational and free ride when they are told to contribute to common or public goods? To assess the efficiency of eco-labels in contributing mitigation and adaptation challenges, we have to answer 3 questions:

- First, do eco-labels explicitly include the objectives of mitigation and adaptation to climate change? Studying charters and standards for forest-based products and cocoa, we show that mitigation criteria are almost systematically included in eco-labels standards, whereas this is clearly not the case for adaptation ones.
- Second, why should eco-labels be successful in inducing consumers' behaviors' change when regulation and market-based instruments failed? We show that there are two hypotheses behind the efficiency of labels: i) consumers are willing to pay for contributing to common or public goods and ii) labels solve two types of asymmetry/uncertainty: the first is an asymmetry of information "a la Akerlof" [Akerlof, G. A.: 1970, 'The Market for ''Lemons'': Quality Uncertainty and the Market Mechanism', Quarterly Journal of Economics 84(3), 488-500], the second is an uncertainty "a la Darby and Karni" [Darby, M. and E. Karni: 1973, 'Free Competition and the Optimal Amount of Fraud', Journal of Law and Economics, 16(1), 67-88]. Research show that i) consumers are willing to pay for common goods, ii) asymmetry of information about the respect of standards is not a problem but that iii) uncertainty about the efficiency of standards (i.e. what criteria should eco-labels include) is still prevalent.
- Third, labels should not create new externalities or perverse effect, which could be the case if; for example, consumers do not consider the impact of their aggregated consumption but only by units consumed.

As a conclusion, we draw the lessons in terms of possible action for donors and public powers.

P-2225-04

Assessment of the olive tree adaptation to water stress and tool to increase crop performance in the context of climatic changes

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Global climate change will introduce substantial changes to the agricultural ecosystems and consequentely will affect the agricultural productivity. Water stress is the most important factor limiting plant growth and production. Thus, monitoring of plant water status in field grown is considered of great interest, as it would allow the diagnoses of the onset and severity of water stress so as to optimise the cultural practices according to the actual plant needs. Changes in plant water status could be described by using a sensitive physiological indicator, which integrates both soil and climatic conditions. The aim of our study is to evaluate a quantitative direct relationship of the olive tree water status and the environmental conditions that might be used to evaluate the response of the tree to some unconventional cultural practices: use of hydro absorbent, increasing plantation density and supplement water of traditional olive tree grove. For online control two techniques was used: the sap flow measurement system and the leaf patch clamp pressure probe (LPCP) which give information about the relative changes in turgor pressure (Pc) of the monitored plant.

The results of the sap flow measurement show the direct influence of changes in environmental factors, water state and the physiological parameter of the tree on the sap flow level among the olive tree. For the LPCP the instantaneous data, provided by the probe, have allowed us to have accurate information on the hydraulic behavior of the olive trees and the efficiency of hydro absorbent injected in the soil to enhance the effect of the available water. Indeed, we found that the effect of the water provided by the hydro-absorbent doesn't act directly on the olive trees as is the case of direct water supply; its effect is delayed for a few days. This product can be used effectively to support the

tree during periods of intense biological activity. Also, the results confirmed some of the findings observed on olive tree particularly its high adaptability to environmental conditions, as after a period of stress observed in plants grown under rained conditions where an improved of turgor potential was recorded.

P-2225-05

Broadening the genetic base and knowledge of cultivated crops for climate adaptation: A citizen science approach

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Climate change has already started to roll and showing its effects on different aspects of today's world. Climate change affects crop production directly through the intensity and frequency of different types of stress, such as drought, heat stress, and flooding. One important adaptation measure is that farmers change to new varieties and crops. To make these changes, farmers first need information about new options and how they perform on their farms. This requires a massive effort in creating new information about crops and varieties in different contexts that is difficult to achieve with current approaches. Our work uses a novel citizen science approach to accelerate the creation of new information. We started in 2012 in the Indo Gangetic Plains of Bihar and Uttar Pradesh in India with rice and wheat. Since then, the approach has also been applied in Eastern Africa and Central America. This presentation focuses on India, where the application of the citizen science approach has advanced most.

The citizen science approach uses the farmers' views and preference in a participatory way using crowdsourcing to look for the best set of genotypes that can perform well under the changed climatic conditions of India. We first screened more than 300 varieties released from the National Agricultural Research System (NARS), selecting 12-20 varieties in each site through Participatory Varietal Selection (PVS) trials, comparing with current varieties. From this set, we distributed different combinations of 3 varieties to each of the farmers to be grown alongside their own regular crop. The variety names are not marked on the packages to avoid any bias based on previous knowledge or comparisons with neighbours during the crop cycle. We ask farmers 8-9 questions about their preferences. Farmers rank these 3 varieties evaluating various characters such as germination, yield, and resistance to pests and diseases. At the end of the season these data is compiled to see the overall performance of these newly introduced varieties as per the farmers´ verdict of different characters. We also did a set of carefully managed on-farm trials with quantitative evaluation of the full varietal set (15-20 varieties) and varieties currently grown in the area for agronomic performance. One or two of these trials are done per village and managed by leader-farmers who invite their neighbours to evaluate these varieties. We also record local weather conditions by using low-cost meteorological sensors. Every season, we repeat the process with a new set of varieties as we replace the varieties that received low marks from the farmers by a fresh set of varieties.

In wheat, the farmers of Bihar and Uttar Pradesh were growing only two varieties, UP 262 and PBW 343. Our evaluation shows that in three districts in Bihar the 12-20 varieties introduce by the project yielded more than the current varieties. Similar results were obtained for rice. Of the introduced varieties, 7 outyielded the 5 most popular hybrid varieties that the farmers are currently growing. This shows that genetic broadening and an increase in production can be combined and that the introduction of diversity can quickly close the climate adaptation lag.

Varietal evaluation data produced by the participatory variety evaluation done through on-farm plots with all varieties provided very similar results to the data provided by the crowdsourcing trials with 3 varieties per farmer. This was true for both wheat and rice. This indicates that crowdsourcing gives reliable results, while exposing the materials to a broader group of farmers with lower costs. We are analysing the feasibility of combining the variety evaluation data with the meteorological data to generalize variety recommendations to a wider area.

The impact that was noticed from the first season is farmers have started to save the seeds of the varieties that they like and find superior to the ones that they were already growing. The farmers are also trained in producing the seeds of these selected varieties and a number of groups are now producing and selling seed. Seed sales by farmer groups will help to make it financially sustainable to continue the introduction, testing and marketing of new varieties and adapt to new climatic conditions.

P-2225-06

Managing the biological function of N2O reduction for mitigating soil N2O emission

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Human activities are currently considered to emit 5.3 Tg N-N2O per year, mainly from agriculture that accounts for around two-thirds of these emissions (UNEP, 2013). The atmospheric gas N2O is involved both in the greenhouse effect with a contribution on a molar basis of around 300 in relation to CO2 (Rodhe, 1990) and in ozone depletion (Ravishankara et al., 2009). The development of new approaches to increase agricultural efficiency and potential mitigation pathways are required in particular in the context of the continuing population growth.

In soils, N2O is mainly produced through the microbial processes of denitrification and of nitrification. The last step of the denitrification process (N2O → N2) is currently the only known pathway for the terrestrial removal of N2O. N2O reduction is catalysed by the N2O reductase enzyme encoded by the nosZ gene (Viebrock and Zumft, 1988). The efficiency of soils to reduce N2O to N2 is highly variable. Soils with low N2O reduction potential have also been observed to emit high levels of N2O on a field scale (Hénault et al. 2005). We developed strategies to mitigate N2O emissions from agricultural soils based on the stimulation of the microbial process of reduction of N2O to N2. We therefore developed two different approaches for promoting the biological reduction of N2O in soils.

The first one, is based on the results previously obtained by Sameshima-Saito et al., 2006 who had observed that Soybean roots nodulated with Bradyrhizobium japonicum USDA110, carrying the nosZ gene, were able to remove low concentrations of N2O. We studied the consumption of N2O by strains of Bradyrhizobium japonicum (USDA110 and MSDJ G49) on inoculated soybean plants cultivated in soil pots during a greenhouse experiment. During this experiment, we switched from a system acting as an N2O source (soil + soybean inoculated with a nosZ gene depleted strain) to a system acting as an N2O sink (soil + soybean inoculated with strains carrying the nosZ gene). Calculations using the obtained quantitative results clearly suggest an environmental benefit of nosZ+-nodulated leguminous on the field scale, with an assessed abatement of field emission of 60 % during the investigated period, (Hénault and Revellin, 2011).

The principle of the second approach is to understand the physico-chemical determinism of the N2O reduction in soils and then to manage these conditions to promote N2O reduction. Around 100 soil samples of the RMQS, the French Soil Quality Monitoring Network, were sampled and analysed for determining their physico-chemical conditions associated to their capacity to reduce N2O into N2. Soil pH was observed as an essential determinant of the capacity of soil to reduce N2O, this capacity increasing with soil pH. A field experiment was then set up on an acidic soil, receiving calcareous amendment. We observed a pH increase followed by an increase of the soil capacity to reduce N2O and at the same time a reduction of soil N2O emissions at the field scale, with an observed abatement of field emission up to 50 % during the investigated period.

The management of the biological reduction of N2O into N2 appears possible both by biological (inoculation of leguminous crops by strains having a functional nosZ gene) or physico-chemical (pH management) actions. A stimulation of the N2O reduction function in soil allows mitigating soil N2O emissions. These both approaches are very interesting because they don't create any transfer of nitrogen pollution in environment and because they do not compromise agricultural production of proteins. Their

economic aspects are currently investigated.

These studies are supported by the ADEME (SOLGES project), the Conseil Regional Centre Val de Loire (PUIGES project) and the Labex Voltaire (ANR-10-LaBX100-01).

P-2225-07

Climate Smart Adaptation on Lake Kariba: A Case Study of Siavonga District

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Siavonga district has for the last two decades experienced declining, unpredictable and poorly distributed rainfall and experiencing climate change impacts. Climate impact studies on Lake Kariba Kapenta fish stocks show increased temperature and reduced rainfall are the main climatic factors affecting fish catch. This has led to reduced primary productivity, fish productivity and resulted in reduced Kapenta fish catch. These studies however, have not considered resource users perceptions and their adaptation to climatic variability and change.

The adaptation strategies of Kapenta fishers to climate variability and their perceptions were investigated in Siavonga district, using primary data collected by a structured questionnaire, interview schedule and secondary data. A random sampling technique was used to select 90 Kapenta fishers on Lake Kariba. Descriptive statistics, Multiple Regression Analysis, Pearson Correlation Coefficient and a Likert scale were used to analyze the data collected.

Strategies employed by the Fishers to adapt to impacts of climate variability included no adaptation (9.5%), shifting fishing times (28.8%), fishing for longer time periods (38.4%), fishing in waters further away than before (69.9%), changing fishing gear (8.2%), catching smaller fish (8.2%), alternative livelihoods (5.5%) and 'Other' specified options (6.8%). About 64.3% of the strategies used have the potential to be climate-smart as they comply with Climate-Smart Agriculture Sourcebook by FAO (2010) and Principles of the Code of Conduct for Responsible Fisheries Management.

The fishers who were adapting did not all exclusively use one strategy. Based on the number of strategies employed, 36 respondents (44.6%) used a single strategy, 27 respondents (33.9%) used two, 12 respondents (14.3%) used three, 4 respondents (5.4%) used four and 1 respondent (1.8%) used five adaptation strategies. This implies that the fishers are diversifying ways to deal with climate impacts on the catch and use a variety of strategies depending on which option is available at the time.

The respondents noted that there were constraints to adapting to climate variability. A total of 66 (82%) of the adapting fishers stated that they faced some difficulties in adapting. Of these, 48 respondents (60%) cited a lack of money as being the main constraint to adaptation and 24 respondents (30%) cited other reasons.

A total of 79 Kapenta fishers (87.7%) were aware of climate variability. In terms of the amount of rainfall in the district, 44 respondents (49.2%) perceived a decrease and 25 respondents (27.9%) perceived an increase. In terms of temperature, 31 respondents (34.4%) stated there was an increase and 10 respondents (11.5%) perceived a decrease. About 15 respondents (16.4 %) perceived an increase in Kapenta catches and 53 respondents (59%) perceived a decrease in catches. The Regression model gave an R2 value of 0.195. Multiple Regression analysis showed that Age ($p \leq 0.01$), Years of Fishing Experience ($p \leq 0.024$) and Access to Extension services ($p \leq 0.054$) have the most significant relationship with perceptions as well as having the highest Beta values contributing to perceptions to climate variability. Pearson correlation coefficients showed that the independent variables are not highly correlated. They had a range of values between -0.273 and 0.066, which are below 0.3, indicating a small strength of association.

P-2225-08

Revamping Agriculture Sector through Sustainable method: Using Solar Water Pumps in Punjab state (Study of selected Districts)

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Abstract- Sustainable agriculture is the activity oriented concept to produce food in a suitable quality and quantity and guarantee food security for the world. Land use, crop choice, irrigation, and fertilization should be done in such a way that it should not lead to land degradation and desertification. India's irrigated agriculture sector plays a significant role in India's economic development as 28% of India's GDP and 67% of employment is based on agriculture. The reliable irrigation is a critical demand as farmers in India are facing issues like erratic grid supply, increasing unreliability on monsoon rains and high cost of diesel pumps. The availability of less than 1000 cubic metre per capita is considered as scarcity as per International Standards and remedial measures. Government of India at union level and State Governments had formulated certain policies and programmes to overcome this issue and launched Solar Water Pumps (SWP) as a solution to irrigate fields adequately as it is environmental friendly and cost effective. Presently, Punjab state food grain production has failed by 16.65 million tonnes to meet its target as Punjab face problem of less energy generation for farms. Ministry of New and Renewable Energy in coordination with other governmental agencies and state nodal agencies like Punjab Energy Development Agency (PEDA) have implemented SWP schemes for improving irrigation system to increase production of food grain.

An attempt will be made through this to analyse need and scope of the implementation of SWP scheme in state of Punjab for sustainable irrigation to increase crop production. The main objective of the study is to evaluate the extent of scheme in creating awareness among population involved in agriculture while considering the perception of beneficiaries towards their installation process to meet their requirement of energy. Paper will also discuss involvement of Government machinery involved in enforcement of scheme and will suggest measures to improve irrigation through SWPs. Primary and secondary sources will be used in the proposed research paper. The primary data will be taken from two districts, Gurdaspur (max, SWPs installed) and Fatehgarh Sahib (min SWPs installed). 100 farmers will be selected as sample size for survey (50 from each district). Secondary data will be collected from annual reports of PEDA, e- Journals and other Government documents. Paper is beneficial for Government agencies and Research Scholars.

P-2225-09

Barriers to linking mitigation and adaptation in smallholder farming systems: lessons from maize cultivation among Mayas in southern Belize

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Linking of adaptation and mitigation in agriculture is proposed as a necessity, as the sector will need adaptation to resist future climatic changes, and because high emissions from the sector contribute significantly to climate change. This study investigate the barriers for making adjustments in the maize production among Maya communities in Southern Belize. It is an exploratory case study based on qualitative interviews and field observations, where four low external input adjustments that potentially will result in both adaptation and mitigation benefits were suggested. The findings show that adjustments to enhance the adaptation-mitigation link in small-scale maize production in Maya villages in Southern Belize are possible in principle, however several of the barriers can make the overall climate-smart objective difficult to implement in practice. The barriers are of proximate and indirect nature, exist at different spatial scales and involve various governance levels. Land tenure, market access, and changes in the traditional culture are shown to be some of the barriers, but it is also demonstrated that barriers are not homogenous across the villages in the region. An

overall district level strategy for enhancing the adaptation and mitigation link is possible, but the toolbox should contain a wide variety of approaches. Which could happen, for instance, through alterations of the land tenure and land taxation system at the national level, enhancement of the agricultural extension system to ease the access to knowledge and input at district level, and by supporting a less complex governance structure at village level.

P-2225-10

Tropical climate-smart soil conservation technologies for agro-ecosystem resilience

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Enhancing resilience in ecosystem changes for improved agro-ecosystem services is a prerequisite for sustainable land management. Sustainable land management in the context of climate change presents great potential for protection and enhancement of ecosystem services in all land use systems. The degradation of water, soil and vegetation, as well as greenhouse gas emissions contributing to climate change can be significantly abridged by climate-smart soil conservation technologies that simultaneously conserve natural resources and increase crop yields. These climate-smart soil conservation technologies are however scattered and poorly documented in the literature with varying levels of adoption among the smallholder farmers who are the backbone of tropical agriculture. This paper therefore reviews different soil conservation technologies that have been found effective in different agro-ecological zones, and with the capacity to enhance resilience in tropical agro-ecosystems. These technologies were grouped into improved farming system technologies, soil cover/residue management technologies, cropping system technologies, soil management technologies, soil fertility amendments technologies, and mechanical field technologies. The need for further research, extension and appropriate policy formulations on these technologies were further highlighted. It was concluded that no single technology is best for any particular area in the tropics but a combination of two or more technologies or systems within the technologies may be very effective and productive in terms of increased crop production and sustainable land management, particularly, within the socio-economic competencies of smallholder farmers.

P-2225-11

Climate-smart agriculture and cocoa: engaging with farmers and their supply chains in Ghana

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Global demand for cocoa has been increasing 2-3% annually, especially due to growing demand in Asia. The cocoa industry is challenged to produce the additional million tons required over the next years. The historic growth model for cocoa, especially in the Upper Guinea Rainforest areas, was largely based on successive waves of migrant cocoa farmers moving into virgin forests. With less than 15% of the original forest cover remaining in West Africa, this model has collapsed. Recent studies have revealed that climate change further threatens the current production zones, negatively impacting production if nothing changes. Sustainable, profitable and climate-smart intensification is required, not only to sustain the global industry, but also the livelihoods of its smallholder producers. Previous recommendations to improve productivity, including full-sun or low shade intensified cocoa, today apply to an ever-decreasing group of cocoa producers who have the necessary resources for this type of farming; moreover, it may increase the vulnerability of cocoa farmers to climate change. Availability and access to the right agro-inputs is necessary but insufficient to prepare farmers for climate change. Success raising productivity has been achieved especially in Ghana's last cocoa frontier, the Western Region, which has been the prime focus of vast government subsidy and distribution schemes. However, demonstrated yield growth figures could not sustainably be scaled to a national level. This is also clearly demonstrated by the persistence of a 50 to 75 percent yield gap for cocoa under on-farm compared to on-station conditions. Climate-smart cocoa initiatives will not only need to look at the farming systems (incl. crop diversification to buffer farmers against market, policy and environmental risks), but will also need to take on an integrated value chain approach. Proposed solutions will need to be adopted at scale, based on real-world incentives and resonating with a diverse landscape of stakeholders. Awareness needs to be raised by the identification of exposure levels and ranking of potential impacts that may vary significantly across the country and region. Relevant climate smart practices will need to be disseminated using appropriate vehicles to reach scale, e.g. by linking with existing training programs and impact investors to reach producers and their organizations. With the age of the average cocoa farmer being about 50 years, adapting for the future will also require the industry to make smallholder cocoa farming more attractive and accessible for younger farmers with strong climate smart business models. To confront all these challenges we present an inclusive approach that unites stakeholders throughout the value chain and marries existing value chain interventions focused on changing farmer practices and the provision of innovative financial vehicles with climate science. Our approach tests new methods for identifying and scaling site-specific and appropriate CSA practices, assessed against the risks of exposure on a climate change gradient, which are then mainstreamed into voluntary certification schemes and linked to impact investment in producer organizations.

P-2225-12

Exploring socio-economic and bio-physical indicators for trade-offs in Climate Smart Agriculture adoption: a case study from Tanzania and Uganda

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The contribution of climate smart agriculture (CSA) in the achievement of sustainable development goals under climate change cannot be overemphasized. CSA sustainably increases productivity, enhances resilience, lowers greenhouse gas emissions, and enhances achievement of national food security. In employing CSA, a critical gap lies in the understanding and correct representation of trade-offs across temporal and spatial scales to inform decision makers. The challenge is greater in smallholder farming systems in East Africa, implied by their highly diverse and complex bio-physical and socio-economic environments all of which produce multiple livelihood strategies, opportunities, and constraints for agricultural productivity. Unlocking the indicators for trade-offs in these production system is key in understanding prospective or ex-ante effects of technology changes and the bio-physical, social and economic outcomes under climate change.

We illustrate key bio-physical and socio-economic indicators for trade-offs in CSA adoption, across diverse landscapes drawing on household surveys in four districts in the Acholi sub-region of northern Uganda and four districts across the Southern Agricultural Growth Corridor of Tanzania in 2014. The data revealed key indicators include yield, input use, gender-disaggregated labor, off-farm employment, asset poverty, on-farm food security and soil health. The indicators varied across and between sites. In addition we use the indicators to show the tradeoffs in CSA adoption between economic outcomes (greater farm income) and environmental and social outcomes (increased environmental health, reduction in poverty levels, reduced labour demand) across landscapes and to determine the likelihood that farmers will adopt

new practices. For instance farmers are less likely to make changes during months of food insufficiency as they engage more in off-farm employment. In addition ownership of farm assets enhances the uptake of CSA. Some practices such as slash and burn, common in northern Uganda lower soil quality with negative impact on adoption of CSA practices. Engaging heavily in off-farm employment can be an indication of low farm income and willingness to change current practice. In other contexts CSA might require more time spent on the farm reducing the likelihood of engaging in off-farm activities. Farmers with better soil health were generally more willing to adopt CSA practices that in areas with high land degradation. Socio-economic attributes such as higher off-farm income, high education levels, good technical knowledge and high social preference also increase the likelihood of CSA adoption.

This analysis revealed key barriers for each of the communities that need to be overcome in order to implement and out-scale adoption of locally appropriate CSA practices as well as the importance of assessing the spatial and social context. The study highlights that assessing bio-physical and socio-economic trade-offs indicators across diverse environments could help to better target CSA farming systems to foster adaptation to climate change.

P-2225-13

Exploring solutions in response to Biosinvasions threatening agroecosystems under climate change scenarios: pest/predator adaptation and biodiversity management of acarofauna as an example

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Under climate change scenarios, increasing ecological and climatic stresses create new conditions posing a major threat to global agriculture. Particular relevant are invasive alien species introduced into agroecosystems where they often grow into destructive pests. The examples of bioinvasions threatening agricultural systems are unfortunately frequent and their number is expected to increase. Processes of range expansion and adaptation of pests but also natural enemies are fundamental for understanding the impact these organisms have or will have on populations, communities and ecosystems under new climatic conditions. These issues are here addressed taken as an example the acarofaune in crop solanaceous systems in the Mediterranean region. A focus is done on an invasive spider mite, Tetranychus evansi. While considered to be native to South America this tropical species has emerged as a new damaging pest in more temperate areas of the planet, in Europe and in other continents. Population genetics approaches unrevealed that colonization routes of the mite are complex. By distinguishing among multiple pathways and timing of introductions, there is evidence for different genoyptes of T. evansi responding to climate in distinct ways, affecting the ability of populations to adapt and being invasive. The effect of climate change affecting future range shifts is taking in consideration by using niche distribution modelling under several climatic scenarios. By exploring plant protection strategies along with predicting pest adaptation, much effort has been done on classical biological control to find native predators (Phytoseiidae mite family) in the area of origin of the pest, but none are completely efficient. Also, the introduction of exotic natural enemies is more and more questioned, in an environmental side effects point of view. More relevant would be to explore how the agroecosystem diversification could be managed to limit pest species abundance (under the resource concentration hypothesis) and to enhance natural enemy diversity and abundance (under the natural enemy hypothesis). To exploit natural biodiversity but also predicting the species potential for range expansion under new climatic conditions, appear as highly informative to advance adapted strategies for climate-smart agriculture.

P-2225-14

The Dynamics of East African Climate and the Suitability of crop Mapping over the Mountainous Areas in a changing climate

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The East African region is bordered by mountains that are crucial in modulating the climate of the region. The current evidence of climate change and climate variability poses risks to the sustainable development of the society.

The study examined trends in projected rainfall and air temperature and suitability of growing major staple food under a changing climate around the mountainous areas of Kenya, Uganda, Tanzania and Ethiopia.

The data used were observed rainfall, temperature datasets, the second version of African Rainfall Climatology (ARC2) for the period 1981-2010 and future projection from 2011-2040. The downscaled model estimates of future climate scenarios under Representative Concentration Pathway (RCP 4.5) from Coupled Model Inter-comparison Project Phase 5(CMIP5). The Mann-Kendal test was used for trend analysis and the FAO ECO-crop model was used for suitability mapping of various agricultural zones for production of maize and beans at the lowlands and down slope of the mountainous areas.

At least ten stations indicated a temperature rise of 0.3 per decade. High seasonal rainfall variability was experienced during March-May and October-December seasons. The values of Mann-Kendal were in the range of 0.8 - 2.0. The projection showed that temperature will continue to rise by about 0.5 per decade.

There was marginal suitability for production of beans and maize over most parts of the four countries. Most of the western and central part of Kenya showed high potential for production of the two crops. This trend was also reported in central Part of Uganda and coastal area of Tanzania.

The future suitability mapping for crops production showed quite similar patterns as the current situation. The highland and rift valley regions would no longer be suitable for growing the crops. The increased human activities around these regions like deforestation probably could account for the decline in suitability of growing these crops.

The threats from climate change are likely to impact negatively on the agricultural activities around the mountainous areas. The farming community living around the slopes of the mountainous areas should diversify the farming activities and best practices to cope with current climate variability and adapt to future climate changes.

P-2225-15

Climate smart rice practice under drip irrigation

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Drip irrigation studies were conducted in aerobic rice during Dry Season (DS), 2011 Summer Season (SS) 2012 and Summer Season (SS) 2013 in Coimbatore, Tamil Nadu, India. Drip irrigation treatments comprised of three levels of lateral distance (0.6, 0.8 or 1.0 m lateral distance) with the two discharge rates (0.6 or 1.0 L h-1 emitters) in DS 2011. In SS 2012, 2013 the micro irrigation treatments namely; surface, sub surface drip irrigation (SDI) and conventional aerobic rice practice. Among the lateral distances, 0.8 m lateral distance registered as the optimum spacing for the better performance in root characters, growth and yield attributes than rest of the lateral distances. From the surface-drip and sub-surface drip irrigation (SDI) treatments, the SDI performed better in terms of root character, growth and yield attributes. Interactively,

laterals spaced at 0.8 m with 1.0 L h-1 drippers laid sub surface-drip through fertigation exhibited better performance in terms of root parameters (such as root length, Root Mass Density, root biomass and root volume) along with growth attributes (Leaf Area Index, Specific Leaf Weight, Crop Growth Rate and Net Assimilation Rate), yield and its components (such as productive tillers, spikelet numbers, filled grain percentage and Harvest Index) along with water saving when compared with the conventional irrigation treatment. Drip irrigated plants emitted lesser methane over the others. Therefore, it is suggested that the lateral spacing of 0.8 m with 1.0 L h-1 drippers under SDI through fertigation is adjudged as a climate smart practice for enhancing the values for water productivity, grain yield and reducing methane emission in areas of limited water availability.

P-2225-16

Private Sector Actions to Enable Climate-Smart Agriculture in Small-Scale Farming in East Africa

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Climate change is projected to disrupt food production in East Africa, in particular for small-scale farmers; however, adoption of agricultural innovations is linked to improved food production and food security, which in turn, will help farmers adopt to altered weather patterns. Agricultural innovations are comprised of practices that increase crop productivity and improve the natural resource base that crops are grown on that improve the resilience of agricultural systems. Access to equipment, farm tools, tree seedlings, seeds, agrochemical inputs, etc. - all which are channeled through private sector entities - are needed for the realization of those innovations. Moreover, dissemination of climate information and improved farming practices needed for climate smart agricultural landscapes, which typically fall under the purview of government extension, may be more effectively diffused through the private sector.

The private sector plays the most important role in financing agricultural investments, innovation and information dissemination where constraints on government investment render private sector actions all the more important. In East Africa, little is known about the participation of small businesses, independent traders, farmer organizations, large-scale wholesalers, marketing boards and cooperatives in climate-smart agriculture (CSA) and its diffusion to small-scale farmers. In particular, small companies and the informal sector are out of view. Yet such information is critical in exploring how best to harness private sector comparative advantage to benefit the food security of small-scale farmers in East Africa impacted by a changing climate. This study is an attempt to fill this research gap and examines patterns of, and incentives for, private sector investments and activities in climate-smart agriculture at three pilot projects implemented by Climate Change, Agriculture and Food Security (CCAFS) in Nyando, Kenya; Hoima, Uganda; and Lushoto, Kenya.

This research uses social network analysis (SNA) to examine relationships between private sector actors and farmers to visualize and interpret patterns of networks for information services for the following areas: climate, crop and livestock extension, credit and banking, and legal. It also examines supply chains of agricultural inputs, as well as agricultural product value chains. Focus group discussions and surveys were administered to 289 farmers. Local businesses were also interviewed. This study also examines local-level linkages with national agricultural organizations to determine if the latter play a role in facilitating climate-smart agriculture.

Preliminary results suggest that independent traders dominate trade in all sites and that even though the supply of inputs is sufficient, farmers often lack access to credit. Also, distinctive differences exist in terms of the concentration of business activity amongst local actors and the diversity of marketable crops produced. The efforts of Kenya's National Farmer's Federation to establish locally based farmer's groups is reflected in its highly diversified groups that grade amongst themselves, in contrast to Uganda where a select few dominate locally traded agricultural output. Lushoto's proximity to Dar es Salaam is evidenced in its high number of independent traders, and to a lesser extent, locally registered businesses. Despite its high level of trade, it is also the least food secure of the three sites. The results indicate that while independent traders focus primarily on the trading of crops, they do disseminate information relevant to climate smart agriculture suggesting that efforts to strengthen this sector is important. Finally, the implications of these findings for food security are discussed. This study demonstrates that social network analysis is an important tool for identifying which private sector actors can be strategically targeted for strengthening efforts to scale up climate-smart agriculture and where weaknesses in input and output supply chains exist.

P-2225-17

Promoting Climate Smart Agriculture along the Coastal Belt of Bangladesh Using ICT

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Bangladesh is a small country and the highest densely populated country in the world which is vulnerable to different types of environmental disasters. The major disasters and environmental vulnerabilities are floods, water stagnancy, droughts, cyclone, tidal surge, river erosion, salinity, extreme temperature and low light intensity, pests and diseases etc. The vulnerabilities due to climate change are likely to aggravate more in the future. These catastrophic events significantly hinder the agriculture production systems, economic and social development of the country firstly, through damaging the crops, livestock, fisheries and agro-forestry, natural resources, establishments and infrastructures and secondly, pulling back the on-going developments, business and trade at local, regional and even global levels. Costal areas are mostly inhabited by the poor and disadvantaged groups. Usually coastal belt is flooded from May/June to November/December. Salinity also restricts agriculture in the coastal areas. In the Coastal Zone, crops are lost due to water stagnancy/standing flood water or tidal surge during July/August-November/December (5-6 months) in wet seasons. On the other hand, during winter salinity is major threat to agriculture in this area. During summer season, due to lack of irrigation availability, farmers can not produce crops in their lands. The aim of the action research is to ensure food security of ultra poor climate vulnerable farmers promoting climate-smart agricultural system using ICT in costal belt of Bangladesh. The study was conducted in flood and saline prone Bagerhat District of South-West Coastal region of Bangladesh adopting establishment of Climate-smart Agricultural Information Centre; generating local agro-meteorological, soil and hydrological information; developing and regular updating customized software on generated information; dessiminating seasonal agro-meteorolical, soil and hydrological informatinon relating to crop suitability using cellular phone, community radio message and mobile internet; educating farmers on ICT and climate resilient agricultural system, soil health, flood & saline tolerant varieties. Based on the empirical findings, the study reveals that ICTs are powerful tools in climate-smart agricultural development. Radio, cellular phone and mobile internet are strong platform in interaction between farmers and climate change experts. It made a tremendous improvement in climate-smart agricultural promotin in the study area.

P-2225-18

Floating Vegetables Gardening: Climate Smart Agriculture Technology for Food Security in Tidal Flooded Area of Southern Bangladesh

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Bangladesh is ranked as one of the most climate-vulnerable countries in the world, where agriculture is the most climate sensitive sector. The consequences of

climate change concerned here are: floods, intrusion of soil and water salinity, sea level rise and tropical cyclones, which are major constraints for sustainable agricultural production in Bangladesh. The coastal area covers about 23 percent of the country and lies on the 'front line' of climate change and sea level rise. Most of Bangladesh is less than ten metres above sea level, with almost ten per cent of the country below one metre, making it extremely vulnerable to increasing high tides. Intergovernmental Panel on Climate Change predicted that about 17% of the country's landmass could be inundated with a one metre rise in sea levels in Bangladesh (IPCC'S AR5, 2014). Therefore, climate change adaptation measures must be taken for improving the food security of the people. The coastal area adjacent to sea-bank in southern region of Bangladesh remain under submerge condition for a long period (generally from June to December) during monsoon season or even all the year round due to tidal flooding and erratic rainfall. As a result, there is no scope of crop cultivation on this land naturally that hampers the crop production as well as food security severely particularly for the vulnerable poor people. To cope with the situation, the farmers of tidal flooded area have been practicing a climate smart technology of soilless vegetables gardening since two centuries, which is locally known as "Vasoman or dhap chash," meaning "Floating Agriculture" (similar to hydroponics). In considering its innovativeness, a study was conducted using questionnaire tool among the randomly selected farmers (n=150) in three southern districts (Gopalganj, Pirojpur and Barisal) of Bangladesh during 2012-14 to assess the agro-economic performance of floating vegetables gardening and its potential for adaptation to climate change in the country. The floating bed is built up with various types of local materials and the single most important component is water hyacinth (Eichhornia crassipes), but topapana (Pista stratiotes), dulali lata (Potamogeton alpinus), son ghash (Imperata cylindrica), noll ghash (Hamerthria protensa), aquatic algae (Nitella sp.) wood ash, and dissected coconut fibres are also used for floating bed preparation. A large number of people are involved with this business for supplying the local materials to the farmers. Size of the floating bed varies over district ranges from 15-45 meter long, 1.2-1.5 meter breadth, and 1.0-1.2 meter height. The floating beds lift up with rising of tidal flood water level without any damage. Farmers of Gopalganj district usually grow different vegetable crops (okra, Indian spinach, bottle gourd, bitter gourd, tomato, brinjal, snake gourd, cucumber, ridge gourd, yard long bean, water melon, musk melon, chilli, etc.) on floating bed during monsoon season without using any fertilizers and pesticides. However, seedlings of above stated vegetable crops are produced on the floating bed in Pirojpur and Barisal districts. Seedlings of vegetables are grown for 3 to 5 times/bed/monsoon season (June-October), where 1000-1200 seedlings/bed are grown in a time. Before growing of vegetables and/or seedlings on floating bed, a series of backward tasks (media ball preparation, seed sprouting and set-up, primary nursing etc.) are done mostly by women at homestead nursery. After vegetables cultivation, the decomposed floating beds can be used as compost for succeeding crop production that saves the use of chemical fertilizers as well as environment. The seedlings are sold at local market of nearby districts for income generation (average net return USD 20/bed). Floating gardening provides fresh vegetables for household consumption of the local people and the surplus amount of the product are sold at the local market to earn some cash particularly for the women. Thus, the technology has the potential to provide a means of income and food security for the millions of small households who have no access to plan land but live close to large bodies of water in southern region. The local innovative technology (floating gardening) may be recognized as agricultural heritage as well as suitable adaptation option in considering its environmental and social aspects in Bangladesh. Therefore, the floating vegetables gardening have been considered as a climate smart agriculture technology for food security in southern region of Bangladesh.

P-2225-19

Multi-Criteria Decision Analysis (MCDA) Technique a Tool for Assessing and Comparing Sustainability of Climate Smart Agriculture Systems with Conventional Agricultural Systems

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Assessing and comparing sustainability of climate smart agriculture (CSA) systems with conventional agricultural (CA) systems is essential for future policy and planning of CSA. In this paper we proposed a holistic approach based on MCDA methodological approach that helps to assess and compare CSA with CA. Through a case study from south west coastal region of Bangladesh the sustainability of CSA and CA are assessed and compared. To assess and compare of CSA and CA the indicators were developed based on productivity, stability, efficiency, durability, compatibility and equity categories of sustainability of agricultural systems. To develop indicators, data was gathered through questionnaire survey, secondary information, focus group discussion and key informant interview. The indicators of six categories of sustainability were assessed and compared through weighting and aggregation methods of MCDA. The findings of this research work demonstrate the overall sustainability status of CDA and CA. The results of the study show that this approach has the potential to become a useful framework for agricultural sustainability assessment of CSA.

2226 - Health and climate change : the need for a diversity of approaches

ORAL PRESENTATIONS

K-2226-01

Ecology, climate change and health

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(1) CNRS-CIRAD, Environment and Society, Vientiane, France

Abstract not communicated

K-2226-02

Ultraviolet radiations, climate change, and human health issues 1

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Abstract not communicated

K-2226-03

Ultraviolet radiations, climate change, and human health issues 2

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Abstract not communicated

O-2226-01

The Future of Emerging Diseases Under Climate Change: Current Knowledge and Synergistic Solutions for Health and Sustainability

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Climate change is anticipated to pose serious threats to public health this century. Infectious diseases present an especially relevant health consideration, as they currently cause over one billion human cases and millions of deaths annually. In particular, in many cases emerging infectious disease (EID) outbreaks in humans, which may be novel or appear in a new region, are sensitive to climate variability. On a micro level, temperature and precipitation-dependent pathogen development cycles may affect the basic reproductive rates determining pathogen survival and spread in a population, and may similarly affect suitable habitat range of its competent host(s). On a macro level, however, EIDs are dependent on a wide range of factors, and thus climate cannot be viewed in isolation when assessing risks. Rapid changes to ecosystems and resulting alteration in composition and abundance of species, as well as anthropogenic practices that are facilitating increased and novel human-animal contact, pose complex biotic dynamics that interface with abiotic climate variability. Given that changes in land use (e.g. deforestation), agricultural production, and global trade and travel are among the leading causes of disease emergence, and overlap with the underlying drivers of biodiversity loss as well as the major direct contributors to greenhouse gas emissions, integrated solutions can be taken to address challenges of all three. From the work of the Future Earth ecoHEALTH project and its partners, we highlight findings from ecological niche modeling for disease such as Nipah virus and malaria to examine the different dimensions of EID risks over the coming century, and propose near and long-term solutions that can mitigate known risks and better anticipate future risks where research gaps remain. Given the high economic impact of recent EID outbreaks, we also identify priority areas of collaboration with other sectors, including on strategies for land use and agricultural production, to minimize future burden of EIDs while simultaneously promoting a sustainable future.

O-2226-02

How climate is intertwined with Dengue Fever Outbreaks in French Guiana

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Introduction
Dengue fever (DF) is a serious and potentially life-threatening infection acquired through the bite of infected Aedes aegypti mosquitoes and responsible for major outbreaks in French Guiana. DF transmission is driven by complex interactions between hosts, vectors and viruses that are influenced by environmental, anthrogenic and climatic factors which results in annual seasonality and multiannual variability. Although the onsets of outbreaks seem to be associated with the start of the rainy season, the mechanisms involved in the occurrence of epidemics are not well understood. With the objectives of explaining and predicting DF outbreaks occurrence in French Guiana, we explored the impact of climatic factors on DF epidemics at different spatial and temporal scales in French Guiana.

Methods
For this analysis that covers the 1991-2013 period, we used biologically confirmed DF epidemiological data, climatological parameters including Niño and NAO indices, atmospheric reanalysis gridded data and meteorological stations record including rainfalls, temperatures, relative humidity, sunstroke average and wind force.

We sudied the association between incidence of DF and climatic variables to identify temporal predictors of DF outbreaks. Year-to-year disease variability was investigated by linking atmospheric and oceanic synoptic patterns to the epidemiological regional context. Finally, contextual sequential patterns extraction techniques were used at local scale and weekly time step to identify the most significant climatic factors influencing DF incidence dynamics.

Results
From 1991 to 2013, more than 23,600 biologically confirmed DF cases were recorded in French Guiana and 8 major outbreaks were identified. Annual activity was characterized by a seasonal increase of incidence levels during the first quarter of the year. We found that outbreak occurrence can be linked with summer Niño conditions, 6 months before the onset of the outbreak. Furthermore, a statistical model based only on climate indicators indicated that 30% of the disease variance from year-to-year is explained by the dry season rainfall, forecasting epidemic years with a hit rate of 75% and a positive predictive value of 75%.

At regional scale, the outbreak onset in specific areas was frequently associated with a 4-6 week lag with an increase in the relative humidity, high levels of rainfalls and a decrease of temperature. During epidemic period, local specific weather conditions were not predictive of the epidemic peak, where a predominance of the cumulative incidence occurred.

Conclusion
Using complementary approaches at different geographic scales we explored the role of climate conditions to understand and predict DF outbreaks in French Guiana. Our findings will be useful to timely target appropriate public health interventions to mitigate the effects of major outbreaks, particularly in areas where resources are limited and the medical services may become overwhelmed by large epidemics.

This first successful step opens new opportunities in the DF risk prediction. Future work will be a more in-depth focus on influence of future climate conditions according to different scenarios of climate change on epidemiologic patterns.

O-2226-03

The PALUCLIM project. Impacts of climatic factors on the production of malaria vectors in the rural Sahel: Application to the Nouna region (Burkina-Faso)

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Emerging/re-emerging infectious diseases with high epidemiological potential risks, lead public health managers to adapt their policies. Adaptation includes early knowledge of risks. The latter requires new tools to prevent re-emerging risks.

Infectious diseases such as Rift valley fever or malaria are closely tied to climatic and/or natural and anthropogenic environmental factors among which some could be identified using remote-sensing. Then they can be assimilated into bio-mathematical models thus allowing re-emerging risks' assessment. The French Spatial Agency (CNES) with its partners has developed a conceptual approach so-called Tele-epidemiology based upon studying climate-environment-health relationships with applicable products.

This multidisciplinary approach is based upon the study of the key mechanisms favoring the surge and spread of those diseases. Analysis of those processes is a key step in the development of new and original risk mapping using Earth observation satellite data. The primary mission is to show how those adapted space products could contribute to diseases surveillance policy and improve Early Warning Systems (EWS). The overall objective is to attempt predicting and mitigating public health impacts from epidemics.

This approach has been applied with success for malaria in Burkina Faso through the Paluclim project. This project was to apply the Tele-epidemiology conceptual approach linking climate, environment and vector-borne diseases such as malaria in the Sahelian region of Nouna (Burkina Faso). It was proposed to study the impacts of environment/climate variability on malaria entomological risk, a first step for risks of malaria outbreaks and then to analyze impacts from risks' forecasting.

The project objectives were to provide and validate dynamic entomological risk maps, then to study adaptation processes for controlling management, i.e., addressing the predicted risk, and to study the impacts of climate variability (from seasonal to low frequency climatic signals, including tendencies and climate change) on risks' forecasting.

To achieve these objectives, the Paluclim project integrated efforts from several teams and partners: CNES, Météo-France, Public Health Institute of the University Hospital of Heidelberg (Germany), Centre de Recherche en Santé de Nouna (Burkina Faso) representing the Health Ministry. As such it benefited from previous expertise and results obtained by the different partners in entomology, climate, environmental sciences, and in Tele-epidemiology. In this work it was shown that:

- based upon satellite (SPOT 5) and in-situ data it was possible to build an operational model to predict location of larvae sites and distribute dynamic maps on larval productivity for local villages ;
- based upon the larval productivity maps for targeted larvicide strategy could be implemented.

The added-values from the use of entomological risk maps were obvious in terms of additional element such as economical savings for decision makers. The use of larval productivity maps for larvicide treatment was perceived locally as extremely positive.

As of today, rainfall is the main meteorological driving parameter for the knowledge of vectors' density (which is used for the evaluation of entomological risk maps). The malaria entomological risk as a function of the weather/climate spatio-temporal variability was undertaken. An impact model was developed based upon an existing model (Graig's model), particularly efficient when resources are limited. The climate analyses were done for different temporal scales (i.e., seasonal, quasi-biennial, inter-annual, low-frequencies and climate change). The model could thus be used immediately on an operational mode. It was found that the new main driving factor for the upcoming years will be the temperature increase leading to a decrease of malaria risks (for at least the next 50 years), knowing that models have a hard time to predict rainfall variability in the near future.

O-2226-04

Will climate warming decrease winter mortality in Europe?

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The steady increase in greenhouse gas concentrations is inducing a detectable rise in global temperatures. The sensitivity and degree of adaptation of human societies to warming temperatures is however a transcendental question not comprehensively addressed to date. Recent studies have pointed to improvements in housing, standards of living and healthcare systems as primary factors explaining the progressively decreasing year-to-year association between excess winter deaths and winter temperatures in economically developed societies such as Europe and the United States.

Here we show the link between temperature and daily numbers of deaths in nearly 200 regions in western Europe, which are subsequently used to characterize the spatial picture of human vulnerability to climate conditions in winter. Our analyses show that only the United Kingdom, the Benelux and northern France have successfully taken steps towards the adaptation to harsh winters, and that the Mediterranean and eastern countries, including Germany, Austria and Switzerland, still remain sensitive to intense cold seasons. Results however reveal that the countries exposed to the most extreme climatological conditions in winter are the least vulnerable to cold spell episodes, while the incidence of these events is again particularly damaging in the temperate regions of southern Europe.

The different sensitivity of European regions to cold temperatures highlights the kind of adaptation strategies that each country has already implemented, and reveals the actions that could potentially be taken in order to increase the overall life expectancy. In the light of our results, the European society will remain exposed to the natural and anthropogenically-induced climate variability in winter unless a substantial degree of adaptation to both intense cold spells and harsh winters takes place.

O-2226-05

Achieving Health Dividends from Climate Change Mitigation Policies

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There is growing interest in the range of co-benefits from well designed policies to reduce greenhouse gas (GHG) emissions. Importantly, many mitigation-related health impacts may accrue sooner than the benefits projected from reducing the magnitude of climate change and are subject to less uncertainty because the pathways linking the policy measures, changes in exposures and subsequent health outcomes are quite well established from epidemiological studies. A range of studies published over recent years have suggested significant net health benefits across several mitigation strategies in both high and low income countries. Studies estimating the ancillary health effects of mitigation strategies (while acknowledging that co-harms also may result) use a range of modeling approaches, and draw expertise from public health, agriculture, environmental sciences, nutrition, urban planning, architecture and other disciplines to generate policy-relevant outputs. Reductions in fine particulate air pollution, with major benefits to health, result from policies to reduce fossil fuel use - particularly reduced coal and diesel combustion. In the transport sector, policies which increase active travel (walking and cycling) would also reduce CO2 emissions and lead to substantial benefits, including for cardiovascular health, which would greatly outweigh increased risk of road traffic injuries. Interventions which increase energy efficiency in the housing sector have the potential to lead to considerable health benefits through improved internal temperatures during winter and protection against outdoor air pollution, as long as compensatory ventilation is provided to reduce exposure to indoor-generated pollutants. Relatively modest changes to dietary patterns can lead to substantial benefits for health and also reduce GHG emissions. However, drastic GHG reductions may require unpalatable modification of current diets. This presentation will give an overview of recent studies that have estimated the magnitude of health co-benefits from strategies to reduce carbon dioxide and short lived climate pollutants in the energy, transport, housing and food and agriculture sectors in high and low income settings. It will also discuss key methodological issues in designing studies. It will outline how valuation of health and other co-benefits can help offset the costs of mitigation policies and potentially make them more attractive to decision makers. Finally it will also consider potential co-harms of poorly designed policies and how such risks can be minimised.

2226-POSTER PRESENTATIONS

P-2226-01

Urbanization, Climate Change & Human Health A Study on Four Megacities of Urban India

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The World Bank in 2002 reported that in poor countries as much as 80 per cent of future economic growth occurred in cities and 60 percent of the world's population will be residing in cities by 2030. The increase in the average temperatures in the megacities in India is accompanied by the increase in population. The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) has focused that by 2100 the global temperature would increase by 1.8 °C–4 °C and which has effect on increased heat-related mortality and morbidity and greater frequency of infectious diseases like diarrhea, cholera and other bacterial diseases. The paper attempts to address the impact of precipitation in relation to human mortality pattern in India and the distribution of disease vectors like malaria, dengue and diarrhea diseases at the four megacities like Mumbai, Delhi, Kolkata and Chennai of India. In addition, the paper also attempts to establish the impact of urbanization on climatic variables like temperature and rainfall. The objectives of the paper are four fold. First, is to examine trends in summer temperature, monsoon temperature, post monsoon temperature and winter temperature at four megacities like Mumbai, Delhi, Kolkata and Chennai of India. Second, is to examine the impact of precipitation on the disease vector like malaria in India. Third, is to examine how climate change affects the distribution of disease vectors in the four megacities of India. Fourth, is to establish the relationship between urbanization and temperature change at four mega cities of India.

The paper utilizes time series data on temperature and precipitation, number of malaria deaths from the various reports of Indian Metrological Department for period 1978 – 2008. The analysis of trends in temperature at four largest cities is based on data for the period 1901–1991. Regression analysis is done to estimate the effects of precipitation on malaria cases. As the data set comprises time series in nature, before doing regression analysis we have applied unit root test and the Augmented Dickey Fuller test (ADF test) is employed for this purpose. After conforming the data are stationary we have applied regression analysis to show the impact of precipitation on malaria death.

In the univariate case, it is possible to view the stationarity of { Yt } as being dependent on the magnitude (a1–1), that is,

$$Y_t = a_1 Y_{t-1} + \epsilon_t \quad \text{----------} (1)$$

$$\Delta Y_t = \gamma Y_{t-1} + \epsilon_t \quad \text{Where } \gamma = a_1 - 1 \quad \text{----------} (2)$$

In the presence of trend of drift the Dickey and Fuller equation can be written as

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \epsilon_t \quad \text{----------} (3)$$

where a_0 and $a_2 t$ represent the drift and time trend component respectively.

The result of the unit root test shows that death due to malaria (MDt) and precipitation (Rt) are stationary at the first difference. After checking stationary test we have regressed death due to malaria on precipitation.

The regression equation is given below

$$\text{Log } K_t = b \text{ Log } Z_t$$

Where $K_t = \text{Log } MD_t - \text{Log } MD_{t-1}$

$Z_t = \text{Log } R_t - \text{Log } R_{t-1}$

The result shows that there is a positive and significant relation between precipitation and death rate due to malaria. The higher is the precipitation and higher is the death rate due to malaria. Most of the trends showed positive change in temperature with different rates in different seasons. In some cases, the trends showed asymmetry. The results of the impact of urbanization on temperature revealed that there is a positive relation between the increase in temperature change and the increase in population change on the annual scale. But on seasonal scale this is applicable for monsoon, post-monsoon and winter season and not for summer season. The paper has important policy implication for improving water quality.

P-2226-02

Scalling heat-mortality relationships recorded in cities to the global scale

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A large number of epidemiologic studies relating air temperature and mortality in cities have been conducted but they findings not generalized to continental scales. The studies usually culminate with the determination of a threshold-mortality temperature (TMTs), that is, a temperature value beyond which recorded mortality in a city deviates from the normal expected.

In this work we have compiled and homogenized threshold-mortality temperatures (TMTs) found in peer-reviewed literature for circa 90 cities worldwide. The chosen unit for homogenization was mean apparent temperature, since it is a composite measure of temperature and humidity. A multivariate linear regression between TMT's and a set of 12 independent variables was preformed. The set included several measures of the climatologic features of a city, as well as physical urban features city density, size and fraction of urban spaces. The linear regression exercise returned 30-year mean amplitude and 30-year average temperature as the best explanatory variables (adjusted R2 = 0.66). Results point therefore for a significant role of climate alone in shaping the ability of urban population in sustaining heat-stress, while the remaining variability is likely attributed to factors such as demographics or health care standards.

In order to reflect the existence of a physiologic limit for temperature, a sigmoid function (S-shape curve) was fitted to the TMT's using the same set of independent variables as for the case of the linear regression. 30-year mean of the hottest month returned the fit with the lowest residual standard error. The saturation value for the sigmoid function, that is, an approximation of the physiological limit (or adaptability limit), was set and 45 degrees, in reflection to the upper limit of temperatures recorded at permanently habitable regions in the world and further evidences from literature. The robustness of the sigmoid function was tested for subsets of TMT's from different climatic zones. The fit preformed best at sub-tropical-wet climates, and worst at humid-continental climates. Climate projections of temperature were superimposed with the results of the sigmoid fit in order to highlight the regions where the largest deviation from air temperature to TMT's are expected. In particular, the function allows for the exploration of several «adaptability» scenarios by varying the speed with which a region can «move» along the fit function.

There is still a considerable amount of variance in TMTs not captured by our approach but we have successfully captured the role of climate in shaping the adaptive capacity of the urban population. We also moved closer into bridging the persistent gap between research undertaken at the case-study and the need for global generalizations of results. Finally, following the proposed function, first order approximations of TMT's can be made for regions where temperature-mortality studies are absent.

P-2226-03

Climate change effects on the erythemal and vitamin D weighted UV daily doses in South America and Antartica: Impacts on the health of populations

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Recent studies show that the ozone layer will be recovered until 2050. This is a significant result of the Montreal Protocol which points out the success of this environment protection agreement. However, climate change projections show that the total ozone content will have a relevant increase until the end of this century, mainly at higher latitudes. On one hand, this increase can reduce the

adverse effects of UV radiation overexposure. On the other hand, the decrease of UV availability at the surface can reduce the synthesis of vitamin D among the inhabitants of these regions. In this study, we provide erythemal (DoseE) and vitamin D (DoseD) weighted UV daily doses estimates for ten different sites of South America and Antartica. Our calculations are based on the ozone forecasts provided by four climate models reported on the last IPCC report. Unlike previous works, our study evaluates the impact on the daily dose of radiation received. Thus, these results can be used as an important tool for the health studies on the excess or lack of sun exposure. The first results show significant UV attenuation at Southern sites. At 30°S, DoseE and DoseD can be reduced between 5 and 7%, respectively, until the end of this century if the anthropogenic emissions continue to rise throughout the time. At 50°S, these reductions increase to 12 and 21%, respectively; and, in Antartica they will possibly exceed 15 and 30%, respectively. We did not observe significant variations at the equatorial sites. In this talk we also discuss the impact of these UV availability reductions on the population's health.

P-2226-04

Evolution of surface UV radiation in relation to ozone depletion and climate change

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Exposure to ultraviolet (UV) radiation is known to be a risk factor for several diseases such as skin cancers and cataracts. On the other hand, a number of studies have described the benefits of UV exposure in relation to the synthesis of vitamin D and prevention of several diseases. The evolution of surface UV radiation has been under scrutiny in the last decades due to the discovery of ozone depletion in the middle atmosphere. Atmospheric ozone is the main atmospheric absorber of UV-B radiation (280 - 320 nm spectral range) and its depletion has raised concerns about the protection of human populations, living organisms and ecosystems against dangerous UV radiation. The rapid understanding in the 1980s of the main processes involved in stratospheric ozone destruction, which incriminated halogen substances emitted by human activities, led to the regulation of the emission of these ozone-depleting substances (ODS). Since then, ODS abundances have continued to increase up to the mid or end of the nineties, depending on latitude, and have now started to decrease slowly. As a consequence, the ozone layer has stabilized and shows signs of recovery. While the decrease of ODS content is expected to be the dominant cause of the future long-term evolution of stratospheric ozone, climate change effects and natural variability of the atmosphere still hinder the unambiguous detection of the recovery expected from ODS decrease.

Chemistry-Climate models indicate that minimum levels of stratospheric ozone have been reached in the early 21st century. The recovery of the ozone layer is forecasted in a period ranging between 2015 and 2030 in the northern hemisphere and between 2030 and 2040 in the southern hemisphere, with a disappearance of the Antarctic ozone hole after 2050. Due to climate change induced effects on transport processes and temperature climatology in the middle atmosphere, models simulate a super-recovery of ozone in the polar and mid-latitude regions and an under recovery in the tropics. The future evolution of ozone will thus have an impact on surface UV at global scale and on the health related UV doses.

This presentation will review the latest results on the past and future long-term evolution of global ozone and surface UV. Projected changes in clear-sky erythemal and vitamin D effective UV doses for Europe over the period 2006 to 2100, based on CMIP5 simulation of total ozone and aerosols will also be presented.

P-2226-05

Planning for the Impacts of Climate Change on Human Health: A Focus on Cities

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Cities are faced with the task of planning for the present and future growth needs of their citizens. Climate change places pressure on cities ranging from rural to urban migration causing increased demands for housing, to physical changes from flooding and heat waves that challenges the ability to plan. Research and practice have demonstrated the capacity of cities to address the economic and physical impacts of climate change. Less understood is how cities can address the impacts of climate change on human health and well-being; which ranges from death and injury caused by extreme temperatures and weather events, to malnutrition caused by drought. Cities have role in reducing the impacts on human health and well-being. In the 1980s, the Healthy Cities movement aimed to make cities supportive of human health but success was inhibited by a lack of coherence. However, the core ideas of cities: developing action strategies to promote health, being centers for human action, and having an unmatched potential for producing healthy human beings hold today. The challenge for cities now is identifying the causal relationships between human health and climate change; for which there are many. Thus it is the objective of the research that is to be undertaken to conduct a critical analysis of the policy actions of cities in their efforts to address the impacts of climate change on human health through policies and plans.

P-2226-06

Seasonal Variations in Emergency Department Visits of Schizophrenic Patients in Sofia, Bulgaria

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Climate change is making hot summer days hotter and stretching their numbers into heat waves. And the heat is causing more than just discomfort - as temperatures rise, so are the number of illnesses, emergency room visits, and deaths. Among the risk groups are young children and elderly people, people with chronically diseases especially of the cardiovascular and respiratory system, the poor, people who are working at open environment and those living in big cities where the effect of "heat island" makes the heat waves more severe.

It's little studied the effect of hot weather and the effect of the season on people with mental disorders and specifically schizophrenia (as one of the mostly common and severe mental disorders). Schizophrenia is characterized by enormous societal and economic costs due to the extensive therapeutic care and loss of economic productivity, as well as personal suffering and stigma which often affect the patient and his/her family for most of the patient's life. As for schizophrenia patients, there is still no cure, the research of etiologic factors, particularly environmental ones that could be avoided and used in effective prevention programs, is essential.

Many studies have demonstrated evidence of seasonal patterns in the incidence of psychotic disorders, and schizophrenia in particular. It is known since the time of Esquirol (1838) that the number of patients admitted in mental hospitals increases in summer months and decreases in winter. Most of the studies for seasonal distribution of hospital admissions in schizophrenia also report summer peaks, some of these for female patients only. With respect to the factors responsible for the summer excess of admissions, Myers and Davies have suggested a rise in ambient temperature; Parker and Walter, the increasing luminance; and Carney et al., the length of day. Social factors, such as summer holidays, "are unlikely to have an effect" (Takei et al.).

While the problem of seasonal admissions of patients with schizophrenia has been widely discussed in Western Europe, America and Australia, in Eastern Europe it

has been neglected. We are not aware of any published research on this subject in Bulgaria, which makes the present study important as a contribution to the scientific literature on the problem in the country and in the South East Europe region. Its findings could also raise the awareness of the problem of health care management for psychiatric patients in SEE countries besides Bulgaria.

The purpose of this study was to reveal the seasonal distribution of emergency department visits of schizophrenic patients in Sofia, Bulgaria.

We collected daily data for visits of patients with schizophrenia, schizotypal and delusional disorders in the emergency center of the regional dispenser for mental disorders in the city of Sofia for the period 1998-2003. The total number of emergency visits was 5723 (mean daily visits: 5.04±2.4). T-test was used to compare the monthly and seasonal distribution of visits.

The season with the highest levels of emergency visits was summer, and the lowest levels were observed in winter ($P<0.0001$). Spring and autumn had intermediate values close to the mean value, and significantly differentiated from winter values. The month with the highest admission rates was September, followed by May and the three summer's months. The lowest levels were observed in December, October and January, with statistically significant differences observed between the values of all the three months. Differences between July values compared with December and October values were significant, but not with January values.

The study showed significant seasonal and monthly differences in emergency schizophre-nics' visits. The data confirm the outcome of similar studies conducted in countries with temperate climate in the Northern Hemisphere. The results are particularly relevant against the backdrop of rising ambient temperatures and the tendency of increasing of the frequency of heat waves, observed in recent decades in Bulgaria. These results could prove useful for psychiatrists, public health specialists, and governmental authorities dealing with team planning and prevention programs in the field of public health.

2228 - Removing Barriers to Climate Change Mitigation at City Level

ORAL PRESENTATIONS

K-2228-01

Title not communicated

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Abstract not communicated

K-2228-02

Title not communicated

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O-2228-01

Making Cities Resilient to Climate Change: Identifying 'win-win' interventions

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Urbanization has truly become a global phenomenon. From a mere 10 percent in 1900, thepercentage of global population living in urban areas now exceeds 50 percent. With rapid urbanization, urban emissions have also increased over the decades. Cities currently account for about 75 percent of global energy consumption and 80 percent of global greenhouse gas emissions. Even though the greenhouse gas emission footprints of cities have been increasing over the years, for the cities in developing countries, greenhouse gas (GHG) mitigation is still not the priority. It is a «low-priority» issue, if anything. Given the resource constraints and competing local priorities, developing countries' cities are more interested in dealing with rapidly deteriorating air and water quality than use their scarce resources for urban climate change mitigation. The existing reluctance, however, can be overcome if cities are made aware of the fact that bundling of policy tools can actually help them overcome their perpetual struggle against increasing urban environmental externalities and contain rising urban greenhouse gas emissions. The proposed paper intends to identify sectors and policy instruments, adoption of which, will not only ensure the reduction in rising urban environmental externalities in developing countries, but also help contain rapidly growing urban greenhouse gas emissions and provide climate change adaptation co-benefits.

O-2228-02

'Nudging' the city towards sustainability; analysis of leverage points for reduction of urban footprint

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Since 2010 the Earth Hour City Challenge (EHCC) has been encouraging cities to submit data on carbon reduction commitments, strategies and investments that allow assessment of urban governance vision and impact over the years, and has been collecting this data through the Climate Carbonn Registry. Cities meeting certain criteria of data availability and reduction commitment become Earth Hour City Challenge candidates and the most ambitious cities compete for the title Earth Hour Capital of the year. In the 2014 iteration of the challenge more than one hundred and sixty cities from seventeen are reporting on hundreds of reduction commitments and thousands of mitigation actions from all sectors of urban governance. As the primary habitats of human beings and one of the two most important governance units of our civilization along with the nation state, cities must take a leading role in the transformation towards sustainability and reduction of human footprint. However as complex systems, cities exhibit both, a behavioral inertia that is borne of the dense network of interactions between people, infrastructure and intangibles that define the city, as well as the ability to undergo a rapid transformation akin to a face change in complex systems when faced with the right intervention at the right leverage point. In order to navigate a successful transformation to sustainability, meet the relevant targets such as sustainable development goals and stay within the planetary boundaries while improving standards of living for the global poor, we need to identify these points at which a phase change can be triggered in urban systems; these would be the leverage points where large gains in footprint reduction can be obtained with minimum effort interventions. These high leverage points emerge from research in unexpected disciplines as well from investigations at the interaction of disciplines that do not traditionally converse as these points lie concealed in latent correlations. To identify these points thus a multi-disciplinary, consultative, framework approach is needed. The EHCC data has been analyzed to identify high leverage opportunities for reduction in urban footprint. The research uses the framework and data collected as an objective function to identify leverage points for maximizing footprint reduction using various strategies. Various stakeholders from practice and academia have been consulted to provide a survey of strategies for urban footprint reduction from various disciplines. This has included evidence collected from practical policy and technological implementations in the disciplines of transport, housing, waste management, local food production and energy, summary of theoretical and empirical findings from behavioral economics and psychology that can help devise policy interventions to

'nudge' citizen behavior towards footprint reduction, and analysis of theoretical developments in the science of urban complexity that can inform identification of high impact leverage points. A framework has been developed and correlations explored using a preliminary network mapping exercise.

2228-POSTER PRESENTATIONS

P-2228-01

Urban and peri-urban forestry in the face of climate change in Cameroon: challenges and new perspectives for sustainability

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Urban forestry is a relatively new, multidisciplinary approach in international forest research. Rapid urbanization and climate change raise several issues for those who are responsible for developing policies and making decisions at local, national and international levels. Urban trees provide a significant contribution to building resilient cities and improving health and well-being, such as through mitigating natural disasters, providing ecosystem services, reducing energy costs or increasing property values. However, urban and peri-urban forest ecosystems in Cameroon are steadily increasingly under pressure from their city populations. This study assessed the status of urban and peri-urban forestry, evaluated the effect of population growth on urban forests landscape and designed innovative strategies that will ensure sustainability and improvement of urban living environment. It was investigated through secondary data, field investigation, enquiries to relevant stakeholders, direct assessment and observations of urban and peri-urban forest landscapes in Cameroon. These analyses highlight the extreme diversity of environmental resources from urban forests in Cameroon. Rapid urban population growth, limited land area, and poor implementation of government policies are some factors affecting urban forests development and are responsible for vicious cycle of environmental degradation in urban areas in Cameroon. The results contribute elements for strategic and operational planning. Urban forestry management is an important strategy to improve urban living and working environments. There is a need to highlight successful strategies and actions concerning the management of urban and peri-urban forests. Involvement of all stakeholders and users in reflections and in the implementation of policies concerning the management of the urban and peri-urban forests should be adopted and advocated, to ensure sustainable development and to ensure that cities, trees and forests grow together to meet the needs of urbanized societies.

2229 - Cities and their environments: Assessing Climate Change Impacts, Adaptation and Mitigation strategies across scales from rural to urban

ORAL PRESENTATIONS

K-2229-01

Sustainable Futures in Rural and Peri-Urban Areas

D. Purnamita (1) ; J. Morton (2)
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This keynote will focus on the possible impacts from climate change on rural areas and rural-urban continuums, with special emphasis on the implications for human settlements. It will consider alternatives for building resilience for the future in recognition of a two-way relationship between sustainable economic development and climate change. A wide range of human and ecosystem interactions define the risks from climate change, in many parts of the world, including the developing and the least developed, where multiple stressors co-exist. Illustrations to highlight these aspects will be drawn from material from the AR5 report of the IPCC. The opportunities and challenges in bridging the gaps between quantitative and qualitative dimensions, of integration across scales and timelines is also to be discussed given the multiple sources of vulnerability and differences in development across regions of the world. In this context, the presentation will dwell on the economic valuation of climate change impacts which requires moving from pure cost benefit analysis to multi-metric evaluations with consideration of the risk and uncertainty dimensions. Non-market values, inequities, behavioral biases, ancillary costs and benefits of response options and aggregation of values across multiple contexts call for innovative and less conventional approaches.

K-2229-02

Cooling Our Cities: International efforts to implement heat island countermeasures

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As the threat of climate change becomes more pronounced, a number of scientists have proposed supplementing the full range of mitigation efforts with geo-engineering (manipulation of the Earth's environment) to quickly respond to this threat. Many proposed geo-engineering techniques are novel and unproven. One simple technology has been in practice for thousands of years: changing the solar reflectance (albedo) of the built surface. "Cool roofs" and "cool pavements" should be among the first geo-engineering techniques used to combat global warming.

Increasing the solar reflectance of the urban surface reduce its solar heat gain, lowers its temperatures, and decreases its outflow of thermal infrared radiation into the atmosphere. This process of "negative radiative forcing" can help counter the effects of global warming. We estimate that resurfacing conventional dark roofs with a cool white material that has a long-term solar reflectance of 0.60 or more increases its solar reflectance by at least 0.40. Retrofitting 100 m2 of roof has an effect on radiative forcing equivalent to a one-time offset of 10 tonnes of CO2. Similarly, the solar reflectance of pavement can be raised on average by about 0.15, the equivalent of a 4 t reduction in CO2 per 100 m2.

In addition, cool roofs reduce cooling-energy use in air conditioned buildings and increase comfort in unconditioned buildings; and cool roofs and cool pavements mitigate summer urban heat islands, improving outdoor air quality and comfort. Installing cool roofs and cool pavements in cities worldwide is a compelling win-win-win activity that can be undertaken immediately, outside of international negotiations to cap CO2 emissions. We review the status of cool roof and cool pavements technologies, policies, and programs in the U.S., Europe, and Asia. We propose an international campaign to use solar reflective materials when roofs and pavements are built or resurfaced in temperate and tropical regions.

This presentation will discuss the technologies and international policies related to development and utilization of cool construction materials.

K-2229-03

Towards an integrated model for more sustainable urban (re-)planning

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Sustainability has become a byword. Whilst it is understood that we are now mainly an urban species, that the overwhelming majority of economic activity and associated resource use takes place in cities, some surprisingly basic questions remain unanswered: How do we define city sustainability? How do we then measure it to determine how sustainable a city is? Which are the most effective strategies and policy measures to bring about positive change? How do we model them to evaluate their effectiveness? How do we then implement them? These are some of the questions currently being tackled by the Laboratory of Urban Complexity and Sustainability (LUCAS) at Nottingham. Positioned within this landscape, I will focus in this talk on the challenges we face in developing a platform for modelling the principle urban resource flows, in a sufficiently spatially sensitive manner to support the testing of scenarios to minimise these flows (or some measure(s) of them) in the future and how cities might transition to these target future states.

O-2229-01

Climate Change in Rural Areas: Reflections

J. Morton (1)

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The Contribution of Working Group 2 to the IPCC Fifth Assessment Report (2014) included for the first time a Chapter on Rural Areas. This presentation will be a reflection on the writing of that chapter by one of its two Co-ordinating Lead Authors. Some of the questions posed will be as follows:

- Is there something specific about rural areas (or "rurality") that can make them an object of study in the context of climate change, along the continuum from low-income to high-income countries?
- How can the different experiences of poverty and ill-being in rural and urban contexts, as they exist and as they will be exacerbated by climate change, best be compared in a non-reductionist manner?
- How best can we conceptualise and research interactions between adaptation and mitigation in rural areas?

How best can we conceptualise and research linkages between rural and urban areas and the ways they will be impacted, and will adapt, under climate change?

O-2229-02

Efficiency of Waste Management of Different Cities in the Philippines: Assessment and Its Implication to Climate Change Mitigation and Adaptation Policies

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Rapid increase in the emission of greenhouse gases (GHGs) particularly in the waste management processes resulted in socio-economic changes and various environmental issues in major cities of the world. Increasing trends of GHGs emission was due to the rapid urbanization and booming economic development in these cities particularly in developing countries like Philippines. Globally, the risks and uncertainties of climate change tend to be more complex and costly which can aggravate the threat to human civilization and economic development of a particular country. This pressing issue at hand calls for a comprehensive evaluation and consideration for the progressive and sustainable future in a more globalized society. Hence, this paper evaluated the efficiency of waste management of different cities in the Philippines towards climate change mitigation and adaptation. The two-stage approach was utilized in quantifying and understanding the efficiency of different cities in the Philippines. First, efficiency of every city was done using Data Envelopment Analysis. Having the efficiency scores at hand, efficiency measurement was expanded using Tobit Regression Analysis to further analyze the potential influence of environmental factors such as land area, number of barangays (villages), poverty incidence, environmental governance and presence of disposal facility in the implementation of waste management in different cities. Finally, this paper will conclude with the analysis and discussion on its implication to climate change mitigation and adaptation policies.

O-2229-03

Responding to Changing in Climate : Who Act The Most in Greater Jakarta

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Over the past decade, increased knowledge coupled with economic incentives, subsidies and related interventions has raised awareness and concern about climate change in vulnerable Greater Jakarta. This paper will analyze index and status of responsiveness of each region within Greater Jakarta towards climate change by means of Climate Change Effectivity Response Assessment (CCERA) using multidimensional scaling technique (MDS). Total data used is 1261 respondent. Overall, the index shown Bogor responding the most to climate change. Looking through each dimension, it is likely Bogor is the highest in knowledge dimensions (61.14), community resources (63.72) and level of alertness (87.26). While Bekasi holds the highest index in individual resources (71.47). The most influencing attribute regarding to index and status response are willingness to take out insurance, willingness to change lifestyle (knowledge); sign up for early warning alerts and disaster preparedness plan (individual resources); talk to other about taking action and feel involved in decision making (communal resources) and don't know to response and care about natural environment (level of alertness). The result of this study will provide evidence based to support more ambitious regional response to climate change based on the status of responsiveness of each region in Greater Jakarta.

O-2229-04

Continued Growth, Sustainability and Climate Change in America's Energy Capital

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Planners are uniquely situated to contribute a comprehensive approach to evaluating and solving development issues (Myers, 1997). Many of the less discipline specific issues in addressing climate change such as understanding long-range consequences of present actions; understanding needs for disadvantaged populations; and managing the exchange of confluences between the built environment and natural environment fall naturally under the toolbox of planners. Methods and tools in planning are robust enough for this challenge (Talen, 1996). New research is taking a critical look at what approaches should and are being conducted across the US (Jepson & Haines, 2014). This is exactly the type of environment that fosters more integration of planning for climate change into the routine high visibility planning products developed for and by cities. This presentation will deliver findings from a study addressing the question of limits to growth and climate change impacts in America's largest energy metropolis.

The City of Houston, Texas is the 4th most populous city in the United States, with a population of 2.1 million persons as of the 2010 US population census. Houston is the most sprawling city of the top 5 most populous, with a land area of approximately 600 square miles, which is larger than New York and Chicago combined. Less than 10% of the workers use public transportation to get to work. Houston has only 7.5 miles of passenger rail, while New York has 2,047 miles and Chicago has 224 miles. This sprawling city is also home to the Port of Houston, which is the largest port in the US for foreign trade and imports. It supports the largest petrochemical manufacturing area in the world. It is estimated that 1 million jobs are supported by port activity and approximately $178 billion in economic activity in Texas (Port of Houston Authority, 2013). This evidence shows that Houston is a sprawling city, with a dependence on private automobiles and an economy heavily influenced by development and trade in petrocarbons. This city is a challenge to planning for climate change and an ideal

environment to evaluate the impacts of projected major growth inducing forces into the future.

A comprehensive suite of sustainability indicators from the Houston Sustainability Indicators project (HSI), will serve as the base measures to characterize Houston and its environment in this study. The HSI project has reported on the sustainable development of the City of Houston for the past four years and produced four (4) reports showing dynamics at various spatial levels (Blackburn, 2011; King, 2014; 2013; 2012). Indicators will be projected to 2030 and 2050 and multivariate analysis will be conducted on the indicators and communities across the city to support identification of major development factors ongoing at these two times (2030 and 2050). Specifically, this exploratory research will seek to identify factors explaining limits to growth around the stress nexus issues of energy, water and food in addition to land use constraints among communities in Houston in 2030 and 2050. Houston needs to prepare for several climate change scenarios such as increases in temperatures, water scarcity, flooding, seal-level rise, droughts and increased storm frequency. However the political climate focuses more on current issues rather than medium term or long term ones. This study serves to examine one method in which cities can evaluate expected development conditions across many processes and identify congruent development trends that may help to explain environmental stress in energy, water, food and land use. Planning for climate change is essential in current times of uncertainty and this research contributes new findings towards this effort (Barth, 2011).

Barth, B., 2011. Planning for Climate Change: A Strategic, Value-Based APproach for Urban Planners, Nairobi, Kenya: UN Habitat. Jepson, E. & Haines, A., 2014. Zoning for sustainability: A review and analysis of the zoning ordinances of 32 cities in the United States. Journal of the American Planning Association, 80(3), pp. 239-252. Myers, D., 1997. Anchor Points for Planning's Identification. Journal of Planning Education and Research, pp. 223-224. Talen, E., 1996. After the plans: Methods to evaluate the implementation success of plans. Journal of Planning Education and Research, pp. 79-91.

O-2229-05

Climate change and water management issues in megacities, the example of Paris metropolitan area

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Are the effects of the climate change at the dawn of the 21th century already visible at the operational water management level of Paris megacity? Some elements speak in favor of it. The scheme and the infrastructures of the drinking water supply system of the capital of France date back to 150 years; and the recording of the rainfalls in Paris began at the end of the 19th century. The gauging of the underground water springs, which supply even today half of the 2.3 millions of Parisians, also benefits from long and precise records since 1872. And one can note a concentration of rare events during these last years: 2001 was the record year of highest rainfalls in Paris with more than 1,000 mm of precipitation; 2003 was the year of the heat wave which killed 15,000 people in France; and in 2006-2007 following several years of droughts, the level of certain springs which supply Paris had never been so low. On the other hand, the modern tools for real time measurement of the consumptions allow to better understand the consequences of the exceptional climatic episodes which impact the water demand; and consequently to prepare for a more efficient management during these climatic constraints.

As for the future, 4 successive research programs (IGCC-Seine (2004) RExHySS (2009), Explore2070 (2012), Climaware (2013)) have shown, with a satisfactory level of probability, a number of effects of climate change on the hydrology of the Seine River catchment. These changes would be sensitive from the middle of the century.

According to these scientific works, the most significantly perturbed hazard is drought, not flooding. This is linked to the significant increase in temperature from the mid-century which is sufficient to increase evapotranspiration of about 15%. This increase is paired with a likely decrease in summer precipitation with as result a reduction in low flows. The average flow of the Seine River in Paris could fall between 20% to 40% and the five-year low flow return period between 30 to 60%. A significant decrease in the dilution capacity of the Seine River and its tributaries with regards to pollutants is likely then to arise within the next forty years.

At the same time, the Paris area should continue its development. This is certainly the ambition of policy makers. In this context the future of wastewater treatment will become very complex while being impacted by cumulated constraints: increased sensitivity of the Seine to discharges of pollutants, pollutant loads increase at the treatment plants inlet and less possibility for pollutants loads discharges in the Seine River.

In these circumstances, compliance with environmental standards will become more difficult and can lead to put into question improvements that were achieved in recent years. More general questions also arise on broader issues: the search for technical solutions to obtain high waste water treatment performances at affordable energy cost, the search for alternatives to conventional sanitation by implementing an extraction of the chemical elements C, N, P out of the water cycle, or the possibility of lowering thresholds for environmental indicators before returning the treated water into the rivers; the latter issue if implemented being a real regression and a terrible failure.

This example is an illustration of the problems that the megacities will face. But, if the improving knowledge of water resources and the changing needs of the population are keys from promoting new solutions, it will also be necessary to analyse the way how political decisions are being taken.

These issues and many more will be the subject of an international scientific symposium dedicated to water management in megacities and global change (particularly climate change), held from December 1st to 4th 2015 in Paris and organized by ARCEAU-IDF with the support of UNESCO (http://eaumega2015.sciencesconf.org/)

O-2229-06

Assessment of climate change mitigation and adaptation strategies at the district scale

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The urban climate is on average warmer than its rural counterpart. This urban heat island (or UHI) is influenced by the corresponding urban form and materials and their impacts on radiative exchanges and heat storage, by vegetation and byanthropogenic heat gains. In summer, heat rejection from air cooling systems can represent a substantial share of these anthropogenic gains and this is itself exacerbated by the urban heat island, since this diminishes systems' performance. On the other hand, in climates in which buildings' energy use is dominated by heating demands, the UHI reduces demands for applied energy and may, on the whole, improve pedestrians' comfort. These climate-energy-comfort relationships are complex and intertwined. Furthermore, as cities become denser, the magnitude of this UHI increases and this can have significant implications for building energy use and greenhouse gas emissions, comfort and indeed for mortality; as the influence of heat waves isintensified. Solutions to climate change mitigation, energy transition and climate change adaptation must thus be tackled simultaneously. The effectiveness of these solutions requires, in addition to knowledge of the relationships between climate and the thermal behaviour of buildings, the development of approaches that support predictions of energy use in the urban context and its impacts on the urban microclimate. In that context, policymakers face an increasing need to improve knowledge of environmental impacts from city layouts and uses on the urban climate, in order to assist with planning climate change mitigation and adaptation measures. This proposed contribution aims to gather and debate the state of the art regarding assessment of UHI reduction strategies, with a particular emphasis on the district scale, which is the usualurban planning and design scale.

O-2229-07

A 'Sustainability Window' of Urban Form

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Climate change mitigation becomes an important policy goal for cities worldwide, but local environmental objectives are equally important in policy-making. This study investigates the impact of urban form and modal shares on air pollution, greenhouse gas emissions, congestion and cost of living by using both empirical data from a number cities, as well as a straightforward urban economics model. Denser urban form would nearly unambiguously mitigate climate change, but also translate into a higher proportion of air pollution affecting citizens. We introduce a window of most sustainable urban form to highlight trade-offs between the externalities of urban form. Only a combination of transportation policies, infrastructure investment and progressive public finance enables the development of cities that meets all sustainability dimensions simultaneously. We identify a minimum urban density of 50 persons/ha to meet sustainability goals.

2229-POSTER PRESENTATIONS

P-2229-01

Promoting Sustainable Human Settlements and Eco-City Planning Approach: Southeastern Anatolia Region and Southeastern Anatolia Project (GAP)

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In the recent years, there have been many opportunities flourishing through the development of Turkey. One of these is unvalued rich agricultural and hydro-sources in the Southeastern Anatolia Region. The Southeastern Anatolia Project (GAP), one of the most important projects to develop the remarkable natural resources of the world, is considered as a chance to make use of rich water and agricultural resources of the Southeastern Anatolia Region.

In the recent years, the concept of promoting sustainable human settlements and eco-city planning approach has been included into the GAP Project. And, by applying these concepts in real projects caused remarkable results through development of the region.

The aim of this study is analyze the concepts of promoting sustainable human settlements and eco-city planning approach in the GAP Project that has been still processed.

In the first section, the region of Southeastern Anatolia and the GAP Project will be introduced briefly. In the second section, the stages of GAP Project and the project existing will be analyzed. In the third section, the projects and sub-projects used for promoting sustainable human settlements will be introduced.

In the last and fourth section, a series of policies and strategies for providing the process of settlements which is optimal and harmonizes with eco-system will be given.

P-2229-02

Producing nature for public: panel data analysis of public green spaces provision in Chinese cities

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The landscapes and infrastructures of cities have long been viewed as products of human-nature interaction. This study sheds new light on how a critical constituent of urban landscape and infrastructure, urban public green spaces, has been produced in China's ongoing profound urbanization process. Over the past decade, China's urbanization has been characterized by a land-based pattern centered on the commercialization and capitalization of urban land induced by the decentralization of state power. The non-budgetary revenues generated from urban land leasing hold the promise to empower local governments' fiscal capacity and flexibility in financing various urban infrastructures aiming to enhance local amenities and attract external investment. This paper investigates the impact of land-based urbanization on the provision of urban public green spaces, an integrated part of urban public infrastructure, using panel data across 285 Chinese prefecture cities from 2002 to 2009. The results reveal a negative relationship between the reliance on land finance and the amount of urban public green spaces, indicating that local governments' pursuit of maximizing land lease revenue will not be able to finance more public green spaces, and may even cause the loss of public green spaces. The regional variations amongst the eastern-coastal, central, and western cities confirm that an initially positive relationship between land finance and the provision of urban public green spaces at the early stage of development would reverse to a negative relationship with the increasing pace of urbanization and economic development, which may lead to a social inequity pertaining to public accessibility to urban green spaces. A balance amongst economic growth, environmental concerns, and social equity is very much needed in the quest for sustainable development.

P-2229-03

Green roof cooling effect as climate-adaptation tool for tropical cities

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Global warming has accentuated the urban heat island (UHI) effect in cities. Urban green infrastructures can provide ecosystem services and attendant climate-change adaptation. Compact cities have urban green space (UGS) deficit due to deficient ground-level sites. Numerous building envelopes, including rooftops, facades and walls, furnish ample yet largely untapped greening opportunities. Their efficacy in mitigating climate-change impacts deserve to be investigated by empirical experiments. In compact humid-tropical Hong Kong, two green-roof and a control bare-roof plots were installed on a high-rise building. Precision temperature sensors were installed in a holistic vertical profile extending from outdoor air to roof surface, green-roof material layers, and indoor ceiling and air. The apartments under the plots were kept unoccupied to monitor air-conditioning energy consumption. The comprehensive-systematic data allowed in-depth analysis of thermal performance of vegetation (Sedum and Perennial Peanut) and weather (sunny, cloudy and rainy) in summer. Intense solar radiation at Control plot triggered significant material heating, which in turn warmed near-ground air to intensify UHI effect and indoor space to lift energy consumption. Sedum plot with incomplete plant cover, low transpiration rate and limited substrate moisture experienced feeble evapotranspiration cooling. The warmed roof passed heat to near-ground air and subsurface layers to impose an indoor cooling load. Peanut plot with high transpiration rate can significantly cool foliage surface and near-ground air to ameliorate UHI. Its high moisture-holding capacity, however, can generate a heat-sink to push heat downwards and increase indoor cooling load. Practical hints on green roof design and management were derived from the findings for application in tropical region to contribute to climate-resilient cities.

P-2229-04

Building Urban Climate Resiliency and Adaptation Strategies: A Case Study of an Indian Mega Cities

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India is experiencing rapid urbanisation, and consequently water demand in urban areas is escalating rapidly. Many megacities of India are located in the central part of the

Gangetic plains. The Indian mega cities are amongst the oldest surviving urban centres in the world, with a continuous recorded history dating back to the fifth century BC (Ramchandran 1999). The Indian cities are one of the fastest growing urban centres in the world. Despite the fact that cities are located on the banks of the river, residents are primarily dependent on groundwater aquifers for domestic water supply. Increasing pressure on groundwater supplies is exacerbated by the unregulated construction of deep tube wells, along with the development of apartment complexes to accommodate a mushrooming urban population. For example, an overall comparison among data sets for the periods 1960–1967, 1977–1986, and 2008–2010 reveals a decline in the level of the deeper aquifer, in the range of 2–10 m (Saha et al 2013), The decline in the piezometric head of the deeper aquifer (13 cm/year) during the previous two decades is another concern (CGWB, 2011). This raises concerns about the security of Indian mega cities water supply, and, hence, the economic vitality and sustainability of the city.

In this environment, with already existing pressures on water availability and use, climate change puts further stress on water management and the sustainability of water supplies. Climate change is already having impacts on temperature. Observed average minimum temperatures (annual temperature Jan–Dec) have increased from 19.00C to 20.50c over the period from 1989 to 2009. These changes are associated with the changes in population, which has increased from 0.5 million in 1971 to 15 million in 2011). Trends in temperature also interact with non-climatic factors, such as the removal of natural vegetation drainage patterns, loss of rainfall absorbing capacity of soil due to urbanisation and the provision of man-made drainage systems. These interactions complicate planning for water supply and demand and increases water insecurity. Moreover, regional annual average monthly maximum temperatures are projected to increase 2.5°C by 2049, based on the ensemble average of 41 CMIP5 models and assumptions of moderate future increases in greenhouse gas emissions (i.e., RCP 4.5; data source: http://climexp.knmi.nl). These projected increases in temperature will put further stress on water supplies, through increased demand for water, and through increased evapotranspiration. In addition, the increasing exposure to climate change, described above, will be superimposed on existing vulnerabilities, which include a lack of groundwater regulation and monitoring. Currently, Indian mega cities lack building by-laws to encourage water conservation. Furthermore, based on informal interviews with water management personnel, it is clear that they lack information on and understanding of projected climate change impacts.

The present study examines the nature of the aquifer system within the urban areas, the temporal changes in the water level and the recharge mechanism of the deeper aquifers. It also looks at associated dialogues and actions related to climate adaptation strategies about water sector in urban areas.

The purpose of this research is to understand the complex dynamics of the water sector and ultimately to suggest the resilience interventions to address these vulnerabilities and tools to support overall resilience, which are needed just to address Indian mega cities non-climate water management concerns, are necessary as a stepping-stone to transformative pathways for addressing the uncertainties associated with our common future under climate change.

P-2229-05

Urban land-cover types, thermal differences and relative vulnerability to climate change: quantification of South Africa's coastal metropolitans using remotely sensed data

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Coastal landscapes have historically attracted a larger number of settlements than inland. This trend is expected to continue. Commonly, increase in coastal settlements has been accompanied by growth of existing urban areas, particularly coastal cities. Such growth is characterised by transformation from natural landscapes to impervious surfaces associated with thermal elevation. These result in urban micro and macro climate alteration and vulnerability to climate change and associated impacts. In this study, we determine the relative vulnerability of the eThekwini, Buffalo City and Mandela Bay metropolitan areas on South Africa's eastern seaboard using remotely sensed thermal and multispectral datasets. Duncans post-hoc one-way analysis of variance, multispectral Landsat 8 scenes and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) were used to determine differences between the major land-use-land-cover (LULC) mosaics and their respective surface skin thermal values. Based on each of the metropolitan's LULC proportions and their respective thermal values from MODIS imagery, the Contribution Index (CI) was used to determine the source/sink contributions within each metropolitan area. The eThekwini metropolitan area, due to its dominant impervious surfaces proportion, was more vulnerable to elevated urban heat and therefore higher relative vulnerability to climate change than the Buffalo City and Nelson Mandela Bay metropolitans. Results in this study show the value of remotely sensed datasets in determining inter and intra urban landscape matrix, thermal elevation and relative vulnerability to climate change. Such findings are particularly valuable for sustainable coastal urban landscape planning and mitigation of climate change related impacts at local, regional and even global scales.

P-2229-06

Trapped in a flood-prone zone: Poverty and policy in a Tanzanian slum

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Dar es Salaam is a coastal city with more than 70 per cent of its five million residents living in informal settlements that lack adequate infrastructure and services. Here climate change is expected to exacerbate the vulnerability of poor communities located along stormwater drainage channels through sea level rise, increased rainfall variability, and possibly more intense coastal storms. In mid-April of 2014, heavy rainfall led to the worst flooding since Tanzania's independence in 1961 and left at least 15 people dead. It also caused devastating damage to private property and public infrastructure, leaving thousands stranded and without shelter. Apart from significant loss of property and risk to human life, floods pose widespread health risks for poor residents due to pit latrine overflow.

Not all areas of the city are vulnerable to flooding, however. This paper will explore why the residents of the most flood-prone zones are unable to leave and move elsewhere. Our focus is on the subward of Tandale, located five kilometres from the centre of Dar es Salaam and bordering the Ubungo-Ng'ombe river system. This river system experiences severe annual flooding during the long rainy season, and both informal home owners and renters living along its banks find themselves 'trapped' by chronic poverty, lacking the means to rent or purchase homes in other central urban areas (necessary to livelihood) due to rising land values elsewhere. Moreover, disaster risk in this area is exacerbated by the practice of creating landfill from solid waste along river banks to increase space for home construction. Government programs to upgrade infrastructure and formalize land tenure through residential licenses so far do not apply to flood-prone areas, and thus cannot help these residents. Our ethnographic research into residents' experiences of flooding and the reasons for their immobility is based on in-depth, thematic interviews and observation carried out during 2010 - 2014.

2230 - Transport and climate change: mitigation and adaptation measures for transport infrastructures

ORAL PRESENTATIONS

K-2230-01

Title not communicated

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Abstract not communicated

K-2230-02

Title not communicated

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Abstract not communicated

O-2230-01

Climate change mitigation and adaptation strategies in the transport sector

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International scientific works confirmthat climate changes (IPCC, 2007). Climate change already impacts our society and economy in different sectors: energy, infrastructures, agriculture, etc. Tackling climate change is complex, as it requires anticipation; transversal cooperation between elected representative, scientists, the civil society, etc.; and both adaptation and attenuation strategies.

Greenhouse gazes emissions from transportation are likely to increase in the coming years. Thus, international policies have been decided to limit greenhouse gazes emissions due to the transport sector. The French Ministry for Ecology has applied these policies and also introduced proactive policies,e.g.to better understand and quantify greenhouse gazes emissions and to encourage stakeholder cooperation to reduce there emissions.

All forms of transport are affected by the impacts of climate change on transport networks. Adaptation has become vital due to the long functional lifespan of networks and transport equipment. Four actions toadapt transporthave been decidedin the French Climate Change Adaptation Plan. This plan, set up in 2011 and available for 5 years, results from a consultation of various stakeholderat national and local scales and then, an administrative production. Itsfourtransport actionsareaimed atanalysing the impact of climate change on transport infrastructures and networks, anticipating transport system vulnerabilities and making preparations to improve the resistance and resilience of existing and future infrastructures to ensure the continuity and safety of transport services for goods and passengers:

- action 1: review and adapt technical standards for construction, maintenance and operation of transport networks (infrastructures and equipment) in continental France and French overseas territories
- action n°2: study the impact of climate change on transport demand and the consequences for reshaping transport provision
- action n°3: define a harmonised methodology to diagnose the vulnerability of infrastructures and land, sea and airport transport systems
- action n°4: establish a statement of vulnerability for land, sea and air transport networks in continental France and in French overseas territories and prepare appropriate and phased response strategies to local and global climate change issues

O-2230-02

Adaptation of transport infrastructures and systems to gradual climate change and to extreme climate events

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There is no remaining scientific doubts that climate changes (IPCC, 2007). First impacts of climate change are already being felt in numerous sectors, such as energy, agriculture, transport, etc. These impacts are predicted to increase in the coming years. The French Climate Change Adaptation Plan, implemented in 2011 and covering a five-year period, has identified actions and measures to tackle impacts of climate change in these sectors. Since transport infrastructures and systems are vital for economic and human activities and requires long-lasting investments, there is a high need of adaptation solutions. Thus, transport adaptation actions have been identified in the French Climate Change Adaptation Plan. These actions are aimed at improving resistance and resilience of transport systems to climate change. Therefore, a transversal working group with experts of various transport systems was established in 2011. The group met numerous times, among other things, to review and adapt technical standards for the construction, maintenance and operation of transport networks (action 1) and to develop a methodology of risk analysis (action 3).

A diagnostic of impacts due to long-term evolution of climate on infrastructures and on technical and normative reference documents for infrastructures conception, maintenance and operation has been done. Experts representative for all transport modes - road, bridge, rail, aeronautic, waterway, maritime mode, etc. - worked together to understand climate scenarios and to screen major long-term impacts of gradual climate changes and gradual changes of extreme weather events on infrastructures. Hundreds of technical and normative reference documents have been analysed. Documents that may be impacted by climate change have been listed and classified in categories which reflect their priority of adaptation. Climate variables that are required to adapt documents have been identified. The way forward will be to make climate projections to adapt documents and then, construction, maintenance and operation standards.

Adaptation of transport infrastructures to extreme events has also been addressed by the working group, through the development of a methodology for risk analysis. Extreme events are defined here as not easy to anticipate, localized and with high impacts on transport infrastructures and system - networks deficiency or failure and then, environmental, societal and economical impacts. The methodology comprises three main stages:

- analysing past and future extreme climate events - intensity, occurrence and spatial distribution, to identify climate events that are likely to impact transport,
- analysing infrastructure vulnerabilities of extreme climate events to build impacts scenarios
- analysing system functional vulnerabilities - mobility devices, accessibility, access for rescue services - to identify consequences of network disruption.

O-2230-03

A review of adaptation practices in Europe and challenges ahead

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This presentation makes a summary of recent adaptation initiatives in the transport sector in Europe, and discusses

the key challenges ahead, based on the recent report of the European Environment Agency (http://www.eea.europa.eu/publications/adaptation-of-transport-to-climate). The factual information collected was based on data available in the Climate-ADAPT information platform, a literature review, case studies provided by many stakeholders, and a questionnaire on transport and adaptation addressed to EEA member countries in 2013. A total of 23 countries answered this questionnaire. Although the results obtained reflect the perceptions of a limited number of respondents, they provide interesting insights and encourage further analysis and discussions.

The review of experiences in Europe shows that mainstreaming adaptation into regular transport planning, and into other policies and plans, is not yet common. For example, measures planned in the context of low carbon transport like improved inter-modality offer also options for adapting transport to climate change but currently do not include it. Many tools developed for natural disaster risk management or contingency plans can easily be made relevant for climate change adaptation too. Meanwhile the adaptation focus is mostly on transport infrastructure, with little attention given so far to proof operations for future climate impacts.

Attention to adaptation remains relatively low in the transport agenda, particularly when compared to action in mitigation. Current action focuses on early, conceptual stages and less, so far, on implementation in spite of the urgent need to consider climate change impacts in those infrastructure investments being made now. Measures mostly follow a piecemeal and spontaneous approach, and are often organised autonomously by the different stakeholders. This fragmented approach is unlikely to be efficient or to guarantee the necessary consistency to address long-term challenges. Effective adaptation of the transport system requires moving from isolated and spontaneous adaptation to integrated, complementary and mutually supportive action of the many different stakeholders involved in and outside the sector.

Climate change mitigation is strongly influencing contemporary long-term visions on transport. Future transport systems (2050 and beyond) could be quite different from today's concepts: economic and social changes may alter current transport needs and transport generation patterns; technological and operational innovations may phase out currently dominant mobility solutions; governance reforms could provide more participatory and transparent decision making approaches, better balancing accessibility needs and environmental footprints. In such a dynamic environment, efforts focusing merely in adapting today's transport systems to future changes in climate could result in dedicating resources to problems that may no longer remain a priority in the long-term future, when adaptation may actually be needed. Ironically, adaptation actions with a narrow approach on today's systems could jeopardize the transition towards low-carbon transport concepts. It cannot be taken for granted that the transport system in 30 years from now will basically remain the same we know today: in fact, influential actors, including many national governments and the European Union (e.g. in the 2011 White Paper on Transport) are actively pushing to achieve a low-carbon transport system in the long term.

Significant changes are expected within the coming years in the transport sector. These are the combined result, among alia, of changes in the root causes of transport demand, changes in accessibility needs, and the implementation of innovative concepts. Although this long-term thinking has been largely influenced by climate change mitigation considerations, adaptation has largely been absent. Integrating adaptation objectives within these concepts could help to better identify the adequate policies, and could also help to properly assess and select the adequate adaptation actions to undertake in the short, medium and long term.

O-2230-04

Cross-border cooperation on adaptation strategies for roads in Europe

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CEDR (Conference of Directors of Roads) is a European confederation of national road authorities (NRAs) that works on facilitating the exchange of experience and information and to analyse and discuss all road-related issues, especially infrastructure, infrastructure management, traffic and transport, financing, legal and economic problems, safety, environment, and research in all of these areas.

Road directors of Europe (CEDR) are aware of the importance of improving European cooperation. This is a key element for making progress in the road and road transport sector and strengthening the relationship with other modes of transport and with society at large.

Addressing climate change adaptation is becoming a very important task in CEDR, as road owners see the consequences of changes as an increasing matter. Cross-border cooperation in an appointed "Task group on climate change adaptation and mitigation" has become a valuable tool to facilitate National Road Administrations outline a strategy for adapting roads to climate change.

The strategy is centered on management, improvement, prevention and cooperation, and provides specific examples on areas to consider. These include examples of information to road users, incident management, implementation through planning phases, tools for risk analyses, legislative work, research and information sharing and many others.

Likewise, a template for an action plan is provided, giving examples on how to ensure responsibility and anchor climate change adaptation in the organization and create awareness in order to actually direct the organization towards a more climate-resilient profile.

The work of the CEDR-task group is a sound example in the context on how cross-border collaborations between NRA's can yield more than merely networking for enhanced means of climate change adaptation. A key outcome of the CEDR-work group on climate change is to provide a paradigm on composing a directly implementable strategy and action plan to every road organization, a plan which likewise will be applicable to other modes of transportation, e.g. railroads.

O-2230-05

Adaptations of road infrastructure to climate change - Selected examples from around the world (session 2230 - Transportation)

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To adapt a road to a new and specific climate affecting one country, there is first need to investigate if it is observable elsewhere in the world. And owing to exchanges in the World Road Association, geotechnical engineers can determine rules to be taken to preserve the existing road network and the precautions to design a new road. We illustrate below some specific actions of five countries: Australia, Mexico, Morocco, Malaysia and South Korea.

Unsealed roads account for most of the roads linear in the world. To climate change, better maintenance is expected to ensure their durability. Australia has produced a guide for non-specialists which contains the technical maintenance of unpaved roads, in accessible terms. The guide introduces a wearing course instead of the surface layer of a paved road. Speed limits and maximum loads are indicated. A chapter is devoted to measuring the damage of unpaved roads by an original measure of dust which is produced in traffic. After the rain falls, barriers are put in place on the roads, for the drying time. The life service of Australian unpaved roads is thus to twenty years if the quality of building materials is respected and if the periodic road maintenance is followed (every three months in wet weather).

To repair the degradation of unpaved roads after the water floods, the Mexico infrastructure Institute has also made large-scale projects to test new soil treatment products, mainly based geopolymer. Geosynthetics can also be associated.

In the South, Morocco faces at an increasing silting of its road network. All forms of silting are encountered, and decrease the road safety. An analysis about road network and actions over several decades has been conducted.

Unfortunately it appears that this natural phenomenon is complex, non structurable and difficult to model or control.

The practices in stormwater management on the roads in Malaysia are very interesting. Malaysia is a tropical country which receives up to 2.5 m of water mainly between November and February. The return period of rainfall for network design does not exceed ten years. The road drainage follows the «Guidelines for the design of the road drainage» produced by the Department of Public Works and the Road Association of Malaysia. These recommendations are drawn from various repositories (AASHTO, British Standard, ...) but applied to local conditions. Malaysia has also dug in its capital Kuala Lumpur a tunnel of 9.7 km in length and 13.2 meters in diameter. The tunnel comprises a highway pavement in its upper half and a channel in its lower half. During thunderstorms, the entire tunnel can be flooded to drain all the water that flooded the city so far, of course after banning the traffic of vehicles.

South Korea has established for all its highways a national risk map and defined the types of landslides encountered. Torrential rains can reach more than 110 mm per hour. Global warming seems to cause an increase in the intensity of rainfall and mudslides and rocks on the slopes. Each highway drainage system (hydraulic structure, surface sanitation, drainage slopes, drainage trenches) has a return period well defined by geography (mountains, plains rivers). A drainage class and a flow rate calculation mode are assigned to each portion of highway depending on the extent of the watershed. Drainage system are adopted. To prevent the solid thrust (blocks, uprooted trees), many dams have been built.

O-2230-06

Assessment of the impact of La Niña phenomenon over the infrastructure of transport in Santander-Colombia

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Extreme meteorological events associated with climate change are a real issue and have important impact over the economy of infrastructure sector, including high ways, hydrocarbon transport by pipelines, mines, etc., because saturation of soils by water can produce landslides and it could produce the fracture of pipelines or other kind of tangible assets. For example, an assessment of historical geotechnical failures in Ecopetrol (Colombian Oil Company) vs. extreme meteorological events shows that during La Niña (extreme rainfall period) geotechnical failures are three times greater. This work shows a method to identify places of risk by extreme meteorological events, mainly La Niña phenomenon, with focus in most probably alteration of rainfall. Our results illustrate the hot spots where there is a high probability of slight excess (120–160% of average rainfall) and high excess (>160%) of average rainfall. The results have been intersected in a GIS whit pipelines and highways with mass movement risk maps to identify the places of high risk along Santander region Colombia.

2230-POSTER PRESENTATIONS

P-2230-01

Socio-technical transitions to low-carbon consumption: Developing markets for electric mobility

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Societal transitions to low-carbon consumption require substantial changes in technological development and consumer behavior. This study applies a socio-technical perspective to study transitions—assessing opportunities and obstacles that are political, technological and social, and how they develop and influence one another. The present focus is the deployment of plug-in electric vehicles (PEVs) in Canada, a technology that is powered by electricity solely or in part. PEVs could reduce greenhouse gas (GHG) emissions in the transportation sector, which currently accounts for 28 percent of Canada's emissions.

The goal of this research is to characterize Canada's readiness for a socio-technical transition to PEVs and inform national and provincial GHG policy. Key uncertainties include Canadian consumers' awareness, perceptions, attitudes and values relating to PEV technology. Uncertain technical constraints include consumer driving patterns, access to PEV recharge infrastructure, and the GHG-intensity of electricity sources.

Data were collected via an in-depth, multi-part consumer survey completed by representative samples of vehicle buyers in Canada (n = 1,754), as well as electric vehicle owners in British Columbia (n = 112). Social readiness is assessed via questionnaire scales of awareness, attitudes, values and lifestyle. Consumers' technical readiness is assessed via a diary of driving behavior, and a questionnaire assessing home electrical infrastructure. Consumers' PEV design preferences were elicited via an innovative series of design exercises and discrete choice experiments. We then constructed regionally and temporally explicit models of PEV market penetration and use from disaggregated consumer data. These demand models are matched with provincial electricity generation data to estimate energy and GHG emissions impacts.

Results highlight opportunities and barriers for a transition to electric mobility. Opportunities includes findings that most car buyers already have access to some form of home based charging for these vehicles, and awareness of existing public charging infrastructure is not required to build consumer demand. Further, at least one-third want to buy some form of PEV under realistic price conditions, though patterns of preference, willingness-to-pay, and motivations differ substantially across segments of potentialy early market buyers (as identifed through latent class analysis).

Potential barriers include a broad lack of familiarity with PEV technology, and controversies about the true (lifecycle) environmental impacts of PEV usage. Most important is the role of strong climate policy, such as carbon pricing or regulations such as a Zero-Emissions Vehicle mandate (as implemented in California and several other U.S. states). Without such supply-focused policies in Canada, it is unlikely that a substantial transition to electric mobility will occur in the coming decades.

Knowledge of PEV impacts, readiness and policy priorities is highly valuable to policymakers considering PEV deployment to meet GHG goals, as well as electric utilities, urban planners and automakers. These results also enhance knowledge regarding the social and technical challenges of low-carbon societal transitions.

P-2230-02

Science-policy-stakeholder dialogues about Low Carbon Strategy in the Colombian Freight Transport Sector

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Colombia as other southern countries has undertaken a serious process for the statement of national post 2020 mitigation scenarios. We have identified and evaluated a package of more than 100 mitigation options by estimating abatement potential and costs. We have proposed sectorial mitigation plans finally adopted by government. A delightful dialogue process has been undertaken with a wide participation of industry, academy and government in order to get appealing and engaging mitigation scenarios and targets. Mitigations Actions Plans were adopted by government ministries.

This process was conducted under the Colombian Low Carbon Development Strategy (CLCDS). The dialogue was part of the MAPS project (Mitigation Action Plans and Scenarios), coordinated by SouthSouthNorth (SSN). Similar processes were adopted in the Long Term Mitigation Scenarios project in South Africa, as well as in the Low Carbon Strategies in Brazil, Chile, and Peru.

Commitments have been achieved in almost all sectors with modest but tangible results in agricultural, power end energy, and industry sectors.Transportation of passengers and freight have showed huge difficulties to decouple their growth from energy use and emissions. Energy demand in Colombia was 1331 TJ in 2010 and transportation sector accounted for 38% of final energy demand. Total GHG emissions were 218 Mton CO2e and transportation sector accounted for 10,5% of total emissions.

Diesel and gasoline are the main fuels used in road transportation. Either fuels account for more than 85% of the total consumption in this sector. The National Energy Plans signals the importance of diversify the transportation basket (as well as the power generation one and the oil and gas sources). Due to national regulations, diesel and gasoline contain a percentage of biofuels (ethanol for gasoline and biodiesel for diesel). Compressed natural gas (CNG) was initially used only by public urban passenger transportation vehicles (taxi cabs and buses). In recent years there has been an increasing number of vehicle conversions (automobiles and small trucks) from gasoline to CNG due mainly to high oil prices. As a result, CNG consumption has increased. Right now the country has a huge availability of Liquefied Petroleum Gas and representatives of the industry are looking for opportunities to increase its participation in the transport business.

We discuss the following questions in this paper: Why Colombia should change its energy matrix in freight transportation? How we succeed in introducing microLNG, GLP biofuels and electricity in the energy basket)? Could we introduce new vehicles and logistic technologies? Could Colombia made changes to river and rail transportation or any attempt will be defeated by stakeholders, reluctant to new technologies and sinked in the comfort of current affairs? How likely appear in the 2050 energy and emissions scenarios these changes? What barriers we have to overcome to get a more efficient transport of freight and finally a more productive economy? Which organizations and what regulations we need to achieve the cleaner and diversified 2050 scenarios?

This kind of issue is culming the analytical corridors in planning offices in Colombian think tanks and research centers. Colombia changed its main fuel for freight transportation from gasoline to diesel, from 1985 until 2000, following the global trends. Colombia has tried to scrappage the old trucks. Colombia has tried to foster cleaner fuels. Colombia has tried to renewed train and river. Little effects out of this strategies. One less unsuccesful than others.

After measuring the benefits, co-benefits, implementation and transaction cost, sectorial and economy wide, we propose a bundle of recommendations to get the energy efficiency and mitigation goals we aimed to achieve. These recommendations are oriented to solve market coordination and government failures.

P-2230-03

Challenges and Opportunities in Climate Change Adaptation of Coastal Cities: Lessons in the Adaptation Road Maps of Metro Manila and Singapore

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The Guide to Climate Change Adaptation in Cities (2011) published by the World Bank considers a city resilient if it is able to respond quickly and effectively to climate change impacts. The same guide contends that a resilient city's adaptation strategies should be integrated into its own disaster risk reduction and sustainable development policies. To get the public engaged and committed to embrace the concept of adaptation however is fraught with difficulty. As Coleman, Offenheiser, and Waskow (2009) argue in the book Climate Change and Global Poverty: A Billion Lives in the Balance, the concept of adaptation is a tough one to sell and remains something incomprehensible to the public. How can one convince people to segregate and recycle garbage when most people find it convenient to just put all things inside one garbage bag and throwing it anywhere? How can state policymakers promote that walking is both a healthy activity for both humans and the environment when they themselves don't even take public transportation? How can environment advocates teach that air conditioning is a source of CFCs when people congregate to the malls to take advantage of free air conditioning to escape the perennial tropical heat?

The road to climate change adaptation indeed is long and winding. Dessler and Parson (2010) consider climate change to go beyond the issue of the environment making it a serious and difficult matter to manage. But, as climate change poses inevitable challenges, it also offers opportunities in carbon trading through the Clean Development Mechanisms. This is the context that frames this policy analysis of the roadmaps of Metro Manila and Singapore in climate change adaptation towards their goals of becoming resilient cities in Southeast Asia. This analysis presents the challenges as well as the opportunities that these two coastal mega-cities in Southeast Asia have. The rate of a city's expansion in terms of territory and population is directly proportional to the increase in the risks it could face against climate change impacts especially if city residents are clueless about what possible hazards they are faced with. The wrath of super typhoon Haiyan in 2013 mirrored in the storm surge devastation of Tacloban City in the Philippines has been a tragic remembrance of a worst-case scenario to date if and when the next bigger storm hits major metropolises. Most people in Tacloban prepared for the usual strong winds but overlooked the enormous storm surges that did the worst damage. As cities are in themselves complexes, coastal cities are in a more precarious situation considering the millions of lives and resources that can be affected by the rise in sea-level and the threat of storm surges.

Adaptation of cities involves initiatives and measures whether formal or informal that leads to resilience against climate change impacts. Singapore is quite unique being an island city-state in itself. Metro Manila on the other hand is a microcosm of the nation-state it serves as a capital and major city. A glaring disparity exists between the two in terms of political regimes, economic and social development. In terms of climate change issues however, both cities have witnessed unusual flooding in the past five years. It is thus fitting in the context of climate change adaptation to examine the strategies that these coastal cities are undertaking how they address old environmental issues such as land use, energy conservation, and sustainable development to the emerging ones like E-waste disposals and Clean Development Mechanisms.

P-2230-04

A Study on Climate Change Impacts Adaptation Measures for the Hilly Road construction: Case of Nepal

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Nepal encompasses 85% of its land as hilly and mountainous area. Out of total 80,000 km road construction within the country only 18000km is with blacktopped. The steep slopes with fragile geology are the characteristics of the hilly region. Geologically Nepal lies on Himalayan area with the mobility of Tibetian and Indian Plate. So the vulnerability seems higher. The Impacts of climate change focused on water resource. The Himalayas towers are the source of rivers and rivulets in the country. 6000 rivers and rivulets are flowing from north to south up to Gangas River in India. The road and transportation sector requires to cross the rivers and return periods for the floods and extreme rainfall. The trend of extreme events seems changing. To cope with such events and impacts it requires some techniques. The Climate change may cause more flooding of roads, bridges and airport runways, especially in low land areas as a result of erratic rains. A range of adaptation responses can be employed to reduce risks through redesign or relocation of infrastructure, increased redundancy of critical services, and operational improvements. Roads, bridges, tunnels and railway lines will be vulnerable to increased precipitation, groundwater levels, temperatures and winds.

The road transport sector is a key area that contributes to climate change by way of greenhouse gas emissions. However, the transport sector is in turn itself affected by climate change. Higher groundwater levels associated with extreme precipitation will mean an increased risk of landslides on excavated slopes. There is a risk that the bearing capacity of bridge and tunnel foundations,

supporting walls and sheet pilings will be reduced by increased groundwater levels. This can be found in number of ways, especially for foundations on sand. Modern safety installations are significantly more sensitive to temperature increases than older installations and this may presents a particular problem. Autonomous adaptation to climate change is important because of the complexity and long lifetime of road. Furthermore, improved maintenance in the form of cleaning existing road drainage systems can retain drainage capacity corresponding to that of a new installation.

Whilst, transport systems and infrastructure designed to withstand typical weather patterns, climate change impacts arising in the near and longer-term can have an impact on the efficiency of transport operations and ability of infrastructure to withstand extreme events.

The designs of project road have been done considering the potential effects of climate change. From a road development perspective in Nepal, impact of climate change mainly takes the form of concentrated high rainfall resulting in the accelerated surface run-off from slopes and increased flows in gullies, drainage channels, streams, and rivers. These phenomena have a consequent effect on the stability and performance of road sections, bridges, and other structures.

P-2230-05

Is electric mobility a driver to climate mitigation in the EU-27 countries? Myths and realities from energy systems analysis

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In many research and policy fora, electric vehicles (EV) are considered effective alternatives to passenger mobility due to their contribution to CO2 mitigation, when compared with internal combustion engines, mainly if the power comes from renewables. Recent research [1] showed that for an EU-wide greenhouse gas emission reduction cap of 40% and 70% by 2050 vis-à-vis 1990 emissions, battery electric vehicles (BEVs) are cost-effective in the EU only by 2030 and only if their costs are 30% lower than currently expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

A bottom-up partial equilibrium 36 multi-region model (PET36) representing these countries' energy systems linked through trade of the main energy forms was used. PET36 is driven by exogenous country-specific energy services demand, and it takes into consideration the evolution of energy prices, endogenous energy potentials and policy assumptions. Its main output is the cost-effectiveness mix of energy supply and demand technologies for the seven sectors: primary energy supply (e.g., oil and bio refineries, natural gas distribution pipelines), electricity and heat generation, industry, residential, commercial, agriculture and transport. This model allows us to get in-depth insights on the energy system transformation of each EU-27 country to deliver cost-effective BEVs for passenger mobilityup to 2050. We use two families of scenarios, shaped by varied EU level emission caps and BEVs cost curve.

Our presentation relies on results just published [1] and goes a step further, focusing on:

- (a) confrontint the national plans of each EU country on EV adoption with current status (actual deployment) and the results from our analysis, aiming to discuss the expectations and failures of electric mobility deployment in each EU country and the current and future role of public policy to overcome current barriers and risks;
- (b) assessing the reduction of greenhouse gas emissions in each EU country due to adoption of BEVs and PHEVs taking into account the whole energy system, i.e., not only the shift from internal engine combustion to electric engines, but also the shift in the power sector and refineries. The goal is to discuss the impact of electric mobility policy measures on the transformation of energy system, including trade-offs, co-benefits, risks and feedbacks.

We argue that the energy system analysis used in this research is the appropriate approach to discuss the impact of mitigation policies. Across Europe, as well as in other regions, electric vehicles are seen, both by climate policy makers and car markets, as a panacea for the mitigation of a significant share (up to 40%) of greenhouse gas emissions. However, detailed analysis at EU member state level shows that the adoption of this technology is far from expectations due to vehicle costs, charging constraints and the mobility model still in place based on individual ownership. We argue that radical mitigation in Europe will rely in electric mobility (including trucks) but there is the need to look across the whole energy system, to prevent risks and undesired feedbacks (e.g. increase of new fossil based power plants) and to expand co-benefits (energy efficiency and foreign oil dependency). Policy initiatives must be designed to make EVs' cost evolution cheaper for consumers than what is currently expected, while looking at risks of such pathway.

[1] Seixas,J., S.Simões, L.Dias, A.Kanudia, P.Fortes, M.Gargiulo (2015) Assessing the cost-effectiveness of electric vehicles in EU countries using integrated modeling, Energy Policy, 80, 165-176.

2231 - Cultural Heritage facing up to Climate Change, Sea Level Rise and Pollution

ORAL PRESENTATIONS

O-2231-01

Creation and evaluation of future indoor climate and risk maps for European cultural heritage buildings and their interior

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In the EU-funded Climate for Culture (CfC) project, an interdisciplinary research team of 27 partners investigated the impact of climate change on Europe's cultural heritage buildings and their interior collections. Thereby regional climate models and building simulation tools were coupled to assess the outdoor and indoor implications. Two different climatic scenarios, A1B and RCP 4.5, from the 4th and 5th IPCC-report were used as baseline for the projection of future outdoor climate data. The regional climate model REMO was applied for high-resolution simulations of outdoor climate over Europe and the Mediterranean for both climatic scenarios. These calculated climate indices were used as input for hygrothermal building simulation tools allowing a prediction of future indoor climate and its risk potential to interior objects.

To investigate the long-term impact of climate change on a variety of historic buildings the CfC project used the so-called "Generic Sacred Buildings": 16 fictitious but representative building models of unconditioned buildings like churches or monasteries, which are based on measurements of existing buildings collected during the CfC project. These Generic Sacred Buildings were placed on 474 locations all over Europe and the Mediterranean and building simulation tools were applied to simulate indoor climate for three time-windows: 1960 - 1990, 2020 - 2050 and 2070 - 2100. Afterwards, each indoor climate, in particular temperature and relative humidity, was evaluated by using a newly developed automated method which assesses nearly 200 parameters, like for example

temperature, relative humidity, deterioration rates or various damage risks. All results of this assessment process were collected and visualised as pan-European maps. Also the differences between the three time-windows were calculated for every parameter allowing the identification of changes from past to future periods.

Because of the sheer amount of available data, more than 52.000 maps were produced, the here presented evaluation of future indoor climate projections focuses on some selected parameters. A common insight from the maps is that mean indoor temperature will increase all over Europe for all investigated building types. As a result of the temperature development, frosting time inside the buildings decreases, mostly in Northern and Eastern Europe. An often inquired damage process is mould growth on collection objects. The maps hint, that mainly in Northern and Eastern Europe possible risks of mould growth will increase in future periods. Furthermore insect growth conditions inside the buildings were evaluated by calculating degree-days. Favourable growth conditions can be found around the Mediterranean and with increasing temperature in future time-windows these will also increase in Northern and mostly in the middle parts of Europe. The assessments also include risks for mechanical damages of wooden objects like panel paintings, statues or furniture. These damage risks were evaluated by analysing long- and short-term changes in relative humidity and show mostly a stable risk classification during the time-windows. Also chemical degradation processes were evaluated by using Lifetime-Multipliers. They indicate increasing damage risks mostly around the Mediterranean.

O-2231-02

Long-term damage of climate and pollution on the stone and glass in Paris

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The urban fabric is affected by both climate and air pollution, but the magnitude of their impact varies over time. The effects of air pollution on the degradation and soiling of materials were particularly noticeable during periods of rapid urbanization, while the late 20th century has seen a reduction as a result of the decline in the aggressive pollutants such as sulfure dioxide. Soiling is more complex as there have been changes in the nature of the deposited particles over time, but as with the gaseous pollutants there have been improvements that accompanied more stringent regulations designed to improve air quality. Over the centuries there has been an increase and subsequent decrease in the rate of damage to building materials which can be interpreted in terms of the environmental Kuznets curve. The decline in the aggressiveness of pollutants in Paris makes it likely that climate driven processes will on balance play a bigger role in the future. Historically frost damage was important, but it is hardy likely to be relevant in a warmer future. This presentation attempts to estimate the rates of recession and soiling of calcareous stone and damage to glass and stained glass in Paris over many hundreds of years and understand how these processes will change through to the end of the 21st century. The long term variation of air pollution is assessed on the basis of past observations and estimated for the future from likely regulatory trends. Meteorological input derives from historical data and some non-instrumental weather records, while future climate is adapted from the Hadley Centre and Météo-France models under a2, RCP2.6 and 8.5 scenarios for the 21rst century. Converting this environmental input to long term change in damage has used dose-response functions from a range of sources to estimate the magnitude of the changes and where possible compare these with historical observations of the state of buildings made by architects and other observers.

O-2231-03

Quantitative Nuclear Magnetic Resonance Imaging, Profiling and Diffusometry on Fluorinated Compounds to Preserve Cultural Heritage Porous Media and Safe for the Environment

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The preservation of historical buildings and outdoor cultural heritage is a necessity to hand down to the posterity works of art, as well as to guaranty an economic resource. The main causes of degradation of stones, one of the most important porous materials of these artifacts, are related to the chemical-physical processes that influence the ingress and diffusion of water (liquid or vapor) into the pore space. It is well known that water dissolves CO2 and pollutants from the atmosphere, causing acidic corrosion of the stone or the binder, and it is responsible of internal mechanical stresses due to freezing-thawing cycles or salt crystallization.

For the treatments, usually hydrophobic compounds (typically synthetic polymers) are applied, with performance (efficiency and durability) that depends on the compounds used, the treatment procedure and the chemical-mineralogical nature of the substrate. Many are the characteristics of the products to guaranty good performance: high stability (chemical, thermal and to photo-oxidation), high adhesion to the mineral substrate (interaction but not reaction with stone), low surface tension and suitable molecular dimensions which allow a uniform distribution, good penetration into the porous structure, and low propensity to pore blockage. Very important is the solubility of the product in solvent safe for man and environment. Perfluoropolyethers, applied on some historical buildings since the 1980s, have high stability, water repellency and low surface tension, but the protective treatment showed a low durability. Perfluoropolyethers containing polar groups able to give better interaction with stone, typically ester and amidic groups, were developed. Unfortunately, these compounds are soluble only in CFC and in supercritical CO2, therefore their use as protective agents for historical stone artifacts was abandoned since the 1995.

This work was focused on the preparation of a new protective agent with low average molecular weight containing short pendant perfluoropolyether segments linked to an oligosuccinamide chain in order to achieve: (i) high hydrophobic effect and photo-stability, (ii) good adhesion to the rock through the polar amidic groups, (iii) excellent distribution on the pore walls surface without their blockage, (iv) solubility in environmental friendly solvents.

Hydrophobic penetration and distribution properties of the compound applied on a biocalcarenite (Lecce stone), have been investigated by Nuclear Magnetic Resonance (NMR) Imaging, Profiling and Diffusometry of 1H nuclei, and compared with a perfluorinated commercial product. These NMR techniques has been proved to be a valid non-destructive and non-invasive technique for monitoring the conservation state and water absorption in materials and objects of interest to cultural heritage, as well as for evaluating the efficiency and distribution of protective or consolidation treatments.

The results obtained by Imaging were compared with those obtained by single-sided NMR apparatus. This last instrument, that allows for in situ non-destructive analyses, was equipped with a lift for automatic shift of the NMR sensor and allowed us to obtain high spatial resolution profiles of the NMR signal inside the samples. Two-dimensional correlations maps of the two parameters self-diffusion coefficient and NMR relaxation time gave further information on the performance of the treatments. The results demonstrate that the partially fluorinated oligoamide satisfies the main properties required to a protective agent (no color changes of the treated surface, high residual permeability and high photo-oxidation stability), and improves the water repellency of treated stone surfaces in respect to a fluoroelastomer, frequently applied as protective agent and here used as reference.

O-2231-04

Urban planning and design to mitigate climate change impact: the role of heritage conservation in a dense urban city

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Climate change and global warming has made urban heat island effects become more severe in cities facing rapid urbanization. The urban heat island phenomenon is even more severe in urban cities with the tall and massive high-rise building morphology. In contrast, built heritage sites consist usually of low rise buildings located in city centres. The conservation and adaptive reuse of historic buildings can provide potential breathing space among the high rise blocks to generate air paths and minimize the heat island effect. Thus, the careful planning and design of heritage sites can enhance human thermal comfort and mitigate the adverse impact of climate change in the dense urban cities, whilst preserving historic pride and cultural spot.

Climate change also alters the way that people live, work, worship or socialize in public space. What role can built heritage play in minimizing the adverse impacts of climate change on the microclimate of the urban environment? Conservation and Planning considerations should emphasize more on clusters of heritage sites in urban districts which can provide much greater impact on the overall urban environment than a single building.

This paper explores the relationship between climate change mitigation and built heritage conservation in a dense urban city.

It is proposed that a robust database of spatial maps will be constructed, of an urban districts in Hong Kong with the aid of GIS. The study maps will display the urban fabric including the locations of heritage sites, building height and mass, building footprint, land use, open space, and topography. Micro-climate environmental maps which include temperature, and wind velocity will also be compiled. Field measurements of the meteorological parameters at the selected studied heritage sites will provide supplementary data for the spatial maps.

Despite the robust maps and measurement are important, the ways in which conservation of heritage buildings can influence the social experience of adapting to climate change would be worth for investigation. The impact of climate change should not be limited to physical and environmental impacts, in fact, the socio-economic changes due to climate change will have also have a great impact on the conservation of cultural heritage. On one hand, climate change alters the ways that people, in relation to the environment they live, work, worship and socialize in buildings, sites and landscapes with heritage values. For example climate change modifies the social interaction patterns in public spaces. On the other hand, heritage can also affect the social experience of climate change. Heritage conservation can have a positive effect on the lives of people in a changing climate and how they perceive climate change. For example, a green common space in a heritage site can provide the community with a pleasant breathing space in the middle of high rise buildings.

Thus, it is of paramount importance to examine the extent to which the adaptive reuse of heritage buildings can also incorporate design considerations which mitigate the physical and social effects of climate change. This proposed research will help towards responsive and innovative solutions to the UHI effects and climate change with the conservation and reuse of heritage buildings. A better understanding of the links between built heritage, urban morphology and the surrounding microclimate is essential to create successful climate change mitigation strategies for dense cities.

The study will provide useful reference data for urban planners and urban designers helping them to incorporate environmental and social considerations on the conservation of heritage buildings, and most importantly, help to ensure the better use of heritage sites to mitigate climate change adverse impacts in dense urban cities.

O-2231-05

Towards a Framwork for Evaluating Existing International Best Practices on Climate Change and Heritage

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This presentation examines the response of the heritage sector to climate change with an emphasis on the key themes and theoretical frameworks that have been adopted by major organizations to date. It finds that a formal concern for the impact of climate change on heritage sites is increasingly being complemented by a broader concern for the impacts on social sustainability from the degradation of intangible heritage and "a sense of place" attendant to climate change. Attention is also increasingly being paid to the ways in which cultural heritage is a solution to climate change, for example offering lessons in past human successes and failures in adapting to environmental changes, and providing insight into the origins of the modern climatic situation.

It has now been almost a full decade since the issue of the impacts of climate change on natural and cultural heritage properties was formally brought to the attention of the World Heritage Committee. This resulted in an expert meeting in March, 2006 at the UNESCO headquarters in Paris which issued a joint report on "Predicting and Managing the Effects of climate change on World Heritage" as well as a "Strategy to Assist States Parties to the Convention to Implement Appropriate Management Responses." The World Heritage Committee endorsed these two documents at its 30th session (Vilnius, 2006) and requested all States Parties to implement the strategy so as to protect the outstanding universal values, integrity and authenticity of the World Heritage properties from the adverse impacts of climate change. In 2007 climate change and heritage experts, including ICOMOS, issued a Policy Document on the Impacts of Climate Change on World Heritage Properties which among other things identified future research needs. Broadly speaking these documents provide guidance on (1) Monitoring and reporting; (2) Mitigation; (3) "Corrective actions" including management, adaptation, and risk management and (4) Collaboration, cooperation, and sharing best practices and knowledge.

As the world approaches the 10th anniversary of these reports, this presentation would examine the climate change strategies from major cultural heritage organizations around the world, using the 2006 and 2007 guidance documents as touchstones. Two examples of these heritage responses are those of the United States National Park Service (NPS) and the International Trust Organization (INTO).

INTO represents national heritage trust organizations in over 40 countries and has been represented at 4 of the last 6 COPs. INTO views climate change through the lens of the Victoria Declaration on the Implications for Cultural Sustainability of Climate Change which was adopted by INTO at its 14th International Conference of National Trusts held in 2011. The Victoria Declaration focuses on the capacity of climate change to undermine the integrity of the world's cultures, and the resulting social dislocation and social instability likely to follow, framing these issues in terms of intergenerational equity.

The NPS is the lead US federal agency for the management of cultural heritage. In 2014, it signed a policy memo Climate Change and the Stewardship of Cultural Resources, which set out a leadership role that looks at both the impacts of climate change on heritage and the capacity to learn from these over time, and applies those to the four pillars of climate change response that NPS established in its 2010 Climate Change Response Strategy: science, adaptation, mitigation, and communication. While focusing on impacts, the Policy includes the science of learning from cultural heritage about climate and environmental change, for example, learning about human adaptation to climatic variability through time from cultural heritage and learning from heritage to reacquaint ourselves with energy-saving practices and methods that have become less used.

O-2231-06

Multi-Criteria Accuracy Assessment for Indoor Climate Change Projections of Historic Buildings

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Recently hygrothermal building simulation has been applied for the projection of damage risks from future indoor climate in historic buildings. This has been done using generic weather data obtained from dynamic downscaling of regional models with different global climate change scenarios (A1B and RCP4.5). The objective of this paper is the development and definition of new concepts to assess the accuracy of hygrothermal simulation models for indoor climate of historic buildings in the contexts of climate change and preventive conservation. Preventive conservation is aimed at the permanent conservation of works of art and objects of cultural value by improving ambient conditions and by reducing or minimizing relevant risks. The quality of simulations is of significant importance especially when assessing climatic risks in historic buildings with precious interieur and works of art, since misjudgements of planned measures can result in irreversible damages. Moreover, hygrothermal simulations offer new opportunities in calculating the effect of different measures to improve indoor climate. But also for the assessment of future risk it is important to know how reliable a simulation model is for the present. Therefore, it is important to develop criteria to assess the results of simulation with regard to preventive conservation, and to verify them by means of case studies. The indoor climate of the small village church St. Margaretha in Bavaria is characterized in detail by means of measured data and reproduced by means of simulation models. For this case study a new approach was developed using multiple criteria in the form of different damage functions for accuracy assessment. This assessment is only one important element in the chain of uncertainties that applies when using projected future climate data from global climate change projections. Therefore also the measured long-term outdoor climate from a weather station nearby has also been compared to the generic weather data for the recent past (1960-1990) for different climate change

O-2231-07

The balance of air pollution and climate as drivers of damage to heritage

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It has been well known from classical times that weather and smoke cumulatively damage buildings. The shifting climates of the past had an impact and historic exposure to aggressive air pollutants, especially those from coal which caused not only blackening, but led to surface recession and crust formation that resulted from high sulfur dioxide concentrations. The situation has changed as air pollution is more effectively regulated. Our understanding of the impact of climate on heritage assets requires the development of material or heritage climatologies that recognise the role of the combination of meteorological factors, cycles of climate and the long accumulation of damage. Although controversy surrounds long-term climate predictions, there seems little doubt that the world will become warmer and rainfall patterns will change, even if we cannot be sure of the magnitude. The changes are often quite small, just a few degrees change in temperature or percentage changes in rainfall or relative humidity. This means amplification is often necessary for the effects to be significant. Phase changes (freezing or salt crystallisation) can be important amplifiers, while biological effects (changing insect numbers or rapid fungal growth) can also enhance the outcomes from small temperature changes. The impact of changed rainfall can be increased by a larger number of wet days or longer times of wetness. The frequency of extreme events may also alter the rate of material damage. Air pollutants will doubtless be more regulated in the future, but new problems may arise through the presence of ozone and diesel particles in the air and novel pollutants might also have an impact.

O-2231-08

Socio-cultural implications of Climate Change for Cultural Heritage

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When considering the interaction between cultural heritage and climate change, the most media-visible effort on climate change is undoubtedly scientific research. Yet society requires science to have wider context and meaning. It needs to be relevant. Therefore the socio-cultural impact of climate change must be part of any discourse on the implications of climate change for cultural heritage.

Not only would this inform our understanding and influence our response to climate change impacts, it can also make our response more resilient and sustainable. There are inherent cultural and social dimensions to climate change. Artists and sculptors, writers and poets, performances and exhibitions engage the public with climate change in ways that are necessary and important. They provide critical pathways for adaptation. The arts and humanities, social sciences and economic disciplines provide different lenses through which to develop new responses to life-changing events. By developing a range of perspectives, we improve our chances of co-creating sustainable survival strategies.

Cultural heritage research until recently, has been largely concerned with the impact on ancient and historic materials and assemblies such as those caused by increasing sea levels and floods, changes in the moisture contents of the air and in the conditions of soil (especially for archaeological sites) and migration of pests. Yet cultural heritage is more than stones, bricks and mortars.

In addition to these impacts, climate change can severely affect the sustainable conservation of cultural heritage places by altering the traditional way of life of communities. The relationship of communities to their landscape, their work and social habits, can be affected by the rapid deterioration of physical assets and loss of authenticity[i].

In 2008, World Monuments Watch and the World Monuments Fund provided dramatic evidence of these consequences when it listed a number of places at high risk of loss due to the effects of climate change. These included:

Herschel Island, Canada (from rising sea levels, eroding coastline and melting permafrost);

Scott's Hut and the Explorer's Heritage, Antarctica (from warming triggering large amounts of precipitation leading to microbial infestation and decay);

Sonargaon-Panam City, Bangladesh (from the low-lying terrain making it especially vulnerable to flooding and rising sea levels);

Leh Old Town, India (from changing weather patterns in the Himalaya bringing more rain in the summer thus creating problems for the flat mud roofs designed for the originally dry climate);

Kilwa Historic Sites, Tanzania(from serious rapid deterioration of the archaeological and monumental heritage due to erosion and vegetation caused by rainwater wash accentuating the risks of collapse of the remaining structures on the edge of the cliff); and

Chinguetti Mosque, Mauritania (from effects of the expanding desert, changing rainfall patterns, vegetation loss, soil erosion and extreme temperatures).

If scientific research is to understand deeply the cause and effect of change on cultural materials, and if it is to develop sustainable adaptation strategies, the values associated with these places need to be integral to the solution. This

contribution will focus primarily on the language that is used to highlight the significance of these endangered sites in order to evaluate the extent to which the socio-cultural impacts of climate change are integrated into scientific studies of cultural heritage.

[i] UNESCO World Heritage Centre (2006) World Heritage Paper No. 22. page 10. Available at: http://whc.unesco.org/en/climatechange/ and published in English and French.

O-2231-09

Protecting coastal heritage from coastal rapid events: Epistemological issues

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Coastal heritage is comprised of many different types of artefacts. Some of them are located along the coast but have no direct relation with the sea (such as tombs, stones circles). Others (for example harbours, fisheries, dykes, shell middens…) do present a deep relation with the sea level, the wave directions, the local winds and possibly with sediment movements. The first group of heritage site may, today, be concerned by relative sea level rise and/or coastal retreat and beg for a protection. Though these archaeological objects may be moved inland and still keep most of their scientific value and cultural interest. In this case their land ward shift and protection is not vey different from their possible inclusion into a museum collection.

The other set of heritage sites is totally different. Most of their scientific value depends on their precise relation with the "natural" environment at the moment of their building. As objects they can be deconstructed and stored in a museum but as a site they cannot be understood outside of the very precise geomorphological setting where they were built. In these two cases the epistemological issues are clearly different. Though a large part of the scientific value is located inside of the object itself (it is a real property of the object, as realists philosophers have often explained it) some other dimension of the scientific knowledge is not in the object but in the relation it has with the local passed environment, and especially with the local ancient morphodynamic condition. Therefore what should be protected (or reconstructed) should not only be the object but the natural ancient environnement (the local site when sea level was different) and the ancient events which may have taken place such as storms or human induced soil erosion. The context of the object is as important as the object itself. This rises new questions about heritage and cultural approaches of heritage conservation. How can climatic events be understood as heritage ? How can ancient human induced erosion processes may be included into the wide and general notion of heritage? Our scientific knowledge about ancient processes is limited and new dating techniques regularly appear and help to produce new information. So there is an always wider range of objects which can be dated : with Pb 210 muds may be dated even when they do not contain organics. The question of how large is the accommodation space around the artefact is totally opened: how far from the object may the environnement provide relevant information? How far should the protected area be extended? Is this protected space compatible with other activities on the coast?

This speech present some pre roman examples in Brittany and some post cold war examples in Taiwan.

O-2231-10

Outdoor-Indoor climate relationships for Cultural Heritage

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Not only historical buildings and outdoor monuments are exposed to climate changes and related risks. The exchanges of air, heat and moisture through the building envelopes will affect the indoor climate too, with potential risks to collections, paintings, furniture etc. The potential impact of mechanical, chemical and biological agents will depend on the outdoor climate change, the building structure and the material type. In order to know the expected changes and assess risk factors, the EU funded «Climate for Culture» Project has investigated the problem and produced thematic maps over Europe, using the REMO regional climate model at 10 km ´10 km space resolution. Two moderate IPCC emission scenarios have been considered: A1B and RCP 4.5. The former to make comparisons with previous studies easier; the latter as updated reference. The situation has been calculated for two future time windows, i.e.: 2021-2050 near future and 2071-2100 far future. Changes have been highlighted calculating and mapping the difference between each future map and the related situation in the 1961-1990 past reference period.

The first step has been to calculate the outdoor climate (e.g. precipitation, dryness, temperature, humidity, time of wetness, repeated freezing thawing, salt crystallization cycles), then the indoor climate and finally the potential damage and risk factors. To this aim, it has been necessary to assess the impact of climate change through an improvement of the prediction models; then to develop a methodology to assess the climate-induced risks on materials and building envelopes. The study has been based on some 120 case studies plus 16 classes of generic building types, each class being characterized by a different building volume (small/large), structure (heavy/light weight), moisture buffering performance (low/high) and window area (small/large). A number of key materials (i.e. stone and masonry, metals, wood and veneers, painted wood, paper, silk and colour photographs) have been considered, either because they are commonly used in this field, or for the potential risk that may derive under certain unfavourable circumstances. The relevance of deterioration mechanisms and the risk factors have been calculated using specific damage functions, either known in literature or tested in laboratory within this Project. Damage functions and/or thresholds link the changes of the climate variables to a specific risk of damage. The level of risk has been defined according to the number of events that have exceeded some specific thresholds, or the time elapsed above them. A traffic light code (i.e. green colour: safe; orange colour: attention; red colour: risk) has been used to express the risk levels. At the end, a total of 55,650 high-resolution thematic maps over Europe have been produced.

The uncertainties related to the project outcomes include the uncertainty band in risk maps, forcing conditions and the used climate model, significance of the climate change pattern, building simulation, damage functions. The above uncertainties have been analysed to assess the confidence limits of the future scenarios that should be considered in view of any decision support/making system. Although the study has been focused on cultural heritage conservation, some outcomes might be useful for other social application fields, e.g. temperature changes and increased number of tropical days may be related to health, cultural tourism and energy consumption; mould growth and pest infestation to sick buildings. The recovery of early instrumental observations and various proxies has also been considered to produce long-term urban outdoor and indoor historic climate series (e.g. 1500-today), or to reconstruct the sea level in Venice (1200-today). This has been useful to improve understanding and to refine future simulations.

The analysis of the results shows that climate change may have negative, neutral or positive effects (e.g. faster or slower deterioration rates, more or less need for heating, cooling or humidifying) depending on specific problems, aims, solutions, and building use. These results offer a timely information to prepare adaptation and mitigation strategies, or to take advantage from the positive aspects, when possible. In this sense, this project provides an informative tool aimed to assist policy makers, conservators, architects and other users, in view

of an efficient strategy for management and preventive conservation of the European cultural heritage.

2231-POSTER PRESENTATIONS

P-2231-01

The Climate for Culture outcomes as tool for energy planning strategies and preventive conservation against mould, pests and other challenges in the Alpine region

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In the times of climate change, a global imperative is to save energy and reduce our carbon footprint. Museums and other cultural institutions are deeply implicated in these concerns as major consumers of energy, particularly heating and ventilation systems often housed in modern buildings. The demand for a better understanding of the interactions between cultural heritage collections and the climate and future perspective of energy consumption are pressing. The current state of knowledge highlights the need to develop strategies for protection and adaptation which requires specific risk assessment not only in the short but in medium and long term. Above all such risk assessment shall be focused on the correspondent building type and geographic location of the end user to provide a scientific support in planning target interventions in terms of lower energy consumption and cultural heritage protection.

This intervention exploits and analyzes the data developed within the EU-funded research project Climate for Culture (CfC) (www.climateforculture.eu) active 2009-2014 to assess, in the Alpine region, the future energy consumptions of HVAC systems as well as the specific risks of mould, pest infestation and freezing-thawing cycles looking at several building types different in level of control, quality of envelope, windowed area, thickness and construction materials.

The CfC project, over the past five years, has investigated the influence of current and future climate change on cultural heritage objects [Kilian et al. 2013; Leissner et al. 2013 and 2014]. This large scale EU research project has now made available for a wide community of stakeholders scientific knowledge, technological innovation and new data concerning future indoor projections of thermo-hygrometric variables and HVAC energy consumption from regional climate models in a range of generic and exemplary buildings. In particular the data which generate the Climate for Culture maps, supported by other CfC outcomes as recommendations to minimize energy consumption, preservation strategies and the exDSS software for implementing the decision support system, provide unique and useful tools for helping stakeholder in planning energy saving and preventive conservation intervention strategies in their area of interest in advance.

The purpose of this work is to create an exemplary data analysis focused on the Alpine region, to help final users in exploiting CfC results as tool to assess in which extension the impact of the ongoing climate change will affect a specific geographic area over the near (2021-2050) and the far future (2071-2100). The results will be analyzed in term of energy saving and risk management strategies.

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P-2231-02

Present and future salt climatology in France

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Following the concept of "salt climatology" introduced by Grossi et al. (2011) which deals with the knowledge of environmental parameters conditioning salt weathering of cultural built heritage, our objective in this work is to compare the spatial salt weathering distribution in France in the near past (1971-2000) to the one predicted in the future (2071-2100).

To quantify salt damage, different methods are used depending on the salt type. For some salts the number of phase transitions is estimated from meteorological data, temperature (T) and relative humidity (RH). For other salts the damage is estimated just from the environmental conditions. In this study we took into account three different salts: Sodium Chloride, Sodium Sulphate and Calcium Sulphate. For NaCl we estimate the number of times salt can crystallise from a solution. To do that we consider the number of times that daily relative humidity crosses the deliquescence value of 75.3%, from RH higher than 75.3% to RH lower than 75.3%, and for temperatures above 0°C. To estimate the weathering produced by Na2SO4 we count the number of times the equilibrium line between thenardite and mirabilite has been crossed in the phase diagram temperature - relative humidity. On this phase diagram for Na2SO4 we assume that the line separating thenardite and mirabilite domains is a straight line for the temperature range between 0 and 35°. For gypsum, it is assumed that when relative humidity is higher than 80%, gypsum will precipitate on the inner part of the rock inducing important damage, whereas it will precipitate on the surface when relative humidity is lower than 80%, with less damage associated. Therefore the number of days with relative humidity higher than 80% has been considered as an estimator of gypsum weathering. In this way we calculate the number of transitions of Sodium Chloride and Sodium Sulphate and the number of days with RH higher than 80% for two locations in the North-West of France, Rouen and Caen.

To estimate salt weathering distribution in France we use the methodology presented in Grossi et al. (2011). To obtain a "simple" way to estimate salt transitions in different locations, we plotted the number of monthly salt transitions calculated for the period 1960-2008 in Caen and Rouen data as a function of the difference between mean relative humidity and the equilibrium relative humidity for each salt. For sodium chloride the relative humidity equilibrium is equal to 75.3% and it is independent of temperature, in the range 0 to 40°C. For sodium sulphate we obtain the equilibrium relative humidity for each temperature from the phase diagram. For calcium sulphate we consider the 80% relative humidity threshold. By a regression fit of this plot we can associate a number of monthly transitions to the mean relative humidity for the month by a polynomial function. This methodology allows estimating the salt damage from simple data as the mean monthly relative humidity.

We estimate the salt weathering in 44 locations uniformly distributed in France, applying the obtained regression to meteorological data from 44 stations and to future model data at the same locations obtained from climate models. All the past data come from Météo-France stations from 1971 to 2000 and future data from simulations of Arpege model for 2071 to 2100, A1b scenario. The final goal was to classify the different salt weathering behaviours in different regions. For each station we calculate the mean, max, min and standard deviation of the number of transitions (NaCl and Na2SO4) or the number of days (CaSO4) obtained from the polynomial regression functions. After that we apply an Ascending Hierarchical Classification to the data to classify the different locations.

The results show that for past data 3 different "salt behaviour" classes are well differentiated but for future data the classification is more complex and does not correspond to the actual one. In general, we can distinguish three geographic areas in a N-W to S-E direction. In the Northern part weathering by NaCl and Na2SO4 will remain constant or slightly decrease but gypsum effect will be more important. In the central part, covering most of the France, salt weathering will increase for the three salts and in the southern part, NaCl and Na2SO4 salt weathering will increase but gypsum weathering will decrease.

2232 - The Copernicus Climate Change Service : an European answer to Climate Change Challenges

ORAL PRESENTATIONS

K-2232-01

Europe's Eyes on Climate Change

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Climate change is a major global challenge with a range of potential social and economic impacts and the need for accurate information about the impacts of our changing climate is growing increasingly urgent.. Copernicus, through its new thematic service, will support policy-makers and relevant public authorities in monitoring the changing climate in order to better understand its potential effects and take appropriate actions. To illustrate the effort dedicated to this operational programme, a a total budget of EUR 4.3 billion has been allocated to the Copernicus programme (including the satellites), EUR 900 million thereof are dedicated to the six services. The importance of the climate change is reflected by the allocation of EUR 215 million (almost a quarter of the services budget) to the Copernicus Climate Change service (C3S). This service will bring together and integrate many different sources of information about the Earth, including data from the dedicated and operational Sentinel satellites and information from the other Copernicus services monitoring our oceans and ice masses, our atmosphere, and the Earth's land surfaces. The study of climate change involves a wide range of stakeholders and different scientific disciplines. Consequently, the C3S will be inherently cooperative, collaborative and international. Copernicus aims at becoming a trusted reference source for climate-related information and will become Europe's main contribution to global efforts to better understand and monitor our planet's natural systems. The C3S products will comprise ECVs (Essential Climate Variables), a set of key variables identified by GCOS for monitoring and predicting climate change, as well as Climate indices and Indicators required to address sector specific issues. Amongst the first sectors to be taken up by the pre-operational service are domains of particular interest, for instance water management and energy. Based on the ECVs and the indices and indicators tailor-made products will be developed integrating geophysical data with ancillary data on population, infrastructures, industrial assets, transport, etc. These products will support the holistic assessment of proposed climate policy measures for different possible scenarios for future developments. The Copernicus Climate Change service is ready to begin operations in a phased approach, starting with a proof-of-concept and the pre-operations. The service is implemented by the European Centre for Medium-range Weather Forecasts (ECMWF) [cf. Jean-Noel Thepaut «The Copernicus Climate Change Service», same session] The service will embody a comprehensive operational climate change monitoring system, which will continue to evolve in light of, and in close cooperation with, existing European and international initiatives, projects and activities, which it will complement with integrated modelling, reanalysis and observation capabilities.

O-2232-01

The Copernicus Climate Change Service (C3S)

JN. Thepaut (1)

(1) ECMWF, Research, Reading, United Kingdom

This presentation will provide an overview of the C3S:

This service will combine observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide. The service will benefit from a network of observations, both from in situ and satellite sensors, and modelling capabilities. Moreover, it will provide key indicators on climate change drivers (such as carbon dioxide) and impacts (such as reducing glaciers).

The service will deliver substantial economic value to Europe by (1) informing policy development to protect european citizens from climate-related hazards such as high-impact weather events, (2) improving planning of mitigations and adaptation practices for key human and societal activities, (3) promoting the development of new services by providing datasets and tools following an free and open data policy.

The talk will review the expected portfolio of C3S products and datasets which include consistent estimates of multiple Essential Climate Variables, global and regional reanalyses (covering a comprehensive Earth-system domain: atmosphere, ocean, land, carbon), products based on observations alone (gridded; homogenised station series; reprocessed Climate Data Records), a near-real-time climate monitoring facility, multi-model seasonal forecasts and climate projections and scenarios at global and regional scales.

This wealth of climate information will be the basis for generating a wide variety of climate indicators aimed at supporting adaptation and mitigation policies in Europe in a number of sectors including (but not restricted to) energy, water management, agriculture and forestry, insurance, health, tourism, infrastructure, disaster risk reduction, coastal areas). The service will be fully operational by 2018, and continually and independently evaluated and improved, to ensure that C3S represents the latest developments in climate science and that innovative service elements are introduced reflecting current research. Appropriate channels and interfaces with Research and Innovation activities in Europe will be established to ensure an efficient transfer from research to operational climate service related activities.

O-2232-02

How is the climate changing? Climate monitoring based on observations

D. Dee (1)

(1) ECMWF, Reanalysis, Reading, United Kingdom

Earth observations, recorded over time by a multitude of instruments ranging from early mercury barometers to synthetic aperture radars and other advanced satellite sensors, contain the fundamental information at our disposal to describe in detail how the climate has changed

since the pre-industrial age. Observations contain the evidence that the Earth surface is warming, glaciers are melting, sea-level is rising and the oceans are acidifying. Observations allow us to monitor and assess more subtle changes taking place in our environment related to air quality, regional rainfall patterns and the occurrence of extreme events. Observations provide the foundation for developing and testing the Earth-system models and prediction systems that are needed to help us understand our common future.

An important challenge for the Copernicus Climate Change Service therefore is to improve access to observations and to the tools needed to render them useful for climate science and climate services. A dedicated Climate Data Store is being developed for this purpose, with a catalogue that includes in-situ observations, measurements from space, homogenised and reprocessed climate data records, model-based climate reanalyses and information about data quality and uncertainties. The reanalysed data sets, constructed by combining climate observations from multiple sources with state-of-the-art models, provide the most comprehensive view of the changing climate. They contain time series of many essential climate variables, pertaining to the atmosphere, land surfaces, oceans and cryosphere, that extend back by decades or more. Continual improvement of climate reanalyses with complete and consistent descriptions of the Earth system at global and regional scales will be key to the success of the Copernicus programme.

O-2232-03

Climate prediction and projections in support of climate services

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One main basic component of climate information disseminated by climate services are future climate predictions and projections. Either used directly or through sectoral impact analyses, future climate simulations are needed to develop adaptation strategies or to evaluate the efficiency of climate policies. Long-term forecasting is already developed at the European and at the international level with some applications that are already useful in different socio-economic fields, like in the energy sector either at mid or tropical latitudes. Climate projections, from global to regional scale, are already feeding services within the context of national climate services all around the world with a very large spectrum of potential applications. We will give some insights on the usefulness of climate predictions and projections within the context of evolving requirements coming from the user community. We will give specific attention on the uncertainty issue with the common practice for climate prediction and climate change projection consisting in using multi-model ensembles of simulations putting some constraints on the climate services construction.

O-2232-04

The impacts of climate change - Sectoral applications

R. Vautard (1)
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Climate change, its current and future foreseenable impacts have been assessed in the 5th IPCC report. Beyond mitigation, necessary to keep climate warming at a manageable level, the report pinpoints the need for adaptation for coping with unavoidable consequences. However most damageable impacts are expected in several decades, which is sometimes too far a horizon, with a number of uncertainties, to easily foresee businesses in a sustainable market for adaptation.

The talk will present exemplified areas where impacts of climate change present sufficient evidence and challenges to be implemented in a public service like de Copernicus Climate Change Service. It will also review, for a few cases, new challenges for science, and the need for even basic science to support climate change services. These exemples will cover classical sectoral areas such as water, energy and health. It will also develop from a few examples how extreme events and their impacts, as a consequence of climate change, and their attribution could, after overcoming several scientific and communication challenges, be fully part of a public climate change service.

The presentation will also develop the challenges for modelling but also for monitoring the earth, and particularly the impacts of climate change.

O-2232-05

How to inform policy-makers ? Supporting and enabling evidence-based policy-making

G. Barker (1)
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As we get closer to the UNFCCC legally-binding international climate change agreement set to be agreed in Paris in December 2016, policy-makers need to be equipped with evidence-based information to assist them in determining future strategies to address climate change challenges.

Developing and improving the science is one thing; making it available to its intended users and presenting it in a format and language which will actually assist policy-making are today's challenges. We have identifies three main areas to discuss:

- Language and visualisation - though the evidence is scientific, the language should be adapted to its intended users -how science-literate are policy-makers anyway?
- How to translate uncertainty in policy-making? One of the UNFCCC core principle is that national governments should err on the side of precaution in the face of scientific uncertainty. How do we justify this approach to citizens?

Policy-making cannot satisfy itself with a 'one size fits all' approach and needs a sectoral approach to help target strategies and policies to each specific industry.

2232-POSTER PRESENTATIONS

P-2232-01

Time course of weather variables in malaria-related mortality in Sub Saharan Africa rural population

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The current and potential future impacts of climate change on human heath have attracted increasing attention in the recent years and it is expected to significantly affect the spatial distribution as well as intensity of infectious diseases. Changes in climate are likely to lengthen the transmission seasons of important diseases and to alter their geographic range, potentially bringing them to region which lack either population immunity or strong public health infrastructures as it is the case in most of SSA.

The relationship between human health and weather conditions has been extensively studied although mostly focused on urban settings. Therefore little is known about the effects and associations between human health and weather conditions in rural populations of SSA hitherto. Studies on these associations are rather limited and scarce due to scarcity of good quality data.

Malaria features among the infectious diseases whose impacts are expected to exacerbate under future climate change scenarios in SSA. However, despite an apparent ostensibly simple association between particular weather conditions and increased abundance of mosquitoes, there still remains a lack of information on the relative importance of the different weather variable in the occurrence of the disease Indeed both the mosquito development and survival as well as incubation period before an infected human develops symptoms of malaria

strongly depend on prevailing climatic conditions. Furthermore there is always a lag time between climate suitability and change in mosquito's population and both the temperature-dependant sporogony within the mosquito and the incubation period in human add an additional complexity and uncertain lag time.

The lagged effects of weather on daily deaths are believed to dissipate with distant lags. However choices of the different lag structure in earlier studies have been usually motivated by model adjustment parameters that reduce serial correlation and confounding.

In this study, we set out to model flexibly lagged effects using fifteen years of weather variables namely temperature and rainfall on malaria related daily mortality counts using distributed lag non linear models.

Distributed lag models (DLMs) allow for a flexible estimation of the time course of the effect size of weather variable over time on the outcome.

The results show a harvesting effect of high temperatures on malaria-related mortality with an increased relative with the rising temperatures; while mortality show a steady and linear increase with high rainfall.

P-2232-02

Modeling of the vulnerability of «biomass energy» sub-sector to climate change in Togo

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Biomass energy accounts for 80 % of total energy consumed in Togo. But its potential decreases exponentially as a result of population growth and the fact that the techniques of production and consumption are still archaic and climate change. The aim of this work is to contribute to the assessment of vulnerability and adaptation to climate change in the sub-sector of biomass energy in Togo by a modeling approach. Specifically, it is i) to study the evolution of the household demand for fuelwood and ii) to analyze the vulnerability to climate change of sub-sector of biomass energy (mainly charcoal and firewood) in Togo. Demand scenarios of fuelwood were developed from the LEAP model. The vulnerability analysis is made by coupling the demands and the potential of fuelwood and by taking into account the parameters of climate change. At the end of this study, it appears that the fuelwood demands evolve exponentially and that the sector is vulnerable to future climate change. In addition, the potential of fuelwood is very deficient compared to the demand for years to come and will be exhausted before the year 2025. The current energy and forestry policies are far from fill this gap.

P-2232-03

Seasonal Rainfall Forecasts and Climate Change Adaptation Among Smallholder Farmers in South West Region of Nigeria

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Climate change is undoubtedly one of the most serious environmental threats facing mankind worldwide. It affects almost all sectors in agriculture (crop, livestock, pastoralism, fishery, etc) due to the high reliance on weather and climatic elements in agricultural practices. In the south west Nigeria, crop production is the dominant agricultural enterprise among smallholder farmers and is the primary means of their food security. This enterprise is currently faced with the challenges of changing climatic conditions. The smallholder farmers in south west Nigeria are highly vulnerable to climate change due to their general weak capacity to adaptation and this vulnerability is worsened by their heavy practice of rain fed agriculture. Recent evidence from the Nigerian Meteorological Agency [NIMET] (2008), indicates that the climate of the south west region of Nigeria is already changing based on the assessment of the climate over the period 1941 to 2000. This is manifested in changes in seasonal rainfall patterns and more unpredictable, severe and frequent extreme events like floods and droughts threatening livelihoods among smallholder farmers in the region. This scenario is having significant impacts on crop yields and product quality as a result of changes in temperatures, moisture, air and soil. To a large extent, the smallholder's farmers in the region have continuously been adapting to varying weather and climatic conditions; however, the increasingly erratic climate variability and the rapid pace of other drivers of change are overwhelming their capacity to adapt. Consequently, the need to explore new methodologies to endure the climate uncertainty and variability in the region have become more critical more than ever before among smallholder farmers. The use of seasonal rainfall forecasts may be an important adaptation to a more dynamic climate as it can provide valuable insight into future weather and climate variability. While seasonal rainfall forecasts can serve as a potential tool for adaptively managing agricultural systems in response to climate change, it is not clear whether smallholder farmers in south west Nigeria are receptive to innovations such as the use of seasonal rainfall forecasts in planning for adaptation activities. This paper evaluates the applicability of seasonal rainfall forecast in climate change adaptation as well as the determinants and constraints to application of seasonal rainfall, forecast in climate change adaptation among smallholder farmers in South West Nigeria. Simple purposive sampling was used to select Oyo State out of six states in the south west Nigeria while agricultural communities that are prone to climate change in the state were also purposively selected. Primary data were obtained from 425 farmers using questionnaires while two Focus Group Discussions (FGDs) were conducted for men and women smallholder farmers in the communities. The data obtained were organized in Microsoft Excel, cleaned and analyzed on the Statistical Package of the Social Sciences (SPSS) using descriptive and inferential statistics while the FGD were content analyzed. Results indicate poor understanding and little or no application of seasonal rainfall forecast in planning for adaptation in the study area. Results further shows that only 12.7 per cent of respondents had access and utilize seasonal rainfall forecast in planning adaptation activities. It further identified the main constraints to the non application of seasonal rainfall forecast to include poor access to seasonal rainfall forecast, lack of information on its content as reported by 49.8 per cent of the respondents. Finally, results show a high positive correlation between usage of seasonal rainfall forecast and educational attainments, income, ownership of ICT facilities as well as membership of local community groupings. The paper calls for greater enlightenment programmes and the integration of local medium in the communication of seasonal rainfall forecast in the region for effective access and utilization of seasonal rainfall forecast by small holder farmers in the region.

P-2232-04

From weather to climate: responding to climate risk across timescales

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Weather and climate risks occur on a range of timescales, from severe weather to extreme seasons to centennial changes, all of which require a response. Over the coming century we will need to mitigate and adapt to these risks, taking into account additional challenges posed by rising population levels, increasing urbanisation and associated increases in demand for water, food and energy.

Forecasts and early warnings are both critical contributors to climate change adaptation across a range of timescales: at decadal timescales, they enable introduction of adaptation policies and planning of major infrastructure changes on appropriate timescales; at monthly to annual timescales, they enable planning of public and business preparedness; at hours to weeks timescales, they enable emergency managers and individuals to protect communities and themselves through defence and evacuation measures.

Recent advances in weather and climate forecasting capability by advanced weather and climate services have shown remarkable skill in providing valuable advice at each of these timescales. They have also demonstrated substantial benefits of working in a seamless manner across these different timescales. Investment in building the capacity of less developed National Meteorological and Hydrological Services to make use of these new advances is a highly cost-effective way of reducing the impact of climate change across timescales.

2233 - Climate Change Adaptation and Disaster Risk Reduction: International and Urban approaches

ORAL PRESENTATIONS

K-2233-01

Linkage between DRR and CCA

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Not communicated.

O-2233-01

PLACARD: building a platform for CCA and DRR cooperation by 2020

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Significant challenges exist towards strengthening the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities for coherent, mutually and pragmatic planning and action. While efforts to increase complementarity continue, much work is still required to coordinate and integrate the two domains. Within the complex landscape of research and policy initiatives of these two areas various international and European efforts have been undertaken to better integrate CCA and DRR, and thus minimize the current and future risks presented by climate change in the context of extremes. Paradoxically, the past decade has seen a major fragmentation of CCA and DRR agendas, particularly at the level of research, policy, knowledge and practices. International frameworks, political processes, funding mechanisms, information exchange fora and practitioner communities have largely developed separately and operated in isolation from one another.

PLACARD is a newly funded Horizon 2020 European project that seeks to support the coordination between these two communities. PLACARD will tackle current challenges by 1) providing a common 'space' where CCA and DRR communities can come together, share experiences and create opportunities for collaboration; 2) facilitating communication and knowledge exchange between both communities; and 3) supporting the coordination and coherence of CCA and DRR research, policy and practice. PLACARD's approach to achieving these goals is to establish a strong and operational network of networks by connecting to existing networks and boundary organisations, to foster dialogue among stakeholders (e.g. researchers, research funders, policymakers, practitioners) engaged in CCA and DRR at the international, European, national and sub-national scales. This overarching network will enable these communities to share knowledge, to discuss challenges and to jointly co-produce options to bridge the gaps they experience. It will support the development and implementation of a research and innovation agenda to make better use of research funding, as well as to develop guidelines to strengthen relevant institutions in their efforts to mainstream CCA and DRR.

O-2233-02

Adoption as Adaptation! Long-term consequences of cyclone disaster in coastal Bangladesh

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Disaster risk reduction strategies and adaptation practices vary from region to region and community to community, for example, the practices of southern part of Bangladesh are different from the northern part. The sustainable disaster risk reduction strategies or adaptation practices of one region may be not be replicable to another region or community but the learnings from each strategies can introduce a new one that is adoptable to the other region. Therefore, this research aimed at to identify the short-term and long-term adopted strategies that are practicing after a devastated cyclone in southwest coastal Bangladesh. It is given that, in coastal areas people live under the constant threats of natural hazards. Thus raise the questions: how they react to the risk of those natural calamities and how they adapt with the adverse situations that derived by those calamities. Particularly, this research has empirically explored community level practices in agriculture, housing, water resources, communication and employment generations in Bangladesh.

The empirical research was designed with a mixed-methods approach: (1) content analysis of face-to-face interview of 145 respondents by using semi-structured questionnaire with selected social groups and their households' assistants; (2) contingent debates concerning the local attitude and perception for the improvement of their livelihood, which was understood as a case-study of livelihood complexities in coastal areas. Therefore, Focus Group Discussion (FGD) was conducted with three different groups: farmers, fishermen and general people. Key informant interviewers (KII) were: chairman of the Union, Upazila Agricultural officer, Upazila Fisheries Officer, NGO Representatives. Sector wise disaster risk reduction strategies and adaptation practices are recognized by the discussion with the FGD participants.

Results show that people have to start cultivating saline tolerant rice and vegetables on raised homestead instead of traditional rice varieties, as a consequences of saline intrusion after cyclone Aila. They were using dripping irrigation methods and rain water harvesting and artificial aquifer tube-well were introduced for water management. Mud wall of the houses were replaced by or even built newly with Goran wood or bamboo sticks. They have to start forming groups to save money for next disaster and taking credit for small entrepreneurship. Due to the crises of fodder, pastureland and freshwater people was forced to rear small animals and birds like sheep, goat and pigeon instead of cow and buffalo rearing. New technology based shrimp farming also has been started.

Besides, an external aid must not be the only solution to increase the coping capacity of a community, and thus to develop a resilient one. Likewise, the measures/strategies are identified that were taken by various actors based on their existing socio-economic conditions and both positive and negative consequences of those adopted strategies are discussed. The pros-and-cons of each adopted strategies states the interests of the different actors behind the respective strategy. It also explore that such adopted strategies in the long-run will be seen as traditional form of adaptation option for them. This study is therefore be of importance for regional planners and policy makers help to develop a comprehensive disaster management plan that is helpful in building resilience in the affected communities.

O-2233-03

Early Warning Systems - seamless between Disaster Risk Reduction and Climate change Adaption

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Our climates change continuously, due both to natural causes and as a result of human activities. There is a growing consensus in the scientific and policy communities that the consequences of worldwide industrialisation and rapid urbanisation are also affecting our climates. Increase in global temperature may have impact on frequency and intensity of extreme weather events, sea level rise, as

well as shortages of food and water, just to name a few examples. Consequences of climate change constitute, under present and future climates, a threat to the more developed countries such as Europe, but even more so an obstacle to poverty reduction and stability in less developed countries. In already fragile regions and countries, climate driven disasters can negatively influence development, security and stability and thus reduce resilience.

Therefore, joint efforts between scientists and policy makers are needed to find feasible solutions to keep climate change within manageable limits, to assess adaptation strategies to minimise negative impacts, and to develop early warning systems to reduce the residual risks associated with extreme weather events. Early warning systems contribute to anticipation of the event, allow decision makers to take appropriate actions to reduce the impact.

The JRC has been developing continental systems for monitoring and forecasting floods, droughts and forest fires which will be illustrated in the presentation: the European Flood Awareness System (EFAS) has been developed since 2003 following the devastating Elbe and Danube floods which highlighting the need for European solutions to be prepared for cross-border events. EFAS provides twice daily information on ongoing and expected floods up to 10 days in advance to the Emergency Response Coordination Centre (ERCC) of the European Commission and the National Hydrological Services. The European Forest Fire Information System (EFFIS), initiated in 1998, aims at providing harmonized information on forest fires in Europe. EFFIS provides the European Commission services, the European Parliament and the forest fire services in the countries with harmonized information on forest fires. Both EFAS and EFFIS have become integral part of the COPERNICUS emergency management service, one of six operational services under the EU Copernicus space programme. Furthermore, the JRC has been developing a prototype of a European Drought Observatory (EDO) which is to providing in pre-operational timely and consistent information on droughts in Europe. EDO allows to monitor, detect, forecast, and assess drought situations throughout Europe, serving as a platform for information exchange between various stakeholders. After all systems have demonstrated their added value for cross-border management of severe events, they are now being expanded experimentally to global scale.

While the focus of the systems is to monitoring and forecast floods, droughts and forest fire events in Europe and globally they also represent a framework for further studies on assessing past and future trends, scenario modelling with regard to different drivers, management plans and potential adaptation measures. By promoting seamless forecasting from now-casting to seasonal and longer time scales the systems can be useful for both climate change adaptation as well as disaster risk reduction at different levels. The presentation will illustrate how these systems, in partnership with leading organisations and international initiatives and programmes, have the potential to contribute to both disaster risk reduction and climate change adaptation studies in a multi-hazard framework.

O-2233-04

Participatory socioeconomic scenario development as building block of a local risk management tool to climate change adaptation - an Alpine test-site in the East-Tyrol, Austria

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In Austria as elsewhere, extreme events such as heavy precipitation, storms, debris flows and floods are expected to show fundamental changes with respect to magnitude, frequency and duration caused by climate change. Today, risks associated with climate change are mostly still understood and analyzed in a sector- and hazard- specific and rarely in a dynamic, scenario-based manner. The project ARISE (Adaptation and Decision Support via Risk Management Through Local Burning Embers) develops a decision support system for climate-sensitive iterative risk management as a key adaptation tool for the local level. One of the building blocks of ARISE are socioeconomic scenarios that capture main features of the future local economy. Regional socioeconomic scenarios are the pillars to identify future climate related risks and thus to shape disaster risk reduction and risk management which support the building of resilience and adaptation capacities at the local level. The scenarios are based on the current state and trends of sector developments in employment and value creation in the test-site City of Lienz and its surroundings in the East-Tyrol. They include drivers such as demography, a story line and a vision into the future. Scenarios were developed using a participatory approach. Participatory approaches are increasingly recognized as an important element of management and decision-making. There are various reasons why to pursue a participatory approach. For instance, problems in today's world are complex and require knowledge from many different domains and disciplines; participation is said to be a process of collective learning that changes the way people think and act. The paper presents results of two socioeconomic scenarios that were developed using insights from stakeholders and decision-makers of the City of Lienz as well as scientific findings from available data sets and the literature, i.e. a "boom" and a "bust" scenario. Categories of drivers of socioeconomic scenarios discussed during the scenario workshop cover inter alia institutions and socio-political frameworks, demographics, production and demand, markets and trade, scientific and technological innovations, and value systems. Based on empirical data on local employment we identified 6 relevant sectors of the local economy with specific trend developments that served as framework to discuss scenarios: 1) infrastructure and natural hazards, 2) tourism, 3) industry and manufacturing, 4) agriculture and forestry, 5) politics and the administration, and 6) health, education and other services. As the City of Lienz is situated south of the main Alpine ridge in the East-Tyrol it is characterized as peripheral region with population loss in the recent past. One of the major challenges for conceiving a "boom"-scenario was thus to imagine the region to become attractive for well educated people. Last but not least, another feature of the participatory scenario workshop was to communicate knowledge from science to local decision-makers. Regional climate scenarios, socioeconomic data and projections as well as a summary of perceived current climate-related risks were presented. The latter were gathered by subjective expert reasoning (personal interviews) with stakeholders from the region. Participation thus incorporated a two-way information exchange, from science to practice and from practice to science. The presentation will finally give a perspective on the development of the climate related risk management tool.

O-2233-05

GIS-based Climate Change Vulnerability Assessment of the Municipality of Del Carmen, Surigao del Norte Province, Philippines

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A GIS-based mapping and assessment was conducted to determine the vulnerability to the impacts of climate change and climate risks of ecosystems, communities, and infrastructure in the municipality of Del Carmen, Surigao del Norte Province, Philippines. The study involved collaboration with bio-physical and socio-economic survey teams in undertaking qualitative and quantitative assessment of resources and their capacities against climate-related hazards. It also included assessment of past and present impacts of climate change vulnerability in the project areas and assessed and prioritized adaptation strategies, and identified gaps/needs in the implementation of the selected strategies.

Approximately equal number of hectares are exposed to either high (6,340 ha) or low risk (6,039 ha) to drought. In particular, Brgy. San Fernando has the largest area exposed to high risk with 1,186 ha of uncultivated lands. For cultivated lands, Brgy. Bagakay has the largest area exposed to high risk with 232 ha. In terms of exposure, Brgy. Mahayahay has the highest with 100% of its land area exposed to high risk. In contrast, Brgy. Caub and Brgy. Lobogon have the lowest exposure to the risk.

Further, analysis shows that around 137 ha of populated areas which is about 1% of the total land area of the municipality of Del Carmen are exposed to very high risk to rain-induced landslide. These areas are mostly located in Brgys. Caub, Mahayahay, Quezon, San Fernando, and Tuboran. Likewise, about 1,644 ha (14%) of unpopulated areas are also exposed to such risk. Further, around 31 ha and 79 ha of populated areas have moderately high to moderately low risk to landslide, respectively. However, it should be emphasized that more than 8,792 ha (71%) have no risk to landslide. Further, the safest area as far as risk to landslide is concerned is Brgy. Del Carmen with virtually no areas exposed to the hazard.

Moreover, around 143 ha (1.1%) of the municipality are exposed to low to medium risk to storm surge. These are obviously confined to coastal areas. Brgy. Del Carmen has the largest populated area exposed to medium risk with 49.3 ha while Brgy. San Fernando has 1,024 ha of unpopulated areas exposed to the same risk. Spatial analysis also shows that Brgys. Concohoy, Lobogon, Mahayahay, Quezon and Tuboran are virtually free from risk to storm surge. The condition is due to the fact that these barangays are mostly located in the higher elevation section of the municipality

2233-POSTER PRESENTATIONS

P-2233-01

A model of choice under uncertainty for flood preparedness intention in Brazil

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This paper performs an econometric analysis based on selected dimensions of the Protective Action Decision Model (PADM) for Brazil. We empirically estimated preparedness determinants by using Seemingly Unrelated Regression models. PADM survey instrument validation was based on Cronbach alpha, inter-rater agreement index, factor analysis, and mean-comparison tests. The PADM was applied to a representative sample of 1,200 households in the municipality of Governador Valadares, State of Minas Gerais. The site was chosen because river floods are recurrent in the area, reaching thousands of households along the river. Its urban environment has undergone dramatic change in the last decades, creating an ideal scenario for flooding: riparian deforestation, river silting, unplanned occupation of riverbanks, and garbage and sewage discharge into the river. In addition to the econometric analysis, event calendar of major floods in the area, also collected in the survey, allows for comparison between intended and actual preparedness behavior. Building on models of private insurance, we provide a theoretical framework stating that risk aversion is a key factor affecting the directions of influence given by the price and resource effectiveness on the probability of adopting preventive behavior. Thus, for a given nominal budget constraint an increase in insurance price could change one's risk aversion, leading to a higher propensity to buy insurance. We found that, under certain conditions on risk aversion, hazard-related attributes (HRA) positively affect propensity to take protective actions. This was confirmed by our regression results. In contrast, resource-related attributes (RRA) positively or do not affect propensity to adopt protective actions. This non-intuitive finding can be justified by our theoretical framework: risk averse individuals would feel relatively deprived with increase in the opportunity costs of action, leading to additional effort to take protective actions against flood hazard. Finally, the impact of HRA was empirically higher than RRA on preventive behavior since the effective cost of preventive actions is low relative to a person's budget constraint. These findings suggest that public action should promote educational campaigns aiming the reduction of subjective uncertainty on resource effectiveness.

P-2233-02

The Power of Communication in Post Disaster Reconstruction and the Implication for RIA: A Cross Country Synthesis

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This research presents a research project funded by International START secretariat, and earlier co-sponsored by International Social Science Council and Integrated Research on Disaster Reduction (IRDR). The project is built on the RIA model developed by Risk Interpretation and Action working group of IRDR and further examines the effects of communication across scales and social entities that might influence personal RIA in the arena of post disaster reconstruction and resettlement phases. The ontology of the conceptual framework pertinent to this project views risk interpretation and decision making as dynamic and interactive. Based on the rationale, we develop an analytical framework to investigate the higher level of legislative, institutional and political structures that determine the scope of engagement and the relationships among the governed stakeholders in the policy making processes, with the lower level of norms and values that not only frame the essence of the society but also inherent in the personal interpretation about certain risk of interest. We also examine the factors addressed in RIA model in the cross scale communication dynamism. A three-staged hierarchical research design is thus developed corresponding to these research inquires in the case studies across five countries, namely Taiwan, Philippines, Uganda, Honduras, and India. The research results of the cross country synthesis are displayed at governmental and institutional level and at the community or individual level that finally come along with the provisional pathologies for analyzing communication influences throughout the processes.

At the governmental and institutional level, it is found that the robustness of the legislative and institutional framework to regulate engagement and participation of civil society is fundamental for strengthening the influences of communication on policy making. Taiwan and Philippines, followed by India, have shown the higher standard of the trajectories, while Uganda and Honduras display weak or absence of the related legislation and thus the least strength of communication waged with higher social conflicts and instability. At the community and individual level, the RIA factors are examined including experiences, trust, culture, social norm, rational choices and uncertainty. Dramatically this research finds that risk interpretation and decision made for taking action are two different things. The interpretation of risk has deep rooted in the population's cultural basis, which is not easy to be changed. Moreover, people's decision for risk reduction does not singly reflect their interpretation of the certain risk of the physical hazard as narrowly defined by scholars or experts; it actually builds on the interpretations of enormous uncertainties relating to any socio-economic and cultural changes following the possible action. Thus risk interpretation is multidimensional, reflecting people's social, cultural and institutional embeddedness, far beyond the theoretical debates between rational or irrational discourses. The decision made for taking certain action usually reflects the net outcome of factor competitions behind the embeddedness. Communication thus brings imperative functions for sharing the interpretation of the risks and the concerned uncertainties; and obviously as revealed in the study, shared rights for local people to participate in the policy making processes could bring positive effects on formulating more desirable and acceptable policies for post disaster reconstruction and resettlement that would reciprocally influence personal decision making towards a more mutually desirable solution.

P-2233-03

Modelling Agricultural Risk in India from an Insurance Perspective

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After China, India is the second largest agriculture producer globally where over 120 million farmers with an average farm size of only 1.3 hectares produce a large variety of crop types in two main growing seasons. With only 30% of the arable land being irrigated, India's agriculture sector relies heavily on the timely onset and spatial distribution of monsoon rainfall for successful cultivation of summer (Kharif) crops. Breaks in monsoon rainfall can trigger severe droughts as experienced in 2002 where rainfall deficits reached 21% over the growing season and a drop of 18% in nationwide grain production resulted. Conversely, particularly active periods within the monsoon can lead to flood damage to Kharif crops. The winter (Rabi) crops are sensitive to prolonged cold spells, frost events and abnormal heat.

As part of measures to cope with severe droughts, cyclones and floods, the Indian government has implemented and supported a variety of national crop insurance programs which entirely rely on weather and yield indices. The current insurance schemes include the Weather Based Crop Insurance Scheme (WBCIS) and the yield-based modified National Crop Insurance Scheme (mNAIS). With the anticipated growth, annual agriculture insurance premiums are likely to reach USD 1 billion making India the third or fourth largest agriculture insurance market globally.

With the increasing complexity of the weather and yield indices pricing WBCIS and mNAIS portfolios has become a challenge for insurers. Key constraints for robust risk modeling and exposure management are i) the lack and accessibility of weather station data and ii) the short and often incomplete time series of historical yield data which often show strong trends depending on the crop type, region and season. For mNAIS, insurance terms are based on only 11-15 years of historical yield data and payouts are triggered if actual yields are 10%-20% below expected (insured) levels. In areas where larger yield shortfalls have not been observed in the last 11-15 years, insurance terms might not adequately reflect the risk potential, especially for systematic events such as droughts, floods and cyclones. Based on the short historical time series, extreme events such as the 1987 or 2002 droughts cannot be consistently assessed and insurers are concerned about spatial correlations of such events and resulting financial losses.

This paper presents results of research undertaken by Asia Risk Centre to assess insurance losses of mNAIS portfolios in India. A crop model is developed using key parameters such as high-resolution gridded weather data, soil types and structures, slope coefficients, irrigation levels and crop-specific growing season parameters. To generate synthetic yields for the last 45 years the model is then driven with historical climate variations. The model resolution is set at 25 x 25 km which approximately corresponds to a sub-district ("block") on which triggers for mNAIS insurance products apply. Following market practice, other insurance terms such as premium rates and indemnity levels are used at a district level. The synthetic yields are processed to calculate insurance losses to mNAIS portfolios after consideration of original policy terms and conditions.

This paper reveals how synthetic yields allow a quantitative and robust assessment of i) the profitability levels of a given mNAIS portfolio and growing season and ii) the expected losses from historical extreme events such as the 1987 and 2002 drought events. Synthetic yields of wheat and rice in Uttar Pradesh are compared to historical to determine the model's ability to accurately represent climatically-driven variability in yield. Further, outputs of crop models in general are discussed in terms of benefits for the insurance sector including improved risk assessment, risk pricing, risk transfer and risk management and how simulated weather events can be used in crop models to generate several hundreds of years of synthetic yield series.

P-2233-04

Government-NGO Collaboration for Disaster Risk Reduction in India: A SWOT Analysis

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Effective and meaningful collaboration between the two stakeholders: Government and Non-governmental Organizations (NGOs) is imperative to attain the goals of Disaster Risk Reduction (DRR). The involvement of NGOs in all phases of DRR programmes is very crucial because of their grass-root presence and community-focussed approach. Literature documents GO-NGO partnership is a harmonious and constructive approach with mutual respect and recognition based on four aspects such as co-operation, co-option, complimentary and confrontation (UNESCO, 1989; the World Bank, 1990; Nazam, 1999). Though lots of studies have been carried out on GO-NGO collaboration, but on the aspect of disaster management is not explored much. Over the last couple of years, a paradigm shift in the approach to disaster management has been carried out by the Government of India. National policies and Acts like Disaster Management Act, 2005; the National Policy on the Voluntary Sector, 2007 and National Policy on Disaster Management, 2009 emphasize the proper coordination of actions of Government and Non-governmental Organizations in a holistic and proactive manner. However, the study is an attempt to identify the Government and Non-governmental Organizational relationship in disaster risk reduction programmes particularly at district and panchayat level. To accomplish this objective, this study has attempted to find out the answers of certain questions like i) how far the existing GO-NGO collaboration is effective in managing disasters, ii) what are the strengths, weaknesses(internal factors), opportunities and threats (external factors) affecting to achieve the policy-goals of DRR.

In this paper, the study was carried out in Balasore and Kendrapara districts of Odisha, India which are more prone to disasters like floods. Respondents from both Government Organizations and NGOs engaged in disaster management directly or indirectly were interviewed in order to have broader views and opinions on policy matters, problems and potentials and to evaluate their roles in that particular area. Open and close- ended questions were used for this purpose. A SWOT analysis was used to focus on the strengths and weaknesses of collaboration in relation to efficiency, capacity building, quality and accountability. The study found that the effective collaboration is lacking between Government and NGOs at local level. Majority of the respondents were not satisfied with the existing mechanism of collaboration because of more control and authority over NGOs. There is irregularity of interaction between Government officials and NGOs which makes the collaboration weak. It is recommended that mutual respect, trust, transparency and accountability should be present between both the stakeholders.

P-2233-05

Community based disaster risk reduction practices in Bangladesh

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Bangladesh is one of the most disaster prone countries in the world. Conversely, this country has proven superb experienced for disaster risk management as the disaster and relief ministry of Bangladesh has envisaged long term risk reduction strategy through community involvement instead of relief distribution. To explore the best practices for sustainability of community based disaster management (CBDM) in Bangladesh is the prime aim of this study. Qualitative approach was adopted to conduct the research. The activity of Disaster risk reduction and emergency management is managed and implemented by disaster management regulatory framework. The active bottom to top level disaster management committee (DMC) headed by elected person in every administrative tier is the main actor for disaster management. According to disaster order, the local level DMC develops risk reduction action and disaster management plan periodically with community involvement aiming to reduce risk during disaster cycle. Following this, district level Risk Reduction action plan and contingency plan has developed and implemented with the active people's participation and then incorporation Disaster Risk Reduction (DRR) into sectoral and local level development plan. Local level disaster management fund creation is another milestone for effective local risk reduction and emergency management. It is also found that the people are placed

in central for planning, implementation and monitoring in the risk reduction interventions which creates community ownership and it increase their resiliency to disaster. Social, economic and environmental considerations are also focused in the CBDM. Disaster management network and information center, DRR issues incorporated into text books, school based preparedness programme and capacity building of different stakeholders are the major ongoing initiatives to enhance knowledge and skills for CBDM. In conclusion, community involvement in both software and hardware DRR interventions make sure the sustainability of CBDM in Bangladesh.

P-2233-06

Multi-Hazard Early Warning Systems for Effective Disaster Risk Management

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Every year, disasters related to meteorological, hydrological and climate hazards cause significant loss of life, and set back economic and social development by years. Over the past decade (2005-2014), 3 253 hydrometeorological hazards were reported around the world, resulting in 283,035 deaths and economic losses amounting to US$ 983 million. From 1970 to 2012, storms and floods accounted for 79 per cent of the total number of disasters due to weather, water, and climate extremes and caused 55 per cent of lives lost and 86 per cent of economic losses, while droughts caused 35 per cent of lives lost. Climate change is exacerbating the impact of hydrometeorological hazards and compounding disaster risk. Disaster risk reduction is one of the effective ways of climate change adaptation.

According to the Hyogo Framework for Action (HFA), effective disaster risk management calls for a paradigm shift from emergency response to a more proactive, holistic and systematic approach with strong focus on risk reduction. This paradigm shift requires meteorological, hydrological and climate services to support science-based risk management decisions, as well as investments in Early Warning Systems (EWS) which are well recognized as a critical life-saving tool for floods, droughts, storms, bushfires, and other hazards. The National Meteorological and Hydrological Services (NMHSs) who are members of the World Meteorological Organization (WMO) made considerable advances in EWS in the recent years, which are characterized by better observation and monitoring of hazards and improved forecasting and warning services. Also, risk assessment and hazard mapping have been of assistance in development planning and increased the awareness and understanding of risk by the people. However, the societal benefits derived from this progress in EWS have been uneven among countries and communities. Significant gaps remain, especially in servicing the grassroots communities and benefiting poor and vulnerable families.

The global changes in societal structures, rapid urbanization, growing exposure of populations and assets, and climate change, altogether result in a highly dynamic and complex state of disaster risk. This situation, together with the increasing globalisation of risk, calls for strengthened EWS at all levels. It also calls for an integrated and holistic approach to early warnings for multiple hazards and risks tailored to user-needs across sectors. In this regard, international and regional collaboration as well as multi-stakeholder partnership at all levels is critically necessary, given the borderless nature of most natural hazards.

At the Third United Nations World Conference for Disaster Risk Reduction (WCDRR), Member States of the United Nations, through the post-2015 framework for Disaster Risk Reduction (DRR), agreed on the necessity of enhancing multi-hazard early warning systems (MHEWS). In response to this call, the multi-stakeholder partnership - International Network for Multi-Hazard Early Warning Systems - is forged to facilitate and make available to governments and key stakeholders the necessary technical support for strengthening MHEWS as a national strategy towards building disaster and climate resilience. The network embodies the commitment of its partners to act and work together in advancing MHEWS and to foster multi-stakeholder partnership in DRR for promoting societal resilience. A comprehensive description of the International Network and its operational procedures to promote effective disaster risk management are presented.

P-2233-07

Hurricane Sandy and the Prospects for Climate Resilience and Transformative Adaptation in New York's Jamaica Bay Urban Communities

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Climate change resilience and transformative adaptation requires a greater understanding of how current extreme events influence local and regional development trajectories. Within the New York-New Jersey Metropolitan region, Hurricane Sandy and the immediate response to the storm have created conditions for a potential large-scale transformation with respect to settlement of the coastal zone. While the vulnerability of this region to climate change has been well-documented, Sandy's impact has placed this issue into the forefront of public and private discussions about the appropriate response at every level from individual homeowners who are contemplating whether and how to rebuild after devastating losses, to small coastal municipalities which are considering construction of protective engineering structures and changes in zoning laws, to the City of New York, the states of New York and New Jersey, and the federal government which are engaging in discussions about how to better protect the region's population, property, and vital infrastructure from future storms. These discussions are particularly complex given that they are now beginning to be discussed within the context of emerging and potentially intensifying climate change.

This paper presents results of a research study that entailed documentation of the initial phases of a transition in coastal communities and neighborhoods in the Jamaica Bay region of New York City that were heavily impacted by Hurricane Sandy's storm surge and flooding. Drawing upon results of stakeholder and community-based organization interviews, we explore: 1) evidence of socio-ecological system stress and crisis; 2) associations between stress and crisis, the resilience of local stakeholders, and shifts in system-level equilibria; and 3) cross-scale connections between stakeholder responses, socio-ecological system transitions, and broader-scale, community level transformations. The results indicate the conditions of resilience practice and tranformative adaptation are highly contested and spatially and societally uneven. This unevenness reveals emerging equity and justice implications within and across the impacted communities.

2234 - Building Resilience to Climate and Weather Extremes: Sustainable Solutions Grounded in Socio-Cultural Context

ORAL PRESENTATIONS

K-2234-01

The Contribution and Centrality of Indigenous Knowledge Systems to Developing Sustainable Adaptation Strategies

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All over the world, communities that contributed least to the increase in greenhouse gas concentrations are facing their harshest impacts. At the vanguard of climatic variation are indigenous communities at high altitudes and latitudes as well as coastal regions. Increasing climate variability

means that these communities cannot simply adapt to a 'new normal'; they must prepare for a broader range of possible conditions and patterns. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change identifies the urgent need to 'downscale' climate model projections in order to anticipate climate change impacts. The difference between predictive capacity and anticipatory capacity is that the former presumes knowledge of future outcomes whereas the later involves being prepared for the future under varied outcomes. Developing anticipatory capacity of communities drastically affected by climate change is not only an intellectual challenge but an ethical imperative.

Applied transdisciplinary research is best suited to meeting these challenges. This means active engagement of the biophysical and social sciences as well as the humanities with indigenous knowledge. Indigenous knowledge not only contributes valuable context-specific insights but also facilitates the mooring of adaptation strategies within the local sociocultural and ecological milieu. The cornerstone to resilience is socioculturally and ecologically grounded approaches to climate change adaptation. These approaches contribute to long-term sustainability and dynamism of collaboratively generated knowledge and solutions.

In this presentation, we will illustrate how ecological calendars represent such a collaborative transdisciplinary approach to anticipating climate change in the Pamir Mountains of Central Asia. Calendars are knowledge systems humans use to synchronize activities with seasonal changes in our habitat. Calendars are essential to food systems, because hunting, fishing, gathering, producing crops or rearing livestock all depend on the ability to anticipate patterns of temperature and precipitation and plan accordingly. Ecological calendars are based on phenological indicators, such as the last day of snow cover, the first flowering of a plant, the emergence of an insect, or the arrival of a migratory bird. By keeping track of time in relation to such events, communities are better able to align their livelihood activities with the weather. Ecological calendars could play a critical role in building anticipatory capacity for climate change, because they are able to account for new trends and variability. Furthermore, they are grounded in local ecological knowledge and embedded in cultural values.

K-2234-02

Title not communicated

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Abstract not communicated

K-2234-03

Economic Resilience to Natural Disasters: Application to 87 Countries and Mumbai

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With disaster losses increasing globally, it is ever more important to measure the ability of a country or city to cope and recover. This ability, often termed "resilience", is complex. At its core, resilience is about the welfare loss from a disaster, and how to reduce it (i.e. increase resilience). In this paper, we estimate welfare impacts (and resilience) of 87 countries to a flood/storm that affects 1% of the population. Our contribution is that we account for distributional impacts, examine outcomes, and that our paper is based on a welfare analysis. We develop a model which includes the hazard, exposure, and vulnerability, and also the impacts on household assets and income, and the ability to bounce back (or be trapped). Economic resilience for each country, as we calculate it, is the ratio of a "reference" welfare loss (e.g., in a country with no inequality and with perfect loss sharing) to the welfare loss from a flood/storm. We also go beyond assessing resilience and evaluate a series of country-specific policy options (e.g. reducing exposure, increasing social transfers) and the benefits each policy produces (in terms of increasing resilience). All data used is open-source and our methods fully transparent. The approach is also validated ex-post using detailed data after a specific event, the 2005 floods in Mumbai.

O-2234-01

Resilience to extreme weather: using science to inform policy

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Extreme weather can have a devastating impact on people's lives and livelihoods. It represents a major obstacle to development, often preventing people from escaping poverty or pulling them into it. Societies are not well adapted to the extreme weather being experienced today. Compounding this, future climatic and demographic changes will increase the exposure of people and their assets to this threat.

In this presentation, Professor Georgina Mace CBE FRS will outline the findings of the Royal Society's 'Resilience to extreme weather' report (see royalsociety.org/resilience). The culmination of 18 months' evidence gathering and analysis, this policy report examines not only the risks posed by extreme weather, both now and in the future, but also the range of ways in which people can adapt and become more resilient to these risks.

Resilience-building solutions range from specific physical defences (ecosystem-based approaches, engineered approaches, and hybrids of the two) to more general principles and processes for building resilience globally, nationally and locally.

The use of scientific evidence to inform which solutions are most appropriate in which circumstances is crucial. In the context of this year's international agreements on disasters (March), sustainable development (September) and climate change (December), ensuring that efforts to build resilience are joined-up across different policy frameworks is also important.

2234-POSTER PRESENTATIONS

P-2234-01

Climate Change Resilience and Vulnerability Analysis of Indigenous Community in Western Himalaya

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Present research is an attempt to investigate the impact of microclimate change on agro horticultural crops, water supply and vulnerability of livelihood security among the local community in Upper Beas Basin of Western Himalaya. Study is based on both the Primary as well as Secondary sources of data. To collect the primary data, twenty two hamlets of the Valley between the elevations of 2000-3000 meters were surveyed on the basis of Stratified Random Sampling (SRS). Two hundred questionnaires were fulfilled along with the physical investigations of quality and quantity water and land use changes between 1954 to 2014. Attempt has been made to assess the changes in food availability, quality and quantity measurement and analysis of changes in method and mode of food supply. At the end, effort has been made to analyse future vulnerability and changes in the nature of occupations and household economy due to local climate change.

The research findings highlight that the number of livestock has been increased in the valley, while the areas under grazing land has been reduced. This is because of the privatization of the land and closing the forest area. Consequently more pressure has been exerted on agricultural land. The number of households of the nomadic herders has been considerably reduced, as the new generation is migrating towards plain for job in metropolitan areas like Delhi and Mumbai. Agricultural practices have been shifted upwards 400 meter to 1000 meter between 1954-2014. Another finding highlights that there were less than 10 hotels in Manali in 1975, which has increased to more than 1500 in 2014. Land Use Land Cover Changes, Urbanization and vehicular pollutions are the principal factors for local climate change. Growth of

Tourism based urbanization has taken place on agrarian land in the Himalayan geosystem is economically lucrative today, but can pose a risk of food crisis tomorrow as non agricultural uses of the land is increasing in the interest of the outside population on the cost of the local farmers. A planned land use from the government is of dire need to save the livelihood security and vulnerability of food supply to the local community of the Western Himalaya.

P-2234-02

Public policies and risk management in extreme hydrological events in Southeast Mexico

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Extreme hydrological events have already jeopardized development in Southeast Mexico. Their economic impacts have been regularly assessed and exceed by far any other socio-economic aspect. A clear example may be found in the floods that affected the State of Tabasco in October-December 2007, when nearly one million inhabitants -more than half the State´s population- was severely affected, and 80% of Villahermosa, the capital city, was underwater. Attribution issues- natural variability / climate change superimposed effects- remain uncertain, but some statistical data, some of them included in this presentation, point at the increasing relevance of anthropogenic factors. Not only the vulnerability of socio-environmental systems has been aggravated, but the hazards themselves are apparently gathering momentum. Current public policies dealing with risk management are considered now inadequate, and will be even more defective as climate change progresses.

This contribution focuses on these policies, which neglect to a large extent the preventative measures and adaptation approaches. It includes a comparison between the expenditures from FONDEN (Fondo de Desastres Naturales) and those from FOPREDEN (Fondo para la prevención de desastres naturales). Land use planning tools are also questioned in terms of their effectiveness. An in-depth revision of the risk management policies, that should pave the way for new systemic approaches, will be spurred by an increasing recognition of climate change as a process that brings about a new sense of urgency.

P-2234-03

Cost-benefit analysis of flood resilience strategies to cope with global change impacts. Application to the Barcelona case

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Urban areas are, due to the concentration of population and economic activities, one of the most sensitive regions to natural hazards. This work presents the results of a flood damage assessment taking into account the effects of drivers such as socio-economic trends and climate changes. This work is part of the FP7 CORFU project (Collaborative Research on Flood Resilience in Urban areas) focusing in the Raval district of Barcelona.

The first stage of this work consisted on creating a detailed flood damage assessment for the case study area. The implementation of a new 1D-2D coupled model was used to obtain flood depths (Russo et al., 2014), and new stage damage curves were developed to estimate the direct tangible damages (Velasco et al., 2015a). The curves were validated using data from surveys and actual reported damages to the Spanish re-assurance. Then, combining the hazard and vulnerability levels by using a GIS-based toolbox, the expected annual damages (EAD) of the area was obtained. This enables the determination of the critical points of the district in terms of flooding impacts, and highlights the need to implement strategies to cope with these impacts.

For a time horizon centered in the year 2050, several future scenarios of climate and socio-economic changes were created. Using the previously developed tools, the EAD values of the several future scenarios were obtained for the Raval District (Velasco et al., 2015b). The comparison between future and current damages presented increase ratios that ranged between 1.5 and 4. This highlighted the need of implementing adaptation strategies to cope with possible future impacts.

Finally, different measures were modelled so the corresponding damages could be calculated. Three different levels of adaptive capacity were studied:

- Low: measures implemented should be non-structural, and only focusing on vulnerability and risk reduction. In this case, local protection measures (flood board) linked to an early warning system were analysed
- Medium: it consists of SUDS (Sustainable Urban Drainage Systems), and specifically green roofs
- High: it considers classical structural measures, which were 6 new pipes upstream the Raval district, and one storage tank in this area

By undertaking a cost-benefit analysis, the effectiveness of the strategies was assessed, and a prioritization of the most adequate ones for each scenario was done.

The non-structural strategies presented higher net benefits than the structural ones, due to their low cost. However, the structural strategies could better cope with flood impacts, but at higher costs. Nevertheless, the economic benefits of these strategies were only related to the Raval District. By extending the domain analysed, the results would be different.

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P-2234-04

Medium-term effects of early-life weather shocks on cognitive and health outcomes

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This paper investigates medium-term consequences of negative weather extremes experienced during early stages of life on children's physical and cognitive development. In rural, rain-fed agricultural settings, rainfall shocks are often cited as the most important risk factor faced by households (Progresa-Mexico 1998-99; Fafchamps et al. 1998; Gine, Townsend and Vickery 2008). Young children and pregnant women represent particularly sensitive populations to events of this nature.

The idea that stimuli or stressful conditions during critical periods in early life can have lifetime consequences is well established in developmental biology (Barker 1998). Previous work in the economics literature has also shown how pervasive conditions (e.g. malnutrition, sickness, pollution, etc.) in-utero and during the first years of life have considerable long-term consequences. Some of these studies identify effects of early life conditions on outcomes at adulthood, such as income, health, educational attainment, and physical and mental disabilities (Alderman et. al. 2003; Almond 2006; Almond and Mazumder 2011; Maccini and Yang 2009). In this study we shed light on medium term impacts: test scores for language development, working and long-term memory, and visual-spatial thinking provide information about specific dimensions of cognitive development. This information, added to objective anthropometric measures (like height and weight) and gross motor skills, has been

proven as a strong predictor of success later in adulthood (Case and Paxson 2006; Grantham-McGregor et al. 2007).

El Nino Southern Oscillation (ENSO) is a recurrent climatic event that causes severe weather shocks. This paper employs ENSO-related floods at the end of the agricultural season to identify medium-term effects of negative conditions in early child development (in utero and up to two years of age). The socio-economic and health data used in this study comes from a rich longitudinal household dataset gathered as part of Mexico's PROGRESA randomized poverty alleviation program. This database is exceptional for size and data quality and data includes valuable information for children aged 2 to 6, namely, specific indicators of cognitive development, motor skills, as well as objective anthropometric and health indicators.

Our analysis shows that, four to five years after the shock, children exposed to floods in early life have test scores in language development, working-memory, and visual-spatial thinking abilities that are 11 to 21 percent lower than same aged children not exposed to the shock. Negative effects are also found on anthropometric characteristics: children exposed in early life exhibit lower height (1.07 to 1.803 cm), higher likelihood of stunting (11 to 14 percentage points), and lower weight (0.381 kg) than same aged children not exposed to the shock. Negative effects of weather shocks on income, food consumption, and diet composition during early childhood appear to be key mechanisms behind the impacts on children's outcomes. Finally, no mitigation effects were found from the provision of the Mexican conditional cash transfer program Progresa on poor rural households with children exposed to ENSO-related shocks. This might suggest that children were not prioritized in distributing resources within the household or that the cash transfer was not sufficient to buffer the liquidity constraint faced by the household and generated by the weather extreme.

Climatologists indicate that ENSO cycles will continue to affect global climate, and events might become more frequent and intense with global warming (Vecchi and Wittemberg 2009). ENSO-related studies are therefore relevant from an economic, climatic, and public policy perspective. To the authors' knowledge this is the first study to investigate the impact of ENSO-related weather shocks on human capital formation. More broadly, this study represents an important test bed to further understand the possible impacts of weather extremes associated to climate change on human capital formation (i.e. child cognitive and physical develpment). These types of impacts are still vastly underestimated in the economics literature.

P-2234-05

Early warning systems for climate related extreme events: The development of an ICT based multi-hazard and multi-sector early warning platform in Kenya

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The Fifth IPCC Assessment Report on climate change shows that the frequency and/or intensity of different types of weather extreme events is likely to increase in a number of regions across the globe. Additional pressures on socio-economic and environmental systems due to population growth, rapid urbanization, conflicts and environmental degradation, particularly in developing countries, are likely to further increase the vulnerability of populations and to exacerbate the risks of severe impacts from climate hazards. Early Warning Systems (EWS) form an important part of national disaster risk management (DRM) strategies and are important to protect communities against the immediate threat and consequences of climate-related extreme events.

However, although great efforts have been made to improve EWS worldwide, many of the existing systems have important shortcomings: Often, EWS focus on one hazard type only, ignoring interactions between concurrent hazards. Many fail to provide estimates of climate impacts in a standardized way and taking into account all sectors that are vital to the functioning of societies and relationships between sectors. Furthermore, the communication of warnings is not always adequate, either by not reaching affected populations or by not providing timely and reliable warning. Finally, in many cases early warnings are not sufficiently linked to rapid response measures.

The aim of the United Nations Environment Programme's CLIM-WARN project was to review the current state of multi-hazard Early Warning Systems in three African countries (Kenya, Ghana and Burkina Faso), to identify capacity gaps, to assess the needs of vulnerable communities, to review best practices for early warning communication and response and to develop a set of recommendations for decision makers to improve existing Early Warning Systems which are applicable beyond the case study countries. An important gap that was identified by stakeholders is the lack of a central platform which integrates hazard warnings from relevant national agencies and provides a visual interface for accessing hazard risk data and which facilitates the communication of warnings to vulnerable groups. These findings resulted in the development of a prototype of a multi-hazard and multi-sector Early Warning Platform in Kenya, building on collaborations with partners and using information and communication technologies (ICT). This talk will present the methodological framework which underpins the development of this prototype platform and will demonstrate the web-based tool which integrates hazard data from different data sources, automatically calculates hazard impacts and disseminates subscription-based warnings and response recommendations to users, based on their data needs and preferred communication channels.

The combination of multiple forecasting datasets in one platform has several benefits: It ensures a comprehensive assessment of impacts in all major sectors, taking into account relationships between hazards and sectors; it facilitates the creation of integrated response plans and the exchange of data and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness. Remaining gaps and challenges are related to data availability and accuracy as well as to the creation of a national, legislative and institutional framework with clear roles and responsibilities. The development of an Early Warning platform requires strong partnerships with and the support of regional, national and subnational governmental and non-governmental institutions to ensure that the platform will be used by disaster managers in the long term.

2235 - Reinforcing Resilience

ORAL PRESENTATIONS

O-2235-01

Tree-based energy for resilient livelihoods and ecosystems under climate change in Kenya

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Kenya has a population of 39 million people with 68% of the population living in rural areas and half of her population lives below poverty line. Kenya has a land area of 580,728km out of which approximately 85% is arid and semi-arid land (ASAL) and support 30% of the population and 70% of the livestock production. Agriculture is the backbone of the Kenyan economy directly contributing 24% of the GDP valued at KSh342 billion in 2009 and another 27% indirectly, valued at KSsh.385 billion. The country is experiencing climate-related impacts such as prolonged droughts, frost in some of the productive agricultural areas, hailstorms, extreme flooding, receding lake levels, drying of rivers and other wetlands, leading to economic losses and environmental degradation. For instance the floods of 1997/98 affected 1 million people

and cost the economy US$ 0.8-1.2 billion.

Trees provide various ecosystem services that build resilient social-ecological systems through (i) providing biological products such as fruit, browse for livestock, medicines for human and livestock, oils, construction materials, woodfuel and gums and resins, (ii) supporting services of soil fertility management, soil moisture and biodiversity, (iii) regulating services on macro and micro climate, air quality, soil erosion and water regulation and (iv) cultural services. The loss of trees under climate change is of great concern to the country which has retained only 2% forest cover.

One of the drivers of tree loss is the unsustainable woodfuel sector. Over 80% of households in rural areas and 70% of households nationally depend on firewood. Charcoal ranks second as a source of cooking energy in Kenya and is used by 82% of urban and 34% of rural households; and most of it comes from the drylands. Trees on-farm provides cooking energy hence saving women and girl's time and drudgery in traveling long distances in search of firewood and reduces household expenditure. Recycling organic by-products into briquettes generate income and employment for women and youth and the product burns cleaner and longer. Improved cook stoves generate income from sales of stove, save fuel and time, reduce emissions and some produce charcoal as by-product. As such scaling-up the following local innovations will reinforce resilient livelihoods and ecosystems through tree-based energy; (i) wood energy production through short rotational forestry, farmer managed natural regeneration, coppice management, intercropping trees with crops or pasture, (ii) briquetting agricultural, tree and municipal organic by-products, (iii) improved cooking technologies (iv) large-scale gasification of biomass, for instance of invasive tree/shrub species, for electricity production and briquetting of by-product -charcoal dust and (v) policy framework that supports and creates awareness on growing of trees for energy and resilient livelihoods and ecosystems and regulate tree-based energy trade.

O-2235-02

A Community based initiative of afforestation for charcoal production: Case study Siaya County, Kenya

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It is estimated in Kenya that about 90% of rural households use fuelwood either as firewood or charcoal with firewood meeting the energy needs of over 93% of rural household, and the charcoal being the dominant fuel in urban households. Besides being the most common cooking fuel for the majority of Kenyan households, fuelwood is also an important energy source for small-scale rural industries such as tobacco curing, tea drying, brick making, fish smoking, and bakeries, amongst others. The principal sources of fuelwood are agro-forestry (84%), biomass in trust lands (8%) and gazetted forests (8%). Kenya is a relatively dry country, with approximately 80% of total land area defined as arid and semi-arid. The current status of much dry land forest resources is the direct result of wasteful practices and degradation, from overgrazing, overexploitation of trees for the acquisition of firewood and charcoal particularly in the close vicinity of towns and refugee camps.

Currently, there is a growing imbalance between supply and demand of biomass energy. In 2012, the firewood and charcoal demand stood at 18,702,748m3 and 16,325,810m3 respectively against an estimated supply of 13,654,022m3 and 7,358,717m3. The principal drivers of biomass energy demand are population growth, lack of access to energy substitutes and the growing incidence of poverty among Kenyans. This biomass energy supply and demand imbalance is exerting considerable pressure on the remaining forest and vegetation stocks, thereby accelerating the processes of land degradation and desertification. In addition, the production of biomass energy poses a threat to competing land use systems such as agriculture, forestry and human settlements.

Initiatives of reforestation and afforestation are being carried out to mitigate this deficit, mitigate the effects of climate change and to raise the total land area in Kenya under forest to 10%. This paper gives the experiences of a community afforestation project in Siaya County that was started in 2002 using Acacia xanthophloea and A. Polyacantha species. Research was carried out on the optimal tree spacing, wood yields, efficient production of charcoal and the optimal age for charcoaling. Spacing trials of 1m X 1m; 1.8m X 1.8m; 2m X 2m; 2.5m X 2.5m, 3m X 3m up to 4m X 2m and 4.5m X 1m were set up. Three efficient charcoal kilns were used (half orange kiln, drum kiln and Casamance kiln) and lastly the optimal age for charcoaling was determined by charcoaling the two Acacia species aged 4 and 6 years old.

The optimal tree spacing (where it allowed selective harvesting - not clear felling) was 2.5m X 2.5m. The total biomass estimation based on diameter and height was calculated as Y= 0.0006x where x is (dbh2 * ht), R2 =0.8374. The optimal age was found to be six years, where the weight of the same volume of charcoal increased by 10kg.

The current estimated area of land under acacia is 240 hectares with an estimated yield of 100 tons of round wood or 30 tons of charcoal per hectare under six years rotation. The number of farmers who have set aside land sizes ranging from 0.5 - 3 acres (0.21 - 1.25 Ha) for wood lots, now stand at 545.

O-2235-03

Are we ready to scale-out climate-smart agriculture in South Asia?

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Recent IPCC report and several other studies indicate a probability of 10-40% loss in crop production in India and other countries of South Asia with increases in temperature by 2070-2100 and decrease in irrigation water unless steps are started now to increase our adaptive capacity. There could be significant losses in some crops such as wheat even in short-term. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves are known to negatively impact agricultural production, and farmers' livelihood. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers. Increased production variability could be perhaps the most significant impact of global impact change. Early signs of decrease in yields due to changing weather have started becoming visible.

Several technological, institutional and policy interventions have been proposed that can help us adapt to climate change as well as to current and future weather variability. These include simple adaptation practices such as change in planting dates and crop varieties. Additional strategies for increasing our adaptive capacity include bridging yield gaps to augment production, deployment of adverse climate tolerant genotypes and diversified land use systems, the use of solar irrigation, assisting farmers in coping with current climatic risks through providing weather linked value-added advisory services to farmers and crop/weather insurance, and improved land and water use management and policies. It is interesting to note that most of the proposed adaptation options, if implemented scientifically, come with large mitigation co-benefits.

CCAFS is scaling out the Climate-Smart Villages (CSVs) model in several countries, including in South Asia, to promote climate-smart agriculture (CSA). Climate Smart Villages are sites where a portfolio of the most appropriate technological and institutional interventions, determined by the local community, are implemented to increase food production, enhance adaptive capacity and reduce emissions. Interventions are bespoke to each village but the concept lends itself to be applied in any region under the right circumstances. Initial results suggest a large potential to maximize synergies among different interventions in order to scale out CSA.

While most of these interventions have indeed shown increased production, resilience and even mitigation, their area coverage is still small. This paper argues that evidence base for many of these interventions is still limited and we need enough context specific targeted knowledge about them before they can be applied on a large scale. In addition, lack of appropriate 'business models' around

these interventions limits scaling-out efforts.

O-2235-04

The impact of bioenergy development on the climate resilience of vulnerable communities in Kenya

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The purpose of this project is to examine whether bioenergy developments have an impact on the climate resilience of vulnerable communities in Kenya. Interviews were conducted with professionals and several projects and programmes were visited on site. The research, based on evidence, shows that traditional use of solid biomass, which is the most popular source of energy in Kenya, is believed to have a negative impact on climate resilience. However, most of the interviews and projects visited have also demonstrated that, in certain conditions and under specific circumstances, bioenergy developments can reveal strong climate resilience characteristics. If they cannot by themselves improve considerably the resilience to climate change, some of them, when combined with measures and initiatives aimed at improving the life of the most vulnerable, do achieve this purpose. This study also demonstrates, once again, how important it is for any project, programme or technology to address the specific needs and tastes of the populations they intend to serve and how engagement, empowerment and ownership by the communities is key to achieve success. A higher consideration and respect for local cultures and ways of living, promoting a grass-¬-root approach, encouraging collective actions through capacity building and awareness raising, and finally providing financial and political support, will help generate more suitable and targeted technologies and programmes, including those related to bioenergy, that would improve the climate resilience of vulnerable communities in Kenya and elsewhere.

O-2235-05

Multiple benefits of biochar: Synergism or trade offs

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Poor soil fertility is a key constraint to improving farm productivity and farmer livelihoods in sub-Saharan Africa. The search for sustainable soil management practices is still on. Biochar, a pyrolysed biomass in recent years has gained international recognition to improve soil productivity.There are however limited research on biochar in Ghana to warrant government policy. A field study was conducted in the major season of 2012 in the semi-deciduous forest zone and the Guinea savanna agroecological zones of Ghana. The objective was to determine soil management scenarios that will enhance the beneficial effect of biochar application to soils. The treatment were control no amendments, 2 t/ha biochar and 4 t/ha biochar. Each main treatment received 0, 30, 60 and 90 KgN/ha. The test crop was maize. 4 t/ha biochar + 90kg N/ha increased maize yield indices across sites. Biochar increased N use efficiency and improved gravimetric soil moisture contents across sites. The synergistic effect rather than tradeoffs of the biochar technology to address energy use of the smallholder farmer through the use of efficient cookstoves, the bio-physical constraints in the context of soil improvements to increase food security, soil carbon sequestration for climate change mitigation as well as the socioeconomic constraints of the smallholder farmer needs to be explored for wider adoption of the biochar technology.

O-2235-06

Moving from climate vulnerability to Resilience: a case study of Bangladesh

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Bangladesh has been identified well over a decade ago as being one of the most vulnerable countries to the potential adverse impacts of human induced climate change . Over the last decade the country has been one of the first of the Least developed Countries (LDCs) to carry out their National Adaptation Programme of Action (NAPA) as mandated by the United National Framework Convention on Climate Change (UNFCCC) as it's 7th Conference of Parties (COP7) held in Marrakceh, Morocco in 2001 under the Marrakech Accords, which provided technical assistance and financial support to the LDCs for carrying out the NAPAs.

Subsequently the Government of Bangladesh built on the NAPA which was only meant to identify urgent and immediate adaptation actions, to develop a more elaborate and longer-term Bangladesh climate Change Strategy and Action Plan (BCCSAP) which has six pillars and forty actions. These actions have been funded by creating two Climate Change funds, one with the Government of Bangladesh's own finances and the other with donors contributions. Both the funds together have now funded over three hundred projects to tackle climate Change . While most of them are adaptation related a a few are also mitigation. Related as mitigation was one of the six pillars of the BCCSAP.

Thus over the last decade Bangladesh, including the government as well as other stakeholders such as civil society, universities, media and private sector have already invested in various activities to tackle climate Change and as a result have climbed up a knowledge ladder that enhances the collective understanding of what is needed. The latest development in this journey of tackling the adverse impacts of climate Change is to focus on Resilince as opposed to Vulnerability, so, while the focus until now had been on identifying vulnerability and helping to build adaptive capacity it has now moved to identifying underlying characteristics of resilience and building on them. This is a much more positive agenda and enables all the relevant actors to focus on their strengths and build on those strengths rather than focus on vulnerability and only invest on risk management alone. This is also in many ways a transition from investing in incremental adaptation to transformational adaptation using the climate change challenge as opportunity.

O-2235-07

Building resilience in dryland Africa

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This presentation outlines IIED's experience on building resilience in dryland Africa. Drawing on a range of field sites, we show the timeframe and process for strengthening local capacity in decision-making, in ways which provide sound public investment choices. Between 1980 and 2012, it is reckoned that the annual damage from extreme-weather related events rose from $20b to 150b, totalling close to US$2 trillion, of which only 1Ž4 was insured. Examples include floods in Bangladesh and Thailand, typhoons in the Caribbean and droughts in the West African Sahel and Horn of Africa. Poor people and nations have been particularly vulnerable to the impacts of these events; people living in countries with a low Human Development Index make up only 11% of those exposed to hazards but account for 53% of disaster mortality.

Even if we manage to cut greenhouse gas emissions rapidly and effectively from today, we must anticipate 20-30 years of growing impacts from climate change due to lags in the global atmospheric system (IPCC, 2014). Drought, floods, and heat waves are all likely to increase in both frequency and intensity. The impact of tropical storms and associated sea surges will be amplified by sea-level rise. Disaster preparedness is key to help minimise loss of life and property, as well as speeding recovery post-disaster. "Resilience" has become a widely used term to describe the quality of human-environment systems and their response to disaster. In the recent study by the Royal Society of building resilience to extreme weather events, resilience is taken as "encompassing more than merely coping with individual extreme weather events; it means looking at the capacity of individuals, communities and systems to not only survive, but also adapt and grow in the face of stress and shocks." While "resilience" has spawned an increasing number of definitions, essentially it refers to our ability to deal with changes, in terms of reducing the risk of a hazard, and minimising the subsequent impacts.

Building resilience to extreme weather needs a systems approach, which involves investing in a combination

of technical, economic/financial, and institutional dimensions. When faced with a threat such as drought or flooding, the first instinct is to invest in hardware – such as dams to capture and store water for dry periods, or sea-walls to protect from floodwater. And such tangible infrastructure is clearly very important. But alongside such investment in the physical hardware of protection, there are a range of vital intangible investments needed in the software of institutions for managing variable resources, and sharing risk. Institutions may be invisible, but their strength can make a big difference in how societies cope with disaster. Building resilience also requires shared action and responsibility at local, national and international levels, by the public and private sectors, local communities and non-governmental organisations. We will use the case of northern Kenya, Mali and Senegal to illustrate this systems approach, and the role that different actors need to play.

2235-POSTER PRESENTATIONS

P-2235-01

Adaptive Resilience as an integrative concept for understanding and managing the response of ecosystems to multiple disturbances and changes

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(1) 10 Integrated Carbon Observation System (ICOS RI), Head Office, Helsinki, Finland; (2) Thünen Institute for Climate Smart Agriculture, Braunschweig, Germany; (3) University of Witwatersrad, Johennesburg, South Africa; (4) Friedrich-Schiller-Universität, Jena, Germany; (5) University of Appleid Sciences, Hamburg, Germany; (6) University of Witwatersrand, Johannesburg, South Africa; (7) Stellenbosch University, Stellenbosch, South Africa

Nowadays, many ecosystems are affected by multiple kinds of disturbances and changes on different time scales: one might be the strong disturbance by land use (e.g. harvest of the woody biomass in forests, grazing) or land use change (mainly conversion to agricultural land); the second, slower and more a change than a disturbance is climate change, caused by rising concentrations of greenhouse gases in the atmosphere (Higgins et al. 2010). Climate change results in a variety of changes in temperature and precipitation patterns, but also higher probability of extreme weather events. These changes may massively influence biogeochemical cycles as well as the balance between species.

Based on this, it can be hypothesized that many ecosystems, even if they are very resilient, may not return to their initial state after disturbance, but will rather adapt to a new steady-state (e.g. associated with the intermediate change in climate). We can name this phenomenon «Adaptive Resilience of Ecosystems». It can be used as a further development of classical resilience concept and use it as base for integrative research and management concepts. This is outlined with the example of semi-arid savanna ecosystems.

P-2235-02

Climate vulnerability of the supply chain: methodological review

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The increasing complexity of the present economic system and the strong interdependencies existing between production activities taking place in different world areas make modern societies vulnerable to crisis. The global supply-chain is a paradigmatic example of economic structures on which the impacts of unexpected events propagate rapidly through the system. Climate change, which affects societies all over the world, is one of the most important factors influencing the efficiency of the present economic networks. During the last decades a large set of studies have been oriented to investigate the direct impacts generated on specific geographical areas or productions. However, a smaller number of analyses have been oriented to quantify the cascading economic effects generated all over the world. The great complexity of the global economic system, coupled with methodological and data gaps makes it difficult to estimate the domino effects of unexpected events. A clear understanding of the possible consequences generated all over the world is, however, a fundamental step to build socio-economic resilience and to plan effective adaptation strategies. Within this context, the main objective of the present report is to provide an overview of the main studies, methodologies and databases used to investigate the climate vulnerability of the global supply chain. This information can be useful to i) support further studies, ii) to build consistent quantification methodologies, and iii) to fill the possible data gap.

P-2235-03

Testing and Piloting Climate Smart technologies in Pastoral and Agro Pastoral systems; The case of Ijara sub-county, Garissa County in Kenya

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Ijara is one of the six sub-counties that form the Garissa County in North-Eastern Kenya; it falls into agro-ecological zone V-VI: temperatures range from 15°C – 38°C and rainfall is bimodal ranging between 700–1000 mm per annum. The average relative humidity is 68%. The sub-county covers an area of 10,000 km², with more than 90% of the land as trust land. The population within the sub-county was estimated at 100,000 during the 2009 national population census, with a population growth rate of 3.7%, while the poverty index stood at 63% with over 90% of households depending on pastoralism. The main economic livelihood of the inhabitants of Garissa County is livestock keeping. The pastoral households face a number of challenges that constrain their ability to employ productive systems effectively. These include among others population growth; the allocation of land for other purposes such as agriculture and wildlife conservancies; inadequate maintenance of infrastructure such as roads and earth dams; poor planning resulting in haphazard creation of water points; insecurity in Somalia; unsustainable management of land, water and other natural resources; and deteriorating livestock management practices. These issues are exacerbated by climate change, which has led to environmental degradation such as loss of biodiversity and soil erosion. Climate change is also a driver of poor resource management, as people resort to increasingly unsustainable coping strategies such as charcoal production to manage recurrent shocks to their livelihoods. To deal with challenges affecting major livelihoods in the county and to reinforce the resilience of the community, the Kenya Agricultural Livestock Research Organization (KALRO) and International Development Research Centre (IDRC) project used various approaches including reconnaissance surveys; Risk and Vulnerability Assessment, including downscaling of climate information; and participatory identification of viable adaptation options. These adaptation options were piloted through farmer field schools. The project also organized field days and exchange visits in fodder production and livestock management as part of stakeholder capacity building, with a mix of adaptation options to establish pastures at the individual farm level. The downscaled climatic information indicates that Ijara sub-county is getting warmer. This coupled with increased climate variability implies that planning for appropriate adaptation options is mandatory. In order to counter the expected loss of livestock and subsequent livelihoods, a mix of adaptation options needs to be put in place in the sub-county. A key option is the establishment of pastures at the individual farm level. Results from the project's fodder component showed that the establishment of rain-fed Sudan grass is feasible as both a short-term and a long term adaptation strategy. The grass is highly adaptable in the region and gave an average yield of 24 tonnes/hectare/year. This can support up to 16 milking cows per year, and so can contribute greatly to food security at the household level. The benefit-cost ratio was 1.25. Socio-cultural and economic changes had negatively affected the traditional livestock management practices e.g. breeding

management. After a series of capacity building initiatives, households started putting in place measures to improve their livestock herd. These included selecting of breeding males and females; castration of excess males; avoiding the use of polled bucks; culling of one testicle males; taking care in the administration of drugs; adoption of camels as opposed to cattle – it was a cultural taboo for them to keep camels despite camels' better resilience to climatic shocks compared to cattle. Study/exposure tours had a strong positive influence on agricultural technology adoption among pastoralists. From the project initiatives, the farmers' ability to perceive climate change and related climate variability was a key precondition for their choice to invest in fodder production and conservation. Demonstration and information allowed the households, and also policy makers, to make rational decisions on investment options.

P-2235-04

Three decades of changes in stream communities of France reveal ecosystem shifts and resilience mechanisms in temperate region freshwater ecosystems

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Global warming is assumed to be a threat to temperate stream biodiversity. Still, many of the processes and mechanisms behind the predicted threats to diversity remain uncertain. We identified current trends and drivers of change for freshwater communities over a large spatial and temporal scale already revealing a strong ecosystem shift.

We analysed diversity and composition shifts in stream invertebrates communities during the last three decades in relation to geographic elements and human stressors over the French river network (circa 1000 km in longitude and latitude). We observed a 42% increase in the taxonomic richness of stream invertebrate communities, largely caused by climate change (23% purely climate–induced taxonomic richness increase). As a local mechanism, a bottom–up food web productivity response to rising temperature was responsible for this strong increase in diversity. Stochastic assembly processes (both environmental stochasticity and dispersal related stochasticity) increased the regional scale diversity, giving spatial insurance to biodiversity and lowering the risks of biotic homogenisation.

Thus, stream invertebrate communities show strong resilience to environmental changes thanks to local and regional responses of productivity changes (resource resilience), and thanks to landscape heterogeneity (refugia resilience) and dispersal processes (recruitment resilience). For the French stream invertebrate communities, up to now the resilience mechanisms seem to outweigh the predicted threats. From this knowledge emerge scenarios that enhance the temperate streams' resilience to cope with further global changes.

2236 - Scenarios, public deliberation and decisions

ORAL PRESENTATIONS

K-2236-01

From scenarios to policy action: exploring transformative climate futures at national and international levels

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Abstract not communicated

K-2236-02

Scenarios Emergent!

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Responding to climate change may require us to imagine future worlds, both good and bad, different than the one with which we are familiar and to take concrete steps now to shift towards more favorable pathways into the future. Scenarios can play an important role in such visioning and action. At their best, scenarios can effectively represent deep uncertainty; integrate over multiple domains; and enable parties with different expectation and values to expand the range of futures they consider, to see the world from different points of view, and to grapple seriously with the potential implications of surprising or inconvenient futures. These attributes of scenario processes can prove crucial in helping craft effective responses to climate change. But traditional scenario methods can also fail to overcome difficulties related to choosing, communicating, and using scenarios to identify, evaluate, and reach consensus on appropriate policies. Such challenges can limit scenario's impact in broad public discourse. In recent years, new decision support approaches employing new quantitative tools, now enable scenarios to emerge from a process of deliberation with analysis among stakeholders, rather than serving as inputs to it. Such approaches can significantly increase the impact of scenarios on decision–making. This talk will survey this emerging field of computer–assisted scenario design, describe some applications, suggest how the underlying concepts can inform a broad range of scenario activities, and help make scenario more impactful in shaping both incremental and transformative responses to climate change.

O-2236-01

Building and analyzing large numbers of socio-economic scenarios for decision support under uncertainty: a modelling experiment to explore the main determinants of economic growth in a carbon-constrained world

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Climate change poses a challenge to traditional decision making techniques due to long time scales, complex systems that couple human, technical and natural elements, and multiple uncertainties. Scenario technique is a key tool for decision making in such context. Here we demonstrate how building and analyzing databases of scenarios that explore the "uncertainty space" can bring novel insights for decision support. We do so in an illustrative study that focuses on identifying the main sources of technological and socio–economic uncertainty for indicators used for policy decision.

The relevant measure for the macroeconomic evaluation of mitigation pathways depends on the question at stake: deciding on the level of mitigation to target or choosing a strategy to meet an already fixed target. Choosing the level of greenhouse gases emissions reduction to target requires balancing mitigation costs against avoided costs from climate change damage. Both costs are usually measured by GDP or welfare losses compared to a baseline – a scenario with no mitigation and no damage. However, whether this balancing approach is appropriate for climate change is being increasingly called into question, in particular because estimates of the damage that can be caused by climate change are highly uncertain and possibly in the realm of the "unknowable". But when the stabilization target is already fixed, the design of the best strategy is better informed by absolute levels of GDP in pathways that meet the target.

We construct a modelling experiment to explore the role of a wide range of socio–economic uncertainties for the two metrics: absolute per capita GDP under mitigation scenarios and GDP losses with respect to the baseline. The modelling experiment takes the form of an analysis

of an ensemble of 648 scenarios, built with an Integrated Assessment Model that represents the intertwined evolution of technical systems, energy demand behavior and economic growth. The model parameters are grouped into six parameter sets: productivity growth in the leading country, productivity catch-up in other countries, energy demand behavior, end-use energy efficiency, availability of low-carbon technologies, and availability of unconventional fossil fuels. Combining alternative assumptions on the values of the parameter sets leads to 216 baselines. For each baseline, two mitigation scenarios are modeled. Both meet an exogenous emissions trajectory constraint leading to a 50% reduction in global emissions by 2050 compared to 2000. They differ in the use of the carbon tax revenues - revenues are either redistributed to households or used to reduce pre-existing taxes.

In the resulting ensemble of mitigation scenarios, we find that GDP losses and absolute GDP are not well correlated and are not determined by the same (uncertain) drivers. We identify the most important sources of uncertainty for absolute GDP in mitigation scenarios and for GDP losses with respect to the baseline, using a regression tree algorithm. We find that GDP losses against baselines are mainly determined by the design of the climate policy and the availability of low-carbon technologies whereas absolute GDP in mitigation scenarios is mainly determined by end-use energy efficiency and energy demand behavior. More generally, our modeling experiment shows that, in a context of uncertainty, GDP losses and absolute GDP are not well correlated and do not give the same insights for policy designs. Realizing the difference is important to focus on the relevant information for each type of decision.

Despite, and because of, the uncertainty surrounding future damage caused by climate change, decision-makers in many places around the world have set mitigation targets in terms of concentration of greenhouse gases or temperature (at the global level), or in terms of future emissions (at national or local levels). They are now designing strategies to meet these targets. In this context where mitigation targets are already fixed, our results challenge the practice of macroeconomic evaluations of mitigation pathways that mainly focus on investigating the role of technological uncertainties for GDP losses relative to baseline scenarios. Instead, analysts and decision-makers should to devote more attention to GDP levels under a carbon constraint on the one hand, and to uncertainties on energy demand behaviors and energy efficiency on the other hand.

O-2236-02

From scenarios to climate action: insights from scenario-guided policy development across six global regions

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Scenarios can be a powerful approach to exploring future climate and socio-economic uncertainties. However, scenarios are not strategies - instead, they provide challenging contexts for decision-making. In the face of pressing policy concerns around climate adaptation and mitigation, the need to integrate scenarios with governance and planning processes is high, and greater understanding is needed about how such links could be made effective.

We present a global research project that evaluates the use of scenarios for policy development in the context of climate adaptation, socio-economic development and food security through six case studies. First, regional scenarios were developed by stakeholders in six global regions: East and West Africa, South and Southeast Asia, the Andes and Central America. Participants used a novel method for the combination of many interacting drivers in the scenarios. The scenarios were then quantified using two global agricultural economic models, IMPACT and GLOBIOM, and linked to the new global Shared Socio-economic Pathways (SSPs). In each of these regions, dialogues with governments led to the identification of a number of specific national policy processes (Cambodia, Honduras, Peru, Bangladesh, Ghana, Uganda) where the process leaders welcomed the opportunity for scenario-guided policy design. For this purpose, those involved in the processes and wider groups of stakeholders used a method for re-imagining the regional scenarios to ensure a perfect fit with policy concerns. These adapted scenarios were used in detailed analyses of the policy drafts, and suggested changes were taken up into new policy drafts and taken forward toward finalization and implementation, supported by the project researchers.

To study these processes, hypotheses about best practice and indicators were formulated with regional partners. Research results show that 1) a focus on specific policies yielded the clearest impacts; that 2) the establishment of trust between researchers and policy makers was key to ensure an effective, open process; that 3) the scenarios had to be flexible enough to be adapted for specific policy concerns but credible enough to be seen as useful; 4) that challenges associated with government turn-over and re-structuring had to be overcome and 5) that scenario-guided policy processes have to be highly transparent for those not involved in them. We translate these lessons into recommendations to help respond to a widespread need for effective scenario-guided policy development.

O-2236-03

Social responses to climate change: What can participatory games and scenarios tell us?

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Climate change concerns are exceptionally pressing in agro-ecosystems, where social-ecological connections are particularly close. However, inherent climate uncertainties make anticipatory adaptation of agriculture-dependent communities particularly challenging. This paper draws on scenario analysis in order to understand how local level decision making processes in three rural communities in West Africa may unfold as climate change progressively reveals itself.

Empirical evidence was collected using a game designed around future uncertainty with climate change. Participatory games based on scenarios provide a safe space in which to explore potential futures and the respective patterns of individual and collective decision-making. The gaming method was used specifically to understand how the social actors might respond to climate change impacts on agricultural production, paying particular attention to the ability to maintain the fundamental functions of the agro-ecosystem. The method proved particularly valuable for eliciting information on potentially negative futures that participants are otherwise reluctant to consider and discuss, due to the predominance of inherently fatalistic worldviews in the case study region. The results have revealed important insights on the role of thresholds and tipping points in decision making. These can be reached through both sudden and gradual changes, yet with significantly different implications for adaptation decisions and the consecutive system configuration.

Based on this novel method, the paper is able to make a number of contributions to the empirical and conceptual understanding of adaptation decisions in coupled social-ecological systems. Lessons can in particular be drawn on the question which role different speeds and depths of environmental change have on triggering the level and type of adaptation action. The data suggest that sudden and extreme events are more likely to trigger more reflexive and more fundamental adaptation responses than gradual environmental degradation, with the latter implying a high risk or rigidity traps in the case study regions.

The research further allows drawing a number of methodological lessons, particularly with regards to the strengths but also weaknesses of participatory scenario methods. In order to arrive at wider conclusions, the lessons from the rural agricultural context in West Africa are juxtaposed with lessons learned in another project, where participatory scenario development has been applied by the authors in a very different setting, i.e. on adaptation trajectories in coastal megacities, jointly generated with adaptation and planning professionals. Recommendations for other researchers are formulated and amendments to the current literature discussed.

O-2236-04

In search of analytically sound and socially viable energy strategies: linking stakeholder narratives with energy scenarios

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Climate change mitigation requires a rapid transformation of the energy sector. Energy strategies that are both analytically sound and socially viable can lay foundation for this transformation. I will propose a set of scenario methods that enable development of such strategies by linking narratives of stakeholders and the public (to capture the social viability component) with quantitative energy scenarios (to capture the analytical component). After discussing the limitations of the conventional story-and-simulation approach, where several narratives are represented by one quantitative scenario each (from one narrative to one scenario), I will propose three alternatives. The first approach translates normative narratives, or so-called stakeholder visions, into many scenarios (from one narrative to many scenarios). The second approach compares several narratives, based on multiple scenarios, in order to elicit commonalities and differences of the narratives (from many narratives to many scenarios). The third approach develops the narratives and scenarios simultaneously and then finds best matches (many narratives and many scenarios, side by side). These three methods will be illustrated with the cases of regional and municipal energy strategies in Switzerland, electricity system transition pathways in the UK, and risk governance process for deep geothermal power plants. I will close with reflections on the real-world impacts and stakeholder learning effects that were captured in the described studies.

O-2236-05

The IPCC narrative(s) – themes, actors, and storylines

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This abstract is submitted to the session «Scenarios, public deliberation and decisions»:

The IPCC has the challenging mandate to produce "policy-relevant and yet policy-neutral, never policy-prescriptive" reports related to climate change. The policy relevance, based on the most comprehensive assessment of climate change research undertaken, is condensed and presented in the IPCC Summaries for Policymakers (SPM). With this as a backdrop, as well as numerous previous studies undertaken on IPCC communication (e.g. Bowman et al. 2009; Budescu et al. 2009; Budescu et al. 2014; Harris et al. 2013; Hulme 2013; Jonassen and Pielke 2011), the current paper proposes to undertake a textual and narrative analysis of the SPM of the 2014 IPCC AR5-SynthesisReport (SYR). The chosen perspective here is particularly interesting since IPCC authors themselves now have started to characterise their documents as "narratives". We will examine to what extent the SYR-SPM corresponds to the typical narrative structure (Adam 2008), with a clear storyline or scenario comprising specific content components and actors. Our intention is to broaden the current discussion of language use in the IPCC assessment reports, by looking not only at the calibrated language for handling uncertainties set out for the IPCC authors, but also the contribution of other language and textual devices that may contribute to fulfil the communicative goals of the IPCC, which are to present a consensual message to be used by policymakers.

Narratives are crucial to people's understanding of the discourse and to their potential engagement with the challenge at stake (Jones 2011, 2013). The notion of narrative has been used in a somewhat loose sense to describe a variety of texts genres. However, some research has also been done on applying the notion in a more rigorous way in order to understand to what extent there may be a storyline in texts related to climate change (Fløttum 2013; Fløttum and Dahl 2012; Fløttum and Gjerstad 2013), with a point of departure in the hypothesis that such texts can be considered as climate change narratives. This expression refers to text and talk presenting climate change as a certain type of COMPLICATION, with implicit or explicit recommendations or imperatives for ACTION(S) taking place or that should take place in order to achieve some particular EFFECT(S) or FUTURE SOLUTIONS (Adam 2008).It is this last part of the narrative which is particularly interesting to the scenario focus given to the present session – the action(s) and effect(s) components. We will further investigate how the three SPMs from Working groups 1 – 3, representing to some extent three different worlds, are combined in a new narrative in the SYR SPM. What are the themes, scenarios and ways of thinking promoted, which could prime, guide and frame audiences' appropriations of the conveyed messages?

Narratives have plots with different actors involved, in the roles of HERO, VICTIM or VILLAIN. Recent research on the concept of narrative in the policy process (Jones 2010, 2013) has found that the use of "heroes" is "particularly powerful in shaping opinion about climate change" (Shanahan et al., 2013: 456). We investigate to what extent there may be room for heroes in the SYR SPM, or whether actors such as victims and villains are the only appropriate actors in the IPCC context.

Questions to be further discussed: To what extent is there a storyline structuring the SYR-SPM? Which scenario may best promote transformational policies?

Our findings will provide a basis for discussing the potential impact of texts such as the SPMs on target audiences and for discussing links between linguistic and scenarios research, public deliberation and decisions.

2236-POSTER PRESENTATIONS

P-2236-01

Scenarios Exploring Climate Change based on Soft Computing

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The study presents an integrated view of soft computing to solve Climate Change problems. Having a collection of methodologies, soft computing may take advantage of tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low Climate Change solution cost. The focus is to apply the highest quality analysis in application and convergence of the areas of Fuzzy Logic, Neural Networks, Self-Organizing Maps, Evolutionary Computing, Rough Sets and other similar techniques to address Climate Change complexities that may affect Our Common Future.

Scientific communities should work more together on understanding of future climate risks, Disaster reduction and emergencies, and Hazard mitigation. Models and observations of the climate system play an important role in protecting our future climate. Especially extreme events can disrupt society. The impacts concern increased risks of coastal, river, surface water flooding and/or drought. Such issues may be considered by using Soft Computing Techniques: future sea level scenarios globally and regionally, future changes in storm surges, changes in precipitation regimes and associated river discharge, analyses of multiple threats to coastal areas and river delta due to climate change, measuring/recording climate change induced change, extremes and compound climatic events, and the role of adaptation in hazard mitigation and on possibilities to strengthen post hazard reconstruction with a long term adaptation perspective.

Climate change, socio-economic development, ineffective water policy and governance, and basin-wide

developmental interventions are causing increasing threats to the availability and access of fresh water for drinking, agriculture, ecosystem sustenance and industrial activities. Sea level rise, Stalinization and long periods of drought are posing challenges to optimization of freshwater supply and demand. Such issues may be considered by using Soft Computing Techniques: research on how river delta can be adapted to threats of Stalinization and increasing uncertainties in fresh water supply, including technical, economic, policy and spatial planning measures that can be applied for improved fresh water management.

Uncertainty about climate change increases the complexity of decision-making. Limits to the predictability of natural and societal processes prevent scientists from making firm statements about the possible consequences of adaptation decisions. This contrasts with the public's expectation that decisions will be based on sound science. Such issues may be considered by using Soft Computing Techniques: bridging the gap between science and decision-making; Better methods and tools for assessing; simulating and communicating climate risk and the environmental, social and economic costs and benefits of adaptation.

P-2236-02

Going beyond integrated assessment: big emitting nations and the 2°C target

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This year, the United Nations Conference of the Parties in Paris is tasked with delivering a land-mark agreement on avoiding the 2°C warming associated with 'dangerous interference with the climate system'. If such an agreement is reached, it will re-invigorate analyses of how global and national energy systems can deliver the rates of mitigation accompanying the 2°C threshold. Commonly such studies rely on detailed integrated assessment models combining physical and economic relationships to postulate future climate and energy systems. Typically these models optimise on the basis of minimum costs in developing 'feasible' scenarios in terms of technology, infrastructure and efficiency change, as well as providing longitudinal outputs related to parameters such as capital costs, carbon tax rates, etc.

This paper reflects upon the reliance of decision makers on the outcomes of these models, and their suitability for producing plausible outcomes. One criticism is aimed at their limited ability to explore future societies under the pressures of climate change mitigation and adaptation, given that their economic parameterisations are underpinned by historical relationships fit for a world unperturbed by climate change. A second questions whether their theoretical basis is appropriate for articulating the outcome of non-marginal change, when the very futures they are set up to explore involve non-marginal rates of change; for example radical cuts in CO2, or severe climate change impacts. Quantifying societal responses within such models is a particular challenge. Finally, these models downplay risks through disregarding low-probability, high-impact events and their consequences, including wars and migration. It is argued here that as currently formulated these tools are unsuitable for modelling the revolutionary transformations necessary to stay within 2°C carbon budgets, or similarly, futures with higher levels of warming and subsequent impacts.

To address these deficiencies, this paper takes an alternative approach to contextually explore the 'possibility space' appropriate for avoiding 2°C. In contrast to exercises that build future scenarios using 'immutable' relationships within and between the energy and climate systems, a more transparent and dynamic framing based on highly constrained cumulative carbon budgets is proposed. Building on previous assessments that use a similar approach by authors Anderson and Bows, this analysis looks beyond the contested 'Annex 1' and 'non-Annex 1' division to backcast what the remaining CO2 budget implies for the world's top emitting nations. The analysis takes the top 25 nations, responsible for 85% of global CO2, and groups these nations on the basis of similarities within their energy systems. Using a range of explicit variables such as short-term CO2 growth, a suite of emission scenarios for these groups are developed, constrained within a range of 2°C carbon budgets. By varying the levels of near-term emissions from each group's energy system, under a highly constrained CO2 budget, important sensitivities are revealed. Results demonstrate the significance of the rates of CO2 growth in the highest emitting groups, the importance of short-term change and the relevance of bunker-fuel emissions in shaping our collective futures. They also illustrate that only non-marginal change resulting in radical transitions across all energy systems can now be reconciled with the 2°C policy objective.

P-2236-03

The Integrating Assessment Modeling Community: overview, structuring and interactions with the IPCC expertise

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The intellectual debates expressed by the Club of Rome about the "Limits to Growth" (Meadows, 1972) and the oil crisis in the 70s have given rise to energy-environment-economy (E3) models to explore the feasibility of long-term development pathways. The rise of climate change on the public agenda since the late 80s has prompted the need for quantitative assessment of mitigation strategies, in particular in view of the IPCC reports. E3 models gather different types of models, in particular IAMs (Integrated Assessment models). IAMs are simplified, stylized, numerical approaches to represent complex physical and social systems, and the most relevant interactions among the systems (e.g., energy, agriculture, the economic system). From a set of input assumptions they produce outputs in the form of quantified scenarios: energy system transitions, land use transitions, economic effects of mitigation, emissions trajectories. These scenarios are central to the work of the IPCC "Working Group III" on mitigation of climate change, and play an increasingly important part in the negotiation and elaboration of climate policies.

In this paper, we investigate the conditions of the production of such scenarios and the diversity of the models behind them. These models have been developed by an heterogeneous, interdisciplinary community of research. This paper analyses the development and the evolution of this community since the early 90s and provides an overview of the main models and research teams. The climate debate fostered the rise of a new generation of models in the vein of the first global and technico-economic models developed in the 60s and 80s. A main divide in the 90s was between macro-economic models (top-down) and more engineer styles models (bottom up). Bottom-up models give the priority to a detailed description of technologies and sectoral systems, while top-down models represent macro-economic consistency but encapsulate a limited description of technologies. The gap between has narrowed and an increasing number of hybrid models now combine comprehensive top-down representations of macro-economic processes with a technologically explicit bottom-up representation of energy systems.

We explain this narrowing gap as a result of the structuring of the IAM community. How did these models emerge as unified - though diverse - category? How and where did the IAM community organise as such, and what is it made of? This paper stresses the role of intercomparison modeling exercises under the framework of key institutions (for instance the Energy Modeling Forum coordinated by Stanford University, European Framework projects…). It traces the development of an epistemic community which participates, through the production of socio-economic scenarios, to the framing of the assessment of climate policies in group III of the IPCC. This history of the development of IAM relies on a mapping of existing models and modeling team, on interviews, as well as on an analysis of the content of the research programs conducted in these forums, the material produced (reports, articles, IPCC assessment reports in particular AR4 and 5…).

P-2236-04

Native American Vulnerabilities to Climate Change and the Emergence of Federal Mitigation Strategies

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Native Americans in the United States face a variety of existential threats due to climate change. This paper presents a typology of the specific vulnerabilities these groups face, and explains why they are unique groups when it comes to programs to mitigate the effects of climate change. The variety of climate change vulnerabilities include the well-documented problem of sea level rise and its effects on coastal communities, impacts of drought on such things as water availability and agriculture, increased riparian flooding due to shifts in rainfall patterns and vegetation change, and cultural impacts stemming from the loss of hunting and fishing for migratory species. Vulnerability patterns are furthermore complicated by the fact that the 566 federally-recognized Native American tribes vary considerably in terms of their populations, land areas, and resultant population densities. As semi-sovereign governments with land assets held in trust by the federal government of the United States, these groups represent an interesting problem for climate change mitigation, in that the federal government has specific obligations towards the protection of these groups. What this means for climate change mitigation is unclear. What does the federal government "owe" to a tribe whose land base is under threat due to climate change? Do certain mitigation strategies pose threats to the cultural and/or social fabric of the group, particularly if mitigation involves relocation? After providing the basic typology of climate change vulnerabilities faced by tribes, this paper goes on to describe several mitigation programs currently in the implementation phase. These include federal-tribal land swaps and relocations, as well as renegotiation of water rights. Thus far, these programs have not been controversial due to the fact that the tribes involved were small in terms of population and land base. However, I argue that the political feasibility of these types of mitigation strategies are limited by several factors specific to the types of vulnerabilities being addressed. As an example, the successful negotiation of land swaps and relocation are fundamentally constrained by the availability of federal lands adjacent to affected tribes, and which are not under pressure from additional stakeholders. As a result, the potential for land swaps as a standard mitigation strategy is likely to be limited to small and geographically remote tribes, as land swaps must contend with the principle that land exchanges must involve equivalent sized tracts of land. Thus I argue that larger coastal tribes that are closer to more urban areas are thus more vulnerable, both politically and environmentally, than the groups that have thus far been able to negotiate mitigation programs involving land swaps. The federal response to issues involving water scarcity and other issues, on the other hand, are relatively less well-developed. For instance, while renegotiated water rights accords have strengthened the position of various tribes vis-à-vis other water rights stakeholders, the continued drought throughout much of the American West continues to diminish the total stock of water all users rely upon. As such, the negotiation of more advantageous water rights does not in and of itself address the vulnerability of certain groups if there is no water to be had. Furthermore, the political conflicts in such situations are likely to be much more acute than in the other types of climate change issues faced by other Native American groups insofar that all stakeholders over a broader geographic region face the same underlying vulnerabilities. These type of situations represent zero-sum games and any concessions granted to Native American groups are likely to be perceived as unfair by other stakeholders. The paper concludes with a series of policy recommendations which suggest that a broad and flexible approach to climate change mitigation should be pursued, one which takes into account the specific type of climate change vulnerability, the physical and demographic characteristics of the tribe in question, the costs involved, and the nature of political opposition towards specific policy proposals.

P-2236-05

Global and regionalized land uses in 2050: scenarios taking into account climate change

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How will future changes in land uses - within regions and on a global level - will affect food security, taking into account possible climate changes, as well as changes in cropping and livestock systems, changes in farm structures, rural and urban relations, food regimes as well as changes in the general context.

The Agrimonde-Terra foresight project on "Land use and food (in)security" considers this question. Launched by the French research institutes Cirad and INRA, the Agrimonde-Terra conceptual framework can be used to build land uses scenarios at national and global levels with narratives and quantitative illustrations. At national and regional levels, the foresight process involves a group of diverse stakeholders, and discussions on the direct and indirect causes of land use changes facilitate thinking about the possible futures (anticipation), getting new ideas and understanding different points of view (appropriation) as well as decision-making (action). A first workshop has taken place in Tunisia and land use scenarios have been built. On top of that, global and regional levels scenarios are built with the support of a Scenarios Advisory Committee and their are the basis for discussions on possible consequences of land use changes on food security. The scenarios have been build combining hypotheses on direct and indirect causes of land use changes, and looking at interactions and retroactions between the variables. The foresight exercice has a wholistic approach..

Climate change is one of the important indirect drivers of land use changes. It impacts the food production capacity of ecosystems in several ways. It changes the time maturity of crops, it alters annual yields as well as their inter-annual variability, and it changes the nutritious qualities of crops. As far as climate change is concerned, two contrasted scenarios have been taken into account, focusing on temperature change and biogeochemical cycles. The first scenario, entitled "Stabilization of Global Warming" corresponds to the RCP26 the AR5. The agricultural system does not experience any major change due to climate conditions compared to the current situation. The area of cropland suitable for agricultural production does not notably change compared to the current situation, but the stabilization of anthropogenic emissions requires massive efforts for sequestering carbon in the vegetation which may take the form of afforestation and/or production of bioenergy production with carbon capture and storage, or agro-forestry. Most of the land use changes, however, occur after 2050. The second scenario entitled "Runaway climate change" corresponds to the RCP 85 of the AR5. The agricultural system experiences strong impacts: there are increases in the area of cropland suitable for agricultural production but it is unevenly allocated as it mainly concerns the northern latitudes while arable cropland areas decrease in tropical regions. The average suitability of cropland areas also decrease significantly.

The combination of the climate change scenarios with scenarios concerning the direct and indirect causes of land use changes show that food regimes, crooping and livestock systems, and farm structures, will have to adapt to new situations.

P-2236-06

Geo-political maps of CO2(s) to facilitate scientific policy and public debate

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In the last decades, a humble chemical molecule has become one of the most important actors of modern collective life. Carbon dioxide, or CO2, is increasingly used as a key marker for politics and economics both at the national and international level. As such, establishing thresholds for C02 emissions is one of the main objectives of the UNFCCC (United-Nations Framework Convention on Climate Change).

This does not means, of course, that the CO2 has passed from the natural to the political sciences. It means that the molecule has assumed a variety of different meanings according to who use it. Chemists, biologists, geologists, soil scientists, physicists, climatologists, all have different CO2 definitions. And their definitions differ from those of the economists, geo-politicians and NGOs and probably

even more from perceptions by the public opinion. If we had to design one single CO2 cycle, we would have to erase all these differences to obtain some 'mean version' that would be unrealistic.

Instead of trying to average these definitions, it would be much more interesting to find ways to compare their different meanings. Each of them designs and represents a specific vision of the world and orientates future policies and actions. For instance, measurements of C02 emissions entail different responsibilities when represented in terms of CO2 per GDP, CO2 per capita or consumption/production-based CO2.

We started by exploring the scientific literature and used advanced scientometric techniques to disaggregate and map the references associated with the keywords "CO2" or "carbon dioxide". Our method consisted in:

- harvesting thousands bibliographical notices (299.629) mentioning "carbon dioxide" or "CO2" from ISI Web of Science,
- extracting all the references cited in the bibliographies of such notices,
- constructing series of co-citation networks (on various time-periods) in which disciplines emerge as tight clusters of references often co-appearing together,
- projecting the period on maps, together with other chosen metadata such as authors, keywords, subjects, countries and institutions.

A dozen of CO2 landscape maps were obtained showing the evolution of the research landscape concerned with CO2 through space and time. A first result to be discussed is the quick evolution of the key words around which research publications aggregate. Some interesting trends are observed (e.g. rise and fall of CO2 lasers in physics, movement from plant sciences to environmental sciences and the emergence of the climate change issue in the 1980s, development of geoengineering-related disciplines in the 2010s). The maps also highlight the role played by different countries, institutions or individuals in different research fields (e.g US dominance in environmental (and climate) sciences and China's proximity with issues of carbon capture and storage). In order to complement and strengthen our analysis, we invited specialists to comment the maps.

At this stage, the quali-quantitative method we developed - empowered by digital computation and guided by expert knowledge - can explicit some of the multiple representations of CO2 from a research perspective. Future works will explore whether the IPCC expertise is really representative of the rapidly evolving research landscape. We believe this exercise to be particularly useful as we approach the negotiating table.

P-2236-07

Probabilistic analysis to improve baseline GHG emission determination in a developing context: The case of Chile

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In developing contexts, uncertainty in most key variables makes it difficult to establish reliable baseline GHG emissions for the near and medium term future. Scarce information, lack of models and high variability in the main variables are typical in this context. However, these baselines are being increasingly required in the context of international negotiations of the Kyoto protocol and particularly the country must define and declare a baseline and a contribution to mitigation by 2015.

It is common to work with the best information available and obtain a "most probable" scenario, usually based on "reasonable" assumptions of values and trends in key parameters and also to consider extreme cases and assume that these are equally probable, generating scenarios with a wide range of variation in results. Another possibility is using mean values, however in this case, proposals can turn out to be very difficult to reach or affect productive sectors significantly since they may not adequately reflect the existing variability. Depending on the assumptions, a wide range of variation in results can be obtained, making it difficult for policymakers to identify the risks associated to a specific policy.

Probabilistic analysis may be very useful for determining these baseline emissions, incorporating uncertainty in the variables and propagation of uncertainty through the different processes in which they are involved. In particular GDP growth, one of the main drivers of increases in emissions, fuel prices, technology penetration levels are variables frequently used in this estimations. Expert opinion can also be incorporated systematically to improve these information gaps.

For this reason, in this paper we compare the results of a deterministic and probabilistic analysis for baseline GHG emissions in Chile up to 2030, based on the results of the Mitigation Actions Plans and Scenarios (MAPS) project (www.mapschile.cl). Considering the significant uncertainty attached to the main variables involved we establish the relevance for policy-making associated to incorporating uncertainty. Phase 1 and 2 results of this project show, using deterministic analysis, that emissions will increase in the period between two to five times compared to current emissions. Probabilistic analysis allows fine tuning these results and richer conclusions for future policy-making by establishing GHG emissions that are possible to achieve with a given level of certainty. This provides the regulator with more freedom in defining a baseline which he/she will not later regret. Additionally, the results of the importance analysis of uncertainty allow establishing the variables where more information is required for better decision-making.

P-2236-08

Transition to sustainability: are normative participatory scenarios a useful tool? Two case studies in the Brazilian Amazon

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Environmental scenarios were largely exploratory in the past decades, mainly at global and regional scales. Normative/backcasting approaches gradually become more popular and more widely applied over the last decade, due to the strongly normative concept of sustainability. Backcasting can be defined as enviosioning a desirable future, and then looking backwards in order to strategize and to plan how that vision of the future could be achieved. Here we present a normative participatory scenario approach conceived to explore what a «transition to sustainability» would mean (and require) in a heterogeneous and conflicting region such as the Brazilian Amazon. Scenario discussion for the Brazilian Amazon has mostly focused on future deforestation trends at broad-scale. In this work, we explicitly included the social dimension in the scenario construction process, enforcing that all the sustainability dimensions (social, environmental and economic) are taken into consideration. Here we present a synthesis of the scenario process and a synthesis of the results of two case studies at different scales.

The first case study was developed on a settlement project in Pará State, with the specific goal to explore how participatory scenario methods could contribute to the strengthening of territorial units, such as indigenous lands, settlement projects, conservation units. At PAE Lago Grande, a multi-scale approach was adopted, involving stakeholders at three communities and representatives of organizations at the settlement level. Thorugh a series of structured workshops, the actions to reach the sustainable/desired future at the several scales were

discussed, including the divergence/convergence between the scales. Then, we successfully reproduced a similar approach to the whole Brazilian Amazonia, involving representatives of civil society organizations, productive sector and the Federal Government.

Two contrasting futures for the region (Sustainability and Chaotic/Fragmentation) were built using the same workshop structure as in PAE Lago Grande. In this second case study, besides the qualitative scenarios, selected elements of the resulting storylines were quantified to generate explicit spatially representations of land use in the region in coming decades. The land use scenarios were in turn used by multiple climate, vegetation and hydrological models in the scope of the AMAZALERT project at different research institutions to explore the impacts on the provision of ecosystem services and regional climate in Amazonia. The resulting quantitative scenarios and impacts were then feed backed to the stakeholders, illustrating the outcomes of the stories they envisioned.

The normative scenario approach we adopted here was conceived as a tool to subside a broader discussion about "the future we want and how to get there", under the hypothesis that it may favor understanding of diverging points of view, facilitating the collective decision-making process and empowerment. In spite of the well know limitations of participatory methods, we consider the main indication of the potential of the approach the fact that, at the final debate of both case studies, some key stakeholder (from Government, environmental ONG and research institutions) showed interest in replicating the process in other contexts.

P-2236-09

Social and economic tipping points in adaptation processes: Reason for concern?

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Tipping points have become popular epistemic elements within the assessment of climate change. The study of tipping points helps decipher the complexity in climate change dynamics. Yet, despite the increasing engagement with tipping points in hazards and expected impacts there has been little work to empirically assess tipping points in adaptive capacity and adaptation processes. Along the same line, tipping points have been linked predominantly to large-scale bio-physical systems (e.g. the instability of large ice sheets and the breakdown of ocean circulation systems). Little attention has, thus far, been paid to potential adaptation tipping points in social and economic systems and at lower scales. Resulting knowledge gaps are particularly relevant for coastal areas and cities where socio-economic change is often rapid, coupled with heightened levels of exposure and vulnerability to climate change hazards.

Through its conceptual and empirical engagement with tipping points in adaptation processes, the paper aims at contributing to a better understanding of potential future adaptation trajectories. The analysis links two scales: First, a global index-based assessment of risk patterns and trends is presented with a national resolution, focusing in particular on the possibility and effect of large-scale adaptation tipping points. Second, an in depth analysis of selected coastal urban areas in Asia, Africa and Europe is presented, drawing on ongoing research projects. The findings suggest that many types of tipping points in adaptation processes and capacities can be observed, spanning across hard and soft aspects (e.g. related to the financial costs vs. political feasibility of certain adaptation measures). A taxonomy of such adaptation tipping points is thus developed and implications for model-based appraisals of adaptive capacity are explored. The paper concludes by discussing epistemological challenges for a future adaptation science as well as practical lessons for risk and adaptation governance (e.g. how to incorporate tipping points into adaptation 'planning' or into a global architecture of adaptation financing).

P-2236-10

Climate change geo-indicators for policy-makers: downscaling for land-use planning in Caribbean Islands

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The Lesser Antilles are exposed to major and various hazards (earthquake, volcanism, hurricanes, floods, tsunamis, landslides, etc.). In a significant context of climate change, a set of institutional responses for the sustainable management of territories is being drafted. Recent works on the importance of using high-resolution model to study the climate change on small islands by Cantet and al. (2014), underlines the importance of the dynamical downscaling to study the impacts of climate change on the Lesser Antilles. The projections provided by the regional climate model suggest an increase in extreme rainfall events: longer dry periods, a bigger annual total precipitation, more frequent very heavy daily precipitation and a stronger 1 d maximum precipitation, whereas for the driving Global Climate Model, these trends are less intense. Within the framework of the EU Interreg CARIBSAT program, a Multi-natural hazards CARIBSAT GIS was produced by the GRED research laboratory (University of Montpellier, France) and the IRD agency (Institute of Research for Development, Martinique). The aim was to harmonize multiple sources of historical, scientific and geographical information. CARIBSAT GIS is useful to develop several sets of geo-risk and natural disasters indicators: natural hazards activity, human and socio-economic impacts, exposure levels. These geo-indicators are therefore helpful to elaborate territorial diagnosis and comparative risk analysis, at international or regional levels. In the poster, one main question will steer future research: How and by which mechanisms do the actors, who have produced and manage regional knowledge, can participate in drawing up and adapting or changing the frameworks of decision makers final action, mitigation intervention as regards to climate change information?

P-2236-11

Exploring the social-ecological dynamics of a coral reef resource system using bayesian belief networks

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Social-ecological system approaches are now considered as the most relevant conceptual lens to establish biodiversity management strategies accounting for human-nature interactions. It reflects the dramatic paradigm-shift that environmental sciences have undergone in recent years, with increased recognition of the role of people in the dynamics of all natural ecosystems and of the feedbacks of ecological change on human uses and well-being. Social-ecological systems are complex adaptive systems characterized by complex feedback interactions, emergent processes, non-linear dynamics and uncertainty. While the science for modelling social-ecological systems is improving, transdisciplinary empirical studies aimed at investigating their dynamic under different scenarios of stressors or management actions are scant. Here, we developed a transdisciplinary approach to investigating the social-ecological system of Moorea island, French Polynesia. Conceptual models were built through participatory modelling workshops. Then, a Bayesian Belief Networks was developed using a 11-year long database and expert opinion to provide scenarios testing the effects of different stressors and management actions on the system defined by stakeholder groups. Preliminary results suggest that (1) the management of the social-ecological system of Moorea should be more targeted towards specific user groups, (2), more coordination is needed between marine and terrestrial agencies for a more

integrated coastal zone management and (3) the lagoon and the outer slope could be considered as two social-ecological subsystems.

P-2236-12

Climate impacts on adequate human livelihood conditions for well-being and development: framing uncertainties in projections of water availability

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Climate change vulnerability and the consequent need for adaptation are unevenly distributed in the world and many developing countries are especially vulnerable to changes in climate. Climate change often adds on to existing development pressures that are responsible for low levels of social and economic welfare, increasing the vulnerability of such regions. Climate impacts may substantially reduce the adequacy of livelihood conditions, if adaptation and coping strategies are insufficient. Integrated approaches, including climatic as well as aspects of development are needed in order to identify adaptation requirements, opportunities and co-benefits. Ideally, development strategies as well as adaptation and mitigation should be complementary strategies, working towards improved livelihood conditions and sustainable pathways. The trans-disciplinary concept of «Adequate human livelihood conditions for well-being and development» (AHEAD) provides a conceptual framework for the identification of limitations to adequate livelihood conditions and the consequent need for adaptation and development. The approach allows addressing several topical challenges of climate impact assessments, such as the integration of concepts from different disciplines, data integration as well as the combination of processes at different scales. A particular challenge for the assessment of climate impacts and adaptation needs lies in the treatment of uncertainties, which normally multiply along the assessment chain as has been shown by the recent Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP). The methodological implementation of the AHEAD framework provides a way of dealing with these uncertainties based on the representation of gradual adequacy of conditions using fuzzy logic.

To illustrate the utility of the AHEAD approach, we assess the adequacy of AHEAD conditions on a global scale at national resolution. We focus in particular on the availability of water resources in adequate quantity and quality, which plays an important role in meeting human livelihood needs. We use multi-model water resource estimates from ISI-MIP to illustrate, how the approach can provide a way forward in dealing with the substantial uncertainty in projections of water availability. Our results indicate that water availability limits the adequacy of livelihood conditions in some countries today, a situation that will aggravate over the course of the century; however for the majority of countries other aspects limit the adequacy of livelihood conditions. The presented approach shows how uncertainty ranges in modelling results may be framed in a way, which allows assessing their relevance with regard to specific questions. The uncertainty range of data on water availability is considerable for many countries, but for more than a third of the countries this range is outside of critical thresholds for water security and overall AHEAD conditions.

P-2236-13

From Static Socio-economic Sensitivity to Interactive Scenarios: New Tools in Support of Climate Change Adaptation Decision-Making

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For many years long-term scenarios of future socio-economic developments were mostly hidden in the background of climate change impact and vulnerability assessments. At the forefront of scientific studies on climate change were advances of the climate modelling community. Long-term socio-economic scenarios were nevertheless needed as drivers of the underlying emission projections. For this purpose four main 'storylines' of demographic, social, economic and technological developments were defined by the IPCC's Special Report on Emission Scenarios. But the socio-economic scenarios of the 'storylines' were coarse and remained largely in the background of impact and vulnerability assessments. In fact, the socio-economic sensitivity components of most assessments remained static, i.e. they used only the most recent data on population, economic output and other related indicators. Thus future climate conditions were often related to current (and not future) societal conditions.

Since the SRES scenarios new approaches and methods for demographic and socio-economic projections have emerged. And the IPCC eventually adopted a 'parallel modelling approach' allowing climate researchers and social science researchers to develop their models in parallel instead of in a sequential fashion. Social scientists developed a set of 'shared socio-economic pathways' that are only loosely linked to different policy assumptions and thus opened up even more flexibility for exploring different socio-economic constellations.

These methodological advances reflect the realization that socio-economic developments are much more open and dynamic and therefore perhaps even more difficult to project than long-term climatic changes. It is also an often neglected fact that socio-economic conditions in most parts of the world have in the past 50 years changed to a much greater degree than have climatic conditions - and this is likely to hold true for the future as well. Thus, the level of future climate change impacts will also be primarily determined by socio-economic changes. Moving from fixed (e.g. the most current) socio-economic sensitivities to a variety of flexible scenarios therefore holds the promise of greatly enhancing impact and vulnerability assessments and applied tools for policy advice.

This paper reviews examples of recent climate change impact and vulnerability assessments that treat socio-economic sensitivities in different ways - ranging from static status quo to flexible scenarios. A special focus is put on studies that have fully embraced the scenario approach. For example, some recent and ongoing European research projects like CLIMSAVE (Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe) or CLIP-C (Climate Information Platform for Copernicus) are offering users the ability to interactively explore different socio-economic development trajectories. The paper identifies methodological achievements as well as requirements and opportunities for decision-makers, but also highlights key challenges of these new approaches.

P-2236-14

Chaos in climate change impact estimates

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Global Circulation Models incorporate chaotic dynamics to reflect real-world weather patterns. This implies that extremely small perturbations of the climate system may generate very different weather patterns. Here I show that the SRES climate change scenarios generated by the Coupled Model Intercomparison Project phase 3 (CMIP3) --- ubiquitous in the impact literature --- display strong chaotic dynamics at regional and sub-regional level, at least until 2065. Chaos is triggered by changes to historic forcing in the year 2000 to reflect different emissions trajectories. This suggests that large uncertainty exists on how to link local climate change and global forcing. Furthermore, short- and mid-term differences in local climate change across different SRES emission scenarios reflect chaotic dynamics rather than different forcing patterns. I show that the «chaos» in the climate scenarios generates a «chaotic» relationship between exogenous forcing and local economic impacts on agriculture. «Perturbed exogenous forcing» model ensemble would resolve this uncertainty.

P-2236-15

Low-carbon transition scenarios for the French transportation sector: exploring the role of uncertainty on technology costs with robust optimization

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Reaching very ambitious GHG reductions objectives will likely require abatement efforts from the transportation sector. On the supply-side, technological options for reducing transportation emissions consist in reducing the carbon intensity or increasing the energy efficiency. On the demand-side, reducing the amounts of travels and increasing modal shifts towards less carbon-intensive means are the major levers.

The identification of cost-effective mitigation strategies critically depends on the relative costs of transportation technological options which determine the competitiveness of substitution options. In long-term energy system models, cost assumptions need to be defined over distant horizons. The forecasted costs and prices take part in the uncertainty that carries weight on the model hypotheses and which is at the root of many criticisms (IPCC 2014).

Motivation The literature on energy modelling with uncertainty is very large: stochastic programming which mainly deals with large socio-economic or political uncertainties, scenario analysis (Babaee et al, 2014) or Monte-Carlo analysis can be used to obtain distributions of model outcomes (Rosakis and Sourie, 2005).

In this paper, we introduce an alternative way to tackle uncertainty in optimization energy system models. We rely on robust optimization (Ben-Tal et al, 2009) to make many model parameters simultaneously uncertain. So far, this technique has been scarcely used in energy modeling (Babonneau et al, 2012). The contributions of the paper are twofold. From a methodological perspective, we argue that robust optimization techniques are appropriate for introducing cost uncertainty from many sources in long-term optimization models. We use recent results from operations research to economically interpret model outcomes, and assess the robustness of the model to economic parameters through optimization. From a policy perspective, we aim to evaluate the hedging potential of alternative technologies, making a step towards the identification of robust technology portfolios and policy designs.

Methodology In order to assess how deeply our model solutions are affected by uncertainty and to help the decision maker to define policy, we used a recent methodology developed in the field of operations research: robust optimization (RO). The general principle of RO consists in immunizing a solution against adverse realizations of uncertain parameters within given uncertainty sets. The basic requirement for a robust solution is that constraints of the problem are not violated whatever the realization of the parameters in the set.

While stochastic or Monte-Carlo frameworks require the definition of probability density functions, the principle of RO consists in set-based descriptions of uncertainties. As such, only the extent to which parameters are likely to vary needs to be known. The robust counterpart of the initial problem thus includes variables that traduce the deviations of the worst-case parameters with respect to their nominal values. The number of potentially deviating coefficients can be controlled through an exogenous parameter - the uncertainty budget, which gives control on the degree of pessimism of the optimal solution. Our experimental setting consists in using a TIMES-based long-term planning model of the French energy-transport system. We derive a dynamic implementation of the RO method. We perform a set of parametric runs by setting increasingly stringent (i) abatement objectives on CO2 from transport by 2050 and (ii) uncertainty budgets. We make primary energy prices and transportation investment costs uncertain.

Results and discussion We identify robust technological mitigation portfolios (compliant with the modeled policy objectives for any random realization of the uncertain parameters), which vary with both the required level of abatement and the degree of pessimism on the certainty of the exogenous price/costs projections. Key messages are that (i) the diesel-gasoline balance is affected by uncertainty, partly in response to system effects (ii) there is a general tendency to incorporate more biofuels (iii) natural gas (including biogas) and electricity pathways are relevant hedging option for low carbon caps; for stringent objectives, they are pushed out of the market. We then discuss policy insights, showing that if the uncertainty budget is reasonably low (good confidence in prices/costs projections) it makes sense to incorporate a diversification logic in policy designs. However, if confidence is poor (high uncertainty budgets), then diversification may not be relevant.

P-2236-16

The application of scenario planning for decision-making in the face of climate change: issues of scale

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There is widespread recognition that climate change will affect cities and regions worldwide. Projected impacts of climate change will be spatially non-uniform and the ability of communities to respond to those impacts will also vary significantly. Assisting multi-level decision-making involving climate change adaptation with scenario planning is well placed given the uncertainty related to climate science and projected impacts. This paper seeks to distill lessons on the use of scenario planning involving multi-stakeholders for decision-making related to climate change adaptation. Lessons are extracted based on the development and application of explorative scenarios (multiple plausible futures) by three distinct action-research projects involving different scales of stakeholder engagement in Australia: (i) regional, (ii) community of practice, and (iii) community scales.

The regional scale project focuses on the South East Queensland Climate Adaptation Research Initiative (SEQCARI) involving a multi-sectoral investigation of climate change adaptation in the South East Queensland (SEQ) region, comprising the sectors of urban and regional planning, coastal management, physical infrastructure, emergency management and human health. The SEQ region has been identified as one of six vulnerability hotspots to climate change in Australia. The community of practice scale project focuses on planning for climate change adaptation involving regional bodies responsible for natural resources management in the East Coast Cluster of Australia. The East Coast of Australia comprises a wide range of landscapes that will be impacted by climate change, including coastal areas, major catchments and agricultural areas that support two capital cities. The community scale focuses on the recovery phase of the Cardwell community in far north Queensland in the aftermath of category five tropical cyclone Yasi. Tropical cyclones affecting this area are likely to become less frequent but more intense in the face of climate change. At least two scenario planning workshops were conducted for each project to assist in the development and testing of proposed adaptation options. Adaptation options were developed through collaborative planning processes involving a range of stakeholders and aimed to reduce their vulnerability to future climate change impacts.

Findings indicate that at broader scales, such as regional level, exploratory scenarios enable the integration of multi-stakeholder and sector perspectives related to complex challenges such as climate change adaptation for human settlements. In particular, at that scale, scenarios provide opportunities for improved interaction between practitioners and understanding of sector-specific issues. In parallel, community of practice and community scales are better positioned for scoping more specific and tailored adaptation options. However, they lack broader interaction between different layers of actors involved in decision-making therefore hampering stakeholder's ability to ascertain feasibility and envision the implementation of adaptation pathways. Multi-stakeholder scenarios processes are known to be time consuming given stakeholder's unfamiliarity with the method. In the community scale project, it was also noted stakeholder's difficulty in grasping with both multi-dimension challenges related to and longer-term strategic thinking demanded for climate change adaptation.

P-2236-17

Designing experiments for climate prediction

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Complicated global circulation models are used to simulate and study the climate system. Increasingly they are also used to make projections of future climate. For instance, the results of the Coupled Model Intercomparison Projects (e.g. CMIP5) play a significant role in the IPCC assessment reports and are often used to guide adaptation planning and impacts assessments.

Here we will discuss what we mean by climate prediction and to what extent the modelling experiments which are run today, are sufficient to quantify changing climate in the 21st century. We will argue that the design of climate modelling experiments needs to be changed in the light of conceptual understanding in nonlinear dynamical systems theory, and better informed by concepts being explored in the philosophy of science and in approaches to robust decision making.

The concept of climate as a changing distribution will be illustrated using a low-dimensional climate-like mathematical system undergoing a forced change. The different roles that uncertainty in initial conditions can play will be discussed and used to illustrate the limitations on the probabilistic accuracy of predictions. It will be argued that today's ensembles of AOGCMs and ESMs are likely too small to be able to robustly quantify the changing climate within the model itself. This severely limits there value for both scientific understanding and for guiding societal decisions.

The implications of model error will be discussed and put in the context of the balance which must be achieved between the study of emergent properties and the use of reductionist models.

The consequences of initial condition uncertainty and model uncertainty will be drawn together to argue for a new approach to the design and interpretation of climate models and climate model ensembles; one which requires larger ensembles and greater computing resources but which encourages diversity in models and interpretational approaches mediated by physical understanding rather than statistical post processing. This stands in contrast to arguments which have been made for increasing resolution while reducing the diversity of different models.

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2237a - Planetary Economics (1): Costs of Inaction and Benefits of Policy Action

ORAL PRESENTATIONS

K-2237a-01

Consequences of Climate Change Damages for Economic Growth

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This paper focuses on the effects of climate change impacts on economic growth. Simulations with the OECD's dynamic global general equilibrium model ENV-Linkages assess the consequences of a selected number of climate change impacts in the various world regions at the macroeconomic and sectoral level. The analysis finds that the effect of climate change impacts on annual global GDP is projected to increase over time, leading to a global GDP loss of around 1% to 3.3% by 2060 for the likely equilibrium climate sensitivity range. Underlying these annual global GDP losses are much larger sectoral and regional variations. Agricultural and health impacts dominate in most regions, while damages from sea level rise gradually become more important. Negative economic consequences are especially large in Sub-Saharan Africa and South and South-East Asia whereas other regions will be less affected and, in some cases, benefit thanks to adjustments from international trade. Emissions to 2060 will have important consequences in later decades and centuries. Simulations with the AD-RICE model suggest that if emissions continue to grow after 2060, annual damages of climate change could reach 4%-11% of GDP by the end of the century. Some impacts and risks from climate change have not been quantified in this study, including large-scale disruptions and the disutility from premature deaths. These will potentially have very large economic consequences, and therefore the costs of inaction presented here likely underestimate the full costs of climate change impacts when no policy action is taken. The stylised analysis clearly shows that with efficient adaptation policies, costs will be significantly lower. Mitigation not only brings the expected level of climate damages down, it also considerably reduces the likely uncertainty range. However, the role of adaptation is much more limited when ambitious mitigation policies are adopted. The opposite is not true: even with ambitious adaptation policies, there is a large role for mitigation to play in keeping the total costs of climate change as low as possible.More research is needed to assess the costs of inaction and the benefits of policy action, as well as the various uncertainties and risks involved. However, this should not delay policy action, but rather induce policy frameworks that are able to deal with new information and with the fact that by their nature some uncertainties and risks will never be resolved.

K-2237a-02

Climate change impacts and market driven adaptation: The costs of inaction including market rigidities

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To manage the complexity of economic assessments of climate change impacts, climate change research saw an increasing development and application of integrated assessment models (IAMs). Their distinctive feature is to describe in a controlled environment the "climate-change issue" in its entirety, i.e. connecting the climatic, the environmental and the social components. Two broad approaches can be identified in the economic quantification of climate change damages with IAMs. One makes ample use of reduced-form climate change damage functions. Basically, a more or less sophisticated functional form translates temperature increases into GDP losses. Parameterization of these functions derives from extrapolation of the impact literature or expert opinions. A different approach, often coupled with the use of Computable General Equilibrium (CGE) models, consists in translating climate change pressures into changes in quantity/quality of factors of production and/or in agents' preferences driving demand and supply behaviour in the models. GDP losses are thus the direct outcome of the simulation and do not stem from an explicit function and its ad hoc parameterization.

More than twenty years of IA research produced a vast literature on the cost of climate change. Due to their obvious policy relevance, these estimates are surrounded by a heated debate, and many authors suggest that they are likely to underestimate climate change costs. Many features of climate change, environmental and social

responses are still uncertain and/or not well captured by IAMs. For instance, relatively small changes in climate sensitivity can greatly change the cost estimates from these models (Ackermann and Stanton, 2012; Anthoff and Tol, 2013). Quantitative modelling frameworks are also ill suited to measure important social phenomena like conflicts, mass migrations, disruption of knowledge, learning and social capital potentially triggered by climate change (Anthoff and Tol, 2013; Stern, 2013). IAMs emphasize impacts on GDP, which even disregarding its deficiency as a welfare measure, captures flow and tend to overlook stock losses (Stern 2013). Risk and irreversibility associated to high damage low probability events is usually left out of the analysis which can seriously bias downward damage estimates (Weitzman, 2007, 2008, 2009, 2010; Ackerman and Stanton 2012). IAMs tend to be overly optimistic in describing timing and scale of adaptation processes, disregarding the fact that, agents may not use perfect information and for technological, economic, psychological and cultural characteristics may resist to some changes (Patt et al., 2010). All these critiques are particularly relevant when climate change impact assessments are conducted with CGE models. They provide a peculiar richness in the analysis of climate change costs, highlighting sectoral effects and, above all, tracking endogenous market adjustments and rebounds triggered by climate change shocks. But, at the same time, they are grounded on GDP, account just for marketable relations, typically model instantaneous and frictionless adjustments. Against this background, the assessments performed with CGE models tend to fall somewhat in the lower end of cost estimates.

This paper presents a simple exercise to address the following questions. Do climate change impact assessments performed with CGE models estimate lower GDP losses than reduced-form climate change damage based assessments? What is the role of market driven adaptation in determining these estimates?

We run a standard climate change impact assessment exercise with a recursive-dynamic CGE model using updated estimates of an extended set of impacts for different temperature increase scenarios. Then we extrapolate a reduced-form climate change damage function. We show that, at the global level, this is not significantly different from that produced by some established hard-linked integrated assessment models when the same impact categories are included. Furthermore, we perform the same exercise reducing what can be defined "market driven adaptation". In practice, we restrict the elasticity of input substitution in the production function, the substitutability of domestic and imported inputs, and finally sectoral workforce mobility. We demonstrate that, notwithstanding these frictions increase the cost of climate change impacts, they do not change substantively neither the qualitative nor the quantitative picture.

K-2237a-03

Accounting for Climate Impact and Cost Uncertainty in Integrated Assessment Models

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We develop a methodology that uses the concept of a risk premium to account for risk aversion to climate change damages in the affected population. The premium is derived from the notion of risk aversion in the framework of expected utility theory, namely the amount that society would be willing to pay in order to reduce the riskiness of future damages. We estimate the risk premium for plausible average damage functions that are currently being used in Integrated Assessment Models to calculate the optimal levels of mitigation and adaptation. The new functions are referred to as risk-adjusted damage functions and they have higher damages than the expected values used previously. We have calibrated three sets of risk-adjusted regional damage functions for three different level of risk aversion, low, medium and high. With low and medium coefficients of relative risk aversion equal to 1 and 1.5 the additional damage component is quite small. The damage addition due to risk aversion is highly nonlinear and it increases significantly when the coefficient rises to 2. It is also interesting to note that the risk premium varies from region to region, implying that the degree of the adaptation response will be region-specific.

The new functions are used to estimate what they imply for optimal adaptation and mitigation with different versions of the AD-Witch model. The results show that the percentage increase in allocation to adaptation is around 10-20 percent for values of the coefficient of risk aversion of 1 and 1.5, but rises to as much as 80-200 percent for a value of the coefficient of 2. The impacts of including risk in damage estimation on mitigation are interesting and somewhat different. In the cooperative solution mitigation is increased 5-10 percent with the higher damages for low values of risk aversion and by 10-20 percent for higher values. Finally as far as the growth scenarios are concerned there appears to be little difference in terms of the impact that taking account of risk has on the calculations.

Further work is continuing to see the effects of the new damage functions at the regional level.

O-2237a-01

Global climate impacts: a preliminary economic analysis

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Understanding the global implications of climate change at the appropriate country resolution is important for the policy process. The purpose of this presentation is to gain some first insights on the sectoral and regional pattern of the biophysical and economic consequences of climate change at the global scale, benefiting from the current bottom-up sectoral impact evidence. The study will consider a set of climate model runs and a limited set of impact categories within an integrated climate-biophysical-economic framework.

The main questions to be addressed are the following. Firstly, how important are the impacts of climate change for the big players in the international climate negotiations? Secondly, what are the distributional implications of climate impacts vis-à-vis Europe? Thirdly, what are the main uncertainties in the modelling and how they influence the results?

The project scope has several dimensions. Regarding the time horizon, it covers the climate impacts over the 2071-2100, compared to 1961-1990. The study considers few impact areas, for which there exist empirical bottom-up evidence: agriculture, coastal areas, and if possible, energy.

The study methodology is based on results from process or bottom-up biophysical impact models (from the ClimateCost EU project and, possibly, the ISI-MIP project). The economic valuation of climate impact categories will be carried out in a coherent and harmonized way with an economic multi-country, multi-sector computable general equilibrium (CGE) model in order to enhance the comparability of the different damaging patterns.

The authors have already conducted preliminary analysis of impacts in agriculture and coastal areas. The results indicate that there is a wide dispersion of impacts across the world, with strong geographical asymmetries.

O-2237a-02

Effort sharing taking into account adaptation costs and climate change damage

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The ongoing discussion about the feasibility of maintaining global temperatures below 2 °C encompasses not only the costs and benefits of achieving the target, but also the difficulty of reconciling regional efforts with the inequity of climate change impacts. If mitigation and adaptation actions, as well as residual damage from climate change,

will be distributed diversely across the world, can we devise a policy which aligns different country and regional views and incentives? In most of the scientific literature, equity issues related to mitigation, adaptation, and impacts have been disconnected. Most studies on effort sharing have focused on fair distributions of mitigation costs without considering adaptation costs and residual damage. Our study aims to fill this gap by investigating which mitigation targets in 2030 and 2050 lead to equalizing the sum of mitigation costs, adaptation costs, and residual damage as share of GDP across regions.

We employ two alternative modelling frameworks combined with two sets of regional climate change impact functions. These models provide a mapping of the residual climate change damages of 2 °C and of the resulting adaptation costs, and allow exploring how emission rights should be allocated to equalize the sum of mitigation costs, residual damage, and adaptation costs as share of GDP across regions. We show that a 2 °C world leaves considerable residual impacts and adaptation costs. Sharing the burden of the total costs of climate change, including residual damage and adaptation costs, reshuffles the emission allocation compared to an effort-sharing regime based on mitigation costs only. The financial implications can be significant, with a total of additional resources in the order of 100-200 USD billions in 2030 would need to flow to the high impact countries in India, Africa, and Rest of Asia, by means of trading emission rights. Countries with lower-than-average impacts, such as OECD countries and China, would buy such rights thereby financing those transfers.

The above numbers assume a global carbon market being in place from 2020 onwards. Even though such a global carbon market with the implied sharing rules is not easy to implement, our paper suggests that accounting for the total costs of climate change and including adaptation and damage considerations could achieve an effort distribution being perceived fair by a wider group of countries.

O-2237a-03

A predictive model of production loss under unanticipated shocks by extreme weather events

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Risks of extreme weather events like floods, heat-waves and storms are likely to increase due to global warming. Since world markets are highly interlinked and local economies extensively rely on global supply and value added chains, extreme weather in one place may have repercussions elsewhere. Accordingly, a comprehensive climate risk management and cost estimation should take these interactions and dynamics into account.

Here, we present the dynamic damage propagation model called «acclimate». On the same time scale as the local events the model explores immediate response dynamics as well as the subsequent recovery phase of the supply network. While the pure damage propagation dynamics [1] as well as possibilities for demand changes and extension of production [2] have already been described, we concentrate here on a major extension that includes price dynamics and local economic optimization.

The model focuses on analyzing the indirect effects of local perturbations without taking into account economic growth. Its agents, i.e. production or consumption sites, are organized in a production network based on multi-regional input-output data (Eora MRIO database). This constitutes the baseline and is assumed to be an optimal state with respect to the economic rational of the model. Direct damage as perturbation due to climatic extreme events causes cascading deviations from the baseline along the network and thus leads to indirect production and consumption losses.

Each producing agent optimizes its purchase, demand distribution, as well as production and supply distribution to maximize their revenue. Due to the unanticipated nature of the events we assume limited foresight for the agents, who perform their optimization locally in a spatial as well as temporal sense. Since the time scale is too short to allow for immediate market clearance local price deviations are hereby taken into account. The agents for final consumption optimize analogously with respect to their consumption. This short-term behavior is complemented by middle-term adaptation in the form of rewiring within the production network. We furthermore allow for dissipation effects using storage capacities and temporary production extension.

With this model we estimate the economic costs of climate change induced production failures, including indirect costs with potential low-probability but high-damage events. We furthermore aim to systemically assess the limits of adaptation of the supply network. Concerning risk management, we stress the importance of global structural adaptation measures in addition to local adaptation.

[1]: Bierkandt, R., Wenz, L., Willner, S.N., Levermann, A. (2014). Acclimate – a model for economic damage propagation. Part I: basic formulation of damage transfer within a global supply network and damage conserving dynamics. Environment Systems and Decisions, 34, 507-524.

[2]: Wenz, L., Willner, S.N., Bierkandt, R., Levermann, A. (2014). Acclimate – a model for economic damage propagation. Part II: a dynamic formulation of the backward effects of disaster-induced production failures in the global supply network. Environment Systems and Decisions, 34, 525-539.

2237b - Planetary Economics (2): expanding the horizons of economic sciences and the policy implications

ORAL PRESENTATIONS

K-2237b-01

'Planetary Economics': The Three Domains and their implications

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This paper summarises and outlined evidence for the economic framework developed in the book Planetary Economics. It maps out three domains of decision-making, each of which involves different actors, processes and for which our understanding rests on different theoretical foundations. Each operates at different scales of time and social entities: they are complementary, not competing, explanations of diverse economic phenomena. For this session, the paper will also tentatively map different economic theories on to this framework.

The paper will then explain the unique characteristics of energy and climate change issues which make all three domains simultaneously important, and indeed argue that the issues raised span all three domains in approximately equal measure. The paper will also suggest that understanding the different domains help to explain the extremes of cycles in international energy markets and the poor history of energy forecasting.

The paper will then outline lessons on the three corresponding pillars of policy and why any individual policy pillar has been in practice prone to failure. It will outline correspondingly the need for policy packages spanning all three are credible, economically efficient and environmentally effective – and hence, politically stable. The concluding part of this overview talk will touch on the international dimensions, in which each pillar would raise different aspects of international cooperation.

K-2237b-02

Discussion on the «Three Domains» framework of Planetary Economics

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Will present a discussion of the Economic framework presented in the book «Planetary Economics» and debate the merits (or not) of its approach and the resulting policy prognosis

O-2237b-01

Evaluating Common Futures: Rethinking Prescriptivism and Descriptivism

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Stern's (2007) report has engendered an interesting methodological debate among climate economists. In evaluations of climate policy, assigning values to some key moral parameters (e.g. in the Ramsey formula, the pure rate of time preference δ and the elasticity of marginal utility of consumption η) weights the interests of future generations more or less strongly. This influences conclusions about the evaluation of damages and how imperative it is to respond to these damages.

In IPCC SAR WG3, Arrow et al. (1996) called the participants of this debate descriptivists and prescriptivists. Descriptivists like Hutt (1940); Manne (1995); Nordhaus (1994, 2008) think that, by appealing to (empirical) market data, they can avoid making their own value judgments. This view contrasts with prescriptivists (e.g. Arrow et al. 1996; Broome 1994, 2012; Dasgupta 2008; Stern 2007), who have argued that explicitly weighing the moral import of parameter assignments is an unavoidable part of addressing these types of long-term policy evaluations.

In this presentation, I have two contributions. First, I intend to help classify these methodologies among ethical theories, to help incorporate moral philosophical contributions. Second, in the case of the Ramsey framework, I introduce new worries for both the descriptive and prescriptive positions. These worries come from application of recent behavioral psychological theories: prospect theory and heuristic theory.

First, to understand the positions in a philosophical context, it is necessary to recognize that there is an important presupposition underlying the debate. I argue that economists have a particular metaethical orientation with respect to assigning values to such parameters: they are subjectivist.

I argue further that the two economic groups (descriptivist/prescriptivist) represent a disagreement between two subjectivist views: social constructivism and expert judgment. However, there are well-known economic problems with the descriptive methodology of assigning values to these moral parameters based on market data alone (Arrow et al. 1996; Broome 1994). First, we do not operate in a perfectly competitive market, and market distortions prevent price signals from reflecting the full social costs. Second, it is not clear that individuals make market decisions with consideration of future generations; it is much more plausible that individuals are acting on personal time preference. Third, we do not see safe assets with maturities on climate impact timescales.

To avoid these issues, one might suggest that the moral parameters in the Ramsey formula be investigated directly from market participants. There is a shortcut with η, for example, since under utilitarian assumptions, η characterizes both inequity aversion and risk aversion. Since the experimental paradigms for testing risk aversion for individuals are well-understood, one might try to reveal risk aversion from behaviour under risk.

My objection is that a psychological theory called prospect theory (Kahneman 2011; Kahneman and Tversky 1979) indicates that revealed risk aversion will not be appropriate for normative judgments about η. This is primarily because η considers the absolute value of changes in consumption (and in utility) whereas prospect theory suggests that individuals will view outcomes as changes from a neutral reference point. This means that prospect theory tells us that risk aversion elicitation will fail to provide normative guidance.

These worries might lead one to take the expert judgment methodology. However, such judgments are precisely the kind of judgments that Kahneman (2011) warns might be subject to heuristic evaluation. We might substitute more easily accessible quantities in for η. Instead of asking "What is the elasticity of marginal utility with respect to consumption [i.e. η]?" one could answer a question that is more easily answered, such as "What is the psychological value of imagining having different levels of consumption?" Affective responses to having a various restricted consumption patterns are easily accessible to guide the decision making process, but can distort it (Finucane 2000). It is also easier to comprehend one's own response to consumption over time than to explicitly consider intergenerational distributions. This second worry should also be accounted for in expert judgment.

O-2237b-02

Methodological foundations of policy-making in sustainability transitions

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Policy-makers currently face unprecedented challenges and uncertainty when taking decisions that simultaneously affect economic development, technology and the environment. A lack of consensus on the impacts of climate policy in this complex interacting system has paralysed the policy-making processes, and policy indecisiveness has generated stagnation in investment decision-making, at the core of economic development. It is not clear to policy-makers how to reconcile economic policy supporting growth with climate change mitigation, and it is not clear how effective policies are likely to be.

This paper argues that policy-making based on conventional equilibrium science and economics is not fine-grained enough to capture the complexities of real-world human behaviour and its diversity, leaving a wide uncertainty gap for policy-making. We suggest that the use of dynamical methodologies involving complexity science coupled to behavioural science with sophisticated uncertainty analysis can provide appropriate tools to understand policy issues that involve a high degree of cross-sectoral interaction and correlations between agents, even at the aggregate level. This is to be used in a feedback loop with researchers in policy and law, in order to test potential policy packages while assessing their feasibility in the policy process.

We describe how policy-related interactions between each of three critical interrelated areas: technological change, the macroeconomy, and the natural environment, could be dynamically represented in much greater detail, allowing better representation of feedback processes related to policy choice. We describe what impact these developments would have on our predictive power and ability to constructively inform coupled technology-economy-environmental policy-making aimed at addressing climate change. We identify three areas of environmental policy where the high degree of behavioural correlation (positive re-inforcing feedbacks) and/or behavioural diversity makes their analysis impractical using conventional methods, and where the application of this methodology could be determinant for gaining appropriate insight for policy making: (1) the analysis of green growth, (2) cross-sectoral impacts of sector specific policies (e.g. biofuels), and (3) the effectiveness of policy for emissions reductions in consumer based sectors (e.g. private transport). By providing a concrete example, we suggest how a wider adoption of this approach could provide a step change in our ability to address the complex policy problems raised by sustainability transitions.

O-2237b-03

A framework to manage national decarbonization regimes

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There is widespread agreement that mitigating global warming to prevent disruptive climate change requires nations or regions to internalize the global externality of anthropogenic carbon dioxide emissions. The most straightforward approach is to establish a price on carbon emissions, either directly through a carbon tax or indirectly through a cap-and-trade market mechanism. Several studies attempt to find an "optimal" price of carbon that depends largely on intertemporal consumption preferences (notably discount rates) and the estimated "damage function" that changes in weather, crop yields, and productivity, among others,impose to the global economy. These models, however, provide little theoretical insight into the dynamics of the decarbonization transition and they cannot inform the consequences of different carbon prices in the evolution of a socio-technical system. Many jurisdictions are considering incremental carbon prices without acknowledging the existence of technological "tipping points" triggered by specific carbon prices that suggest stable but more aggressive earlier action. We use high temporal and spatial resolution model SWITCH(see, e.g. Mileva, et al., 2013; Carvallo, Hidalgo-Gonzalez, and Kammen, 2014) to study the effect of the trajectories of prices for carbon emissions on the evolution of power systems. We have developed this linear programming optimization tool and utilized it to examine energy and climate objectives for distinct models of four different regions: the Western U.S., China, Chile, and Nicaragua. For each of these regions we find a common pattern of non-additive effects of increasing carbon prices and non-linear/non-decreasing marginal abatement costs. Despite the significant differences in the current energy mix and local resources in these regions, we find that tipping points at ~$30/ton and ~$60/ton lead to significant 'transformative phases' in each system. Specifically, as these carbon prices are reached we observe significant changes in the energy investment portfolio that would not likely have taken place with simply small, incremental, changes in carbon prices. Our analyses for each particular region suggest significantly different socio-technical evolution pathways for each area depending on an initial choice of carbon prices and its interaction with other policies. For example, in Chile carbon prices below $30 favor entrance of natural gas, while higher prices make renewable energy sources economical but impose different operational restrictions in the grid that require a different set of investment decisions. In the case of China, a high-adoption of renewable energy stage and a carbon capture and sequestration stage are defined before and after a $10/ton price respectively, with major transmission infrastructure implications. We propose a framework of decarbonization regimes with four critical stages: an earlier stage of natural gas/nuclear replacement; a second stage with higher renewable energy penetration; a third stage defined by earlier retirement of coal plants; and a four stage with minimal marginal gains from higher prices. We use this framework to recommend appropriate supplementary environmental and technology policies to achieve mitigation goals.

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2238 - Indigenous and Non-Indigenous Science in Collaboration for Our Common Future

ORAL PRESENTATIONS

K-2238-01

Collaboration of Indigenous Science and Western Science to Protect Landscapes and Our Common Futures

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Indigenous people of the world have unique knowledge systems that can contribute to all fields of scientific endeavors, particularly of generational experiences of being living witness to changing biodiversity and cultural landscapes as documented in our report titled Indigenous Engagement with Science towards deeper understanding (see http://www.innovation.gov.au).

The major challenge of generating and maintaining Indigenous knowledge systems and intergenerational practice is not simply an issue of science engagement; it is an issue of international importance for the earth's co-existence with humanity. The solutions presented by Indigenous researchers/scientists, and knowledge holders are founded in a trans-disciplinary approach of collective wisdom, an approach that recognizes and celebrates unity in diversity. The opportunity needs to be realized to invest in future partnerships which value and include Indigenous and western scientist/researchers and practioners working together.

These partnerships must recognize and respect the earth has rights and we as world citizens must guarantee custodianship of the commons, reliable prosperity and sustainable world development. The United Nation Declaration of Human Rights (1948) promotes the wellbeing and sacredness of all life not just human life (see http://www.un.org/en/documents/udhr/). In the words of twenty two Indigenous Philosophers in the Redstone Statement (2010) ,we are at a tipping point, and it is therefore essential for non-Indigenous and Indigenous, native and non-native people to act now, to hold and care for Mother Earth in order to protect the sacredness of all life (see http:// ww.Indigenousenvirosummit10.unt.edu). This world belongs to all of us and we must again learn to live, love and work together to protect the sacredness of all life.

As traditional custodians in Australia we recognise and value the protection of all inhabitants who are connected to ancient geological and living water systems; rivers, arteries giving life to our dry sun burnt country. We have a responsibility as scientist, researchers and practioners to generate multiple bodies of information and practice to inform our role not as activist but rather as actionist. I am passionate about working in a dialogic action way to bring about transformational change in the recognition and promotion of the multiple values of this uniquely rich Australian cultural landscape. Late last year with fellow Australians we showcased and shared the places we love, see https://www.youtube.com/watch?v=VBh0gnwzuwI

The Kimberley region of Western Australia is considered one of the last great wildernesses of the world. Vast areas of the region were National Heritage Listed in 2011 for multiple world values containing ; vast ramsar wetlands a rich feeding ground for extensive species of migratory birds, the world's largest dinosaur footprints and extensive trackways, ancient rock art, pristine coast lines, rich ecosystems, and unique living Indigenous cultures co-existing with Asian and European heritage. We need transparent participatory planning, which values existing natural assets as capital and includes people in planning. My vision is the planning, development and delivery of a Maroodwarra (Fitzroy River) and the Broome Coast Global Geo Park. Investment needs to be mobilised to conduct a Feasibiity Study to build on the recognition of national cultural and envrionmental heritage landscapes. The time is right to build a body of evidence, for valuing these multiple assetts as a geo world parks. We need to map alternative strategies for innovation and diverse economies on country if we want reliable prosperity and a sustainable common future against climate chaos.

K-2238-02

Indigenous and Non-Indigenous Collaboration: Essential for Addressing Climate Change in the 21st Century

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Indigenous peoples worldwide possess extensive knowledge that is essential for environmental and human preservation in the coming century. Many scientists, both Indigenous and non-Indigenous, believe that we are at a "tipping point" in maintaining the health of the environment, and consequently, of humanity, and that action must be taken immediately. In order to best utilize Indigenous cultural and cognitive resources in addressing Climate Change issues, respectful, trusting, mutually beneficial relationships and partnerships must be built. This requires that "Western" scientists and policy-makers develop skills for working effectively in Indigenous communities and understand their shared interests. While Traditional peoples and national or state governments are frequently in conflict with each other, examples of collaboration can be found.

The 2004 Indian Ocean tsunami provided one of the most powerful illustrations of the value of Indigenous knowledge. Indigenous communities fared far better than others, and commanded the attention of "Western" scientists, especially in the United States.

In meetings with Indigenous communities in Sarawak (Malaysia) subsequent to the tsunami, with the Tatar-Baskiri villagers of Ufa-Shigiri (Siberia, Russia), and with many American Indian Nations in the central United States, I kept hearing the same shared concerns: the need for cultural preservation, protection of Indigenous land, and a desire to engage with other Indigenous peoples and with Non-Indigenous leaders. Exploration of these shared issues led to requests for mutual dialogue, and from 2007-2010 four annual Indigenous Student Videoconferences were held. Participants from Comanche and Kiowa American Indian Nations, Siberian Baskiris and Tatars, and Sarawakian communities discussed Climate Change issues and related impacts on their communities. They shared various culturally-specific responses. Simultaneously, Traditional leaders expressed the belief that environmental threats needed to be addressed immediately. These concerns were clearly articulated in 2010 through the "Redstone Statement," a product of the International Summit on Indigenous Environmental Philosophy held in a Kiowa American Indian community of central Oklahoma, United States. Individuals from Indigenous communities met initially to compile case studies of climate change impacts. In the first meeting, however, a representative from the American Indian Ponca Nation challenged us to draft a statement articulating perspectives on environmental concerns and necessary responses. The subsequent process produced a consensus document describing a critical "tipping point," the product of environmental and cultural imbalance. The document was translated into Spanish and Russian, and is being used as a basis for education and action in Indigenous communities from Russia to Australia to Mexico.

Effective partnerships are only possible when «Western» scientists come to understand and respect the concerns expressed by Indigenous voices. Non-Indigenous scientists, policy-makers and politicians must recognize the importance of Indigenous participation in planning and implementing mitigation and adaptation efforts. This can only be accomplished if the non-Indigenous put effort into learning how to work effectively in Indigenous settings. An understanding of cultural perspectives such as holistic world-views, the importance of maintaining balance, intimate relationships with the environment and sacred places, and long-term sustainability is essential to building authentic relationships. Additionally, non-Indigenous partners must spend time on-site in Indigenous communities, meeting with elders and other knowledge-keepers. Finally, mechanisms and venues must be created through which Indigenous and non-Indigenous representatives can meet as equals to plan, explore options, draft strategies, and begin implementation projects.

There are examples of successful collaboration. The U.S. Environmental Protection Agency's Tribal Science Council began bringing Indigenous scientists and knowledge-keepers together with non-Indigenous scientists for collaborative efforts in 1999. Effective partnering is not only possible, it is essential!

O-2238-01

Indigenous knowledge from Land to lab to land: A framework to improve the flow for climate change adaptation

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Rich traditional ecological knowledge (TEK) is not only vital for sustainability of livelihoods of indigenous people, it is also vital for the sustainability of natural resource. The efficiency and efficacy of this traditional knowledge on agricultural farms, forests, water, households, community resources etc are to be well recognised in the interest of the humanity and sustainability at large. Redstone Statement recognises that indigenous people across the globe have been confronting climate change and variability on regular basis due to heavy dependence on natural resources for their livelihoods. These hardships beside others have made them develop deep understanding of the natural resources and the climate they live in. Their TEK includes prediction of disasters, mitigation and adaptation to climate change besides conserving and preserving of natural resources. Indigenous communities have been transmitting knowledge for generations regarding judicious use of resource and restricting resource depletion.

The indigenous knowledge prevailing in customs, beliefs, practices and wisdom is rediscovered in modern science. Indigenous knowledge is documented and transmitted through ethos, epics and ancient texts. The modern science is experimented, analysed and documented in the labs under ideal resource conditions whereas indigenous knowledge is practiced on forests, fields, and farms under actual climatic and resource conditions. Therefore new knowledge of modern science is to be built up on indigenous knowledge without discrediting it. For sustainable planet, we need all stocks of indigenous and innovative knowledge which gets enhanced through continuous flow of it and supported by institution which is ethical in its framework. The ethno-ecological knowledge combined with ethno economics provides better understanding and choices to resolve these issues.

In India these aboriginal people are known as atavika and adivasi (indigenous), vanvasi (forest dwellers), girijan (hill people). These tribal communities as Bishnoi, Bhil, Gond, Santals, Bhotiya and Khasis are living majorly in states of Rajasthan,Uttar Pradesh, West Bengal, Bihar, Tamil Nadu, Meghalya and Himalya region in harmony with nature. The farmers in arid and semi-arid regions rotate crops and change the dates for sowing seeds as per climate conditions across India, Koli community of Mumbai change their fish catch pattern to enhance availability of fish in future, Navdanya programme promotes biodiversity conservation with the help of local tribal people. Religious and tribal traditions such as temple forests and sacred groves, rainwater harvesting, maintaining landscape heterogeneity and biodiversity through varietal flora and fauna and growing medicinal plants are just few examples of their efforts.

The aboriginal communities in developing countries like India face many issues alongside their hardship of livelihood like inequality in the access of resources, unequal distribution of growth, increasing urge of growth and consumerism all have impacted the livelihood dependent on natural resources as well as the sustainability of available resources. In many cases natural resources are reaching to the stage of economic depletion. The valuation and integration of their knowledge systems is not only desirable but essential for equity, empowerment, and security of underprivileged community besides natural resource management. Endeavours of integrating traditional ecological knowledge with western science requires due recognition for local long lasting cultural and institutional framework. Within this framework, their security of land, food, energy and livelihood and knowledge is to be ensured through policy framework. In this discussion I propose to provide a framework for traditional ecological knowledge security through innovative market and non-market incentives and disincentives to protect and promote wealth of indigenous knowledge for our sustainable common future.

O-2238-02

Integration of Indigenous Knowledge with ICTs in coping and adapting to effects of climate change and variability on Agriculture in Kajiado County, Kenya

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Climate change threatens production's stability and productivity. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is expected to reduce productivity to even lower levels and make uncertainities in agriculture higher. To help in coping with the negative effects of climate change, local people employ traditional indigenous-knowledge based practices. This local based knowledge, which has evolved over several hundreds of thousands of years in tandem with the domestication of plants and animals, is critical for responding to climate change and variability effects at the local level. ICTs have the potential improve access to this knowledge among other relevant information and social networking opportunities. The research was carried out to assess relevant Indigenous knowledge used by Indigenous people to cope and adapt to climate change and variability effects therefore managing risks and uncertainities in agriculture as well as evaluate opportunities for utilizing ICTs to communicate this information. Results indicates that farmers have shifted to farming historically known drought tolerant crops, rain water harvesting, irrigation, use of organic manure, traditional methods of treating crops pests and diseases, change in planting time, preservation of pastures, indigenous food preservation methods, vaccination ,farmers are also increasingly relying on their own indigenous knowledge in predicting weather patterns compared to scientific knowledge. Various communication mechanisms taking advantage of ICTs such as radios and mobile phones are emerging as viable tools for dissemination of relevant information to the farmers because they are affordable and use of local language which is easily understood by farmers.

O-2238-03

"Blue-ice": Framing climate change and reframing climate change adaptation from the Indigenous peoples' perspective in the northern boreal forest of Ontario, Canada

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The northern boreal forest in Ontario, Canada, in the sub-Arctic above the 51st parallel, is the territorial homeland of the Cree, Ojibwe, and Ojicree Nations. These Nations are represented by the political organization Nishnawbe Aski Nation (NAN). January 6-March 31, 2011 the researchers and NAN collaborated in a study to record observations of changes in the forest environment attributed to climate change and share and exchange information and perspectives about climate change. Data were collected from ten First Nation communities across a geographic area of ~110,800 km2 (43,000 mi2). We explore climate change impacts through the lens of "blue-ice", a term embedded in their languages across the fieldwork area and reframe adaptation in the First Nations' perspective and worldview. Changes in blue-ice on the landscape is affecting transportation in traditional activities such as hunting and fishing, as well as the delivery of essential community supplies. The word 'adaptation' linked to climate change does not exist in their languages and the term is associated with European colonization. We propose the term 'continuity' to reflect the First Nation worldview. Our recommendation is giving First Nations' perspectives and knowledge of their territorial landscape a foundational role in the development of climate change policy for Ontario's northern boreal forest.

O-2238-04

Forest Carbon in Amazonia: The Unrecognized Contribution of Indigenous Territories and Protected Natural Areas

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More than half (52%; 4.1 million km2) of Amazonia's tropical ecosystems are contained within an extensive network of 2,344 Indigenous Territories (ITs) and 610 Protected Natural Areas (PNAs) spanning nine South American nations. These cornerstones of Amazon conservation are widely recognized for their exceptional biological, cultural, and linguistic diversity, and serve as both social and natural barriers to frontier expansion and fire. Carbon sequestration is a widely-acknowledged and increasingly-valued function of tropical forest ecosystems; however, until recently the information needed to assess the carbon storage capacity of Amazonian Indigenous Territories (ITs) and Protected Natural Areas (PNAs) in a global context remained either lacking or out of reach. Here, as part of a novel north-south collaboration among Amazonian indigenous and NGO networks, scientists, and policy experts, we link newly compiled spatial data sets on pantropical aboveground forest carbon density, Amazonian ITs and PNAs, and risks to their integrity from current pressures and/or near-term threats. We show that the nine-nation network of nearly 3,000 ITs and PNAs stores more carbon above ground (47,363 Mt) than all of the Democratic Republic of the Congo and Indonesia combined (40,797 Mt), and despite the ostensibly secure status of these conservation cornerstones, a conservative risk assessment considering only ongoing and planned development projects puts nearly 20% of this carbon at risk, encompassing an area of tropical forest larger than Colombia, Peru, and Ecuador combined. Our analysis suggests that the carbon stored across these landscapes is of a magnitude not previously appreciated in global terms, and is sufficient to either destabilize or contribute to the stabilization of the planet's atmosphere depending on the collective impact of ongoing and planned development projects. International recognition of and renewed investment in this globally vital network are therefore critical to ensuring their continued contribution to maintaining cultural identity, ecosystem integrity, and climate stability.

O-2238-05

Traditional knowledge and benefit-sharing in the 2015 agreement

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Scientists have increasingly recognized the role of traditional knowledge as a means to adapt to climate change. Yet, the international climate regime presently says nothing on how traditional knowledge may be deployed and protected to tackle climate change. This state of affairs may, however, be about to change. States are considering including references to the use of the traditional knowledge of indigenous peoples and local communities in the new international agreement on climate change to be adopted in December 2015.

While it is too early to say whether references to traditional knowledge will be included in the new climate agreement, it is important to reflect on the implications of this possible development in the light of extant international instruments, especially those concerning biodiversity and human rights, which establish obligations to protect, maintain and promote traditional knowledge. This paper will therefore reflect on the scope for elaborating a common approach to the use of traditional knowledge under the climate regime, building on extant international law.

One area of crucial legal development on traditional knowledge is that concerning the interplay between the consent of indigenous peoples and fair and equitable benefit-sharing, as means to recognise, support and reward indigenous peoples and local communities for the contribution of their traditional knowledge to addressing global challenges. The Convention on Biological Diversity (CBD), for example, requires its Parties to promote the application of traditional knowledge with the approval and involvement of its holders, and to encourage the sharing of benefits from its use with indigenous peoples and local communities. The Nagoya Protocol on Access and Benefit-sharing to the CBD requires its Parties to ensure that the use of traditional knowledge associated with genetic resources for research and development purposes (including for the development of climate-related technologies) is subject to the prior informed consent (or approval and involvement) of indigenous peoples and local communities, as well as to benefit-sharing. Equally, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR) recognizes farmers' right to participate equitably in the benefits arising from the utilization of plant genetic resources for food and agriculture. The need to maintain traditional, often underutilized, crop varieties in the face of climate change has been explicitly recognized in the ITPGR framework. The ITPGR Benefit-sharing Fund has supported a number of projects focusing on management and use of plant genetic resources by indigenous peoples and traditional communities for adaptation to climate change. Finally, even though it does not make explicit reference to benefit-sharing, the United Nations Declaration on the Rights of Indigenous Peoples asserts indigenous peoples' right to maintain, control, protect and develop their traditional knowledge.

Presently, the negotiating text for the 2015 agreement mentions traditional knowledge in connection with adaptation to climate change, capacity building, and technology development and transfer. It does not say that indigenous peoples and local communities should receive a share of the benefits accrued from the utilization of traditional knowledge, or that they should consent before others can make use of such knowledge. The proposed paper will investigate how the law and practice emerged under the CBD, the Nagoya Protocol, the ITPGR and international human rights law could or should influence the development of the climate regime with regard to the use of traditional knowledge for climate adaptation purposes. It will argue that biodiversity and human rights law and practice embody internationally agreed understanding on matters upon which states have already reached painstakingly negotiated consensus. As Parties to the climate regime consider including traditional knowledge in the 2015 agreement, it is important to consider lessons that can be learnt from extant approaches to account for crucial equity considerations associated with the use of traditional knowledge.

2238-POSTER PRESENTATIONS

P-2238-01

Quantitative analysis of Greenhouse Gas (GHG) as a Milestone Towards Negative Emissions in Egypt

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Greenhouse Gas (GHG) analysis has been developed with the objective of providing an integrated perspective on Environmental sustainability. Emission baseline has been analyzed on a macro sector basis with a focus on key sectors; Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use and Waste. Data has been collected from available public sources (local and international). A web based IPCC Inventory Software supporting users of the IPCC Guidelines has been used. Additional support to the greenhouse gas emission inventory community by giving inventory compilers a platform for exchange of all the current information and data they need, including a wide range of emission factors has been provided by means of the IPCC Emission Factor Database (EFDB). All Greenhouse Gas emissions divided into IPCC Guidelines Categories may be calculated from sectoral tables. National Key Category Analysis is implemented by performing a quantitative analysis of the relationships between the level and the trend of each category's emissions and removals and total national emissions and removals. The paper concludes that Sharing of research information may enable the African countries to use or develop emission factors that are more applicable than the IPCC default emission factors and may help to improve the quality of GHG inventories in a cost-effective way.

P-2238-02

Toward a transdisciplinary framework for inter-relating indigenous knowledge systems and disaster risk reduction

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Perceptions of natural hazards and climate change vary across regions, societies and culture. While "western" expert-based knowledge focus on measuring, defining and forecasting hazards' occurrence, frequency and localization, local perceptions at the community level - often referred to as "indigenous knowledge" (IK) - adopts a context-specific and holistic view of natural, climate-related and human-made hazards and disasters. Indigenous knowledge systems intertwine cultural, symbolic, technological knowledge, natural resource management practices, beliefs and worldviews in perceiving, preparing and managing disasters.

This talk presents the preliminary results of a follow-up project from the Risk Interpretation and Action (RIA) Fellows of the International Social Science Council, involving indigenous and non-indigenous researchers and practitioners. Acknowledging the diversity of perceptions and understandings of risks, this collaborative work aims to develop an exploratory transdisciplinary framework drawing from literature review as well as from experiences and challenges faced by indigenous peoples in developed (USA, New Zealand) and developing regions (Nigeria, Brazil). The framework can be applied to foster dialogue and guide research and policy-making involving indigenous peoples in disaster risk reduction (DRR) and climate change adaptation (CCA), recognizing limitations and power issues in coordinating different knowledge systems, and respecting indigenous peoples' self-determination, worldviews and concerns.

With an objective to enhance cross-disciplinary learning, the proposed framework offers a broader understanding of disaster risks among indigenous people, scientists, practitioners and managers. Its structure encompasses (and adapts) the usual three phases of the DRR process, represented by indigenous symbols: preparedness (pre-disaster); response (during disaster); and recovery (post-disaster), adding a fourth transversal component, critical during the three phases, and related to framing, understanding and fostering dialogue across knowledge systems. Thus, the framework distinguishes common and contrasting features of DRR and CCA across diverse regions, cultures and types of disasters; it presents nuances of 'risk perception' and 'risk interpretation' among indigenous communities in different countries and contexts, as well as their creative responses or 'risk action'.

The outcomes of this study will be used to connect, foster exchange of ideas and experience, and facilitate training and learning among representatives of indigenous communities who face natural, industrial and climate change-related hazards. Moreover, this research contributes to foster transdisciplinary dialogue and research on indigenous, academic and practical knowledge systems towards DRR and CCA in a global scale.

P-2238-03

The Coastal Community as Context for Culture-Based Science Literacy

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People in a community who are closely connected to the local surroundings were often the first to notice their surroundings. This is because their knowledge is derived from long-term observational data maintained through an oral tradition. It is for this reason that the knowledge held by the community needs to be reflected in local classrooms. When we think of something or discover a new fact, we also think of all the interconnections between that fact and everything else. And so it is with their science: it is going to be connected to everything within their culture. The local funds of knowledge in the community included the culture, attitudes, beliefs, concepts, ideas experiences and stories of the people in the coastal community. The local funds of knowledge are stored in the people's lives, in their environment and their history. The local knowledge, wisdom and experience were valuable, appropriate and still relevant for people and can be capitalized to teach relevant science in schools. These knowledge bases are a rich resource for teaching biology, environmental science and ecology.

There were identified barriers in the teaching and learning situation in coastal communities; academic, situational, and dispositional. The set of learning materials represents my attempt to delineate a preparation content covering how regular classrooms and schools should be designed to ensure all students have appropriate opportunities to learn effectively. This, of course, includes the many that manifest commonplace behavior, learning, and emotional problem. However these materials develop are targeted to address the academic barrier .Nonetheless, parallel to the development of the materials, an approach (culture-based; contextualization: and community-based learning) was also espoused to enrich the material in its delivery to the mainstream classroom. The materials represent my attempt to deliver learning to the local students to answer some usual problems in their place; pollution, health, environmental protection, climate change mitigation, disaster risk reduction and preparedness and biodiversity. Relative to this, training, seminars, workshops are also recommended to address the said barriers.

This research suggests means and ways on how to respond to the question of how to support science teaching in rural and coastal settings and frames challenges to student learning as disconnects between community-based and school-based forms of science. This disconnect occurs when students do not see how the science in schools has value in or relates to their lived experiences and when schools do not see how the lived experiences of learners have value in learning and doing science. I have presented here a case of what I call «connected science,» which uses real-world problems and school—community partnerships as contextual scaffolds to bridge these diverse funds of knowledge.

The study developed two important theoretical contributions. First a model on how to create culturally relevant community-based learning through: (a) mining local funds of knowledge from the community, (b) constructing cultural memory bank, (c) developing a contextual-learning strategy for coastal communities, (d) developing a tailor-fitted instructional material for coastal communities and (d) teaching culture-based, and context-based science in schools. The second contribution is the Theory of Community Learning Exchange Valorization . This theory attempts to conglomerate conceptions and notions about the "mining" of the community funds of knowledge and the way this knowledge can be "valorized" and be "given back" to the community.

On a final note drawing on the assets of the communitycan help schools build citizens while infusing academic course work with meaning and relevance. Rather than diluting the school curriculum, community-based learning strategies increase the intensity of learning and the likelihood that young people will transfer knowledge and skills to new situations. By fostering student interest in their respective communities, these strategies sow the seeds of lifelong learning. When students see themselves as citizens, they take responsibility for what happens to their neighborhoods, communities, and country at large.

P-2238-04

Wunan Law and Human Identity through Connections with Country

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In the Kimberley region of North west Australia, much local knowledge is not only relevant to current scientific observations, but continues the oldest recorded human history of living WITH country. Once the first rock art appears documenting the evolution of the Wunan social order, we have ancient evidence of people sharing a complex legal association with landscapes that weave together identity and country binding people to environments inherited in perpetuity. Wunan law remains documented by Gwion rock art, preserved beneath skins of silica crystals leached by weathering from sandstone through a long history that spans millennia of changing climates from estimates of 25,000 years past up to the present day; the film GWION documents Paddy Nyawarra repainting a sentinel Gwion figure standing guard at the junction of three Wunan districts in 1999. Wunan laws defining human identity through land contradicts the assumptive stereotype of the 'nomadic aboriginal' with nothing new to offer modern science, in fact, and as published in Rock Art Research March 2014, Wunan is living evidence of the longest continuous stable social system documented by the human hand.

Wunan law proscribes social identity as living connections to country so over time Gwion artists were motivated to portray human figures with unique extensions to their body, making specific social connections to local flora and fauna. Many ancient Wunan law songs about birds and knowledge of Wanjina and Gwion rock art survive in Ngarinyin culture as part of customary law, as declared by native title belatedly recognised by the Federal Court of Australia in 2005. The ancestral evidence documented with cameras by four Ngarinyin munnumburra – experts in Wunan law, has been generously exhibited by three major museums in France. Now we can tell our children about a society that begins not with a warrior or king, but an artist called Wibalma. They can learn how the oldest society to record themselves through art began when the visionary artist Wibalma created the first sacred object, not of an animal but an ethic at the core of social order. Wibalma's sacred object of Justice was the catalyst bringing together many nomadic tribes, to find a consensus around the stone table at Dududu.ngari and fuse their identity with their country forever in Wunan law. Lines of stones mark positions where they stood in line to announce by oath, their homeland and name, in sequence from the central desert to the tropical north coast across to the western coastline. Aboriginal councillors who represent their country in public meetings today still follow the Wunan order of representing various districts.

As documented through the graphic evidence of Gwion artists, the Wunan law system has ordered sustainable land tenure connecting human to country for millennia. Aboriginal people across the Kimberley region continue to carry, but must struggle to preserve their ancestral legacy and protect fresh water resources in opposition to invasive mining projects. Observations of climate change must incorporate local knowledge, and across the north-west of Australia from desert to saltwater coastline, planners must include the pre-colonial Wunan map of water and country that gave each human being their individual identity. For example the name Nyawarra, refers to outcrops of black basalt appearing in his Wunan district of Galeru.ngarri dambun. Wunan law preserves many insights into the natural history of this extensive region and provides a historically meaningful nomenclature of flora and fauna and local landscapes as the fundamental framework of knowledge for future research and education.

High on the rock wall of Alyaguma covered with ancient paintings of the first matriarchs of visual metaphors signifying various stages of education throughout life. Starting from the roots of family blood and the single root of Wunan law, education proceeds into maturity once understanding the complex binary system of marriage and environmental relationships to country marked by two separated feet looking down. Then adults educate the new generation symbolised by the ripening plum fruit when monsoonal rains fall from above. The elements and meanings of the painting are illustrated and described with verbatim cultural evidence recorded on site by Ngarinyin munnumburra – experts in Wunan law and the living bush .

P-2238-05

Toponymy of an occupation early hunter gatherers in marine Quintero

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This is a presentation of the state of the art of research conducted in a series of explorations in the line of rocks from San Fuentes Lace up Pirate's Cove area, in the town of Quintero, Chile, between 2011 and 2013. It describes the finding of lithic evidence in five archaeological sites observed from perforations in the rocks as water toponymy signaling; based on the experience of discontinuous occupation of marine hunter-gatherers. As a result of continental settlement in the late Pleistocene and early Holocene epochs. This paleoenvironmental context generated conditions of survival, which according to weather representations, allowed the survival of anthropogenic Paleoindian presence. However the latitudinal gradient was also exposed to periods of cooling or neoglaciation. Therefore, while climate change was constant, it created new demands for adaptation in order to ensure the survival of hunter-gatherers. Therefore, their lithic technology fitted the necessary mobility of the group. A synchrony between their social structure and technology in understanding their decisions, represented in a toponymy of lithic signs to identify water as a source of survival. Keywords: Hunter-gatherers, paleoenvironment, lithic toponymy, Paleoindian, climate change.

P-2238-06

Indigenous Knowledge as Local Response to Globalization and Climate Change in Nigeria/Africa

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As we consider the Post-2015 Development Agenda for Africa, indigenous knowledge may prove to be "the single largest knowledge resource not yet mobilized in the development enterprise". Critics of African development liken the current pattern of development in the continent to building a house from the roof down as "all the institutions of modernization appear to be suspended over societies that have no firm connection to them, and whose indigenous institutions, even when oriented in the right direction, lack the necessary scaffolding to connect them to their modern surrogates". Africa contributes least to, but suffers the most from the disastrous consequences of climate change. While the industrialized and more affluent countries are rightly being called upon to take greater responsibility for the current global environmental and economic crises, Marshall Sahlins has rightly emphasized the need for all peoples "to indigenize the forces of global modernity, and turn them to their own ends", as the real impact of globalization depends largely on the responses developed at the local level. How can Africa engage with globalization, and cope more effectively with the worsening threats of flooding, droughts and other emergencies that result from extreme weather conditions?

For a long time African customs and traditions were misconceived as irrational and incompatible with the conventional strategies of development. But the current global economic and ecological crises have exposed flaws in the Western neo-liberal model of development which is largely to blame for these problems, and for widening inequalities within and between nations. With the obvious underperformance of the Millennium Development Goals in Africa, there is now renewed interest in an alternative approach which emphasizes the cultural dimension of development, and the overlooked potential of indigenous knowledge. This paper considers how indigenous knowledge and practice can be put to good use in support of good governance, agriculture and natural resource management, poverty alleviation, and the mitigation and adaptation to climate change. Although poverty may sometimes force people in the developing world to use resources unsustainably, most traditional African societies have deeply entrenched ideas about environmental protection and sustainability since their livelihood depends largely on the land and on the stability of the ecosystem. They believe that land and other forms of nature are sacred, and are held in trust by the present day users on behalf of dead ancestors and future generations. Chief Nana Ofori Atta of colonial Ghana emphasized to a British official that "land belongs to a large family of which many are dead, a few a living, and countless hosts are yet unborn".

The paper argues that the indigenous knowledge movement is not only a useful and creative way to respond to globalization, it also has great potential for the mitigation and adaptation to climate change. While Africa cannot now contemplate an insular and entirely home grown approach to its development, indigenous knowledge offers a model for rethinking and redirecting the development process, and for enlisting positive traditional values and institutions in a way that enables and empowers local actors to take part in their own development. Development agents, researchers and donors, who often assume a knowledge or capacity vacuum in Africa, should instead try to tap into indigenous knowledge for locally appropriate ways of forecasting weather systems, traditional techniques of soil management, pest and disease control, adopting suitable crop and animal varieties, and so on. By building on the indigenous we can make development more participatory and sustainable, and also promote intercultural dialogue in African development.

P-2238-07

Local Management of Andean Wetlands in Sajama National Park, Bolivia

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Andean wetlands or bofedales are commonly used by indigenous communities for livestock production. Decisions regarding management of bofedales involve the active participation of local people and their social institutions. Consequently, any action addressing emerging challenges must be implemented in coordination and agreement with local actors. This decision process requires an understanding of the local socio-economic and cultural dynamics, especially those related to land and natural resource management. In many Andean communities, the ayllu is the institution that governs decisions on regional land use. However, in the face of increasing challenges such as climate change and population growth, use of the ayllu has declined in favor of individual decision-making. Here we discuss how the Andean camelid herders of Sajama National Park in highland Bolivia rely on both the ayllu and family-level decision-making to manage their pastoralist landscapes, including their bofedales. Using a rights mapping methodology, we describe how water and wetlands are managed, and determine which decisions are taken at the community level and which are made at the family level. We conclude that indigenous collective organization networks are still significant for managing the system at a regional scale and possibly determinant for mitigating risks associated with climate change on sensitive ecosystems such as bofedales.

Since the Spanish conquest in the 16th century, the world view of native Andean indigenous communities had to interact with the dominant sociopolitical systems of the colonial and later republican period (Schiffers 1992, Regalsky 1994, Platt et al 2006). One important element of confrontation between these two visions was the form of land and natural resource management: collective vs individual. Indigenous communities adapted and developed a number of cultural and productive organizational strategies to cope with the new forms of domination, trying to maintain the logic and vision of the Andean territorial management strategies (Orlove 1977; Platt 1982; Spalding 1984).

One of the main strategies in the Andean world was access to the greatest possible number of ecological zones, which was a strategy to achieving food self-sufficiency and also an important risk management tool, mainly for climatic risks (Murra 1972; Browman 1983; Regalsky 1994).

Because of the social and economic importance of wetlands, especially for camelid (llama and alpaca) herders, communities in these areas periodically revise and adapt institutional arrangements for sustainable management. High Andean wetlands, known locally as bofedales, represent one of the most productive native vegetation types of the puna. However, they are seriously threatened by climate change as they depend on constant water flow, which is mostly assured by annual glacier melt and precipitation (Squeo et al 2006; Yager et al 2008; Ruthsatz 2012). In view of these threats, it is particularly important to document how local wetland management strategies are being adapted to cope with emerging challenges (Pinto-Romero 2011; Verzijl and Guerrero Quispe 2013).

Conclusions
The study shows the ability of Andean communities to face up to social and environmental challenges in Sajama National Park. The 5 ayllus that are part of the Park have managed their natural resources, which include Andean wetlands, since precolonial times. In doing so, they have maintained a balance between permanence (the principles and world vision of the Andean culture) and flexibility (changing strategies for adapting to constant environmental, sociopolitical, and economic change).

Finally, we raise the question of how the process of collective vs family-based decision-making will develop in future. Adapting to change appears to have accelerated in the last decades, and market influence is becoming more intrusive in the ayllus' daily operations. It is worth asking if this process will lead to a gradual dismantling of the ayllu and the loss of one of the main strengths of Andean communities: collective organization networks.

P-2238-08

Indigenous knowledge for seasonal weather and climate forecasting across East Africa

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Advance knowledge of climate information is important in helping farmers make decisions about allocation of land, labor, and agricultural enterprises in a season. It enhances their capacity to adapt to climate variably and climate change. Climate information coupled with agro-advisory services offers greater potential to manage climate related risks in the face of increasing uncertainty. While progress has been made in provision of climate services for farmers, significant gaps still exist with regard to downscaling location-specific forecasts, reliability, timeliness, and user-friendly climate information that effectively addresses the needs of farmers. Consequently, most farmers rely on indigenous knowledge (IK) for their seasonal forecasts, where locally observed variables and experiences are used to assess and predict the local weather conditions and particularly the onset of rains as it determines the sequence of many of the farm operations. However, IK experiences for climate forecasting are not widely documented and often passed on from one generation to the other through oral history and local expertise, creating a wide inter-generational gap between its custodians and the young generation.

This paper presents a synthesis of existing IK in weather forecasting across four sites in three East Africa countries — Borana (Ethiopia), Lushoto (Tanzania) and Hoima and Rakai (Uganda). Across the sites, farmers and livestock herders use various local indicators to predict weather patterns, especially the onset, magnitude and cessation of the rainy seasons. The indicators can be grouped into three main categories: meteorological traditional indicators, astronomical indicators and biological indicators. Meteorological indicators commonly used to predict onset of rains included appearance of dark clouds, direction and strength of the wind, maximum and minimum temperature, plant responses to changing conditions, monitoring of the physical state of water and off-season advance indicators of cloud behavior at night. For instance, excessive heat and warming towards the end of the dry season indicates a likelihood of above normal rainfall. Similarly, high temperatures during the night indicates a likelihood of rainfall the next day. Astrological weather indicators include the position and appearance of the moon and sun. In Lushoto, the occurrence of a halo moon indicates the likelihood of the onset of rains for both major and minor seasons. In Ethiopia, the Borana herders employ astrological indicators and interpret the alignment of celestial bodies including the size and appearance of the star, the brightness of the sun, and appearance and form of cloud cover. Biological indicators are further disaggregated into animal and plant indicators. A change in animal behavior at the onset of rains is believed to be triggered by aroma from volatile compounds that increase in intensity when changes occur in humidity. In Uganda, the sound from amphibians during day time and those of specific birds are used widely to estimate the likelihood of the onset of rain. In Tanzania, appearance of certain physiological stages of insect populations, such as thrips in the wetland indicates the likelihood of an above normal rainfall season. Plant indicators most frequently used in Uganda included the sprouting of young shoots of the Mvule tree and blossoming of coffee bushes. In Tanzania, common plant indicators included flowering of venonia, pears, Albizia spp. and plums. Shedding of leaves of black nightshade also indicate the onset of rain.

We observe that farmers and herders were using these local indicators to make important agricultural production decisions including the timing of land preparation, dry planting, and purchase of seeds, type of crops to grow, agronomic practices to use, and labor allocation. In Borana, IK forecasts are used to plan livestock mobility and sharing of livestock amongst relatives to minimize losses during drought conditions. In Ethiopia and Tanzania, farmers considered IK climate forecasting a reliable source of climate information. They extend IK for forecasting of extreme events e.g. droughts and timing of the onset of rains. The paper demonstrates that farmers' trust and willingness to apply scientific forecasts would likely increase when IK forecasting are integrated with modern scientific methods. Therefore, a systematic documentation of IK and a framework for integrating IK and scientific forecasting from the national meteorological agencies can improve the accuracy of climate forecasts for farmers in East Africa.

P-2238-09

Linguistic Identity and Indigenous Knowledge

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The North as a cultural-historical form of civilization is composed of socio-cultural communities of individuals with well-known and persistent traits and characteristics, such as language, culture, environment, economics and spirituality. Geographical and cultural conditions of the North influence the formation of similar elements of the mental and linguistic identity of the peoples of the North. The common feature defining all northern communities is the deeply ecological aspects of their culture and recognition of a special relation with nature.

The research is aimed at study of northern world view through free association experiment's database realized in indigenous communities. The associative verbal nets reveal the peculiarities of spiritual and material culture, ethnic stereotypes of behavior, traditional beliefs and specificity of ethnic world view. The strings of verbal associations translate into assemblages of ideas, identities and behaviours which found their owner experientially located in self-contained worlds of people, events, values, norms and constraints (Rapport, Overing.).

The world view is a major component of culture and contains all the essential elements of traditional and cultural knowledge which an individual, belonging to a particular culture, needs in order to adapt to both natural and social components of his/her surrounding environment. This is the lens, so to say, through which people see the world in which to act. The structure of the world view is shaped in the early stages of ethnogenesis, and remains largely immutable throughout the life of an ethnic group (S. Lurie). It defines ethnic identity and uniqueness of a particular culture and, hence, its carriers - the members of an ethnic group comprising a social community characterized by a specific cultural model which mediates the nature of their activity in the world.

The data of free association experiment (associative-verbal nets) in so far as they reflect unconscious layers of the mind, especially within the context of inter-cultural contact in a multicultural and multilingual environment, present interest not only for the investigation of a variety of scientific problems, but also of many issues of everyday life of indigenous peoples. Language, culture, and the relationship to the land are key elements in a seemingly fragile and yet tenacious Arctic indigenous identity. There is high correlation between language retention and traditional lifestyle of indigenous peoples of the North. They live in close contact with the land, the sea, and the animals. Many indigenous Arctic peoples continue to live partial or total subsistence lifestyles, which is reflected in their languages, most obviously in their vocabularies, but

also in the contents of their everyday stories, which often involve hunting, fishing, and encounters with animals (especially bears).While the links between language, culture and environment may not be obvious to outsiders, they are deeply embedded in the daily life of Northern indigenous peoples (L.Grenoble).

Government policies in the sphere of national relations in the Republic of Sakha (Yakutia) place particular importance upon questions of vitality of small indigenous peoples' languages and cultures. The indigenous peoples of Yakutia, living in the inhospitable climate of the North, created unique modes of life and have interesting and instructive histories, traditions, and original cultures. Globalization and the pressure of mass culture endanger not only their languages but their traditional ways of life.

The researches of North-East Federal University of Yakutsk has been conducting psycholinguistic research on linguistic identities and indigenous world views of the peoples of the North, living on the territory of Yakutia. In this context linguistic research plays a vital role in the efforts to preserve the ethnic languages and by extension cultures of the people living in the North of Russia (Yakuts, Evens, Evenki, Yukagirs) since language not only communicates, but also encodes essential aspects of cultures and fixe their uniqueness for preserve and translate to the next generations.

2239 - Co-production of knowledge : How to interact to produce climate adaptation research, between scientific communities and stakeholders, at local or international, also between North and South countries ?

ORAL PRESENTATIONS

K-2239-01

Unpacking the co-production of knowledge in adaptation to climate change

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The Intergovernmental Panel on Climate Change (IPCC) has been instrumental in raising political awareness of climate change at the global level, whilst the knowledge produced by the IPCC and other high level scientific programmes is seen as relevant it's not always "usable" for decision-making at the local and regional level where adaptation to climate change is crucial. Despite advances in climate science and adaptation policy, critical understandings of which approaches can most effectively harness science and technology for long-term sustainable adaptation is still lacking. "Usability" of science cannot be taken for granted. In order to fill the gap between the supply of scientific findings and its demand at different levels of decision-making, co-production has become a key concept guiding major international research initiatives. "Co-production" has a myriad of meanings, some practical-organizational orientated others social-philosophical. This talk aims to unpack how, why, and to what extent, the concept of co-production can inform scholarly debates and practical exercises on adaptation to an uncertain future climate. The talk is informed by a recent international workshop on the topic and empirical work conducted in the United Kingdom on the construction and use of climate change projections in long-term adaptation decision-making.

K-2239-02

Climate change adaptation: towards a new geography of knowledge?

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Facing critics and distrusts towards a "Northern Science" accused to mainly follow Northern interests (Lahsen, 2004), IPCC strove to better include Southern Scientists in report production (Dahan, 2008). However, as noted in its fifth report (WGII), there remains a North-South inequality in research production and access, in spite of a raising involvement of Southern Scientists. This discrepancy is both rooted in research funding and limits of capacity (Burkett, et al., 2014).

The issue is thus particularly sharp for Least Developed Countries (LDCs), who are both the less responsible, the most affected and the less in capacity to forecast and respond to the impacts of climate change.

In parallel, this perspective led to a progressive construction of Southern capacities, both within UNFCCC (LDC expert group), Ministries (focal points to implement NAPAs) and among civil society (academics, think tanks, NGOs). Beyond North-South cooperation for technological transfers and impact model regionalisation, the emergence of "bottom-up" approaches since 15 years, in particular «Community-based adaptation», deeply changed adaptation framing: this approach involves humanities and social sciences, jointly with the population and authorities actually living the models and striving to adapt.

Through examples from Bangladesh, one of the "hot spots" of adaptation, this talk aims at underlining the current development of Southern capacities that contribute to a "new geography of knowledge".

O-2239-01

Developing robust adaptation strategies: the importance of embodied knowledge, local knowledge and place attachment

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This presentation focuses on the importance of including local knowledge in developing strategies for climate change adaptation. The background for this focus is that the current intertwining of, and reliance on, legal-institutional and scientific expertise in environmental policy-making often leaves little room for inputs from actors on local levels, although these many times possess detailed and relevant knowledge. Regarding climate change adaptation, research in both rural and coastal areas has recently shown how meaning and identity bonds to places (expressed in place memories, norms, narratives, identities and motives) indeed matter for adaptation. Whereas a number of studies have been conducted around place (mainly in terms of place identity, sense of place and place attachment) one thread seems however to be conspicuously missing: that of place knowledge proper. A reason for this maybe the epistemic division of labor in our societies where local knowledge is re-defined as a subjective and cultural construct, contrasting it with the "real", objective and universal knowledge provided by scientific expertise. At the same time there is an increased recognition both in science and society that environmental problems require elements of local knowledge for their solution; contextually generated knowledge about local circumstances and local practices are relevant because global risks always have local and place-specific implications. Local knowledge is bond to place through its relation to living; people live in specific places and gain embodied knowledge (not least in the form of routines and habits) about how things are and work in their local surroundings.

This kind of relations to place developed and supported through knowledge and their implications for addressing climate change adaptation are discussed by using findings

from two different studies in rural areas; i) a focus group study of farmers (N=50) conducted in Natura 2000 areas of importance for climate change adaptation; ii) a study of professional expertise (N=20) that try to persuade forest owners to consider climate change in their forest practices and a study of forest owners (N=15) in forest areas that are prognosticated to be heavily affected by climate change. Through these empirical studies, it is possible to gain knowledge both on how professional expertise try to approach lay actors on local level and on how farmers and forest owners acknowledge their situation as well as evaluate and handle knowledge claims for changed action provided by expertise. The analysis finds a number of strategies through which farmers and forest owners evaluate and negotiate expert claims, resulting in partial appropriation and partial rejection of them. By reclaiming their local knowledge, accentuating how this knowledge binds them to particular places and expressing their embodied and (em)placed knowledge, they re-signify and re-contextualise the original expert advice.

A central finding of this study is that it is not knowledge as a product or property, but as practice that matters when addressing issues of local adaptation to a changed climate. The reason for this is that knowledge is not distributed and transferred in a mechanical way, but is instead actively appropriated and thereby also transformed. In this dynamic process, different kinds of epistemic bonds are central. Thus, by focussing on knowledge practices - how knowledge is developed and appropriated in different institutional and spatial settings - the knowers and his/her knowing are put at the centre, and these practices constitute an important condition for developing adaptive strategies and measures to be implemented locally.

O-2239-02

Blending local and scientific knowledge to support innovative action by community-based institutions to adapt to global change

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Today, scientists, government officials, community members and non-profits work together to blend different knowledges and apply this joint understanding to real world problems concerning global change in local social-ecological systems around the world. This transdisciplinary work often starts with explorations of different ways of knowing and what constitutes 'truth' in the cultures of research, practice and those of other stakeholders. Teams of 'boundary spanners' often lead this work and attempt to not only reach across disciplinary boundaries in academia, but the many institutional, jurisdictional, political and other boundaries that occur in practice when working in social-ecological systems.

At the community level, innovative institutions are arising to improve the sustainability of local systems, sometimes strengthened by the decentralization and devolution of power in different settings globally. These institutions are often led by local community members collaborating with diverse stakeholders at different scales. This is creating a revolution in the ability of local actors to respond to global and climate change in local land-, lake- and sea-scapes.

Here, I describe some principles and examples of the models that different transdisciplinary teams are using around the world to bring together diverse knowledges and create innovative solutions to global change problems. These include different practical methods like workshops to brainstorm research questions and methods, practitioner or landowner-led research projects, integrated practitioner-researcher field teams, 'what does it mean' workshops to interpret data, and co-production of knowledge products. I then review several models for integrating different knowledge sources and co-producing knowledge, based on case studies. I will conclude with a description of future directions for co-production and the potential for co-produced knowledge to be a catalyst for social change when working on global change issues.

O-2239-03

Building Institutional Capacity for Climate Change Policy: The Chilean Experience in Co-producing knowledge for acting

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Chile, as part of its climate change policy, assumed in 2010 the challenge of generating evidence nationwide to project long-term scenarios and options for mitigation of greenhouse gases (GHGs), in order to support its position in the international negotiations on issues of climate change and simultaneously, evaluate alternatives that contribute to a low carbon development for the country.

This effort, was materialized in MAPS - Chile, a project of South-South cooperation with South Africa, Brazil, Colombia and Peru, in which a process of scientific research was integrated with multi stakeholder participation to estimate the baseline emissions of the country and to evaluate mitigation actions and scenarios that might contribute to a low carbon development path.

MAPS Chile integrated a logic of co-production of knowledge with the participation of national scientist, policy makers and experts from the academia, the public sector and NGO`s under the coordination and policy guidance of the State of Chile. The project was successful, giving its results were used to define the Contribution proposal to be presented at COP 21.

From the perspective of sociology of science and technology, the analysis of this experience seeks to deepen in the understanding of mechanisms and methodologies for the formulation of policies on climate change in developing countries. Centered on the concept of Co-production (Jasenof, 2010), the analysis focuses on the governance structure of the project, the strategic decisions, and the methodology that articulated the interaction between institutions and individuals who participated, to finally identify the main strengths and weaknesses to inform climate change policy in developing countries.

The methodological approach for the study was qualitative. I apply content analysis using secondary data together with discourse analysis from semi-structured interviews that allowed knowing the perceptions and opinions of the participants in the project.

Among the main results of the study, I highlight:

i) The valuation of the participants of the process of opening the black box of modeling. The co-production of knowledge was understood as the exercise of defining between the scientist and the stakeholders the main assumptions, evaluating in conjunction the quality and availability information and making explicit the scope and limitations of the methodologies used. This, according to interviewees, allowed a better understanding for non-experts of the constraints and opportunities for sectorial and macroeconomic modeling. Additionally, this process provided credibility and validity to the results, while recognizing the levels of uncertainty intrinsic to this type of research. The methodology generated procedural legitimacy to the results. The agreements thorough the participation process about the key parameters that will be used in the modeling process, facilitate the recognition of the results. The project successfully validate their interim decisions and to rest the legitimacy and validity of their results in their agreements.

ii) The valuation of the participants regarding integrating local knowledge: The process of building the results with the participation of local researchers and experts contributed to a better understanding of the micro dynamics of the sectors, a better understanding of the country's productive structure for estimating emissions and the technological and feasibility constraints. In particular, the discussion about the penetration rates of potential mitigation actions are valued as an exercise done by the incumbent people and not imposed by external actors, outside the country's reality.

iii) The valuation of strengthening decision-making in the public sphere by enriching the understanding of the causes of the problems, their dynamics and implications. The exercise of co-production facilitated the socialization

of complex results because of the opportunity of learning gradually in the process. It includes the «opportunity to learn from the dynamics of other sectors», «the opportunity to visualize areas of complementarity with other colleagues and topics» «The opportunity to learn from methodological tools».

O-2239-04

Strengthening the science-policy interface for climate change adaptation at the regional level

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Despite a vast amount of scientific knowledge, society is unable to properly address the pressing issues of adapting to climate change. Planned adaptation, or adaptation planning, is a policy issue which owns its existence to climate science and it is comprehensible only through abstract scientific models. Adaptation planning therefore involves translations of these, as well as assessments of risk and uncertainty, and in order to support these processes, various institutional arrangements for the strengthening of the science-policy interface have been developed (Hoppe & Wesselink 2014). The Intergovernmental Panel of Climate Change (IPCC) is itself an example of this. While there has been widely recognized that planned adaptation to climate change is a multi-level governance issue (Keskitalo 2010), research on adaptation governance has tended to focus either on the local or the national governance levels; while regional adaptation governance have seen limited attention (Hanssen et al. 2013). The local level of government on the other hand has been deemed a key actor in the governance of adaptation. In the case of Norway, as in most western industrialized countries, there is a strong belief that the local level of governance has the key role in this respect. But despite large efforts from national government agencies and the research community in supplying local government with tailor-made and downscaled climate change projections and comprehensive guidelines, climate change adaptation is still lacking. As a response to the mixed success with municipal adaptation integration, there has been called for stronger involvement of the national level (Amundsen et al. 2010), stronger coordination between levels and across sectors (Hanssen et al. 2013) and a strengthening of the knowledge provision through various boundary arrangements that links experts and knowledge users for the purpose of production of knowledge for policy-making (Corfee-Morlot et al. 2011). This paper contributes to existing research on climate change governance by examining how regional government in Norway has interpreted its role in coordinating climate change adaptation in spatial planning policy networks. Drawing on concepts from research on boundary work, it critically assesses how regional government in Western Norway configured boundary arrangements between scientific and policy communities. This is addressed through an analytical focus on the nature and extent of boundary work, i.e. the translation, mediation and communication (Cash et al. 2003), that regional government actors engage in through their application of policy coordination instruments. Empirically, the research involves a review of on-going spatial planning processes in six municipalities from four counties in Western Norway. The study concludes that even though adaptation is not treated as a salient issue in most municipalities, the regional adaptation governance coordination is creating a hybrid management space that aid mediation between the local users knowledge and expert adaptation knowledge, and thus hold the potential for better local level adaptation planning.

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Cash, D.W. et al., 2003. Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences of the United States of America, 100(14), pp.8086-91.

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Hanssen, G.S., Mydske, P.K. & Dahle, E., 2013. Multi-level coordination of climate change adaptation: by national hierarchical steering or by regional network governance? Local Environment, 18(8), pp.869-887.

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2239-POSTER PRESENTATIONS

P-2239-01

Current adaptation practices: case studies in France, Portugal and Greece

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The warming of the climate system is now unequivocal and a strong warming of air temperature as well as an acceleration of sea-level rise is projected in the Mediterranean regions of Europe (IPCC, 2013). At the same time, adaptation measures are being set up to cope with the impacts of those changes on both the environment and the society. To which extent do these adaptation policies actually meet the challenge posed by future climate change? To answer this question, a detailed understanding of the current practices of adaptation is needed, as well as a comprehensive view of how this adaptation is perceived by its main actors. However, such information is lacking at present. Therefore, a literature review has been combined with 47 semi-structured interviews conducted on three coastal sites in France, Portugal and Greece, where different approaches toward risk prevention and adaptation to climate change are in place. In order to identify gaps between the theoretical framework and the practical situation at local scale; the interviewees have been asked with their general knowledge of climate change (present and future changes) and on the existing and desirable adaptation policies / measures.

The interviews and the literature review underline similarities and differences in the countries approaches, organization and awareness. France, Portugal and Greece have different level of national policies development regarding climate adaptation and climate change awareness can be influenced by local in situ situations. But even when climate change and climate adaptation are subjects of concern, a lack of concrete "local" implementation is pointed out by stakeholders, as very few adaptation measures have been implemented yet. Indeed, climate adaptation is recognized as a traversal issue by the interviewees. Hence, related policies have to fit within already developed and complex sectorial legal frameworks related to water management, risk prevention, health, environment and so forth.

Literature review and stakeholders interviews both highlight the time scale issues related to difference between climate change and political mandate's time horizons. They also stress a gap between science and non-scientific local stakeholders for expected knowledge and actions, and this gap tends to be reinforced by the complexity of the legal framework for climate adaptation. This complexity is particularly pointed out by interviewees acting at regional and local scales in France, which is the country where adaptation to climate change has been the most considered in various regional sectorial policies.

To overcome these specific barriers to adaptation, the interviewees suggested that one first step could be the creation of interest groups at regional level, gathering all concerned actors and a complementary lead could be to adopt laws at the national level to incite local authorities to act together with regional actors. The next step would then be to design adaptation measures and to assess their

efficiency.

This work has received funds from the ADAPT-MED project (CIRCLE2-MED).

P-2239-02

Vulnerability as Transformation: Photo-voice Adaptation in the Philippines

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In this participatory action research (PAR), the author rethinks the role of vulnerability in the framework of transformative adaptation through the application of Photovoice in three disadvantaged urban communities in the Philippines. Few planning scholars and practitioners have developed systematic adaptation models and tools to address climate-related risks and vulnerability from the local perspective. This research explores disaster risks and capacities for adaptation through the lens of a marginalized population and emphasizes vulnerability as the transformational factor for innovative adaptation. The Philippines has faced frequent and devastating typhoons and raging floods, especially in the past few years, which have killed thousands and destroyed millions of homes and businesses. Climate risks as well as adaptive capacities of vulnerable populations, such as women, have been overlooked or even distorted. During a one-year period, this research project provides disadvantaged community members with digital cameras (through smart phones) and fundamental training, facilitates them to cultivate narratives and social media networks, and encourages communities to develop action mechanisms for disaster preparedness, mitigation, and recovery. Through an empowering Photovoice approach, it reveals climate risks and capacity building of a disadvantaged population in metropolitan Manila and Cebu City. Disadvantaged participants facing frequent climate hazards embody resilience via flexible and entrepreneurial strategies. It demonstrates the missing perspective of the current climate adaptation framework: vulnerability can transform creative and collaborative adaptability.

P-2239-03

Evaluating the Resilience of Traditional and Non-Traditional Family Farming Systems in Mountain Areas of Peru

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The mountain agricultural systems of Peru could help to improve the resilience facing the climate change. These systems, mostly of them kept in familiar farming milieu provides ecosystem services (like water basin conservation) and with a low carbon impact, have potential to improve mountain resilience, conserve the biodiversity, and improve the food security. The presentation is focused on comparing the hydro-management, food security and energy consumption of two types of production systems. One based in the use of petrol derivate and «modern» techniques and another based in the recycle of products and with the use of traditional knowledge.

The central Andean region (covering Peru, Ecuador and Bolivia), is one of the world's centers of origin and domestication of animals and plants. In this region the domestication processes innovated the use of traditional and particular agricultural system by means of techniques, experiences and improvement processes.

These systems are part of our bio-cultural history that has been created by people in thousands of years as a result of the interaction of Andean people and its diverse environments. These systems, mostly of them kept in familiar farming milieu, have an enormous potential to improve mountain resilience, conserve the biodiversity, and improve the food security in these key loci. However there are many drivers (included the climate change and wrong federal management) that jeopardize the continuity of this farming systems.

Given that 79.3% of agricultural units in Peru are family farms, this presentation will analyze water management practices amongst traditional family farmers and compare these with the practices of modern settles to analyze whether and how they improve resilience to water scarcity. Likewise, the research will compare strategies for achieving food security and identify potential drivers of food security risk resulting from climate change. Energy consumption between these two groups will also be compared, based on the assumption that traditional farming systems do not employ petroleum derivate products as an agricultural input, instead using traditional knowledge and its techniques, practices and production processes.

P-2239-04

Lessons from local adaptation governance experiments in Quebec (Canada)

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Adapting local areas to climate change is a wicked problem for local policy makers, as it involves a continuous struggle between the collaborative efforts of multiple stakeholders, the changing of mindsets, the lack of resources and the difficulty in deciding between alternative planning scenarios. Even if the percentage of local governments involved in one way or another in adaptation planning is high, most initiatives never leave the drawing board. This can be attributed to the recent emergence of this concern. As well, the research conducted and the tools developed so far by researchers have little application that could help practitioners with their analysis of interactions between the various climatic impacts and their practices.

Also, decision makers involve, more than ever before, a variety of stakeholders in the decision-making process, following, in that sense, the collaborative planning prescriptions: citizen panels, public hearings, audits, charrettes, etc. contribute to reinforce public participation in local governance. These participation possibilities support, in return, the legitimacy, validity and sustainability of decisions taken. Despite this, development targets and public policies are not always consistent with local contexts and local initiatives. Gaps between theoretical objectives and daily life contribute to the shifting of climate governance outside of the institutional frame of action. This is true not only for climate change: the whole urban political space is moving outside of the traditional frame of action.

The discussion and reflection on how to act and adapt the local space to climate change take place on different grounds and through new modes of collaboration, which will be examined through the analysis of the presented case studies. In developing countries and in cities of the developed world, non-governmental organizations, regional governments or other development-based associations draw from and modify existing modes of governance in order to carry out climate governance experiments. Such experiments take form independently from national and international programs, they cross scales and jurisdictional boundaries and their goal is to contribute to the local community response to climate change. These efforts take inspiration from existing governance patterns and improve them. They offer local actors a possibility to coordinate and harmonize between different types of interventions, preoccupations and available resources without depending on public policies and intervention.

Local adaptation experiments are a way to explore original and innovative practices. Although experimentation has been shown to be a significant contributor to the augmentation of adaptive capacity at various scales, little research has been carried out on the analysis of current practices and what they can teach us about the mainstreaming of this process. This presentation will analyze two local adaptation experiments in Québec, Canada, which seek to adapt to increasing flood risk and the urban heat island effect.

How do such experiments take place? What data, expertise and financial resources are mobilized? What kind of institutional, organizational and economical contexts give way to these experiments? Based on preliminary results, this communication analyses the context and implementation of the two local adaptation experiments:

1) a local flood zone Committee; 2) an urban greening initiative. Content analysis, participant observation, a press review and site analysis, are used to highlight the experiment characteristics and to understand how experimenting contributes to enduring adaptation of local systems.

P-2239-05

Towards an International Sustainability Center Bretagne-Loire An international knowledge arena for global partnership and potential links to "Future Earth"

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Orienting research and educational programs to tackle society's major challenges, the new French federal university Bretagne Loire (UBL) is proposing to create the first International Sustainability Center, ISC in France as a highly visible cornerstone of its transdisciplinary IDEX initiative UBL+, focused on ocean/land/food/health/society. It is our belief that the proposed approach could very well be related to the "Future Earth" program in co-design & co-production of scientific knowledge on global sustainability.

UBL represents a very large territory of the size of Ireland with 27380 people working in research, 225000 students in higher education, and five laboratories of excellence in transdisciplinary focus areas (Ocean, Immunology, Nuclear Medicine, ICT and Mathematics), hosting 3 OSU and 4 Zones atelier, smart specialization fields in the area of sustainable agriculture, ocean and renewable energy. Acknowledging the limitations of current disciplinary oriented research and education systems to address global environmental change or global sustainability, UBL aims with the Idex proposition to forge a new type of university, establishing a solution oriented knowledge arena, of which ISC is a central part, increasing impact of leading edge research, cross scale system observation, learning, demonstration and exchange, accounting for the interrelationship between world oceans, global environmental change and climate, and environmental (soil, water, air), agricultural, urban, health and societal changes in our costal regions. The goal is to foster participative and international exchange between scientists, students and civil society, providing for scientific excellence in transdisciplinary studies of very complex global long-term systems, developping new pedagogical methods for transdisciplinary and international culture. Groundbreaking transdisciplinary science includes the need of opening up scientific disciplines to other ones (including numeric and social sciences), to other systems of thinking, and for dialog with stakeholders for joint problem framing, research definition and a plurality of interests on issues in sustainable development.

Inspired by and in collaboration with the Julie Ann Wrigley Global Institute of Sustainability (GIOS) of Arizona State University, the ICS shall become a Center for international meetings, exchange, research and education, focused on the link between transdisciplinary focus areas (oceans, land-sea interfaces and societies in transition; sustainably constructing food of future…) and the notion of sustainability. At the image of the global challenges to address, and with strong symbolic dimension, the place of the center «without walls» will be the entire regional interconnected territory, to offer an exceptional demonstrator in, for example, the major challenges linked to the land-sea continuum, the transitions to a sustainable urban planet, the question of food sustainability and health, digital transition and culture etc., assuring effective linkage between social challenges, transdisciplinary focus areas and territorial development.

The buildup of the ISC will start from partnerships already in existence and propose new international partnerships (ASU, the University of Colorado, Anglia Ruskin University, and French Guyana, University of California, U Laval etc.)). The "Future Earth" program provides an appropriate frame for fully integrating the global mission in the ISC orientations, with contributions by civil society, including NGO, ("co-production of knowledge") to the research process (participative investigations) concerning issues that have a major impact on society (e.g. integrated management of a coastal zone or water).

A typical example for the importance of "Future Earth" program is already in discussion between UBL and ASU/GIOS: the question is how to transition to a future that will be driven by the dynamics of urbanization. The InCAS and other mechanisms will be critical for building the international network and developing the critical questions to develop the world's best program in urban sustainability within Future Earth. Another "demonstration project" could be an observatory (without walls) able to assess long term trends in local and large scale ocean/land distribution pattern of toxic, radiotoxic and nutrition elements and its spatial and temporal variation at local and regional scales including water, soil, plants, trees, animal and human contamination indicators in urban, agricultural, littoral and mining environments, considering biodiversity and food chain sustainability

P-2239-06

From Household Coping to Community Based Adaptation: individual, communal and institutional responses to climate change by low-income households in Khulna, Bangladesh

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The relationship between "coping" and "resilience" increasingly features in academic, policy and practical discussions on adaptation to climate change in urban areas. This study examines this relationship in the context of households in "extreme poverty" in the city of Khulna, Bangladesh. It draws on a quantitative data set based on 550 household interviews in low-income and informal settlements that identified the extent of the underlying drivers of vulnerability in this setting, including very low income, inadequate shelter, poor nutritional status and limited physical assets. A series of focus groups were used to explore the ways in which physical hazards have interacted with this underlying vulnerability, as a means to understand the potential impacts of climate change on this particular group of urban residents. These outcomes include frequent water-logging, the destruction of houses and disruption to the provision of basic services. The main focus of the paper is on describing the practices of low-income urban residents in responding to climate-related shocks and stresses, placing these in a particular political context, and drawing lessons for urban policies in Bangladesh and elsewhere. A wide range of specific adaptation-related activities can be identified, which can be grouped into three main categories - individual, communal and institutional. The study examines the extent to which institutional actions are merely "coping" - or whether they create the conditions in which individuals and households can strengthen their own long-term resilience. Similarly, it examines the extent to which individual and communal responses are merely "coping" - or whether they have the potential to generate broader political change that strengthens the position of marginalized groups in the city.

The vulnerability of individuals, communities and cities to climate variability and change is an outcome of the interaction between an external threat or hazard and the internal characteristics of a system. For residents of low-income and informal settlements in urban areas in the global South, these internal characteristics - which may include limited income, few assets and poor provision of basic services - are particularly important in shaping the consequences of climate-related hazards. Similarly, effectively responding to climate change requires not only addressing the direct outcomes of particular events but also more generally building the resilience of marginalized and vulnerable groups. This study examines these underlying drivers of vulnerability as they affect extremely low-income residents of the city of Khulna, Bangladesh - and the individual, communal and institutional responses to these. The analysis contributes to an understanding of the dynamics of climate change impacts and responses in rapidly growing urban centres in Bangladesh, and to the relationship between urbanization, poverty and climate risk throughout Africa, Asia and Latin America. More specifically, however, it examines the potential for actions taken at the household and community level in urban areas to go beyond offering short-term "coping" solutions in response to specific events, resulting instead in more transformational changes that address the underlying

drivers of vulnerability.

P-2239-07

Exploring the preconditions for transformative change in the context of climate impacts and adaptation

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While climate change is projected to substantially influence primary industries in the northern regions climate change is not perceived to be an immediate concern when compared to outmigration, jobs, and the social and economic viability of municipalities (Hovelsrud et al. 2010). This relates to the apparent disconnect between the abundance of scientific knowledge about climate change, the overwhelming evidence that such changes are caused by human action and the general societal response and political commitment to deal with the challenges (Hulme 2009, Jasanoff 2010; Szersznynski and Urry 2010). And mainstream political science and governance theories fail to explain why people and institutions do not act on climate change (O'Riordan & Jordan 1999).

In this presentation we draw on a broad range of adaptation studies; a useful starting point for studying preconditions for transformative processes. One of our findings inspiring this study is that the perceptions of high resilience towards climate risks are expressed in the narrative «vi står han av» – "we always handle hardship", reflecting deep seated perceptions of resilience, linked to high variability in resources, climate and socio-economic conditions. This phenomenon has by others been attributed to different understandings and interpretations of reality between groups of people or individuals. If climate change is not perceived sufficiently salient to warrant action, resilience may decrease and societal transformation may not be possible. It is a major challenge that the climate change message and the need for societal change do not resonate well with many parts of society, combined with the findings that adaptation is not likely to take place without stronger policy measures (Dannevig et al. 2013, Tøsse 2012). On the other hand adaptation is taking place and has been associated with extreme events, observations of change, engaged officials and contact with researchers, which is reflected in the finding that society needs to better understand how climate change will affect them directly (Dannevig et al. 2013). How climate change knowledge is co-produced by science and policy we argue will be filtered through current perceptions and values, influencing their potential for transformative responses.

Perceptions of risks and the need to act on the basis of scientific knowledge hinge on whether scientific knowledge is viewed as salient, credible and legitimate (Cash et al. 2003) and on the individuals' risk perception, norms, values, culture and livelihood (O'Brien & Wolf, 2010, O'Riordan & Jordan 1999). The presentation will investigate the interplay between the local and national levels in providing salience to the climate change issue. We surmise that perceptions of risk have a bearing on the observed inertia in society to respond to the overwhelming evidence of climate risks. We analyze this inertia by applying the cultural theory of risks (CTR) to our empirical findings.

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P-2239-08

Processes for self-determined transformative adaptation: The learning journeys of small scale farmers in the arid west of South Africa

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A group of small-scale rooibos tea farmers embarked on a transformative adaptation journey more than 15 years ago by defining their community vision. This community is situated in the Northern Cape Province in South Africa and is severly affected by climate variability and change.

Today significant changes can be seen on an individual and communal level. This paper explores the aspects of the learning journey, using the results of qualitative interviews that have been conducted in the course of the past 15 years with various community members. Three key areas are examined: drivers of transformative processes on the personal and communal level, the role of experiential learning in transformative adaptation processes and ways of facilitating transformative adaptation processes.

At the start of the learning journey the Suid Bokkeveld community was socially and politically disenfranchised and economically marginalised. A participatory process facilitated by two local NGOs supported locally driven action research processes, the establishment and organisational development of a local trading co-operative owned by the farmers themselves. Embedded in these processes were opportunities for personal transformative learning specifically focusing on women within the Suid Bokkeveld community.

The paper explores enabling factors for communal and transformative adaptation in local communities, including sharing knowledge and insights with other communities, stimulating personal development and learning, supporting action research processes to develop adaptation strategies drawing on different types of knowledge (scientific and local knowledge alike). Participatory and experiential learning processes have been a key component and included participatory monitoring of livestock exposure to extreme heat stress, monitoring of water resources on farm level and local level weather monitoring. These processes carefully examined the impact and possible responses to climate extremes in order to plan ahead and be prepared for these possible shocks.

Using the transformative journey of the Suid Bokkeveld as an example, approaches and tools for facilitating transformative learning are discussed. These approaches include facilitation of the articulation of a collective vision for effective adaptation, the communication of climate information on the local level, ownership of learning processes by vulnerable communities and ways of facilitating reflective learning processes for transformative adaptation.

P-2239-09

Model Forests and Open Collaborative Science: empowering stakeholders to adopt transformative adaptation practices

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This presentation is related to an ongoing project which is being implemented in two Model Forests of Latin America (in Costa Rica and Colombia). Model Forests are social initiatives which aim at improving governance and the sustainable management of natural resources within forest-rich territories (www.bosquesmodelo.net). Through an Open Collaborative Science (OCS) approach, the project pursues several objectives, including fostering participation and "citizen science" as well as improving

adaptive capacity of local communities within the Model Forest territories by opening up the research process related to climate change.

The contribution presented will describe the context of the study and approach being taken within the specific project and how it can potentially help to tie knowledge to local problem-solving by increasing stakeholders participation in different aspects of the research lifecycle, through establishing a more interactive relationship between citizens and the academia. It is based on the belief that research and education need to be adapted to new realities, and has a strong capacity-building and knowledge-sharing component. It is also based on the premise that adaptation should be holistic, taking into account all aspects of life.

This work is part of the recenlty launched Open & Collaborative Science in Development Network (OCSDNet) research project, supported by Canada's International Development Research Centre and the UK Government's Department for International Development (www.ocsdnet.org).

P-2239-10

Addressing the research evidence needs for evidence-informed city resilience planning: Insights from Shimla city, India

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Cities, the engines of economic growth and centres of innovation, are at greater risk of climate-induced changes. In a rapidly urbanizing India, key urban functionalities and infrastructure facilities are highly exposed to climate-related hazards and extremes. Two recent natural hazards in India, the Kashmir Floods (September 2014) and the Cyclone Hudhud (October, 2014) have highlighted how urban centers are witnessing a new regime of disaster and climate risk. Urban development is one of the key priorities of India's government and the new initiative of 100 Smart Cities is a step in that direction. Climate resilient urban development strategies are the core of this initiative. But one of the key challenges that policy makers, city authorities, planners and investors face is with regard to availability to robust, reliable and relevant climate risk information at the city level. Although city level climate risk assessments are being undertaken by many scientific and research organizations, most of these information hasn't been able to address the needs of city authorities and planners. How do we address these gaps in evidence-informed city resilience planning in a developing country context? Based on a systematic analysis of research evidence needs of city-level stakeholders in the capital city of Shimla in the climate-sensitive Indian Himalayans, including city authorities, this paper highlights a series of barriers, individual and institutional, that result in such gaps. It also underscores some of the emerging opportunities through which the science and research communities could better understand and address the information needs of the policy makers and urban practitioners. More importantly, it demonstrates how such a city-level institutional system could open up new windows of opportunity to mobilise partnerships and resources for city resilience planning and implementation.

P-2239-11

Our common future, our common Global. Assessing Sustainability of local production systems: A proposal based on socio-ecological resilience and collaboration

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Sustainability and resilience are key conditions for reaching a balanced functioning of socio-ecological systems, facing internal conditions and external shocks like those expected from climate change. However, there is no agreement on how to get a good measure for both concepts to allow for managing local production systems. As result of a two-year research a methodology for assessing sustainability was developed based on a collaborative process between science, policy and civil society to improve resilience, and therefore sustainability of local production systems according to the internal conditionings to the system and the impacts of climate change and other global environmental changes as well.

The presented work is a joint contribution from an interdisciplinary research group from seven universities in the Centre-West of Argentina, and summarizes the analytical and methodological procedure to assess sustainability, based on the concept of resilience of socio-ecological systems. The four dimensions of the sustainability (ecological, economic, social and institutional) and their relationships are organized in a Sustainability Matrix which shows, on the one side, the Aggregated Demands from each dimension to the other dimensions, and on the other, it shows the actual contributions to Human Wellbeing. Within the matrix, a number of components (e.g. water, soil, air, and biodiversity, for the ecological dimension) need to be defined according to pre-established criteria for each of the dimensions. These components, expressed through one or more indicators (e.g. for "water", indicators of quality, quantity and source would be needed) are to be related to the rest of components in the Matrix aiming at identifying synergies and trade-offs.

The components in the Matrix are not fixed but they depend on the characteristics of the production system or of the region under analysis. The Principal Diagonal of the Matrix tells on the state of the system or the baseline for each dimension through the set of components under the same stated criteria. The rest of the Matrix establishes relationships among dimensions and their components. As a way of exemplification, it is possible to think about the demand of a production system in terms of the availability of particular natural resources to develop the production process. The existence and specificities of natural resources spatially distributed determine not only the characteristics of an ecosystem but also the potential of the production system to develop, as well as the limits to such a development. The same methodology applies for all the relationships among dimensions.

The value of the methodology and its sensitivity rests in an exhaustive knowledge of the productive systems under analysis and of its functioning. As a matter of fact, scientific interdisciplinary groups, citizens, firms, NGOs, and the government, are required to participate in collaboration through bridging organizations to establish proper relationships between dimensions, the components of the systems and the variables/indicators for accurately assessing each of the components.

Finally, the sustainability indicator to be constructed is a relative measure to its potential value and indicates the current position of the system in terms of its desired state. The inter-temporal and regular application of the methodology will determine an accurate evaluation of a system's dynamic towards sustainability.

P-2239-12

Climate Change Research and Communication: Exploring potential connections

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In face of the delicate moment in which we live through the effects of climatic alterations and the intensification of extreme phenomena, the circulation of information about climatic changes is becoming increasingly important. How can we think about the communication of climatic changes as a potent and effective movement to provoke broader reflections on the subject? In our research group at the State University of Campinas, in Brazil, we participate in the scientific research of climate change, as well as study communication proper, combining to create an important field for reflection and the assembly of knowledge in connection with different areas, such as natural sciences, political science, sociology, philosophy, arts and multimedia. Confronting the complexity that is involved in the subject of climate change, we look to construct interdisciplinary researches and creations, in which we focusing important questions and concepts that cross climate change approaches.

Every day we are drowned by the excess of information and news of climatic catastrophes, scenes that show places devastated by natural disasters, such as dried up rivers, water shortages in cities and the melting of polar ice caps. These images and information create narratives and stories about the potential end of the world. And often, these stories possess sterilizing effects by creating the sensation that nothing can be done because the scale of the problem has already become so big to the point that we don't know what actions to take and therefore become paralyzed. In this context we look to think critically about the quality of the information that is being produced about climate change, seeking to think of communications that create other possible narratives and stories to stimulate other types of thinking related to the environment, to the climate and life. We believe as the author Donna Haraway suggested, with her challenge to live "with the problem" of climate change and create "other possibilities" in the face of these sterilizing stories. We shouldn't think that there's no way out, but rather we should create multiple ways out, developing other trains of thought and new collective actions to deal with the climate changes already in motion.

It's with this intuition that in our research we seek to create other means, together with communication, telling new stories and establishing connections with different ways of knowledge. We believe in the interaction between art, communication and science as a powerful possibility to disseminate new scientific findings in a different approached. In this sense, we developed productions that seek to provoke distinct experiences with climate change communication creations like videos, reports, art installations, and workshops. We are developing a video collective creation workshop named TransClimatic VideoNarratives that we will work aesthetic and videos concepts to create new stories with the public. How do people understand and interact with the climate and nature? How can we establish relationships with water and heat, and how can we establish connections with the climatic elements and feelings that they can generate? Therefore, we aim to study possibilities of generating knowledge from sensory experiences in order to enfold climate change subjects through different approaches, seeking to contribute for the dissemination of knowledge and promote public participations. Our studies integrate the activities of the sub-group Scientific Communication and Climate Change from the Brazilian Network on Global Climate Change Research (Rede CLIMA).

2240 - Perceptions of climate change

ORAL PRESENTATIONS

O-2240-01

International Perceptions of Climate Change Over the Past 25 Years: A Review

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The ways in which individuals, societies, and polities respond to climate change are in many cases contingent on public perceptions of its causes, consequences, and wider implications. Understanding popular opinion on climate change is therefore critically important to enable a social transformation to a low-carbon economy. Public perceptions of climate change are known to differ between nations and have fluctuated over time. Several explanations have been put forward for these variations. With over two decades of research on public perceptions of climate change, we are now in a position to take stock of the key trends over this time period and the factors behind the changes. In this contribution we will present the findings from a systematic literature review of studies that have used longitudinal methods to examine changes in and drivers of public opinion on climate change. In this review we consider early, seminal work on public perceptions of climate change from the 1980s onwards, and national and international surveys with a longitudinal component. Studies point to growing scepticism in the latter 2000s in a limited number of developed countries. However, most parts of the world have seen growing concern about climate change in same time periods. We conclude that the imbalance in the literature toward polling data, and toward studies of public perceptions in Western nations (particularly the United States), leaves much unknown about the progression of public understanding of climate change worldwide. Furthermore, more research is required that uses inferential statistical procedures to understand the reasons behind trends in public perceptions. (Session 2240 - Perception of climate change).

O-2240-02

Public perceptions of weather and climate change in the United Kingdom

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BACKGROUND.
Public perception surveys in the US have suggested that Americans' concerns about climate change are related to their experiences of very hot weather. Such findings raise questions about the climate change beliefs of people in regions with moderate climates, including the United Kingdom (UK). Indeed, our work has suggested that UK residents may actually feel good about the prospect of warmer summers (e.g. Lefevre et al., 2015; see also Palutikof et al. 2004). Such findings raise the question of whether other types of locally experienced weather may be associated with concerns about climate change, among residents of those countries. Indeed, relatively little is known about whether public concerns about climate change may also be associated with perceived changes in other weather-related events, such as heavy rainfall. We therefore examined (1) the extent to which UK residents perceive different types of weather and related events to have changed in frequency over the lifetimes; and (2) the relationship between perceived changes in the frequency of these events and climate change belief.

METHOD.
We report on an initial UK-wide survey that was conducted January/February of 2013, with longitudinal follow-up surveys occurring in October 2013, April 2014, and July 2014. These surveys contained items asking participants about the extent to which they perceived nine types of weather-related event to have increased or decreased in frequency over their lifetime (including heatwaves and heavy rainfall, among others). Participants also rated their concerns about climate change, using a reliable 3-item assessment.

RESULTS.
Our analyses showed that participants tended to perceive wet-weather and water related events (heavy rainfall, flooding, coastal erosion) to have increased in frequency over their lifetime, while hot summers and heatwaves were perceived to have decreased over their lifetime. Moreover, controlling for the effects of demographic variables and environmental values, we found that perceived increases in wet-weather were significantly associated with greater climate change concerns, with perceived change in the frequency of of hot-weather making a comparatively small contribution. These findings held in the initial survey as well as the longitudinal follow-up surveys that were held as the weather changed across seasons.

CONCLUSIONS.
We found that amongst UK residents, perceptions of wet weather and related events are more strongly associated with beliefs about climate change than perceptions of hot weather. These findings suggest that those seeking to communicate about climate change with audiences in regions with temperate climates should not limit their focus to heat-related impacts, but also emphasize other types of locally salient weather.

O-2240-03

Analysis of factors shaping small-scale farmers' perceptions about climate change in South Africa: A behavioral approach

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Raising public awareness of the real threat posed by CC has been a common pledge in many countries' CC response policies. In many cases, however, tendencies by policymakers to overlook the differences in public opinions have resulted in policy inertia, passive resistance, and even active opposition. Therefore, effective CC communication requires a good understanding of public opinions and a recognition of individual variation in learning processes. In South Africa, for example, recent empirical studies have shown that small-scale farmers hardly recognize the patterns of local climatic changes. The studies, however, have simplistically argued that the misperceptions could be due to the complexity of biophysical processes that can be hardly discerned by farmers. They have often overlooked the importance of socio-psychological, institutional and cultural processes underlying individual perceptual formation.

Based on key insights of the behavioural decision research, this study investigated the affective, experiential, cognitive and cultural factors shaping the perceptions about climate change among small-scale farmers in the midlands region of KwaZulu-Natal, a major hotspot of climate change in South Africa. A principal component analysis of perceptions about climate change revealed two contrasting perceptual shapes. Whilst meteorological records indicated that the area has experienced drying trends in summer coupled with warming and wetting trends in winter over the last four decades, CCP1 score revealed inaccurately perceived trends of cooling and drying winters and warming and drying summers. CCP2 score exhibited stark similarity with meteorological observations.

Using a Double-Hurdle estimation strategy, the results of the Probit model suggested that climate change perception is triggered by emotive factors (holistic affect) and value judgement, as well as socio-demographic factors such age, gender, education, and agro-ecological conditions. In line with the conceptual expectations from the behavioural approach, the results of the Truncated regression model showed that the CCP1 score increases with holistic affect and inherently experiential socio-demographic factors such as, age, and distance to the rivers, whilst the CCP2 score is determined by cognitive and socio-cultural factors, including knowledge, education, extension, and trust.

Based on these findings, the study concludes with some recommendations for effective regional CC communication strategies that recognize individual variation in learning processes.

O-2240-04

Mental models of climate change: Basis for risk evaluation, policy support, and message reception

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Human behavior plays a central role in climate change risks. In addition to precipitating rapid global warming by burning fossil fuels, humans can also act to prevent, ameliorate or adapt to climate change and its consequences. It is therefore important to understand how people perceive climate change, its impacts, and the opportunities for and effects of human actions. Mental models are an essential part of risk perception; they shape subjective risk evaluations, policy preferences, and the reception of risk communications.

We present 3 studies in which we pursued three aims: (a) describe lay causal mental models of climate change risks, (b) relate mental models to risk judgments and policy preferences, (c) draw conclusions concerning the communication of climate change risks.

Study 1 (N=133) employs a cognitive mapping technique to elicit people's mental models. Participants also evaluated a set of climate change risks on several psychometric risk scales. Results show that mental models are structured according to a causal chain that ranges from attitudes via behaviors, pollution, and environmental impacts to impacts on humans. These components differ systematically in perceived risk and perceived controllability. Network analysis reveals that lay models tend to be simple and unconnected.

Study 2, an experiment with USA MTurk participants (N=892) suggests that even when controlling for causal beliefs, mindsets can have a significant effect on support for mitigative policies, but perceptions of the costs of action have a much larger deterrent effect on support. Study participants were assigned randomly to experimental conditions, two of which were designed to promote concrete, specific thinking, two to promote abstract, goal-oriented thinking. Participants in an abstract mindset were significantly more likely to support increasing taxes on fossil fuels. But the effect is much smaller than the association with perceived social and personal costs. Causal beliefs—such as that increasing taxes on fossil fuels will effectively slow or stop climate change—remain positively associated with support for such taxes, whereas political ideology drops out as a predictor of policy support, once mindset and other factors are taken into account.

Study 3, a cross-national survey, demonstrates the important role of risk perceptions and causal beliefs in the formation of policy preferences of economics and business undergraduates from six countries: Austria, Bangladesh, Finland, Germany, Norway, and USA (total N = 664). Five constructs were measured: risk perception, perceived causes, perceived consequences, perceived effectiveness of a set of policy actions, and support for the same set of policy actions. Regression analyses with policy support as criterion and the other factors as predictors show that policy support can be predicted by risk perceptions and causal mental models. In all analyses, adding perceived causes and perceived effectiveness as predictors adds significant explained variance. Perceived effectiveness is generally a stronger predictor than ascribed causes.

Taken together, the studies show that mental models shape both people's evaluation of climate change risk and their support for specific policy options. Causal beliefs seem more important that political ideology, but perceived costs may have deterrent effects. One implication of the results is that all communications must relate to people's mental models and that promoting an abstract, goal-oriented mindset strengthens policy support. Furthermore, communicating the effectiveness of policy actions may influence support for these actions more than providing other causal knowledge. Future research should address the exact mediating roles of mindset, perceived risk, causal beliefs, and perceived policy effectiveness in shaping policy support and the processing of communications.

O-2240-05

Believing, Belonging and Behaving: Exploring Mismatch between Climate Change Perceptions and Individual Mitigation Behaviours across 27 European Countries

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Individual behaviour is key to CO2 emission reduction. Despite increased awareness of climate change, climate-related beliefs however do not always translate into actions. This study aims to explain the mismatch between beliefs and behaviours by investigating the role of individual socio-demographic, meso and macro level factors across countries and over time. The study employs a novel 3Bs framework -believing, belonging, behaving- originally developed to analyse religiosity in sociology to identify underlying drivers of climate-related actions at micro, meso and macro levels. According to the 3Bs framework, individual socio-demographic characteristics influence internal attributes e.g., values, knowledge and climate risk perceptions (Believing), which can trigger behavioural responses (Behaving). Similarly, external factors e.g., the institutional and cultural conditions of a social group, community and country where people belong (Belonging) mediate attitudes and behaviours. The empirical analysis

is based on the Eurobarometer surveys for the years 2008, 2009, 2011, and 2013 (Modules 69.2, 72.1, 75.4 and 80.2, respectively) covering over 100,000 respondents in 27 member countries of the European Union. Preliminary results show that women and the highly educated express greater concern about climate change and are more likely to undertake personal actions to mitigate climate change. The public concern about climate change however has decline, especially in the period after the 2008 financial crisis. There is substantial geographic variation for both perceptions towards climate change and climate-related actions, and, importantly, for the extent of the mismatch between attitudes and actions. For instance, residents in countries like Austria, Spain, and Slovenia have both a relatively high concern about climate change and a high proportion of individuals undertaking mitigation actions. On the other hand, a group of many new EU member countries such as Estonia, Latvia, Lithuania and Poland display both relatively low level of concern about climate change and low level of mitigation actions. Likewise, the same proportion of individuals from Luxembourg and Bulgaria (73.0%) perceived climate change as a very serious problem but only 30.8% of residents in the latter perform mitigation actions as compared to as many as 79.1% of the former. Understanding what barriers prevent individuals from some countries to take actions despite their climate change concern is therefore crucial for policy interventions.

2240-POSTER PRESENTATIONS

P-2240-01

Climate Change Perception and Adaptation Strategies In Osun State

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The impact of a changing climate are already being felt in Sub Saharan Africa with more droughts, more floods on the coastlines of West Africa, more strong storms and more heat waves taxing individuals firms and governments, drawing resources away from developments. Continuing climate change at current rates will pose increasingly severe challenges for developments. Since over 90% of agriculture in Sub Saharan Africa is rain fed and water supplied are expected to decrease and to become more erratic in most regions, local water management such as micro-catchments, dams and tanks and small irrigation from underground water will be key opportunities for adaptation. Malaria is spreading to higher previously safe altitudes and becoming resistant to drugs.

The objectives of this research are to; determine farmers perception to climate change, based on farmers field experiences, explore innovative adaptation approaches needed in this kind of African environment and examine tested traditional knowledge useful for adaptation at the local setting

The study is based on four local government areas in Osun State. The areas comprise the food basket areas of the state. Structured questionnaires was developed to generate primary data which are complimented with secondary data. The data collected are subjected to descriptive and statistical analysis.

It is on record that agricultural productivity has declined in all the zones in Nigeria including the areas of study. The region economies are highly dependent on natural resources. This research will be able to indicate strategies for climate change adaptation in agriculture, what lessons have been identified and new innovative approaches that can be applied to similar areas in Sub Saharan Africa.

P-2240-02

Heterogeneity of climate change perceptions in two Caboclos' communities of the Amazon Estuary, Brazil

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There is a general consensus that peoples and societies perceptions are a necessary prerequisite for adaptation and responses to climate change (Maddison 2006, Brain et al. 2009, Capstick et al. 2015). However, climate change impacts, and consequently perceptions, are unevenly distributed with regional, and even local, disparities (Tambo and Abdoulaye 2013). For example, scholars suggest that farmers that have more experience are more likely to perceive climate changes (Maddison 2007, Silvestri et al. 2012). In addition, household characteristics, such as household head's gender, age, level of education, and access on information about climate change, have also been identified has important factors affecting perceptions of climate change (Deressa et al. 2009). Since adaptation to climate change comprises a two-step process: the ability to perceive changes, and subsequently, to respond to those changes, the understanding of the heterogeneity related to perceptions of climate change among individuals and societies is very important when fostering adaptation to climate change.

Our study aims to explore (1) how caboclos communities' residents in two islands of the Amazon Estuary, Brazil, perceived climate changes (2) how those perceptions varied among respondents and communities, and (3) what factors influenced perception heterogeneity to climate change. The caboclos communities studied have their livelihoods based mainly on açaí berries collection, fishing activities, and shrimp harvest. Therefore, we explore how those communities perceived climate change impacts, specifically temperature, rainfall and tide level changes, on those three economic activities, and what factors determine perceptions variation regarding the climate change impacts on those activities.

To collect data on how caboclos communities perceived climate changes on temperature, rainfall and tide level, and their impacts on açaí berries collection, fishing, and shrimp harvest, we applied structured interviews to 239 residents of Arumanduba and São João Batista communities, in the municipality of Abaetetuba, Pará state. Besides climate change perception questions, we also gathered information on gender, age, level of education, time of residence at the community, property size, and filiation to fishers association and workers unions. We also applied focus group discussions to further understand residents' perceptions.

Preliminary results showed that perception to climate chance varied according climate change type (temperature, rainfall, and tide level changes) and also on the type of economic activity being impacted by those changes. Gender and affiliation to fishers association and worker unions seems to influence perceptions regarding rainfall and tide level changes, but not on temperature changes. Further analyses will be performed to refine those preliminaries results, and also to determine if residents' age, level of education, time of residence, and property size affect their perception regarding climate changes occurring in the last 20 years, and on the impact of those changes on fishing, acai berries harvest and shrimp harvest activities.

Knowledge on how caboclos communities perceive climate changes and their impacts, but also the factors that affect the way those communities perceive those changes and impacts, are extremely important to assist policy aiming to foster adaptation and also decrease vulnerability of those communities to future climate changes.

P-2240-03

Has self-interest of climate scientist influenced their perceptions of global environmental change? A Rebuttal to climate change contrarians' allegation against climate scientists

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GEC is still controversial in the public in many countries, although scientists almost reached a consensus over the causes and results of it. One of the reasons is the attack against climate science and IPCC by climate change contrarians. They have claimed that mainstream

climate scientists, influenced by their interest of research fund and liberal political ideology, have exaggerated the seriousness of GEC for political purposes and made uncertain claim of anthropogenic global warming. Social scientists, historians, and environmental NGOs have counter-attacked these contrarians indirectly by debunking the influence of their own conservative ideological orientation, conservative think tanks, and the fossil fuel industry on their activity. However, little effort has been made to examine the validity of the contrarians' claim with empirical evidence: whether or not climate scientists' warning on GEC has been influenced by their own professional ideology and interests. Among many reasons, there is a serious methodological challenge to answer this question: it is difficult to know whether the high level of concern about GEC among climate scientists has resulted from their expertise (as most scientists claim) or their interests (as contrarians claim).

This study attempts to test the validity of the contrarians' allegation by taking an innovative way to separate potential influence of expertise from interests on climate scientists' concern about GEC. To use Collins and Evans (2002, 2007)' terms, this study classified a sample of Korean scientists (n=365) into three groups, 1) contributory experts who conduct climate research, 2) interactional experts who do not conduct climate research but have much knowledge on it, and 3) scientists-in-general who do not have much knowledge on climate change, and compared their perceptions/presentations of global climate change. In this way, this study attempts to distinguish the influence of expertise (contributory and interactional experts vs. scientists in general) and the influence of interests controlling for expertise (contributory experts vs. interactional experts). Using this classification of expertise, this study hypothesizes that, if scientists' interests of research fund have effect on their perceptions/presentations of GEC, contributory experts having such interests may perceive/present GEC as a more serious problem than may other scientists who do not have such interests. In particular, if the contrarians' allegation is valid, there should be a significant difference in the perceptions/presentions of GEC between contributory experts and interactional experts who have a high level of expertise in GEC but do not have professional interests in climate research such as research funding.

The results of this study demonstrates that there has been little difference in the perceptions/presentations of GEC among contributory experts, interactional experts, and scientists in general. The same was the case even when covariates such as gender, age, income, and political ideology were controlled for. These results therefore strongly suggest that the allegation against mainstream climate scientists made by contrarians was hard to find ground and that we should take climate scientists' warning agaist GEC more seriously. Perhaps, climate science has been politicized too much.

P-2240-04

The green of your eyes: Social judgments of different types of pro-environmental behaviours

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There is today an international consensus on the fact that our societies have to alter the way they interact with the environment (IPCC, 2013). Today, environmental claims are part of our daily lives to the point that they integrate different types of environmentally significant behaviours (Stern, 1999): activist, non-activist and private sphere behaviours. A previous study has shown that pro-environmental behaviours can be associated with the perception of both competence and warmth - i.e., people that present them are seen as more competent and warm that people that do not. However, it is not tested whether if these pro-environmental behaviours were activist ones, clearly questioning the current state of affairs, they would still be regarded as competent and warm. Therefore, this study had the objective of comparing different types of environmentally significant behaviours in terms of their attribution of competence and warmth. To do so, we presented participants with a target that presented either an activist behaviours (demonstration), a non-activist behaviour from the public sphere (signing a petition), or a private sphere behaviour (purchase of organic products, recycling and saving water and energy). Then participants were asked to form an impression of the target and attribute to it adjectives from the competence and warmth dimensions. Results show that targets presenting any type of environmentally significant behaviour equally are seen as competent. Where targets are differentiated is in their perceived warmth: activist behaviours are seen as less warm than the others. These results confirm the distinction between perceived agency and communion. Given that all targets behave and demonstrate agency towards the environment, they are all seen as equally competent. But the activist target, which demonstrates intentions to change the current state of affairs, is seen as less cooperative and communal than the targets presenting pro-environmental behaviours form the private sphere. Implications of these results for the environmental social change are discussed.

P-2240-05

Exploring The Concerns Of Emerging Climate Sceptic Groups Within Civil Society

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Exploring the concerns of emerging climate sceptic groups within civil society - a growing proportion of society are using the information age to research the past, observe the present and are subsequently becoming organised to protect the future, reflecting a perception of man's influence on climate change - whether intentional or unintentional.

P-2240-06

How do perceptions of climate change affect performance of risk management instruments & farmer welfare in Malawi?

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This paper provides new insights on how climate change affects Malawian farm households' risk management options. The options considered in our farm-level stochastic simulation model are (i) the adoption of risk-smoothing farm practices, (ii) diversification among crops, (iii) safety nets, and (iv) other public interventions such as improving extension and providing better climate information. A traditional risk management approach typically assumes that probabilities are known by all actors. However, climate change can affect the probability and severity of yield losses in ways that are difficult for individual farmers to incorporate in their decision-making.

Simulations are run solving a stochastic farm model where a farmer chooses a staple crop and technique (conservation or traditional) plus up to one diversification crop to maximize utility within a given Malawian Agro-ecological zone (AEZ). The staple crops to choose from are local maize or hybrid maize, whereas the diversification crops are Groundnut Chalimbana, Groundnut CG7, Beans, & Pigeon Peas. Conservation techniques that the farmer can choose are soil & water conservation, intercropping, or combining the two.

In the results presented here we focus on how improving climate information available to farmers changes the expected outcomes. We refer to a misalignment in expectations when farmers have insufficient information to evaluate the change in systemic risk brought about by climate change and behave as if this distribution had not changed. From the results in Table 1, we observe that (i) mean profits can be greatly affected by lack of information under increased variability of rainfall in sub-humid areas, and (ii) an increased variability of temperature in semi-arid areas can have a considerable negative effect if not anticipated.

Table 1. Impact on mean profits of increasing by 30% the standard deviation of rainfall (Rain SD) or of temperature (Temp SD), depending on whether the change in variability is correctly anticipated by the farmer or not (unanticipated).

		Mean Profits (Malawian Kwachas)	
Malawi AEZs	Scenarios	Anticipated climate change	Unanticipated climate change
Tropic warm/ semi-arid	Baseline	5,578	5,578
	Rain SD + 30%	2,430	2,102
	Temp SD + 30%	6,056	4,901
Tropic warm/ sub-humid	Baseline	5,859	5,859
	Rain SD + 30%	7,950	2,244
	Temp SD + 30%	3,627	3,627
Tropic cool /semiarid & subhumid	Baseline	10,719	10,719
	Rain SD + 30%	4,980	4,729
	Temp SD + 30%	7,944	9,877

In our analysis, improving information available to farmers addresses this misalignment by providing the correct probability distribution to farmers managing risk. The paper then provides insight on the robustness of different instruments, such as diversification or safety nets in the face of limited knowledge of the probabilities of weather events, and the value of providing information in the efficiency of such instruments. Budgetary implications are also explored for different instruments such as weather index insurance and safety nets. Results indicate that misalignment of farmer expectations may cause large budgetary outlays by government due to a lack of appropriate adaptation decisions when only limited information is available to farmers.

P-2240-07

"Visions of the future" from selected scenarios: Science warnings, the changing of scarcity concept and prospects for a new society

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Most of conventional, non-scientific or specialized media nowadays focus on the problems of financial-economic international crisis and on worldwide terrorism actions. Challenges to curb Climate Change and the other major planetary environmental problems appear in the main information vehicles as specific topics, frequently disconnected to these other urgent and fair issues of economic possibilities of the world and the global safety under the menaces of the growing forces of fundamentalism and intolerance.

Yet, these planetary challenges are deeply imbedded in our social, economic and geopolitical world. Facing the first ones will require profound and extensive reorientation of the latter. There will be no possible escape from a dystopic future for the great majority unless this fundamental interdependence are recognized and proper, creative faced by world leaders, jointly with citizens, businesspersons, and society as a whole.

The scientific literature on the future prospects of the world in this sense spreads from late 1960s to the present and brings together a set of issues that can be enlightening when it comes to devise possible paths to alternative socio-economic and political arrangements to face current predicaments of humankind.

This paper draws on the results of a critic literature review on the topic of the visions of future, highlighting the contributions of the reviewed works on three selected and interrelated issues: Science warnings, the underlying scarcity concept (being it openly stated or not) and the prospects of the future of the society (whether it be utopian or dystopian).

The Table 1, below, summarize the contributions reviewed, its authors and the disciplinary scientific field, and institutional and historical contexts within which they have been proposed. The main, even if not the unique, criteria for selecting these works were the adherence to the theme and the prominence of them in the literature reviewed. The sources employed as bases for the survey were SciELO, Periódicos CAPES and Scholar Google for the systematic review and selected books and papers for backward and forward chaining review.

Table 1. Visions of the Future: contributions and reviewed authors

Contribution	Date	Authors
Environment, Power and Society	1971	Howard Odum
The Limits to Growth	1972	Donella and Dennis Meadows and colleagues
Beyond the Limits	1992	Idem
Catastrophe or New Society: a Latinamerican World Model	1976	O. Herrera and colleagues
Great Transition: the promise and lure of the times ahead	2002	Raskin, P., T. Banuri, T.; Gallopın, G.; Gutman, P.; Hammond, A.; Kates, R. and Swart, R.
IPCC (Intergovernamental Panel on Climate Change) 4th Assessment Report	2007	R. K. Pachauri; A. Reisinger
Ecosystems And Human Well-Being	2005	Millenium Ecosystems Assessment

The main purpose of this paper is to draw from the reviewing of these selected contributions a set of answers for the following questions: i) which are the scientific warnings made in terms of environmental change?; ii) which is the underlying concept of scarcity?; iii) which are the ideas or the prospects for the reorganization of social and economic life?; iv) which roles are social and economic actors supposed to play in order to implement this reorganization?

P-2240-08

Does poor understanding of causes for climate change lead to bad protective choices?

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In this paper we analyze how people's perception of causes for climate change, and their understanding of global warming, may be associated with their behavior regarding flood preparedness. We also analyze if their social representation of floods is affected by how they

perceive causes for temperature and precipitation locally. Microeconomic models of optimal choice under uncertainty (as in Savage, 1972) are our theoretical basis to link perceived uncertainty regarding local climate parameters with behavioral intention regarding preparedness against flood hazards. Models of choice under uncertainty state that individuals choose a subjective prior to make sense of the expected benefit of their choice. Among risk-averse individuals, increase in uncertainty may lead to overprotective behavior, which results in an aggregate loss of social well-being. Poor understanding or lack of knowledge about causes of increasing uncertainty, such as the one brought about with climate change, may lead to the choice of incorrect subjective priors, adding an extra loss in expected benefits. Combining mathematical simulations with Thematic Net Analysis applied to a representative sample of 1,200 urban households in Governador Valadares, Brazil, 2014, we show that individuals seem to overuse protective measures against flood hazards, resulting in an aggregate social loss. This loss is even higher among risk-averse individuals. Our qualitative results suggest that, as expected, knowledge on local temperature and precipitation change is more common than the understanding of global warming. Among those who acknowledge local climate change, understanding of causes is superficial and often wrong, adding a layer of difficulty for risk-averse individuals to correctly choose a subjective prior that maps risk of floods onto their portfolio of electable actions. Governador Valadares was chosen because river flood is recurrent in the area, reaching thousands of families along the river every other year. The river water is also one of the most polluted among the Brazilian rivers', producing involuntary risk exposure to waterborne diseases when it floods. The results found in this study highlight the importance of proper scientific communication of causes and consequences of climate change to the general public, in order to increase population support for adaptation policies, as well adherence to protective and preventive behavior.

P-2240-09

Perceptions of climate change in the mainstream media as portrayed through the coverage of the water crisis in São Paulo

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For many decades, drought has been a very cruel and close reality to millions living in the Northeast region of Brazil. By contrast, for those in the Southern regions of the country, water scarcity has rarely been a matter of concern and it was associated only with remote, socio-economically deprived regions. That reality changed in 2014 when the megacity of São Paulo, home to 12 million people, suffered a serious water crisis. The magnitude of the water crisis and the speed in which it occurred took many by surprise and it is referred to as the most severe in decades. Its consequences unfolded throughout the region like an epidemic and turned into front page news. Among the causes of the water crisis listed by the media, was irresponsible management of water resources, excessive water use by the population and an extreme environmental situation. Scientists have been warning that intense drought and lack of rainfall throughout Brazil are a result of climate change (Gutiérrez et al., 2014), and that further warming and reduction in precipitation is projected for the southeast of Brazil for the coming decades (Chou et al., 2014). The present study examines the representations of climate change in the mainstream media, as portrayed through the coverage of the water crisis in São Paulo. It also examines the importance given to scientific data on its reports. It seeks to understand how the most influential outlet press, the newspaper Folha de São Paulo, explains the causes of the water crisis, in particular the extent to which it covered governance and climate change. Attention is given to whether the management and mitigation of the water crisis addressed in the news, took into consideration knowledge and data produced by the scientific community. A sample of reports, published during the period of August 2014 to March 2015 in the newspaper Folha de São Paulo, were classified by section and type, and thus, identifying whether the newspaper relates the crisis to climate change or to governance issues or both, and whether the newspaper content is based on scientific or non-scientific information. Understanding how issues are framed in this and other national news media is important because they shape public knowledge, customs and perceptions of the Brazilian society.

P-2240-10

Navigating the line between participation and tyranny - Lessons learned in using participatory methods to engage community members in pro-environmental behaviours in rural China: The Case of Farm in a Box

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Discussions and responses to climate change have predominantly remained at the global and national levels with limited inclusion of people who live in regions that are heavily impacted by and vulnerable to climate change. The implications of climate change at the local level and the possible positive impact of locally driven climate change actions are consistently overlooked within the international community of climate change experts. It is necessary to not only include, but to also work closely with local communities in the discussion of climate change, sustainable development and resilience building as local communities provide a source of local knowledge rooted in cultural traditions as well as a source of community level action. However, navigating between participatory methods and tyranny is an issue that has received attention within participatory research and community engagement literature. Focusing on the case study of Farm in a Box, a sustainable food source that promotes pro-environmental behaviours and education opportunities, we will examine the lessons learned in the process of using participatory methods to engage community members in pro-environmental behaviours in rural China.

P-2240-11

Learning about climate-related risks: decisions of fish farmers in a role-playing simulation game

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Background: Successful river-based cage aquaculture in Northern Thailand depends on managing a number of climate-related risks. Previous surveys and observation of recent high flow or flood events as well as an extreme seasonal drought with low flows have shown that the risks are season-, river- and place-specific implying that the experience and risk profiles of individual farms vary substantially. Earlier work also showed that farmers use a combination of adjustments to rearing practices, cropping calendars, as well as financial and social measures to manage those risks which they perceive as being manageable. Moreover, individual risks are often addressed through multiple practices and strategies; conversely, a particular management practice can have a bearing on several different risks. Farmers also recognize that risks must be managed at both farm and higher spatial and administrative scales. Social relations and information, and not just culture techniques, play critical roles in managing these complex combinations of risks.

Purpose: The purpose of this study was to improve understanding of how farmers make investment decisions in their fish farms when faced with risks from floods that are imperfectly known and which may be changing.

Methods: A role-playing simulation game was created to capture some of the key features of the decision-making context and explored with farmers in the field on hand-held tablets. In the game farmers were given a choice between low, mid or high stocking densities, representing a wide range of levels of investment in each round or crop. Under normal conditions profits are higher the higher the stocking density, but if it floods losses are correspondingly higher. Selecting a low stocking density thus was a relatively

certain bet compared to choosing a high stocking density. Games consisted of 20 rounds. Each game was randomly assigned to one of 18 different treatments or conditions that included different likelihoods and impacts of floods, investments in adaptation measures, or provision of information. In-depth interviews were conducted post-game to reflect on strategies used in the game and in practice.

Results: As hypothesized more frequent or larger impact floods reduced cumulative profits. Farmers reduced their stocking densities when playing in games with high likelihood of floods but did not do so as expected when impacts were larger. Farmers found it's harder to learn - choose the most optimal density or improve score within a game - when floods were common or had large impacts. Farmers learnt most when risks were decreasing and least when they were increasing. Providing information about likelihoods prior to a game had no significant impact on performance or decisions, eventhough interviews implied a reasonable understanding of likelihood information. Within individual games farmers responded to a flood with a reduction in density in the next crop if they had just chosen high, but with a shift to high if they had previously chosen low. Post-game interviews suggest most farmers found the simulation game represented key features of their decision context, the main discrepancy being inability to take short-term measures to reduce losses when a flood was imminent.

Significance: The methods and findings of this study underline the importance of understanding decision-making behavior around risks for climate risk management. The novel combination of experimental, role-playing and qualitative methods revealed limitations in common assumptions about the ease of learning about likelihoods and consequences from experience. In the context of climate-related risks and a role-playing game situation, the findings suggest there may also be an emotional rather than purely analytical response to losses. The findings also suggest that decision-support systems for aquaculture need to take into account how recent experiences and other factors influence risk perceptions and decisions.

P-2240-12

The media coverage of climate change and air pollution in French press

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Climate change and air pollution has become two major concerns of the French, objects of issues, debates and, therefore, recurring topics in the media. The study of a theme through its media treatment is rich and can illustrate the interface between scientific knowledge and its return to the public. Or it can reveal a potential difference between the two, and more widely be used to understand representations of phenomena through the words and their associations.

This paper presents a media coverage analysis on climate change and air pollution in French national newspapers, from a corpus of 2.961 press articles. The temporal study shows mainly a relative recent and strong media influence of climate change, and to a less extent a response to air pollution episode and policy measures. The semantic analysis identifies four lexical fields: economy, transport, legislative framework - policy and environment. Finally, the articles with the terms of climate and weather show a diversity of approach taken by reporters and are found in various topics (from a HAC). Between these two items, the media treatment of air pollution has been very little covered in contrast to controversial issues around climate change, but the two are often related, sometimes not in a relevant manner.

P-2240-13

Dangerous climate here and now: Do our indicators let us perceive the signals? The 2003 heat wave in France

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Fifteen thousand persons died in the French episode of heat wave in August 2003, during the hottest summer in Europe since 1500. Yet it took months or years for this count to be recognized. The heat wave dangers resulted from the intricate association of natural and social factors. Unusually high temperatures were combined here with socioeconomic vulnerability and in particular, social attenuation of hazards - a multi-form inability of individuals and institutions to recognize that people were dying of the heat. The French experience confirmed research establishing that heat waves are a major mortal risk, number one among so-called natural hazards in postindustrial societies. Yet France in 2003 had no policy in place, as if dangerous climate were restricted to a distant or uncertain future of climate change, or to preindustrial countries. We analyze the heat wave's profile as a strongly attenuated risk in the French context, as well as the causes and the effects of its sudden shift into amplification. Entrenched indicators can mask or reveal the dangers of climate change. Improving indicators might be a significant lever in bringing about more sustainable behaviors.

P-2240-14

Perception, Collapse and Climate Change: an Anthropological Theory Approach

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In this paper, we intend to discuss from the point of view of current anthropological theories, the possibility of misperception of climate changes in human societies that historically have collapsed, as well as those that are in process. We analyze critically the ethnographic cases presented in Jared Diamond's book Collapse, from the ecological theories and Tim Ingold's ecology of life. Our intent is to understand if the new ontologies proclaimed in those anthropological theories, which deny categories such «misperception», since perception is not supposed to be a vision of nature out there, but a process among different person-organisms in continuous changeable environment, can deal with the historical experiences of collective collapse.

P-2240-15

Cultural biases on climate change discourse - Findings on multinational survey in ICA-RUS Project

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Climate change discourse tends to be framed by a particular set of values. There are different fundamental worldviews and perspectives jostling for position, and disagreement among the prescriptions for climate change can partly be explained by the underlying antinomy.

Nation-wide Web surveys were administered in 3 countries (Japan, USA and Germany). Respondents were questioned social value preferences relating to Mary Douglas' grid and group scores, preference on global mitigation target, and risk perceptions on climate change impacts. Then they were shown mitigation options with its GHGs reduction amount, cost, uncertainties and side effects. Finally, they can choose cost allocation options between citizens and industries, and between developed and developing countries. Respondents could immediately confirm the result of their selections on the Web in terms of estimated temperature increase in 2100 and burden of mitigation costs so as to respondents can examine the balance and consistencies among target, costs and GHG reductions.

The cultural characteristics of each country are shown in grid and group score distributions. The respondents in USA put emphasis on interests of individuals ("low-group"). Germany shows tendency of sharing common target ("high-group"). Japan can be characterized by the narrowest distribution biased toward hierarchical tendency ("high-grid and high-group"). These cultural

biases are reflected in the survey results. The public of USA doesn't like legal binding of global common target, in contrast to the other high-group countries. The public of Japan accepted harder GHG reduction efforts in developed countries than in developing countries, in contrast to the other low-grid countries insist on the same level efforts.

In group interviews, public of Japan often shows the tendency to leave decisions on climate change to his institutions. This observation is another evidence of institutional nature of Japanese society.

The Ministry of the Environment, Japan established an interdisciplinary research project, Integrated Climate Assessment – Risks, Uncertainties and Society (ICA-RUS) conducted by Dr. Seita Emori, National Institute for Environmental Studies. This research is a part of the ICA-RUS project.

P-2240-16

Misperceptions of Climate Change among Family Farmers – The Case of Mato Grosso State

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In Brazil, climatological data has shown a steady increase of temperature levels in all Brazilian regions over the last 50 years. On the other side, rainfall levels records have remained stable in many areas of this country. This is the case of several areas of the Mato Grosso (MT) state, Brazil's second largest producer of agricultural products such as soybean, and sugarcane, and one of the most threatened by climate change. Approximately 70% of the surveyed areas of MT, including the Chapada dos Guimarães in the Cerrado biome, have revealed stable rainfall levels between 1980 and 2010. However, when interviewed about climate change, the vast majority of family farmers pointed out to a perceived decrease of rainfall levels and suggested that this was the main reason for their economic losses at the farm level and a threat to the sustainability of their livelihoods.

In this regard, this project aims at understanding why so many family farmers wrongly attribute their loss of agricultural productivity to a decline in rainfall levels that has not been registered by meteorological stations, thus mal-adapting to the challenges that climatic change poses to their livelihoods and to the overall sustainability of family farming in the state.

P-2240-17

How anthropogenic greenhouse gas emissions are changing the odds of individual extreme weather events – a communication opportunity

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Warming of the global climate system is unequivocal, predominantly due to rising greenhouse gases with direct implications from rising mean global temperatures for some slow-onset events such as sea level rise, which can therefore be linked directly to past emissions. In many regions, however, extreme weather events, like heatwaves, floods, and droughts, are associated with greater loss and damage. An increase in average temperatures will lead to an increase in the frequency or magnitude of some extreme weather events including heat waves and droughts. For example, the deaths of at least thirty-five thousand people in Europe are attributable to the record-breaking heat wave of 2003. Extreme heat events and subsequent droughts can be directly linked to the loss of human life as well as damage to, or the significant diminishment of economic productivity.

The emerging science of probabilistic event attribution (PEA) has demonstrated over the last decade that it is now possible to attribute the fraction of risk caused by anthropogenic climate change to particular weather events and their associated losses. In other words, PEA enables us to give a quantitative estimate of how much anthropogenic climate change is costing us today.

This ability could potentially have a huge impact on climate change communication. Extreme events, in particular those that are not just rare from a meteorological perspective but also lead to societal and monetary damages and interrupt everyday life usually receive a very high level of public attention. If attribution studies show that a particular event was indeed made more likely due to anthropogenic climate change, i.e. anthropogenic climate change has increased the chance of the event occurring at this point in time, human induced climate change is transformed from something that is happening at some point in the future to a real threat in the here and now. Previously these studies took months to accomplish, delivering results long after public attention has peaked. Through a new partnership between Climate Central, a non-profit organisation providing TV weather forecasters with climate information, the University of Oxford Environmental Change Institute and other academic partners this huge communication opportunity will be taken to the next level by building a modelling and communication framework that provides decision-makers, and in particular the public, with the means to make clear the quantitative connections between greenhouse gas emissions and extreme weather events in real-time.

This fast turnaround ensures that any communication opportunity will have maximum impact as an extreme event only remains topical while it is unfolding. By hearing the science as the public experience the event, they will really begin to fully understand climate change.

P-2240-18

The Role of Climate Change Concern in the Acceptability of Energy Supply Technologies and Energy Demand Reduction

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As a large proportion of carbon dioxide emissions are generated by the domestic sector, individuals need to make drastic changes to their current lifestyle in order to play their part in climate change mitigation. Not only do they need to change their personal behaviour, they also have to accept new low-carbon technologies in order to decarbonise the energy they are using. This paper presents the results of large-scale nationally-representative survey (n=1,822) on public perceptions of climate change and energy futures in Britain. It examines the role of climate change perceptions in the willingness to accept low-carbon energy-supply technologies, such as solar and wind energy, and their willingness to change their behaviour to reduce energy demand. The study found that concern about climate change was strongly associated with the acceptability of both demand-side measures and supply-side technologies. In addition, the study found that personal values and environmental identity are important factors in the willingness to accept low-carbon technologies and energy demand reduction. It appeared that people with traditional conservative values were less likely to engage in low-carbon behaviours due to higher levels of concern about energy security. Individuals with self-transcendence values were more willing to engage in low-carbon behaviours and to accept low-carbon energy-supply technologies as a result of higher levels of environmental identity, concern about climate change, and personal norms. The results of this study will be put into a wider programme of research on public perceptions of climate change and energy choices to discuss the role of human choices and behaviour in the transition to a low-carbon economy. Furthermore, international comparisons will be made to explore different views on what are acceptable transition pathways. The paper will be part of the session «Towards solutions that transcend technology and markets: the role of choices and behaviour change» (3316 – Behaviour Change).

P-2240-19

Addressing the Adversities of Climate Change through Mindfulness and Resilience : A Conceptual Framework

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In India, climate change could represent additional pressure on ecological and socio-economic systems that are already under stress due to rapid urbanization, industrialization and economic development. With its huge and growing population, long densely populated and low lying coast lines, and an economy that is closely tied to natural resource base, India is considerably vulnerable to the adverse impacts of climate change, which requires exorbitant efforts on the part of respective communities to cope and adapt. There is a need to build a resilient community full of eco consciousness and mindfulness ,capable to face climate change and associated disaster risk with psychological hardiness and strong will power. For that, governments need to be aware of current and future potential risk and take more initiative in order to enhance the eco consciousness and resilience of the urban systems and communities. Co-adaptation is one such form of collective action whereby stakeholders of a community work together with a government agency to undertake some aspects of environmental issues which can be potentially threat full to the changing climate (Tompkins and Adger, 2004).

Socio psychological and spiritual factors play an important role in this regard to make serious efforts to modify and alter the life styles and behaviours of people in order to prove themselves as environmentally sensitive citizens across the planet, better suited to today's environmental needs. Life style change also helped in developing human resilience to climatic variability in a more positive way to promote subjective as well as global well being .Implications for psychological and Spiritual health were also discussed.

P-2240-20

Challenges to climate change adaptation: A case study on flood risk perceptions in the Hawkesbury-Nepean catchment, Australia

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The Australian climate is characterised by extreme weather conditions. Future unpredictability has placed pressure on government agencies to increase their effectiveness of managing adaptation to extreme weather events, increase coordination and improve risk communication and community participation. Efforts to increase adaptation to climate change at different levels of government and among a wide-range of stakeholders require identifying and understanding the barriers that hinder adaptive actions. This abstract is part of a PhD research that looks in to barriers to flood management under a changing climate and intends to identify bottlenecks that create maladaptation. The research takes the Hawkesbury-Nepean catchment as case example. The catchment is characterised by ambitious development goals with 180,000 new developments in the floodplain of the two major rivers (Hawkesbury and Nepean Rivers) of this catchment, unique topography that increases the risk of floods in this regions, and challenge to maintain conservation of the Blue Mountains as a World Heritage Site.

This research paper explores the perceptions of residents to flood risks to their property and the likelihood of other factors that can influence this perception and hence their low response to take action in government-led measures to mitigate impacts of climate change. The data was collected through on-line, face-to-face and postal surveys. A total of 540 postal surveys were distributed and 81 face-to face surveys were conducted from residents residing in the Hawkesbury-Nepean catchment across five suburbs. Findings of this research show that generally communities have a low perception of flood risks in the region and that factors such as proximity to the Rivers, gender, age and duration of living in the area can influence perceptions of flood risks to property. These factors influence an individual's attitude to either be proactively engaged in adaptive action or continue to remain in denial. Another important aspect that was identified to influence perception was the false expectation of communities of government authorities. Government authorities were seen as responsible for 'keeping communities' safe' and so if development is approved on floodplains it translates as a flood-safe region. The outcome of this research is to provide a better understanding of communities residing in inland floodplains to contribute towards developing effective risk communication strategies thus enabling better management of floods and achieving increased level of support from the communities.

P-2240-21

Small Scale Peri - Urban Farmers' Adaptation to Climate Change in Domboshawa, Zimbabwe

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Zimbabwe is a semi-arid country heavily reliant on regular rains (generally November to April). Rainfall exhibits considerable spatial and temporal variability characterized by shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, and increases in the frequency and intensity of mid-season dry-spells. Extreme weather events, namely tropical cyclones and drought have also increased in frequency and intensity in the country. Agriculture is the main source of income for most smallholder farmers who depend on rain fed cropping and livestock rearing in Zimbabwe. Adaptation of agriculture to climate variability and change impacts is vital for sustenance and food security. In order to develop appropriate strategies and institutional responses, it is important to have a clear understanding of the farmers' perceptions on climate change adaptation at farm-level. Thus, this study identified, evaluated and suggested farm-level adaptation strategies to climate variability and change in Domboshawa; a peri-urban communal area located 26km north east of Harare, the capital of Zimbabwe. Domboshawa is located in Ward 4 of Goromonzi District in Mashonaland East Province. Domboshawa is comprised of about 40 000 households with an average household size of 5 people and with more than 75% of these people relying on farming. The research design used in this study was both qualitative and quantitative (mixed) in nature. A combination of both methods yielded more validity and reliability than using either method on its own. The study of climate change adaptation is focused on inquiry based on the description of experience and such studies adhere to a philosophical of understanding social phenomena which traditionally advocates for the use of qualitative and quantitative data. Simple random sampling was used to select 45 respondents for the questionnaire. The population registers from the Headmen of each of the five wards; Munyawiri, Mawanga, Shumba, Murape and Pote were obtained which constituted the sampling frame. Each entity or individual was selected one at a time and independently therefore ensuring that each entity had an equal chance of being selected from the three selected villages. Purposive sampling was used to select people or organisations that are working in the area. Specific method used in the Quantitative approach is the survey. Qualitative methods used include Participatory Rural Appraisal (PRA), specifically, resource mapping, historical trend lines, and seasonal and daily activity calendars. Focus group discussions and in-depth case studies were also used. Climate vulnerability and capacity which combines local and scientific knowledge will be used to elicit for knowledge that is locally generated by the farmers to adapt to climate change. Findings revealed that local people perceived changes in rainfall and temperature based on their daily experiences. The majority of the smallholder farmers have adopted measures to address climate change and variability which include crop diversification, soil and water conservation practices, off-farm income activities and integrated crop and livestock diversification. The smallholder farmers are constrained in their daily farming activities by poor infrastructure, inadequate credit facilities as the farmers lack collateral and multifunctional input and output markets. Empirical analysis of rainfall suggests decreasing rainfall trends between 1920 and 2008.The study concluded that there is need to educate farmers on climate change so that they are able to design adaptation strategies that take into cognizance existing local level knowledge and practices on land and water management so as to boost agricultural production. While there are multiple stressors that confront farmers, climate variability and change remain the most critical and exacerbate livelihood insecurity for those farmers with higher levels of vulnerability to these stressors. Climate

variability and change might also have a positive impact and localised benefits in the context of structural changes in community's social organisation and economic activities under certain circumstances. There is need for agricultural research to support appropriate agricultural innovations and development of new livelihood activities emerging as farmers respond to climate variability and change.

P-2240-22

Public perception of climatic change and the risk control action of the government in metropolitan area of Belém, Brazil

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The extreme hydroclimatic changes such as floods, drought, soil erosion and collapse of river margins expose several negative impacts on the daily life of the population who live in the metropolitan city of Belém, in the Amazon region of Brazil. The characteristics of spatial occupation of the city favour the risk associated with these changes and the whole population is vulnerable to it.

The objective of this study was to analyse the perceptions of students of Federal University of Pará, Brazil (UFPA) about climate change risk caused by extreme hydroclimatic events in the metropolitan city of Belem and their vision about the Government action to reduce the risk caused by these extreme events. In addition, the research analyses public opinion in relation to citizens' participation in decision-making and confidence in the ability of the State in risk governance.

The main hypothesis of this study is that the public opinion on the perception of problems related to extreme hydroclimatic changes is important for making public policies related to risk governance by the State.

This research employed the same structure of questions of Tien (2013)[i] used to evaluate the perception of risk in relation to climate change in Taiwan. The questionnaires were applied to all undergraduate students of economics from Federal University of Para, from the morning and night course during the months of May to June 2014.

In the perception of respondents about climate change, 78% think the importance of climate change is not exaggerated. Despite the accelerated industrialization and commercial farming are important factors for economic growth, 71% of respondents agree that combating climate change would be favourable to the Brazilian economy. More than half of total respondents (51 percent) agrees that a possible implementation of environmental protection would facilitate the Brazilian economic development and 75% of the respondents disagrees with the permanence of oil subsidies.

About 62% of respondents are not willing to pay more taxes on clean energy and environment. It is noticed that the population support Government initiative to mitigate the effect of climate change, but they are not ready to pay for it. In the opinion of 54% of students, the information available on the origin of climate change is insufficient and do not contribute to understand the actual situation of the problem. A significant 72% percentage of students considers insufficient the actions of private companies to deal with climate change. They believe that the Government should establish policies to mitigate climate changes.

The study pointed out that the lack of communication and transparency of Government hinders actions that could be undertaken on climate change mitigation and adaptation. Most respondents disagree that the Government grants subsidies to fossil fuel companies. At the same time, they are not willing to pay more tax to fund climate change mitigation. The study shows that there is a perception of climate change risk by the population and there is demand for more transparent communication available to them of public policies adopted by the government on risk governance.

[i] For more information, refers to TIEN, Chou Kuei. The public perception of climate change in Taiwan and its paradigm shift. Energy Policy. n.61, 2013. p. 1252-1260.

Acknowledgement: IDRC, CAPES and FAPESPA

P-2240-23

A Sense of Place: Social Recovery in the Post-Disaster Reconstruction in Sichuan, China

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Climate change has been triggering frequent global environmental crisis. Those environmental crisis bring plenty unwanted relocations, which deeply affect survivors' physical and social environments. While, most post-disaster reconstruction and recovery give predominant priority to the physical reconstruction, by timely producing enough housing and sound infrastructures for survivors, there is a lack of attention on the social recovery of the survivors, such as assisting them settling in the new environments. Taking the post-disaster reconstruction conducted after the Wenchuan earthquake, Sichuan, China, May 12, 2008 as an example, this paper addresses the problem that the lack of synchronization and imbalance between physical and social reconstruction resulted in the most earthquake survivors to experience unstable attachments to their new environments. Based on this phenomenon, this paper presents a reflection on how post-disaster physical reconstruction (particularly in China) could be improved by utilizing the survivors' social and individual memories. Focusing on the memory workshops and walk-along interviews with the local earthquake survivors, this paper uses the method of storytelling to examine memory's function in the earthquake survivors' relocation process. This paper argues that the local earthquake survivors' memories of their daily lives and their use of spaces in their original homes provided means to support their social recovery process, assisting them to grow attachments to their new dwellings, to reestablish their social networks, and to redevelop a sense of place. This paper suggests that the local residents' place-related social and individual memories should be considered as a new method for policy makers, urban designers and social workers to understand the changing of natural environment and how this is impacting humanity.

2241 - New representations and new frames for the climate change debate

ORAL PRESENTATIONS

K-2241-01

Climate and the Future of Inequality

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Climate change has been presented as the great equalizer, one of those productions of the modern risk society that places all of humanity at the same disadvantage with respect to a calamitous future. Social studies of risk, however, paint a very different picture, showing that the adverse consequences of risk fall disproportionately on the most vulnerable segments of global society. How might the future of climate policy look if climate change were reframed in terms of the inequality of its shorter-term impacts rather than the potentially longer-term equalization of a world at risk? The talk focuses on the

disciplinary and institutional means through which imaginaries of climate equality and inequality are created and propagated, including law, economics, and climate science itself.

O-2241-01

A new framing and a new governmentality order for the climate problem

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For the last 25 years, anthropogenic climate change has been framed as a global environmental pollution problem, which must be solved by reducing human greenhouse gases emissions through a global agreement negotiated under the auspices of the UN. The role played by sciences in the construction of the problem is essential, and is well summarized by the claim «science speaks truth to power,» with science and politics assumed to be hermetically separated. Although in reality this «linear model» is largely inadequate to account for the much more complex links between climate science and politics, notably within the IPCC, it has long been hegemonic, leading to debates focused on science rather than political responses.

This dominant framing has been undermined by the failure of major assumptions underlying international negotiations: it is now clear 1) that climate change is a geopolitical, economic, and development problem as much as an environmental one, 2) that we cannot solve it in isolation from all the regimes (energy, development, trade..) which perform the economic and financial globalization, and 3) that the needed industrial and social transformations have to be named and largely debated.

As the Paris CoP approaches, this paper critically examines the mistakes and the illusions of this framing, suggesting a new order of governmentality.

O-2241-02

Climate Change, Adaptation, and Community Discourse: Framing for Vulnerability and Transformation

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The impacts of climate change are already having an affect on communities. From increased storm frequency and flooding, to heat waves and fire danger, to food insecurity and migration, climate change is no longer a future concern, but a present experience. The politics of climate change, therefore, have moved beyond a sole focus on global or state action on the mitigation of emissions, to local and regional adaptation policy.

One of the central frames for adaptation is risk and disaster management; in Australia, nearly every local government council has a Climate Change Adaptation Plan clearly framed by risk. This paper examines the very different framing for adaptation policy articulated by community groups that are primarily concerned with the vulnerability of basic capabilities and broader social and economic transformation. I assess two sources of this community discourse and framing. First, a content analysis of the websites, Facebook and Twitter feeds of environmental and community advocacy groups in Australia is examined to assess the main topical concerns expressed. Second, a deliberative democratic community adaptation policy consultation processes was run in Sydney. Using Q methodology and discourse mapping, the preferences of individual participants are mapped with regard to adaptation policy priorities both before and after the deliberative events. The consensus statement and policy recommendations put together by citizens as part of the deliberative process are also explored for indications of a framing quite different from a simple risk management approach

There are two key findings to report. First, community groups express a particular concern for vulnerability of basic capabilities in climate-challenged communities; these concerns are also clearly reflected in the community consultations. This contrasts with the language and policy framing of local governments on risk management and emergency response. Second, the deliberative process helps to increase the collective attention to both vulnerable capabilities and communities and the importance of transformation of local policy and process, and brings consensus around such framings. Ultimately, it may be that the disconnect between government and citizen framing is due, in part, to a lack of community engagement and participation in the development of adaptation plans, which has led to the exclusion of the diversity and widely varying concerns of community groups in the development of local adaptation policies.

O-2241-03

Carbon sink geopolitics: Using Science and Technology Studies to explore the futures of collective climate action

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In the mid 2000s, as part of the international effort to decrease greenhouse gas emissions, the negotiation process on climate change started to look at how to reduce carbon releases caused by tropical deforestation - an item and forthcoming regulation referred to as REDD+. By drawing on Science and Technology Studies and a multi-sited fieldwork, which investigated the archives of climate negotiations and followed between 2009 and 2012 the problem of CO2 emissions assignable to tropical forest loss (from DRC's Ministry of environment, to the 17th session of the Conference of the Parties in Durban and Europe-based offices of carbon experts), this presentation suggests using the case of REDD+ to explore the notion of carbon sink geopolitics as a potential learning opportunity for future climate actions.

The transformation of tropical forests into a carbon sink that should be taken care of occurred through diverse public aid interventions deployed in low-income regions (e.g. the Congo Basin), relentless scrutiny exercised by non governmental organisations on behalf of intact forests or the rights of indigenous people, research and commercial activities dedicated to measurement and quantification aspects, and lively debates within intergovernmental negotiations about the rules of a possible market-inspired mechanism. Such effort dedicated to preserve carbon sinks - or at least to make sure that the consequences of their exploitation (e.g. through logging or agriculture) do not go unnoticed - is still inscribed in the interstate and quasi-legal United Nations Framework Convention on Climate Change. Yet, the geopolitics that the REDD+ process might be a precursor of and that this presentation proposes to sketch is an assemblage of, among other things, monitoring instruments like earth observation satellites, financial redistribution vehicles like multilateral funds, and institutionally mobile actors like expatriate consultants and environmental activists. I argue that, while this geopolitics relies on the geographical and political order established by the United Nations, it develops in the interstices of such division, in inter-national spaces, where it creates a collective concern, the carbon stored by tropical forests, and its socio-technical community.

O-2241-04

Politics of the Earth: Three Scientific Challenges in the Anthropocene

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It has been argued that the Earth had entered the Anthropocene since the industrial revolution. The Anthropocene is best described as a geological epoch where humans have become the driving forces of changes on the planet. The epoch is characterized by a radical transformation of the relationship between humans and the Earth, of which climate change is one of the most evident transformations. It signals a new phase in the relations between a planet regulated by he laws of physics and biology, and human societies regulated by the laws of economics and politics. This transformation needs us to reconceive the scales and dynamics of collective action, to think together the World and the Earth.

"Politics of the Earth" is a new interdisciplinary programme

that seeks to achieve this objective. Its scientific perimeter is organised around two central dimensions, which depend on each other: a dimension of representation, and a dimension of government.

These two dimensions encompass thematic and methodological stakes, which can only be addressed through a common work between natural and social sciences. In order to think these multiple scales and dynamics, the Anthropocene imposes new representations, which are being made possible through the production of new data. Many of these data and databases, however, remain impossible to combine together, which prevents researchers from thinking the transformations of the Earth-Workd nexus in its multiple dimensions, and which also prevents an effective government of these new stakes.

The programme "Politics of the Earth" gathers research labs from different disciplines in different universities, around three challenges that crystallise the Anthropocene:

- Geopolitics of carbon dioxides;
- Expertise of risks and mediatisation of disasters;
- Dynamics of critical zones and urbanisation conflicts.

This session aims to present the preliminary results of the programme, which was launched in January 2015, and to show how these interdisciplinary perspectives can help represent climate change in the framework of the Anthropocene.

O-2241-05

Realising consilience. How better communication between archaeologists, historians and geoscientists can transform the study of past climate change in the Mediterranean

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This paper reviews the methodological and practical issues that have bearing on the ways in which geoscientists, historians and archaeologists collaborate in the study of the societal impacts of climatic changes in the Mediterranean basin. We begin with discussing the methodologies of the three disciplines in the context of the consilience debate, i.e. the attempts at unifying different academic disciplines, in particular from among the sciences and the humanities, that work on finding answers to similar questions. We demonstrate that there exists a number of significant similarities in the fundamental methodology between history, archaeology, and environmental sciences, due to their common interest in studying the past societal and environmental phenomena; this has to do, for instance, with the use of narrative structures as the means of communicating research results, which is common to the three of them. Consequently, we also present and compare the different narratives of the societal impact of climatic change that are characteristic for each discipline, which it is necessary to comprehend in order to engage in fruitful interdisciplinary exchange. Finally, in the second part of the paper, we focus our discussion on the four major practical issues that hinder communication between the three disciplines. These include terminological misunderstandings, problems relevant to project design, divergences between the publication cultures, and differing views on research impact. Among other recommendations we make, we suggest that scholars from the three disciplines should aim at creating a shared, hybrid publication culture, which should also appeal to a wider public, both within and outside of academia. Finally, we present possible actions on the part of both scientists and humanities scholars (archaeologists and historians) that – if taken – will solve several of the challenges discussed in paper.

2242 - Migration dynamics under current and future climate change

ORAL PRESENTATIONS

O-2242-01

Climate migration and the politics of causal attribution: a case study in Mongolia

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Migration is always multi-causal. Ascribing a specific cause to migration, such as through the concept of "climate migration," participates consequently to a political exercise – a play of shade and light where attention is focused on the responsibilities of certain actors rather than others. This is the case, this article argues, regarding internal migration in Mongolia, whereby, during the last two decades, nomadic or semi-nomadic herders as well as inhabitants from small urban centres come to settle in insalubrious suburbs of the capital, Ulaanbaatar. The Mongolian authorities are keen to highlight changing environmental conditions that can be traced to climate change: a change in precipitation patterns and an increase of average temperatures contribute to cause large loss of livestock during harsh winters (dzud). Yet, a multitude of other factors concurrently influence the migratory behaviour of Mongolia's nomads: unregulated and unsustainable pastoral practices, the insufficient provision of basic and support services in the countryside, or, more generally, the lack of public support to the agricultural sector. Identifying concurring causes of migration suggests alternative response measures, and this article argues that Mongolia should urgently rectify its development policies to provide a room for each of its citizens.

O-2242-02

How can migration support adaptation? Testing the climate change adaptation-migration nexus

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Empirical evidence shows that in the face of environmental and climate stress, migration is a common household strategy aimed at supporting basic needs and livelihood strategies (c.f. Foresight 2011). Policy makers commonly view adaptation measures as means to reduce migration pressures. But migration may also be seen as an adaptation strategy itself; as a way to reduce population pressures in climate-prone places while migrants already living outside

of vulnerable areas provide important resources to help communities adapt and respond to climate change.

However, the application of the environment and climate change adaptation-migration nexus has not been empirically tested, nor has the policy apparatus needed to deliver this potential been developed and assessed. More research is needed if policy interventions are to enhance the positive effects of migration on adaptive capacities and distinguish potentially maladaptive effects. The objective of this conceptual and methodological paper is therefore to flag different possible choices that can be made to study and represent the relationship between migration and adaptation, employing insights from a recently developed and tested survey instrument for the 'Migration, Environment and Climate Change: Evidence for Policy' (MECLEP) project.

The first section defines adaptation as it relates to mobility in the broad sense, taking care to anchor the potential of migration to build resilience and increase adaptive capacities within complex and potentially maladaptive processes. Then insight is given into the current body of knowledge contributing to this important area of inquiry. The next section addresses the climate change adaptation- migration nexus as it relates to the three main vantage points: the individual migrants themselves, the community of origin, and the community of destination. Conceptual and methodological difficulties met to-date are explored, with a reflection on how different approaches are best utilized in empirical studies. Insights from the MECLEP representative household survey implementation and research strategy, recently tested in at least three countries (Haiti, Papua New Guinea, Viet Nam) are brought to the fore. A final section weighs the challenges and advantages of the MECLEP approach and suggests what solutions may exist to advance the project and the field of research overall.

O-2242-03

Abrupt climate change superimposed to RCP 8.5 IPCC scenario : potential consequences for population migration

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From Paleoclimate studies we know much more about abrupt changes as Heinrich events which are huge amount of icebergs periodically spreading over North Atlantic.

These events occured when the Laurentide ice sheet was unstable during glacial times. Recently, new mecanisms envolving ocean and cryosphere were developped to explain these instabilities [1, 2]. In contrast, Greenland and Antarctica were more stable during last glacial/interglacial cycles. Ongoing global warming has also for consequence to make Greenland and West Antarctica out of equilibrium. Therefore, in future climate, new abrupt climate changes linked with surges from the cryosphere may happen again. To investigate this issue we built 3 scenarios corresponding to about 3 meter sea level rise : one melting part of Greenland, another one without West Antarctica ice sheet and last one is a mix of both. These scenarios are superimposed to RCP 8.5 which is the most pessimistic one used by IPCC. They allowed us to diagnose major climate changes, especially in regions with high population density (Monsoon areas).

We will first explain the methodology and the scenarios we used. These experiments have indeed, many common features with Heinrich events simulations in the past and housing experiments in the future [3]. Especially, the ITCZ shifts and its impacts on monsoon areas but also long term change in thermohaline circulation will be described. The consequences of such atmospheric and ocean perturbations will be also considered from a population migration point of view.

Most of the study focused on population migration only due to sea level rise, but here we developed an original approach using consistent climatic scenarios accounting for both sea level rise and induced climate changes.

[1]Alvarez-Solas J., Charbit S., Ritz C., Paillard D., Ramstein G., Dumas C., 2010. Links between ocean temperature and iceberg discharge during Heinrich events, Nature Geosci. 3, 122-126

[2] J. Alvares-Solas, Gilles Ramstein PNAS «On the triggering mechanism of Heinrich events» PNAS vol. 108 no. 50 E1359-E1360

[3] RONALD J. STOUFFER et al, Climate Response to External Sources of Freshwater: North Atlantic versus theSouthern Ocean, JOURNAL OF CLIMATE, VOLUME 20, 436, 2007.

O-2242-04

Unsettling Futures - Climate change, migration, and the immobility of climate politics

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The message that climate science and current emission trajectories are sending is clear: limiting global warming to 2°C is more and more an unlikely prospect. This predicament is hard to apprehend also because a 3 or 4 °C warmer planet is a largely unknown place, where socio-ecological spaces and relations look differently. Visualizing the impacts of such severe climate change - and of our responses to it - requires a radical imaginative effort.

If we take the possibility of 3 or 4°C warmer planet seriously, we can expect changes in the very ways in which humans understand, plan and experience their (im)mobility. And in effect, the question of how climate change will influence human migration has alimented a florid debate in the last decade. Academics have written reams about climate-induced migration, and policy negotiations have gathered pace. To be sure, various steps forwards have been taken. The securitizing drives once 'justified' by the fear of mounting waves of climate refugees have given way to the milder imaginaries of resilience, adaptation and development. While previously signified solely in terms of forced migration, the nexus climate change-migration is looked upon from a more comprehensive vista. Displacement, reduced mobility (with the issue of 'trapped populations'), voluntary migration (preached as a legitimate adaptation strategy), planned relocation and resettlement are co-protagonists of today's policy debates. The environmental determinism previously dominant is thereby gone, and more nuanced understandings of (climate) migration have prevailed.

Nonetheless, there is a striking dissonance between the paucity of those debates and the re-imagination necessary for formulating a politicized understanding of so called climate migration. While we should feel no nostalgia for the alarmist narratives of the past, the current mundane discourses anaesthetise the radical challenges posed by the climate-migration nexus. The prospect of unprecedented changes is dealt with through an attempt to reproduce "business as usual". The emerging discourses contemplate displacement, trapped populations, migration as adaptation and planned relocation in ways that conciliate the agendas of dominant international agencies. The current approaches to climate migration are a re-proposition of the measures predominant in the fields of development, aid, migration, risk management and climate adaptation, which have proved functional to the re-production of neoliberal relations.

In other words, the emerging discourses foreclose the political by sterilizing the radical questions that might emerge. To the radical transformations associated to a 3 or 4 °C warmer planet, the "new" discourses on climate migration respond with 'more of the same', making sure that nothing can change even in the front of epochal changes.

O-2242-05

Potential Migration Impacts in Extreme Climate Change Scenarios: A Systemic Perspective

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With the target of limiting global warming to 2°C becoming increasingly difficult to achieve, policymakers and other decision-makers need to begin to plan ahead for adaptation to changes in climate associated with higher levels of global warming. The HELIX project (High-End cLimate Impacts and eXtremes), an EU FP7 project funded by the European Commission, seeks to provide a clear, coherent, internally consistent view of a manageable number of "future worlds" under higher levels of global warming reached under a range of physical and socio-economic circumstances. In this presentation, we specifically address how migration will fit into this picture. Assessing future migration under extreme climate change is not a facile task. Often predictions of massive future displacements are based on the numbers of people living in a risk zone, without taking into account differentiated vulnerabilities and capacities for resilience. Moreover, predictions of massive human displacement in the future tell us little about the character, scale, or destinations of these projected movements. Therefore, in one of the tasks of HELIX, a multi-disciplinary team seeks to appraise future migration based on empirical investigation into how people have historically and are currently responding to environmental changes.

One of the critical insights revealed through HELIX thus far is the importance of people's perceptions of climate change in determining their migratory responses and intentions. Based on survey data from several West African countries, we compared populations' perceptions of climate change with objective climatic data. This comparison showed that most West African people are affected by what is externally considered to be 'non-significant' change. These results highlight that people are increasingly vulnerable as the 'system' (social, demographic, economic, environmental) in which they live becomes less and less able to resist different stressors, even those of limited magnitude. This finding has significant implications for migration: some of the surveyed people directly migrated in response to these changes and others plan to migrate if rainfall conditions worsen in the future. As people's migratory decisions and intentions are based on their own perceptions of climatic changes and their ability to withstand them rather external risk/resilience assessments, an increase in migration could occur faster than previously expected in West Africa in the coming decades, calling for new policy responses that have to include the resilience capacity of the entire 'system'.

Much like policy must address the decreasing systemic resilience of vulnerable populations, future climate change-related migration policies and approaches would do well to consider human (im)mobility responses from a systemic perspective. A second HELIX case study details the interconnections between various stressors (demographic, economic, environmental, etc.) and differentiated mobility patterns in a fishing community in Saint-Louis, Senegal. As climate change exacerbates populations' pre-existing vulnerability, it cannot be isolated from other pressures. Likewise, displacement and voluntary migration cannot be separated from each other. Findings show that 'voluntary' labor migration is intimately intertwined with other forms of mobility, including relocation and displacement. Those fishermen who engaged in international migration were often able to preemptively relocate their households to locations safer from the imminent effects of climate change, decreasing their likelihood of future displacement. These interrelated movements call for policy approaches that treat vulnerability and mobility - internal and international, voluntary and forced - holistically. As livelihoods dependent upon natural resources (fishing, agriculture, etc.) will become increasingly difficult to maintain with extreme climate change, people in the future may, in fact, be less able to move voluntarily without some degree of capital (human, social, financial). If migration as an adaptation strategy is not facilitated, therefore, it may decrease populations' capacities to deal with the effects of climate change and put them at risk of becoming 'trapped' or displaced in precarious conditions in the future.

O-2242-06

Predicting the social impacts of climate change: Migration, environment and climate change in a world of global uncertainties

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The links between global environmental change and migration have been explored at length, and existing academic and institutional evidence suggests that environmental migration is a reality; what is harder to foresee is what forms it will take in the future. Will more people be forcibly displaced due to climate change and natural disasters? Will more people resort to migration as a positive adaptation strategy in the context of climate change? Will people be able to migrate at all, or will they find themselves trapped in vulnerability?

This presentation will explore the difficulties around predicting future migration flows in the context of climate change, by presenting the complexity of the phenomenon and the multiple factors at play, and by examining the phenomenon in a more general context of uncertainties around local climate change impacts, around future demographic, social and economic change, adaptation measures to come, future policies that may or may not be taken, and, very importantly, individual perceptions, reactions, needs, and ability to leave or stay. The presentation will build on IOM's long term research, operational and policy experience in the area of environmental migration, and provide some concrete examples and recommendations for future research and action.

O-2242-07

Migration associated with large-scale land acquisitions, land tenure and land degradation

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The proposed presentation intends to extend current debates on migration and climate change to emphasize the importance of land planning for environmentally-induced migration with a particular focus on current research on large-scale land acquisitions, land tenure and land degradation. The panel will use a bottom-up approach to explore examples of local and regional case studies on migration dynamics associated to land management. The first case study will focus on the issue of land tenure in the Pacific regional context, the second will analyze the issue of large-scale land acquisitions in Senegal and Cambodia and the last case study will illustrate how land degradation could be a major challenge in the context of environmentally-induced migration in Burkina Faso.

The need to focus on land in the particular context of climate-induced migration is crucial as the Intergovernmental Panel on Climate Change (IPCC) emphasized in its fifth assessment report released in March 2014; past examples shows that environmental change can affect land rights and land use, and at the same time, change of land use has also become in turn drivers of migration. This is particularly relevant for the Pacific region where retreating from affected coastal areas through migration as an adaptive strategy to changes in environmental patterns has always been part of the Pacific Islands' communities culture and practices. In the coming decades, the adverse effects of climate change in the region are likely to exacerbate both slow and sudden-onset environmental events threatening sustainable livelihoods and increasingly leading Pacific Islanders to use migration as coping method. However, there is a lack of study on land rights and land tenure systems that have been given little importance in the literary and policy debate on adaptation strategies in the context of Climate Change. It is crucial to address this dimension, particularly in the context of Pacific Islands, where in the majority of the countries, 80% of land is under customary tenure. Dalila Gharbaoui will study the role of land tenure in planned relocation exploring a sub-regional case study involving past examples of planned relocations in Fiji, Papua New Guinea and Vanuatu. A major difficulty with this type of human mobility is the disarticulation of communities and social structures following the relocation process, particularly crucial in the context of the Pacific region where the link between individuals and their land, has been an extension of their identity for millenaries.

Another crucial study of land in the context of climate-induced migration focusses on the case of policies aiming at biofuel production incentivising the acquisition of large tracts of land in the Global South, often overlooking the rights of local populations and leading to the forced displacement of whole communities. Through the example of climate change mitigation policies leading to "green grabbing", we can see how the multi-causal links between climate change, migration and displacement are further complexified. The links with the category of environmentally-induced migration occur most visibly when such agro-fuel projects destroy the local land and the water resources, forcing people off their land in what could be seen as a form of tertiary displacement. Whilst those analysing the social consequences of land investments need to pay more attention to the migration outcomes, there is also a need for environmental migration scholars and practitioners to broaden the spectrum of their analyses. In order to better understand how the climatic agenda, through legitimising many recent land acquisitions has impacted local population movements in different ways, depending on particular historical and political circumstances, Sara Vigil will give field insights from both Senegal and Cambodia addressing more deeply those questions.

Another important aspect that will be discussed in the context of climate migration addresses the issue of land degradation. Based on her findings from field research conducted in Burkina Faso in 2012, Nakia Pearson will give insights on the migratory practices and adaptive strategies of farmers who have moved in response to the land degradation since the 1970s Sahel droughts in order to better define the tipping points of loss and damage, as well as how mitigation strategies may play into migration.

O-2242-08

Protecting the rights of people displaced and at risk of displacement

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Every year around the world, tens of millions of people migrate and are forcibly displaced by floods, wind-storms, earthquakes, droughts and other disasters. Many find refuge within their own country but some have to go abroad. In the context of climate change, such movements are likely to increase. National and international responses to this challenge are insufficient and protection for affected people remains inadequate. States and other duty bearers need to protect and assist people displaced or at risk of displacement by disasters and the effects of climate change. Assisting such people is not only a humanitarian imperative; it is an essential component of disaster risk management, climate change adaptation and development planning.

The impact of climate change is most acutely felt by individuals and communities with pre-existing vulnerabilities which often are characterized by the limited enjoyment of rights. Many of the most important protection challenges in disaster situations related to climate change are long-standing protection and human rights concerns which are brought to light and further exacerbated by the emergency. While people displaced within their own countries are covered by national laws, international human rights law, the Guiding Principles on Internal Displacement and a few regional instruments, a serious legal gap exists with regard to cross-border movements in the context of climate change. These people are in most cases not refugees under international refugee law, and human rights law does not address critical issues such as their admission, stay and basic rights. Criteria to distinguish between forced and voluntary movements in the context of disasters have not yet been elaborated.

According to the Inter-Agency Standing Committee (IASC) protection is defined as: "... all activities aimed at obtaining full respect for the rights of the individual in accordance with the letter and the spirit of the relevant bodies of law (i.e. HR law, IHL, refugee law)." Such activities can be responsive, i.e. aiming to prevent imminent or stop on-going violations, remedial, i.e. aiming to provide redress (e.g. access to justice, reparation or rehabilitation) for past violations, or environment-building, i.e. aiming at creating the necessary legal and institutional framework, capacity and awareness that is necessary to promote respect for human rights and prevent future violations. Those affected by the disaster and climate change thus become individual rights holders who can claim rights from particular duty bearers rather than simply being passive beneficiaries and recipients of charity.

Displacement in the context of disasters and climate change cause and worsen protection risks such as sexual and gender-based violence; family separation; child trafficking; unequal access to assistance; discrimination in aid provision; enforced relocation; loss of personal documentation; land disputes and issues related to land and property rights. In view of this protection gap, there is a need for an inter-governmental process to address the challenges of cross-border displacement in the context of disasters and the effects of climate change.

2242-POSTER PRESENTATIONS

P-2242-01

Environment and human migration in context of Climate Change: empirical insights from urban migrants in Ulaanbaatar, Mongolia

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Global climate change and regional environmental changes resulting from the process are known to influence ecosystem-dependent populations relatively directly. Human mobility, particularly rural-urban migration under the changing climate, is one of such complex issues that is highly context specific. This nexus of climate change-environment-migration is gaining growing attention not only from climate change researchers but also rural and urban development policy makers in the recent decades. Thus to contribute to the betterment of understanding of this social phenomenon and to provide with empirical evidence that could aid planning of adaptation strategies to future environmental changes in Mongolia, this paper presents a retrospective in-depth investigation of environmental factors of migration among urban migrants in Ulaanbaatar, who, before immigrating to the city, were traditional rural pastoralists in some of the most weather extreme prone regions in the country. Theorizing migration as one of possible adapting strategies taken by a household as a response to environmental changes, this study explores similarities and differences in forms of migration among households (vulnerable migration versus resilient migration), elements that have enabled successful migration (different forms of capital) and urban integration issues after settlement in the city. The study emphasizes on two major occurrences of drought and drought-related winter disasters since a major socio-political shift in the country - democratization in the 1990s.

P-2242-02

Small Island Developing States, Sea Level Rise and Migration: Exploring Sovereignty and Resource Rights in Abandoned Nations

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Small island developing states constitute the world's most vulnerable nations to the impacts of climate change. Countries such as Tuvalu face the very real risk of permanent abandonment within the next century as a result of sea level rise. The social, political and legal implications of migrants from vanishing countries is currently an area of intense research. Aspects such as retained sovereignty and self-governance in foreign lands are being explored at length. What is largely being overlooked, however, are implications of resource ownership within the borders of what could be described as an abandoned country. If the sovereign governing capacity of a nation collapses with the abandonment of said nation, do they retain formerly established resource rights, or do they become subject to

laws of the high seas? To date, there is no legal answer to this question. To address these matters, as well as those of sovereign governing within a foreign nation, we propose that nations willing to host migrants work to establish a legal framework which mirrors the self-government agreements employed between Canada and First Nations populations. To make this relationship agreeable and beneficial to the host nation, we recommend that the government of the island set to be abandoned agree to cede or share resource rights within the territory waters of the abandoned nation.

P-2242-03

Changements climatiques et la Migration dans les régions de Mopti et de Sikasso

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Cette étude a porté sur les communes de Dourou, dans le cercle de Bandiagara (Région de Mopti) située en zone soudano sahélienne, avec une pluviométrie moyenne annuelle de 477mm et de Kouoro, dans le cercle de Sikasso (Région de Sikasso) en zone soudano guinéenne où les précipitations moyennes annuelles sont supérieures à 1 300 millimètres. L'approche méthodologique s'est appuyée sur une recherche documentaire, la réalisation d'enquêtes quantitative et qualitative.

Les résultats ont révélé que les populations des zones enquêtées ont une perception négative de l'évolution des facteurs climatiques, au cours des 20 dernières années: diminution de la pluviométrie, hausse des températures et augmentation de la force des vents.

Les conséquences de cette péjoration climatique sont multiples et diverses : diminution de la fertilité des sols avec pour corollaire la baisse de la production agricole ; diminution des ressources en eau (tarissement précoce des points et cours d'eau et leur ensablement), diminution du l'effectif du cheptel et des pâturages, etc.

Face à ces effets néfastes des changements climatiques, les populations ont développé plusieurs stratégies d'adaptation dont l'organisation des départs des membres de la famille, à l'intérieur (exode rural) comme à l'extérieur (migration internationale).

Les résultats ont montré que la commune de Dourou, à l'instar du plateau Dogon, est une zone traditionnelle d'émigration orientée surtout vers le Ghana et la Côte d'Ivoire. Les migrations, observées au niveau interne dans la commune de Dourou, sont le fait d'une volonté manifeste d'accéder aux ressources encore disponibles dans les zones d'accueil. Par contre, dans la commune de Kouoro, cercle de Sikasso (zone de forte immigration interne), une rétroaction négative lie cette immigration aux effets néfastes des changements climatiques sur les ressources naturelles. D'où de nouveaux départs des populations de cette commune vers les zones aurifères et les grandes villes à l'intérieur du pays.

Les changements climatiques qui se sont amplifiés de 1970 à 1990, ont renforcé ces migrations internes. Comprendre le lien entre changement climatique et migration consiste à appréhender les facteurs d'accroissement de la migration et d'en évaluer les conséquences, les opportunités d'anticipation pour atténuer les mouvements de populations.

En vue de minimiser les effets néfastes des changements climatiques et des flux migratoires, les populations ont développé certaines stratégies qui son entre autres :

- Le développement des activités génératrices de revenus (AGR) ;
- La création de cantines scolaires dans les écoles pour diminuer la déperdition scolaire par la migration ;
- L'utilisation des semences améliorées plus adaptées ;
- la règlementation de la coupe du bois et le développement de bonnes pratiques de gestion des ressources naturelles pour fixer les populations sur leurs terres d'origine.

Mots clés : changements climatiques, migrations, vulnérabilité, stratégies endogènes d'adaptation..

P-2242-04

Climate change, human mobility and disaster risk reduction: The contributions of international law and pathways for implementation post-2015

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Tens of millions of people are displaced each year due to natural disasters.[1] As the frequency and intensity of natural disasters and slow onset events such as drought increase due to climate change, rates of migration are set to rise further.

The inter-relatedness of climate change and migration has been emphasised in academic scholarship and public policy for a number of years. At the 2011 Nansen Conference, the Special Representative to the Secretary-General (SRSG) on disaster risk reduction, Margareta Wahlström, noted in her capacity as Chairperson that "[c]limate change acts as an impact multiplier and accelerator to other drivers of human mobility".[2] Indeed, the draft negotiation text for a new instrument on climate change contains a call for a climate change displacement coordination facility as part of the loss and damage section.

Disaster risk reduction (DRR) can also provide means to prevent displacement (e.g. through early warning systems), and to mitigate the effects of such displacement.[3] As there is no UN organ dealing exclusively with migration, it is important that entities such as the United Nations Office for Disaster Risk Reduction (UNISDR) contribute to furthering displacement issues, particularly in regards to disasters, which account for the majority of those forcibly displaced around the globe.

The Hyogo Framework for Action 2005-2015 strives to promote a culture of proactive measures in regards to DRR.[4] As the present Hyogo Framework will expire in 2015, UNISDR has been tasked with facilitating the development of a post-2015 framework for disaster risk reduction. Thus, a new Hyogo Framework will be adopted at the World Disaster Conference in 2015 and then put forward to the General Assembly.[5] The Hyogo Framework is referred to in the proposed text for the Sustainable Development Goals,[6] and SRSG Wahlström has also emphasized the importance of such cross-fertilization.[7]

Scholars such as Elizabeth Ferris have proposed suggestions on climate change, resettlement and planned relocation, drawing upon e.g. the rules relating to development-forced displacement and resettlement. These considerations are partly reflected in the zero draft for a new Hyogo Framework, which calls for "regular disaster preparedness exercises, including evacuation drills",[8] and in the negotiating text at the UNFCCC.

This presentation aims to examine the establishment and implementation of the new frameworks on DRR and climate change from an international legal perspective, looking specifically at the rights of displaced persons. A particular focus will be placed on internal displacement caused by climate change. First, this submission will analyse the existing obligations relating to migration and climate change, including voluntary mechanisms for human mobility and planned relocations. Second, it will cover methods of implementation, including good practices, monitoring, and the importance of reliable data. Lastly, it will feature some concluding remarks and potential areas for future research.

[1] Development of the Post-2015 Framework for Disaster Risk Reduction, Zero draft submitted by the co-Chairs of the Preparatory Committee, 20 October 2014, [Zero draft], Preambular para 3. See also Internal Displacement Monitoring Centre, Global Estimates 2014: People displaced by disasters, September 2014, p 7.

[2] Chairperson's summary. The Nansen Conference on Climate Change and Displacement in the 21st Century. Oslo, 6-7 June 2011.

[3] On early warning systems, see Asplet, Mike, Handbook for Parliamentarians. Internal Displacement: Responsibility and Action, Handbook no. 20 2013, IPU-UNHCR, p 58.

[4] UNISDR, Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6), para 13 (i).

[5] UN General Assembly, Resolution 68/211, International Strategy for Disaster Reduction Resolution, 20 December 2013, UN Doc. A/RES/68/211.

[6] See proposed Sustainable Development Goal 11, target 9.

[7] UNISDR, Proposed Elements for Consideration in the Post-2015 Framework for Disaster Risk Reduction, 17 December 2013, see e.g paras 13-15.

[8] Zero draft, para 31 c.

P-2242-05

Migration and climate change in rural Africa

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We study how climate affects migration decisions of households in Ghana and Nigeria. If migration is part of the present adaptation portfolio of households to different climatic conditions, it is reasonable to expect that it will also be an adaptation to climate change. Thus, we also provide estimates of the expected impact of future climate change on migration in Ghana and Nigeria.

It is important to stress that we are interested in climate --- the average of weather conditions over a long period of time --- rather than in short-term weather fluctuations, which represent single realizations of climate. Our approach accounts for the long-run adaptation response to climate. The existing literature has instead mainly focused on the relationship between weather variability as well as weather extreme shocks, such as flood or drought, and migration. Overall this literature suggests that out-migration is a common response to agricultural productivity losses due to harmful weather events. The analysis of migration response to weather variation and shocks is a very interesting area of research but estimated elasticities should not be used to provide estimates of the response to slowly changing climate patterns.

In this paper we instead regress long-run migration patterns of households on climatic conditions and on other control variables. The advantage of this method is that it fully accounts for adaptation to the present climate. Migration is one of the many possible adaptations to local climatic conditions. The method thus identifies the relationship between climate and migration by exploiting the cross-section variation of climate and of long run migration decisions.

What is the expected shape of the relationship between climate and migration? It is reasonable to assume that with less favorable climatic conditions the incentive to migrate increases. However, migration is an expensive investment and it may be too costly for some households. High temperatures and extreme precipitation patterns reduce agricultural productivity in presence of agricultural adaptation for many reasons. However, migration is a costly investment. Climate change may increase the incentive to migrate but with incomplete and imperfect markets households may not be able to migrate because they may see a reduction in the very capital required to enable a move. Thus, given these different channels, working in opposite direction, the relationship between climate and migration decisions deserves an empirical analysis.

In this paper we narrow our focus on Ghana and Nigeria. The data are drawn from two different household surveys that gather individual as well as household information. We heavily draw on the predictions of the New Economics of Labor Migration, introduced by Stark and Bloom (1985), which emphasizes the role played by the family in migration decisions. Migration of some individuals respond to an overall family strategy, designed to adapt to current climatic conditions.

Our results reveal that the relationship between the probability that at least one member of the household is a migrant and temperature in the dry season is hill-shaped. A hill-shaped relationship results as well between precipitation in the wet season and migration. The highest propensity to migrate is at 23°C during the dry season and at 125 mm/month of precipitation during the wet season. This relationship holds only for households that are engaged in farming activities. The empirical findings reveal that migration decisions of non-farming households are not affected by climate. Our findings are robust to a series of alternative model specifications. Households located in districts with mild temperatures/precipitations have a positive chance to become migrant families if temperatures/precipitations increase. On the contrary, in districts with already high temperature/precipitations, the reverse occurs. Mild temperatures/precipitations benefit agricultural productivity and makes migration more likely. On the contrary, for higher levels of temperatures/precipitations, households may be caught in a poverty trap from which they cannot escape, as a consequence of productivity losses. We also calculate non-marginal changes of migration using geographically and seasonally differentiated climate change scenarios.

P-2242-06

The Role of Climate Change for Migration in the Past, Present and Future

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In this article we investigate the changing role of climate change as a driver of migration. We take a temporal perspective, where we analyze why and how climate change affected incentives to migrate in the past, how it affects incentives to migrate in the present, and what this may tell us about how climate change may impact incentives to migrate in the future. Our focus is on economic determinants of incentives to migrate, and how climate change alters these economic determinants.

To this we add a meta-analysis of the literature on climate change and migration, where we study the determinants of migration and climate change in the literature. We single out roughly 60 articles that look at climate change as a driver of human migration. In particular, we focus on the common issues of publication bias, and as to what kind of datasets and variables tend to be the most informative.

P-2242-07

International migration and climate change impact: a macro-economic assessment for SLR

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The relationship between climate change and migration has been poorly understood in the literature (Stern, 2013; Licker and Oppenheimer, 2013). Different methodologies have been used producing different outcomes (Beine and Parsons, 2012; Marchiori and Schumacher, 2011; Morteux and Barnet, 2009; Sheen and Gemenne, 2011). The aim of this work is to show under which economic conditions climate change can cause international migration and to what extent international migration can be beneficial or detrimental to reduce the economic losses of climate impacts.

To achieve this goal we use a Computable General Equilibrium (CGE) model, which is calibrated to the Global Trade Analysis Project (GTAP) database (Narayanan et al., 2012) for the year 2007. Differently from the GTAP macro-economic model (Hertel, 1997) we make possible for labor to move outside the borders of ten large macro-regions: Europe (EU), North America (NA), Latin America (LA), Former Soviet Union (FSU), China (Chi), India (Ind), Rest of Asia (RoA), Sub Saharan Africa (SSA), Middle East and North Africa (MENA), Oceania and Japan (OJ). The physical impacts stem from the DIVA software (Hinkel and Klein, 2009). DIVA is a widespread tool which computes the land loss caused by Sea Level Rise (SLR) at a very high geographical resolution. The cumulative land loss in Km2 (submergence plus erosion) from 2007 to 2100 for each one of the ten regions is divided by the total amount of land in these regions in 2007. We use these ratios as

negative productivity shocks affecting the use of both capital and labor in the CGE model.

In order to build a reliable economic and demographic scenario at the end of the century, we rely on the projections of GDP and population provided by the International Institute for Applied Systems Analysis (IIASA) for the Special Report on Emissions Scenarios (SRES) A2 (Nakicenovic and Swart, 2000). We have two cases. In the first one the labor is completely immobile at the macro-regional level while in the second one we model an integrated global labor market. The migration process is entirely determined by the movements of workers who react to the relative wage signals induced by climate change.

The results show a world SLR economic loss around 2.64% of global 2007 GDP under the assumption of immobile labor and a SLR economic loss around 2.59% under the assumption of mobile labor. Table 1 reports results. Rest of Asia is the most affected region by SLR but interestingly some regions as China, FSU, SSA and MENA gain from SLR. Except Rest of Asia, Latin America and India all the regions are able to decrease their economic losses or to increase their gains when the labor is more mobile at the international level. We observe a migration process mainly from Rest of Asia to the other macro-regions. It is worth noting that we do not consider within-region migration.

All this suggests that the international migration driven by a more flexible and integrated global labor market could represent a useful adaptation strategy option to slightly reduce the economic impact of SLR even if it cannot substitute in any way the adoption of strong mitigation policy to trim down damages, especially in the Rest of Asia.

Table 1	% Pro-ductivity loss on labor and capital	% GDP change (labor mobility)	% GDP change (labor immobi-lity)	Net migra-tion flow (Milions)
OJ	-0.99	-1.05	-0.73	0.25
Chi	-0.79	1.24	2.13	9.57
Ind	-1.71	-2.66	-2.96	0.91
RoA	-4.88	-25.32	-30.48	-32.55
NA	-0.92	-1.22	-0.77	0.86
LA	-1.28	-4.19	-4.36	0.34
EU	-1.75	-2.74	-2.68	-0.75
MENA	-0.35	3.34	4.39	5.17
SSA	-0.27	4.11	6.16	13.43
FSU	-0.33	3.58	4.81	2.77
World		-2.64	-2.59	0

P-2242-08

Ecological and social aspects of the Arctic zone of Yakutia, Russia

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Migration loss of population is characteristic for Siberia and Far East of Russia and is especially influenced Arctic zone. Number of population in Yakutia had shortened for 15% during 1990-2013, while in the Arctic districts of Yakutia - twice (for 53%). In 90-ies migration generally touched non-ingenious population who had migrated to other regions of Russia. Nowadays the internal migration prevails; people from the Arctic districts move to the ones with more comfortable climate and economic conditions and better jobs opportunities.

The fall of industrial production and quantity of population in Arctic had shortened the volume of pollution emissions caused by stationary sources in this area. In 1990-2009 it was reduced twice. In 1990 Arctic zone expel 21% of pollution emissions of the Republic Sakha (Yakutia), today it is only 12% of total mission in Yakutia. But because of the extremely low temperatures and massive permafrost occurrence the potential of Arctic nature to self-healing is low.

Today the main source of pollution is the living-support system, including heating system, transport, especially big vehicles which supplies Arctic zone with goods and fuels using winter roads. Housing and communal system in Arctic is characterized by high costs and low effectiveness, the huge disperse inhabited territory, isolated from the united energy supply system. Distances between populated localities in Arctic are about 600-700 km., heating period lasts from 223 to 365 days. Heating is organized by the low power disjointed boilers (with powers less than 2 Gkal/hour). These low efficiency boilers increase antropogenius environment pollution. Arctic districts heating system runs-out up to 80% and heat losses in the system are about 32%.

Arctic area deficits productive forces for neutralizing stationary sources pollutions. In Yakutia in general the level of neutralized pollution with regard to the level of its emission lowered from 75,9% in 1990 to 64,8% in 2009. While in the Arctic zone this figure started in 1990 lower, only with 15,7% and reached 6,6% in 2009. The same situation is observed in draining water downthrow: in Yakutia volume of draining downthrows is about 60%, while in Arctic zone there are now water cleaning facilities.

The decentralized energy systems modernization strategy of the North and Arctic zone focuses on the projects in alternative energy sources, automation of heating system. But nowadays it can hardly be implemented due to the limited access to the imported equipments and technologies, as well as to the local budget deficits. This situation can stay fixed for the several years.

Before soviet period Arctic was poorly inhabited territory with the extreme climate and poor food resources. This land cannot feed many people, and there were now huge settlements, people were spread over the territory for they can feed theirselves by hunting and fishing. Thaw the antropogenius pressure was low. Beside innovation and new technologies usage for the Arctic development it is necessary to determine the quantity of population limits in this area. It will allow making decisions in economic and social policy in this area. It is probably necessary to move people from the depressive districts of Arctic zone to more comfortable once.

2243 - Multi scale adaptation and responses in vulnerable coastal sectors under climate change risks

ORAL PRESENTATIONS

K-2243-01

Coastal adaptation under high-end climate change

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The reduction of greenhouse gas emissions and the resulting level of global warming remain uncertain. The thermal inertia of sea water commits us to a continued increase of mean sea level at decadal to centennial scales. The increase of human pressure and economic development in coastal zones will aggravate the problem. Conventional hard coastal defences are costly and increase the risk of catastrophic consequences in case of failure and may exacerbate the loss of territory (e.g. wetlands) through coastal squeeze. Adaptation needs to be a long-term process covering a wide range of management strategies.

To face this challenge, advanced scientific information on the processes and impacts will be a key element in order to develop robust adaptation pathways. Such pathways must take into account plausible high-end sea level rise scenarios and changes in storminess as well as quantitative impact projections. This information will allow an objective definition of tipping points for adaptation, the effect of feedbacks between the various components of the coastal system and the efficiency of novel coastal interventions. The adaptation pathways will allow defining a sequential set of interventions that facilitate the maintenance of coastal zones under all climate scenarios. The role of novel solutions promoting natural accretion mechanisms and using eco-morphodynamics to reduce coastal mobility needs to be explored as this has the potential to increase our chances to maintain healthy coastal systems under a variety of climates. From here we shall derive advance information on when, where and how to act, especially if change is at the high end, and this will facilitate the sustainability of these areas.

Within the EU research project RISES-AM- we are projecting impacts at global, regional and local scales. The global modelling is based on the DIVA code, addressing the flooding and erosion impacts worldwide. The regional modelling is based on a variety of hydro-morphodynamic models which reflect the site specific expertise and available model calibration/validation. As illustration for the Mediterranean we are analysing the Catalan and Croatian coast, the former with a sequence of models specially adjusted for this coastal sector and the second one with a regional adaptation of DIVA. The level of resolution and processes at this regional scale is much higher than for the global analyses, including surges, wave action and long shore and cross shore sediment transport components together with the human pressures and infrastructures existing along the coast.

The local dimension can be illustrated by the Ebro Delta and other small-scale Mediterranean deltas where both the vertical dynamics of the coastal plain and horizontal dynamics of the coastal fringe are being studied. For this particular case the suitability of "green" interventions based on promoting natural accretion is also being examined so as to assess its performance under present and future climate conditions. The resulting analysis will allow identifying and partially quantifying adaptation tipping points that will be presented in the paper. This will go associated to determining critical thresholds as a function of scale and related by way of illustration to the availability of space or sediment. The combination of climatic pressures, coastal responses and the expected socio economic evolution will be the building blocks for defining an adaptation pathway suited to the studied coastal areas, illustrated in the paper by the three scales mentioned above.

K-2243-02

Responding to Changes in Coastal Zones

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Changes in climate and associated stressors will impose critical changes in coastal ocean systems. We propose a session to address changes in the coastal ocean, using the California Current Large marine Ecosystem as a model system. The CCLME is a productive upwelling zone along the west coast of North America. It supports economically and culturally important fisheries and provides other essential ecosystem services. A large and growing population lives in the adjacent coastal zone. Climate and associated stressors are projected to influence circulation, productivity, and biogeochemical processes, including acidification and hypoxia, in the CCLME, with consequent effects on social and economic systems. In this session we will include perspectives that range from changes in physical and biogeochemical processes to those of ecosystem services and socio-economic responses. We will close the session with a forward-looking perspective on collective action.

K-2243-03

The Coastal Cities at Risk (CCaR) Project: Research advancing climate change adaptation planning and implementation in Metro Vancouver, Canada

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Many low-lying coastal cities, already coping with population growth, urbanization and economic, social, environmental and health challenges, are becoming increasingly exposed to climate change impacts related to rising sea levels and changing flooding risks. In order to respond to these challenges, proactive adaptation is becoming a fundamental and necessary response in a future that is likely to have increasingly frequent and more severe climate-related hazards. By understanding vulnerability and resilience, and their influence on adaptation planning and implementation, the capacity of these cities to address future climate change hazards and stressors can be improved. A Canadian-funded international research project - Coastal Cities at Risk: Building Adaptive Capacity for Managing Climate Change in Coastal Megacities (CCaR) - seeks to explore these issues in Bangkok, Vancouver, Lagos, and Manila. This presentation highlights results from Metropolitan Vancouver, British Columbia, Canada. It explores the unique challenges and opportunities in a complex urban environment that influence the effectiveness of adaptation planning and policy development. A variety of thematic areas related to this issue were addressed, including physical, economic, social, institutional, and health while employing a broad range of scientific approaches from natural, social science and applied engineering. This presentation highlights the social science component and the advances made in the social and institutional themes. Examples presented explore: the production of vulnerability to flood hazards, identifying indicators of resilience, and mainstreaming climate information. Multiple methods such as literature synthesis, focus groups, interviews, surveys and content analysis were used in combination with social vulnerability and resilience indicator development and mapping. The component on production of vulnerability to flood hazards applied a conceptual framework - across scales

and across actors – to identify and situate factors that influence vulnerability, mapped vulnerability indicators and "ground truthed" results with key stakeholders. Out of this research emerged an interest in developing resilience metrics, particularly examining how social resilience been defined in the climate change and hazards fields and what indicators have been developed for the neighborhood scale. From this literature review, an extensive list of metrics has been developed. The "mainstreaming" exercise used a policy scan to assess how municipal, sub-national and federal government policies facilitate or constrain the incorporation of climate change information into decision-making for adapting to flood hazards. In the project, there was a strong commitment to engage with the community to access local information and expertise in order to ground the research but more importantly to initiate a two-way dialogue as a means of enhancing awareness and knowledge transfer. This process has contributed to building local adaptation capacity as CCaR research results have been incorporated into municipal adaptation planning and implementation.

K-2243-04

Title not communicated

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Abstract not communicated

O-2243-01

A Psychological Perspective on Behavioural Adaptation Challenges to Climate Change in Coastal Cities of India

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Coastal India faces a perceived potential threat owing to the vast sea-side development and huge populations in the vicinity of the coast. Climate change in coastal areas is associated much with flooding, SLR, land inundation, storms, cyclones etc. India has been identified as one amongst 27 countries which are most vulnerable to the impacts of global warming related accelerated SLR (UNEP,1989).Therefore, there is a pressing need to address issues related to climate stress, adaptation, vulnerability and coping in coastal cities of India, especially from the psychological perspective. The established fact that anthropogenic factors account for one of the major contributors to climate change makes it necessary to probe into behavioral facets as in spite of the best possible efforts around the globe to combat climate change, it is felt that people are still not as seriously aware/ alarmed of the expected future risk as they should be. If environmental stressors persist chronically, they may lead to inner conflicts that can be psychologically disturbing for individuals and may even give rise to physiological, emotional, cognitive and behavioral changes.

In light of the above, the present behavioral study assessed the cognitive understanding of climate change, climate stress and actions and reactions of coastal people with a special focus on behavioral adaptation and subjective well being. The study was conducted on a sample of 454 adults, both males and females (Age 18 years and above) in two coastal megacities of India namely Mumbai and Chennai keeping in mind the coastal hazards and vulnerability issues associated with these cities (TERI,1996). Especially designed Climate change perception Inventory (CCPI) based on a four-point Likert type rating scale format was used to assess the respondents' Climate Change Awareness (CCA), Climate Stress and Emotional Concern (CSEC), Coping/Adaptation, Institutional Accountability (IA), and Coastal Subjective Well Being (CSWB). Results indicated a good level of CCA and subjective well being among coastal people. Respondents were found to be experiencing a moderate amount of climate stress and were unable to fully cope with it. They expected more efforts on the part of government and environmental institutions for adapting with climate change in coastal cities and suggested various adaptive strategies in this regard. Results were interpreted in line with article 6 of New Delhi Work Program of UNFCCC (2007) in which special effort to foster psychological/behavioral change has been stressed through public awareness.

O-2243-02

First results from the world biggest coral planting program (Baa atoll, Maldives)

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This work presents the first results of the world's biggest coral planting program, located in Baa atoll UNESCO Bioscphere reserve (Maldives), and led by SeaMarc / Marine Savers association, with scientific support from the MNHN.

Maldives is known as a very low island country, constituted of more than 1200 sandy islands not exceeding 2m high. This country shelters an extremely rich marine biodiversity along with a population of 400 000 inhabitants, but faces concerning threats from weather condition change, water acidification and sea level uprising. All these islands being constituted of coralline sand and protected from wave action thanks to coral reefs, the health of corals directly impacts the very existence of the islands, and severe erosion can already be observed in some urban islands with damaged reefs such as Malé.

The Marine Savers program has started planting coral frames in 2007 and standardized the methods and gears in 2010, on the basis of a crowd founding system financed by resort tourists. More than 3000 coral frames have been planted to date at different sites and depths, totalizing more than 200 000 coral grafts, from more than 20 different species of scleractinian corals. The frame growth have been surveyed, photographed and managed on a biannual basis, and >150 representative frames of different ages have been weighted in order to give a proxy for total biomass.

This study aims at providing a synthesis of these growth results and rate, along with observations on natural colonization by sessile, benthic and pelagic species. Results proved that this method can produce a substantial amount of coral biomass in a rather short time span, and recreate habitat conditions suitable for most reef species. Most coral species proved to be extremely site-sensitive, and show important growth discrepancies depending on slight condition differences.

Such experiment could help understanding growth and survival of different species of corals coral under different conditions, and provide an important technical basis for further restauration or ecological compensation projects. As the frames developed by Seamarc are moveable, this system also aims at developing a way to help conserving young coral sprouts in deeper waters during bleaching events in order to achieve quicker and better ecological resilience, and in a longer run selecting the more resistant genes for climate change adaptation.

O-2243-03

Surviving from "rob" (tidal flood) – how local knowledge helps coastal villagers in Demak, Central Java

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Indonesia is an archipelago country with coastline spans more than 90,000 km, the fourth longest in the world. The coastal areas house around 60% of the total Indonesia population. However, in the past few decades these areas has been threatened by increasing sea level rise, including Demak, a city located in the northern coast of Central Java. In 2010, Bedono, one village in Demak, suffered the most impact from "rob" or tidal flood with half of the village area sunked into sea, including villagers' residences. This has caused a significant number of local people lost their homes and livelihoods. With no sufficient guidelines on how to survive from "rob", villagers forced themselves to adapt based on their own knowledge. A five-year research conducted by LIPI in Demak showed that villagers' behavior to adapt depends on the level of sea rise. The extreme case where houses are permanently drowned, villagers relocate to neighbouring villages. For other cases, villagers elevate their houses' floors, reschedule time to cook, prepare

house cleaning utensils, and protect their children's health. In the context of livelihood, villagers arrange the time to seed the fishpond so it can be harvested before tide comes and destruct the production process. One local knowledge that proves to be useful is silvofishery, integrating fishpond with planting mangroves. It has successfully decreased level of destruction in coastal areas as well as improving villager's wellbeing. These adaptations based on local knowledge should be taken into account by the government to improve the climate adaptation strategies and programs.

O-2243-04

Infrastructure and societal challenges in addressing climate impacts in the North Coast of São Paulo, Brazil

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Worldwide, coastal communities are challenged by the increase in frequency and magnitude of natural events associated with climate variability and change. During the last decade, several significant events such as storm surges, cyclones and sea level rise have caused substantial damage to coastal infrastructure and communities. For example, continuous erosion and frequent storm tide inundation threaten coastal settlements and infrastructure by making then more vulnerable to landslides and flooding, respectively. These issues demand special attention in developing countries, where populous irregular settlements (such as slums) are common in coastal areas, experiencing greater vulnerability to natural disasters and other environmental risks. Nevertheless, climate change and its related impacts are neither well understood nor taken into consideration at local and regional planning scales in developing countries. Brazil is an example of such problem. At the local scale, there are pressures related to settlement for construction and operational assets associated with port expansion and the development of oil and gas industry mega-infrastructure. At the state and national scales, there are political and economic pressures imposed by development associated with the Pre-Salt oil exploration offshore which does not consider local management needs and priorities on land use planning. In this study, we present the major findings of the RedeLitoral, a multidisciplinary project with the objective of evaluating the knowledge climate change impacts effects on society, built infrastructure and land use planning in a region experiencing fast development in the south-east of Brazil. Our results indicate that human settlement, mainly driven by tourism and mega-infrastructure developments, has induced urban sprawl towards the most vulnerable areas, making these populations and associated infrastructure more susceptible to the impacts of climate change. Fragmented and sectored licensing processes does not consider the cumulative and synergistic environmental effects resulting in inadequate public policies. Local coastal management initiatives show intense rearrangement, but changes are mostly focused in the ecological-economic zoning and creation of marine protected areas, and climate change mitigation and adaptation strategies are not a priority in the planning agenda.

2243-POSTER PRESENTATIONS

P-2243-01

Climate Change, Biodiversity and Human Well-Being in the Coastal Communities around the Eko Atlantic City in Nigeria

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With astronomical increase in the rate of urbanisation and deficits in environmental protection in Nigeria, coastal communities are at risk of the consequences of climate change, especially flooding, biodiversity loss, and food scarcity. This situation constitutes dangers to human well-being in the coastal communities in Nigeria. Therefore, this study examines human well-being in the context of climate change and biodiversity in coastal communities around the Eko Atlantic City in Nigeria, focusing on how the dangers of climate change can be mitigated with minimal discomfort to people and organisms in the coastal environment. The study is based on analysis of primary and secondary data in conjunction with the theoretical framework of political economy and underdevelopment. While extant literature and documents on climate change, biodiversity and urbanism in Lagos state of Nigeria constitute the secondary data, primary data were obtained via 20 Key Informant Interviews (KIIs) and 8 Focus Group Discussions (FGDs) conducted in four Local Government Areas (LGAs): Apapa, Eti-Osa, Ibeju-Lekki, and Lagos Island, respectively. The KIIs and FGDs involved youth and community leaders in several coastal communities in the selected LGAs. The discussions essentially dwell on the following issues: (1) the manifestation of climate change in coastal environment in Lagos state of Nigeria; (2) official efforts to mitigate the dangers of climate change in Lagos state; (3) consequences of land reclamation on biodiversity in the coastal environment; (4) public reactions to government's efforts in the reclamation of lands and construction of Eko Atlantic City; and (5) how human well-being can be improved for achieving the goal of sustainable development in the coastal environment. The findings reveal that climate change constitutes a threat to biodiversity and general socioeconomic development through extreme temperature, coastal erosion, frequent flooding, loss of land, drought, and increased salinity of water, which have become a recurrent environmental problem in Nigeria. To prevent further encroachment by the sea, the Lagos state government has embarked on reclamation of lands and construction of a city project known as Eko Atlantic City through public-private partnership. The project is a 4-square mile extension of Lagos towards the edge of the Atlantic Ocean with a view to mitigate the problem of flooding through a 35-foot tall seawall protective barriers on the one hand, and the problem of growth by using the extension as a site for new apartments, on the other hand. Three out of every five participants describe the Eko Atlantic City project positively in terms of its strategic location and attractions. However, all the participants in the KII and FGDs expressed concerns over the perceived failure by the government to take the well-being of the poor into consideration before and after the reclamation of lands for the construction of the Eko Atlantic City. There is consensus among the participants that only the wealthy persons and big industries have bought the lands reclaimed from the Atlantic Ocean. Two-third of the participants observes that land reclamation has created ecological imbalance and displacement of some people and organisms in the affected areas in Lagos state. The findings suggest that the Eko Atlantic City project is a form of internal colonialism which may be largely detrimental to human well-being in the coastal environment in Lagos state. It is noted that with adequate support from national and international environmental protection agencies the current situation in the coastal environment in Lagos state can be corrected through appropriate policies and enforcement of standard practice. Also, there is need for more attention on urban resilience systems to protect coastal communities in Lagos state from natural and manmade disasters.

P-2243-02

Determinants of Farm-Level Adaptation Practices to Climate Extremes: A Case Study from Odisha, India

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A large number of rural households in the state of Odisha, India are dependent on agriculture for their basic livelihoods, which is affected by the frequent occurrence of climate externalities like cyclones and floods. In response, the farm households do also undertake adaptation measures to minimise the economic impact of these externalities. It is, imperative to analyse the current adaptation strategies of the farm households so that future adaptation policies aimed at scaling up adaptation strategies can be designed effectively. Using a survey

data of 285 farm households in the cyclone and/or flood prone districts of Odisha, the present study identifies the farm-level adaptation measures as well the determinants of these measures: agricultural extension, access to Mahatma Gandhi National Rural Employment Guarantee scheme, received crop loss compensation and informal credit. It is concluded that the government adaptation policies and investment options should take into account these determinants in order to enhance the adaptive capacity of the rural farmers in the cyclone and flood prone regions of the state.

P-2243-03

Integrating science into legal frameworks for sea-level rise planning – an Australian case study

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One of the anticipated impacts of climate change is sea-level rise, with Australian communities likely to be particularly affected. It is estimated that 85% of Australians live within 50 kilometres of the coast (Department of Climate Change, 2009), making sea-level rise planning a major concern for Australian governments.

Despite this high level of risk, the inherent uncertainty surrounding the timing and extent of sea-level rise impacts makes it extremely difficult to garner political and public support for sea-level rise planning. Sea-level rise has been a politically divisive issue in Australia, with policies introduced by governments, and then removed following an election and shift in power to a more conservative administration. Sea-level rise has also caused considerable conflicts between state and local governments.

However, despite this challenging political environment, there are some good examples of sea-level rise science being integrated into law in Australia. These examples include large-scale mapping of hazard areas linked to a planning code, planned retreat policies teamed with conditional development approvals, and innovative approaches to seawall planning.

This presentation will explore some of the novel approaches to integrating science into legal frameworks for sea-level rise planning, and demonstrate how legal barriers have been overcome.

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P-2243-04

Planning for coastal relocation: analysis of relocation drivers in Hurricane Sandy affected communities

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The future viability of some coastal communities has been severely challenged by the recent major disasters, as well as other episodic and chronic coastal hazards. These events also instigated a dialogue on their long-term resilience, adaptation options, and the possibility of permanent relocation from high risk areas. Little is known how exposure to disaster, in combination with other contemporary coastal challenges, affects willingness to consider relocation on a household level in highly-developed urban settlements. The main objective of this paper is to provide a bottom-up perspective on this dilemma via identification of demographic determinants and other disaster-related concerns that may influence support for relocation among coastal residents. More specifically, this study takes an interdisciplinary approach to examine the effects of pre-disaster socio-economic household characteristics, level of preparedness, disaster exposure, experience with recovery, concerns with other coastal stressors, relocation assistance support needs, community embeddedness, and resource loss on relocation decision-making. The findings hereby reveal that the willingness to consider relocation is primarily influenced by the age of respondents, disaster exposure, level of experienced stress related to recovery, personal financial recovery concerns, future cost of living in high-risk area, concerns with increase in crime and future flooding, and disaster-induced resource loss. Lastly, the findings reveal that age by itself has a buffering/protective effect on stress and relocation consideration, such that older age predicts less stress and reduced interest in relocation, however, conditional on the level of experienced resource loss. Specifically, as resource loss increased, being older no longer protected respondents from disaster-related stress or consideration of relocation. Considering that relocation process is likely to occur in incremental and successive stages rather than all at once, these observations can provide a vital guidance as of which constituents may and under what circumstances decide to relocate sooner or later. This bottom-up perspective on contemporary coastal concerns and stressors that could drive decision to relocate can help inform the development of relocation policy that will more accurately reflect local circumstances and preferences and therefore receive more support for implementation.

P-2243-05

Paleoenvironmental changes of Heuksan Mud Belt (HMB) in the southeastern Yellow Sea, Korea

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Quaternary paleoenvironmental changes of the Heuksan Mud Belt (HMB), a development stretching south to north along the southwest coast of the Korean Peninsula, are interpreted as having been mostly controlled by rises in sea level after the Last Glacial Maximum (LGM). The present study investigates paleoenvironmental changes in the HMB through clay mineral changes in samples obtained from the Korean Institute of Geoscience and Mineral Resources (KIGAM) borehole, HMB-103(core depth: 38.55 m), of 2012. Preferred-oriented specimens of 174 samples in 20 cm intervals were prepared and semi-quantitative analyses for 4 important clay minerals were then conducted using X-ray diffraction according to the Biscaye's method (1965). Clay mineral contents within the clay portion of core deposits were, in descending order: 58.5-70.6% (avg. 64.5%) illite; 8.7-21.7% (avg. 16.0%) chlorite; 10.1-17.3% (avg. 13.2%) kaolinite; and 1.9-16.4% (avg. 6.4%) smectite. The deposits were classified into the following three units, according to the 4 clay mineral content: top-13.5 m (Unit I); 13.5-21.0 m (Unit □); 21.0-38.5 m (Unit □). Chlorite and smectite contents were lower in Unit I than in Unit □, while chlorite content decreased and smectite content increased from bottom to top in Unit □. The kaolinite content was similar in Unit □ and Unit □, and showed a decreasing pattern with decreasing depth in Unit □. The content of illite was higher in Unit □ than in Unit □, but had the lowest content in Unit □, where it showed a pattern of increase with decreasing depth. In general, illite and smectite had a negative correlation, and illite content was higher in the upper part of the drill core than in the bottom part, the smectite content showed the opposite tendency. The classification of units according to the clay mineral content is similar to that of sedimentary stratigraphic unit classification in geophysics exploration data. As a result of carbon age dating, the top part was found to be 2,700 cal yr BP, and the bottom part 50,000 cal yr BP, showing a range of periods dating from before LGM to the current interglacial period. Before LGM, the sea level was low, and sediments with a high smectite and a low illite content flowed in from the south of the research region where the depth of water was relatively deep. After LGM, as the sea level rose and the coastline moved to inland, sediments with lower smectite and higher illite were then supplied from Korean rivers. It is also supported by the form of uppermost Unit I progressing from the east to west. The deposit rate of the core deposits before LGM, which occurred 18 kyr ago was 2.07 m/kyr, for the period 18-11kyr it was 4.9 m/kyr, and following the last glacial 11 kyr ago it was 3.35m/kyr. Such changes represent deposit rate changes according to the rise in sea level. The

clay mineral composition change in borehole HMB-103 is considered to be caused by the movement of fine-grained sediments and the associated changes in the circulation pattern of surface currents with the deepening of the water depth due to climate change and a rise in sea level following LGM.

P-2243-06

Failure of Resilience & Adaptation in Agricultural Practice and Alteration of Socio-Ecological Structure Due to Ocean Acidification in 3 States of India

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'Climate change' is the major point of discussion of any political & decision- making agenda of any nation in general, and intergovernmental meetings and summits in particular. World community now understand that because of world's development sustainability depends upon its all the 'key-factors' that significantly play into various thrust areas like growth in agriculture, education and industry, and their respective drivers.

The problem of changing climate that reflected into adversities primarily into agriculture, education and industry has already been satisfactorily be identified by many researchers from academia, but not having the direct solution available, as of now, the policy makers have therefore to depend on some approach-- more of theoretical, than 'straightforward practical'. In this premises, the concepts like 'resilience', 'vulnerability' and 'adaptation' have come into play.

This paper shows that how resilience and adaptation fails in agricultural practices in and nearby coastal areas of 3 States (West Bengal, Andhra Pradesh and DIU-U.T.) of India, due to lowering of pH (Ocean Acidification) in nearby estuarine and coastal water increasing the 'vulnerability' in the socio-ecological structure that also have altered the pattern of local economic activities like 'tourism' and 'fish drying industries'.

P-2243-07

Local government responses to sea level rise in Metro Vancouver

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Attention to climate change and sea level rise has intensified in recent years in Metro Vancouver. The region has been identified as one of the top cities in the world with assets at risk from rising seas, and vulnerabilities in the region include municipal property and infrastructure, and agricultural lands, as well as transportation infrastructure that supports the region's position as a gateway for global trade including railways, roads, port facilities and the international airport. Despite dense settlement and more than a century of industrialization, the region continues to sustain rich aquatic and terrestrial biodiversity, but climate change and approaches to adaptation also threaten environmental values. Experts have identified the need for regional collaborative governance to address climate change impacts, across the xx municipalities in the region, and four levels of government (local, provincial, federal and First Nations). There is a clear need for alignment of objectives among neighbouring coastal areas - without this, efforts undertaken in municipal silos could increase the risks.

In November 2012, nine local governments and organizations from Metro Vancouver, BC's Lower Mainland already leading in climate change adaptation work took part in a workshop on regional approaches organized by West Coast Environmental Law and ACT. Sea level rise was identified by participants as the most critical issue requiring collaboration, and WCEL/ACT moved to facilitate the formation of the Sea Level Rise Collaborative (SLRC), designed to add capacity to these entities given a common lack of resources and the challenges of data gaps. Seven local governments are now working together to share scientific resources, risk assessment methodologies and implementation approaches. Additional priorities include understanding legal risks and seeding broader regional collaboration, across other levels of government and sectors. A provincial representative has recently joined the collaborative, and the SLRC has a pilot project underway demonstrating green approaches to coastal resilience.

Actions to date include a design charrette to develop approaches to the new regional flood construction levels - 4.5 metres - based on the provincial estimate of 1 metre of SLR by 2100—exploring strategies that accommodate sea level rise and increase adaptive capacity over time. These approaches will be more cost-effective than shoreline armouring, will enhance community livability and protect coastal habitat. This and ongoing activities will help catalyze policy changes, new codes and standards, development of understanding of regional collaborative approaches as a key response to climate change impacts, and engagement of the local citizenry and professionals practicing in industry sectors related to this area.

P-2243-08

Eco-technological management of atoll island against sea level rise

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Atoll island countries comprise low, flat islands consisting of calcareous sand and gravel formed from coral and foraminifera. The islands are maintained both by the physical processes of sand transportation and sedimentation and by the ecological processes of biological production. In the past, the inhabitants maintained their islands wisely in accordance with geo-ecological processes, such as the conservation of coral reef ecosystems, sandy beaches, and coastal vegetation, and cultivated taro using fresh water lenses formed in the island sediments. At present, however, the population concentration on the capital islands has led to inappropriate land use, degradation of coral reef ecosystems, destruction of geo-ecological processes through the construction of landfill sites and sea walls, and reduction in and deterioration of water resources due to the effects of over use and sewage. All these «local» problems have disrupted sand production-transportation-sedimentation process.

The submergence and inundation of atoll islands are regarded as a result of sea levels rise. However, the present problems are not as simple as submergence caused by rising sea levels; indeed, they are induced mainly by local problems. These problems have reduced the resilience of the atoll islands as historically maintained by their inhabitants.

«Global» issues also degrade coral reefs. Bleaching induced by global warming and ocean acidification resulting from increased CO2 also degrades coral reef ecosystems and reduces sand production. The modulation of El Niño, drought, and intensified typhoons induced by global warming threaten water resources in these islands. The problems in atoll countries involve inter-related local and global problems. Plans to adapt to global changes based on a simple scheme may instead reduce the resilience of these islands. To maintain the sustainability of islands against future global change, it is essential to regenerate geo-ecological processes by removing local problems so as to construct highly resilient islands.

To regenerate coral and foraminifera production, ecosystem rehabilitation is necessary. This should be achieved by improvement of coastal environment by sewage treatment and waste management. Rehabilitation would be supported by foraminifera and coral culture and transplantation and their habitat generation, however improvement of coastal environment is a prerequisite. Sand transportation and sedimentation processes should be reopened. An open-cut the causeway will enhance sand delivery from the ocean to the lagoon, nourishing the lagoon coast. Removal of the jetties or their reconstruction with piles and backfilling the dredges would re-open the transportation passage along the coast. Vertical seawall will enhance erosion rather than sedimentation at its foot. Therefore, beach nourishment is proposed as a shorter-term coastal protection and rehabilitation plan that enhances but dose not conflict with the long-term sandy beach rehabilitation.

Yet, the local problems themselves originate from the globalization of the economy and society. In traditional

island societies, the inhabitants kept their islands robust, albeit poor economically, by means of local governance indigenous to each island. However, the globalized economy and society, together with the introduced Western political system, have led to the centralization of the population on the main islands and to inappropriate land use.

Without considering the background factors, island management programs will never be acceptable for atoll societies in terms of sustainability unless they consider the appropriate geo-ecological processes. Moreover, geo-ecological processes differ with geological, climatological, and biogeographical variation; island governance differs according to historical and cultural background; and the expression of local problems depends on the local economic and societal background. Therefore, resilience and governance must be constructed in accordance with this geographical variation.

P-2243-09

Unpacking the Co-production of Knowledge in Adaptation to Climate Change: The Role of Local Knowledge in a Coastal City – Tainan, Taiwan

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As most of climate change research initiatives are more focused on natural sciences, it is almost impossible to understand the earth system without addressing humans as influencing the planet and as an essential driving force in shaping the future of Planet Earth. Thus, a major new step has taken to the development of science – from disciplinary to interdisciplinary, from one sector to cross-sectoral, and from natural sciences to social sciences and the humanities.

Based on the research results from a 3-year (2013-15) core research program – Taiwan Climate Change Adaptation Technology (TaiCCAT), this paper takes an interdisciplinary approach by examining the role of local knowledge to plan, manage and communicate local adaptation strategies in Tainan, Taiwan. Selected by Lonely Planet and Michelin as a must-see three-star tourist destination, Tainan, at the same time, has been at risks of rain storms and mud slides at mountain regions, urban flooding and coastal sea-level rise. Policy responses like building dikes or not, opening or closing water gates, water distribution among industrial, agricultural and residential sectors are frequently made by relevant government authorities with inputs from community groups.

To ensure government, business, society and academia have the foresight, knowledge and tools to adaption to climate change, this paper further conducts in-depth interviews with stakeholders from mountain, rural, urban and coastal regions for cross-checking its research findings. Tainan experience so far points to the importance of early engagement, trust-building, involvement of all stakeholders and assessment of knowledge needs and knowledge exchange. Hopefully in the future, it may become a robust example for co-design, co-production and co-delivery of knowledge also consistent with and called for by Future Earth research initiative.

P-2243-10

Why urban poor exposed to climate change in coastal Bangladesh are more concerned about ecosystem disservices than services?

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Urban poor get numerous benefits from ecosystem services. Roles of urban ecosystem services in the wellbeing of urban poor are extensively discussed, yet little is known about the vulnerability of urban poor to ecosystem disservices. Particularly in the context of climate change some of the ecosystem disservices might seriously affect the urban poor's wellbeing by impacting their livelihood, security and comfort. Therefore, this research is aimed to answer the question- why some urban poor are more concerned about getting protection from ecosystem disservices than getting benefits of ecosystem services? Accordingly three objectives are framed. First, to identify range of urban ecosystem services and disservices which the urban poor take into account to ensure their wellbeing. Second, to examine whether urban poor really care more about protecting them from ecosystem disservices than taking advantage of services. Finally, to identify the factors that determine urban poor's differential preference for ecosystem services/disservices.

This study was conducted taking coastal Khulna- a metropolis exposed to climatic disasters, as a case. Empirical part of this study was done in a large low-income settlement, named Rupsha slum. Family heads of a total 235 households selected randomly were interviewed through administering a semi structured questionnaire. From a list of 25 ecosystem services and disservices, respondents were first asked to rate in a 5-point Likert scale (very low =1 to very high = 5) if they get benefit from/affected by a particular ecosystem service/disservice. Second, they were asked to rate by using the same scale (a) the importance of those services and (b) their concern against those disservices. By employing Principal Component Analysis (PCA) on their responses to first question, the 25 categories were bought down to four practical utilities/negative utilities. These four categories are related to (a) livelihood, (b) comfort, (c) security and (d) recreation. For the second question, each person's responses (denoting both importance & concern) were first summed up and later dichotomized taking median as the cut-off point. With this, the respondents were reclassified into two distinct groups: (a) low benefit seekers vs high benefit seekers from ecosystem services, (b) low concerned vs high concerned about ecosystem disservices. Taking each of these two groups as dependent variable, two Ordered Probit models were developed to identify the factors that influence the respondent's positive preference (expressed earlier as "importance") and negative preference (expressed earlier as "concern") towards ecosystem services and disservices respectively. As independent variables, in addition to variables that are identified in Personal Motivation Theory (PMT) (such as intrinsic benefits, extrinsic benefits, perceived severity, perceived vulnerability), various socio-economic, ecological, demographic, behavioural, spatial and governance related aspects were employed in the Probit models.

Initial result shows that the urban poor take into account both green and blue ecosystem services for their wellbeing with a varying combination though. Variability is rather less as regards gaining advantage from various green ecosystem services such as green parks, streetscapes, urban forests, playgrounds. However, high variability is observed in regards to their concern over ecosystem disservices, particularly derived from blue ecosystem services such as rivers, canals, urban swamps, natural drainage. Ecosystem disservices which they care most are waterlogging, storm water overflows, surface run off and smell from decomposed waste. Probit models' results show that importance of ecosystem services to respondent's wellbeing are significantly determined by age, occupation, education, distance from house, access fees etc. On the contrary respondent's concern over ecosystem disservices are significantly determined by age, gender, occupation, season of a year, tenure of housing, length of stay, etc. However, other factors have limited influence. The findings would help designing appropriate interventions for (a) enhancing urban poor's access to ecosystem services, and (b) protecting urban poor from the vulnerability of ecosystem disservices. Therefore, this finding would give synergies to ongoing efforts of building resilient urban community in the context of changing climate.

P-2243-11

Social Memory and Social Change in a Portuguese Natura 2000 Coastal Area: Understanding Communities' Adaptation to climate change

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This presentation analyzes how social memory is linked to social change and climate change (CC) adaptation

in a Portuguese Natura 2000 coastal area of fishing importance, by looking at residents' narratives, paying particular attention to those of fishermen. Narratives are fundamental for linking the past, the present and the future, as well as for constructing meanings and identities. The stories that communities in Natura areas relevant for CC adaptation tell about the past are thus important for legitimizing specific social representations of the changes required for CC adaptation (e.g., representations of the new bio-conservation laws and regulations) while de-legitimising other, alternative, representations, and it is important to understand them and their role.

The study draws on (n=24) in depth qualitative interviews and walking interviews with residents of a Portuguese Natura 2000 Southern coastal area (n=16 interviews with fishermen). The guiding research questions are: How do residents' narratives about the past make sense of current social change and contribute to coastal CC adaptation or make it difficult? How do resident's narratives about the past legitimize specific social representations of bio-conservation laws and of coastal trades and practices, in particular those linked to fishing? What can the particular ways in which residents' narratives link the past the present and the future tell us about identity and representational processes, and about how these are affected by power differentials?

The preliminary analysis of the interviews suggests that (1) perceptions of a decrease in the main resources (fish and shellfish), (2) technological innovation and (3) the introduction of new legislation restricting fishing activities in the Natural Park have created a series of tensions in identity and representational processes, with consequences for power relations and social cohesion. These tensions evidence several representations of discontinuity with the past, differentiated according to the type of social change evoked: (1) change induced by a decrease in the 'resource' (2) change induced by technological innovation and (3) change induced by the introduction of new legislation and other social/economic policies.

In the interviews with the fishermen, the claims that the resource has decreased are linked to claims that in the past theirs was a much simpler trade, since they could always count that there would be more fish available to catch the next day. Conversely, in the present, fishermen claim to have to rely much more on their knowledge and experience, and there is an intensification of individual competition within the trade. They link the decrease in the resource to several factors like pollution, technological advances and, although not often, also excessive fishing. Technological innovation is described in a conflicting way: on the one hand, as advantageous since it contributes to facilitating the practices of fishing. As such, it is linked to a claim that in the past the trades and practices of fishing were more dangerous. On the other hand, it is associated with a decrease in the resource. When talking about the introduction of new Natura 2000 legislation restricting fishing in the site, as well other social and economic policies setting the conditions of the fishermen trade, interviewees often claim that before the laws were introduced it was much simpler to be a fisherman. On the whole, this narrative proposes then that (techno)science reduced the risks of the profession, but now laws are too restrictive of the trade. Also present in the narratives are claims that the use of technological solutions by other social actors with competing practices (such as specific kinds of fishing nets used by large fishing companies or diving equipment used for capture in breeding niches) are contributing to the depletion of certain species and that laws in these cases are necessary for balancing the ecosystem. On the other hand, one finds also a representation of continuity with the past, linked to the idea of an ancient attraction/'addiction' to the sea and stressing the agency of the fishermen in their 'career' and pursuing a highly demanding occupation. This research shows the importance of analyzing the conservation of biodiversity and coastal adaptation by considering the narratives of the affected communities and the way that social memory is linked to social change adaptation. It highlights the multifaceted, dynamic and flexible nature of social memory and the way it is regulated by social psychological processes.

P-2243-12

Coping with climate change impacts: The case of coastal fishing communities in Patuakhali region, Bangladesh

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Globally, Bangladesh is considered as one of the most vulnerable countries to the anticipated impacts of climate change. Following that situation, scientific community often uses Bangladesh as a test case of studying climate change impacts and respective adaptation strategies in different professional groups. However, very few studies focused on the coastal fishing people, though they are one of the most vulnerable professional groups to climate change impacts. Based on a fieldwork in four fishing communities in Patuakhali region of Bangladesh, this study identifies livelihoods strategies that fishers adopt to cope with the impacts of climate changes that impinge on them and possible ways to enhance their capacity to make climate resilient fishing communities in Bangladesh. To collect empirical data, household survey was conducted and a number of qualitative tools such as interviews, focus group discussions, and oral history were employed. Coastal fishers in the study areas suffer from a number of climate changes related events such as cyclones, tidal surges, and saline water intrusion. Combination with high frequency of natural disasters, weak economy and acute poverty make fishing people very vulnerable to any shocks. In response to multi-faceted vulnerabilities, fishers adopt a number of strategies in considering long-term sustainability of their livelihoods. Immediate aftermath of the any disaster, fishers are found to survive depending on personal savings, relief from government and NGOs, taking loan from NGO and mohajon (money lender) or by doing extra labor to increase income and savings. Improvement of physical capital such as brick-built housing structure is a common strategy found among better off fishers. Fishers are also found to plant trees around their house to get protection. In response to increased salinization of ground water, fishers harvest rainwater. In case of long-term adaptation, fishers put utmost importance to secured future of next generation and want to educate their children so that they can be able to leave risky professions and vulnerable place. The government support is not enough to increase the adaptive capacity of the people due to insufficient structural protection, poor management, rise of corruption. A number of suggestions elicited from fishers' perception for effective tackling of climate change related vulnerabilities that includes construction of more cyclone centre having effective infrastructure and communication system, construction and repairing of embankment, mangrove afforestation to protect embankment, public private partnership for climate protection such for coastal afforestation, starting of rationing of food support, mobile banking system for cash support, training to improve skills for alternative employment opportunities to reduce pressure from fishing, disaster management training, checking corruption by introducing risk allowance for law enforcing personnel and other governmental officials during disasters rehabilitation, recruitment of trained graduates having deep knowledge on coastal resource and disaster management, providing sufficient buoys in boat, helicopter rescue system from fishing place, wireless network or specialized software response system for early warning of disasters.

P-2243-13

Harvesting energy: People's place-based perspective on mitigating climate change with renewable energy technologies on the German North Sea Coast

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Discussions on mitigating climate change revolve around the question of how to enable low-carbon energy transition based on renewable energy technologies (RETs) such as wind or solar energy. Communities and individuals have increasingly been recognised in public and policy for making an important contribution to sustainable energy transition. This includes the implementation of RETs in places to which people feel attached to (Devine-Wright, 2011). A discrepancy is still remaining between the general openness to ecological ways of generating energy and the local resistance against the implementation or extension

of RETs in the form of NIMBYism (Devine-Wright, 2013a). Considerable research has been undertaken to better understand resistance against RETs while - so far - it has not sufficiently been investigated of how place attachment positively or negatively contributes to individual and collective innovation processes (Rogers, 2003). The paper takes this gap in research as a starting point and presents a socially embedded perspective by drawing on recent research carried-out in the area of place attachment (Manzo and Devine-Wright, 2013) and locally embedded entrepreneurship (Audretsch, 2011; Feldmann, 2010). Our study is based on qualitative interviews undertaken with inhabitants of and a standardised household survey in the coastal municipality Reußenköge (North Frisia; Germany) in 2014 and 2015. It represents a rural area in which grain production and harvesting fields were the main agricultural practices due to historically reclaimed fertile marshland. This situation, however, changed with advent of onshore wind energy at the end of the last century and solar energy and biogas at the beginning of this century. In due course, the coastal municipality of Reußenköge developed from an average agricultural into a so-called model-region for the generation of renewable energy by harvesting wind with wind turbines and sun with solar installations. In brief, Reußenköge represents a recent show-case example for examining the social processes underlying the implementation of RETs in coastal areas. In the course of our qualitative study, analytical emphasis was put on people's place attachment, their understanding of climate change and how the latter two relate to the adoption of renewable energy technologies on an individual and community level. Questions addressed are the following: How does individual and collective attachment to the place of Reußenköge interact with the adoption and implementation of RETs? How do people understand and relate to the phenomenon of climate change? Has local entrepreneurship in Reußenköge shaped the municipality and in what ways? What are the important characteristics of this local entrepreneurship? In sum, the paper firstly aims at unravelling people's place-attachment in times of a climate-oriented energy transition in Reußenköge (Devine-Wright, 2013) by analysing the social meanings associated with RETs and, secondly studies socially embedded drivers of change and perceived social adjustments connected to the transition from harvesting fields to harvesting the energy.

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P-2243-14

Climate variability and change in fisher communities of Benin coastal zone: Vulnerability and adaptation strategies

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Climate variability and change are major challenges for communities in coastal regions. The coastal area of Benin in sub-Saharan Africa is also experiencing the negative effects of climate in terms of sea-level rise, rapid coastal erosion and significant variations in rainfall and temperature. Fishing remains the main livelihoods mean in these coastal areas, and is directly affected by the negative effects of climate variability and change. Fishing communities of Grand Popo and Ouidah in South-western Benin are the most affected by these effects and are more vulnerable. This study used an integrated approach that combines both biophysical and socio-economic factors determining vulnerability within a community or household. Indicators were used to develop an index of vulnerability to climate variability and change in order to compare and explain the levels of vulnerability of fishing communities. This research is part of a regional project funded by the Canadian International Development Research Center which is implemented in Benin, Senegal and Canada. The findings of the study showed, for fishing, that the municipality of Grand-Popo is more vulnerable to climate variability and change than Ouidah in terms of the level of exposure, sensitivity, and adaptive capacity. A community with low adaptive capacity does not directly reflect a high vulnerability. It is the combination of exposure, sensitivity and adaptive capacity that determines vulnerability. However, fishing households experiencing high exposure, therefore experience more climate shocks, have a high probability of being the most vulnerable, this is the case for the municipality of Grand-Popo. Similarly, households with high exposure, high sensitivity and low adaptive capacity have a greater vulnerability. On a practical view, the findings of this research showed the importance of supporting fishing communities in diversifying their livelihoods in order to reduce their vulnerability to climate variability and change.

P-2243-15

Coastal Mitigation and Adaptation in a Small Island Developing State: Vanuatu a Case Study

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Considered one of the poorest and least developed of the Small Island Developing States (SIDS) in the South Pacific, Vanuatu is limited in its ability to reponds to risk associated with climate change. An archipeligo comprising 83 islands located in the western region of the South Pacific between New Caledonia and Fiji, the Climate Risk and Adaptation Country Profile (CRACP Vanuatu 2011) descibes Vanuatu as being «hampered by its highly vulnerable socio-economic and ecological standing». The key challenges that limits Vanuatu's ability to respond to climate variabiability and change include: political instability and weak institutions; unequal distribution of economic benefits gained from existing policies; disparity in income distribution and access to basic services; and, increased urban migration to urban centers with limited employment opportunities(CRACP).

As a natural resource/environmental planning expert with over 30 years experinece, living and working in Vanuatu, I present pragmatic solutions based upon my indepth knowledge and understanding of mitigation and adaptation climate change related issues facing the Ni Vanuatu islanders. The case study addresses adaptation and mitigation measures, including a review of the before and after of the recent Category 5 cyclone that hit the island chain in March, 2015.

Appropriately for a number of the South Pacific Small Island Developing States this presentation focuses on a grassroots perspective oriented towards natural and science based solutions: ecosystem-based adaptation (EbA) + ecosystem-based disaster risk reduction (Eco-DRR).

The innovative component of the oral presentation is not limited to purely scientific analysis of mitigation and adaptation options associated with climate change. It will also bring to the Conference the voices and concerns of local Ni Vanuatu and IKiribati from Vanuatu regarding their current socio-economic vunerabilities and concerns, economic drivers in conjunction with current, cutural

and historic understanding of climate change risk. A key component of the presentation will be to address local and regional responses, discussing pathways for integration across sectors and stakeholders.

The scientific and techolonogical breakthroughs releveant to this paper include ,but are not limited to: computer modelling; development of renewable energy limiting CO_2 emissions and reducing dependency on coal power stations: drill systems for geothermal energy; solar and wind power generation and storage; biological treatment of waste water; protection of freshwater lens and water resource; sustainable agricultural production; early warning systems; and the role of natural ecosystems in increasing coastal community resilience and hazard reduction from projected climate change events.

The trade-offs, co-benefits, risks and feedbacks are discussed along with the primary barriers which include:

1. the dispersed nature of the archipeligo and mountainous terrain making administration, communication and operation costly and challenging
2. limited domestic market with little potential for economies of scale
3. increasingly competitive international markets for tourism and investment
4. a social and cultural system with limited understanding and experience with business concepts and practices

My presentation concludes with a local area case study that examines the integration of EbA and Eco-DRR as a tool for climate change adaptation promoting socio-economic and ecological resilience. The case study Lapita project, which has been running almost 15 years, provides innovativeadaptation and mitigation solutions for climate change from the botton up perspective. These solutions may be readily adopted at the regional basis throughout Vanuatu and the South Pacific.

P-2243-16

Adapting to impacts of coral reef bleaching on ecosystem services in Asia-Pacific

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Ecosystem services are the benefits that humans gain from functioning ecosystems. Coral reef ecosystems provide a lot of economic benefits, especially reef tourism, recreational fisheries, fisheries production, shoreline protection and natural products. However, coral reef ecosystem services are threatened by various anthropogenic and natural disturbances. Determining how ecosystem services are associated with biodiversity is required for investigating the consequences of biodiversity loss and for setting objectives and priorities for coral conservation and management. Studies on functional redundancy within coral communities, the number of taxonomically distinct species that show similar ecological functions, are very important for understanding the consequences of biodiversity loss. A case study in the Gulf of Thailand revealed that the low Acropora coverage at the study sites before the 2010 coral bleaching event was still a result of the previous severe coral bleaching in 1998. Densities of juvenile Acropora colonies before the 2010 coral bleaching event were also very low at the study sites, with no recruitment for several years. Several Acropora species that were previously observed in these areas are presently at risk for local extinction or may have already disappeared.

Quantifying coral reef ecosystem services in the Gulf of Thailand and the Andaman Sea has been documented with emphasis on linking coral reef conditions with various types of ecosystem services. Given coral reef management and restoration plans in Thailand as an example, the coral reefs are categorized into four different groups depending on their threats and type of uses. The coral reef that is in a degraded status and is used for tourism is the priority area for coral reef restoration. The coral reef restoration plan concentrates on using passive restoration in 4 strategies and 15 measures, by reducing threats from tourism, water pollution, sedimentation and fisheries. The active coral restoration by numerous asexual and sexual reproduction methods and techniques will be carefully considered prior to applying at appropriate reef sites for tourism, research, education and raising public awareness. The major concerns are simple and cheap restoration methods, community involvement, high tolerant species to bleaching and multi-species transplantation.

The coral reef management and restoration project in tourist hot spots in the Gulf of Thailand is a good case study for adapting to impacts of coral reef bleaching in Asia-Pacific. The project was initiated and funded by the network of provinces in the eastern Thailand. It aims to survey and establish an ecological and socio-economic database for managing the coral reefs and enhance their resilience to climate change. In addition, artificial substrates for coral recruitment and ecotourism are provided at tourist hotspots with the participation of local communities in managing natural resources and environment, wherein public awareness and education are enhanced. The project shows effective collaboration between scientists, local communities and local government officials as decision-makers to integrate scientific data into policy and adaptation measures. The coral reef restoration sites can be used to support ecotourism and learning opportunities for students. Continuing efforts in capacity building, public awareness and education through disseminating printed materials and conducting training courses, workshops and seminars for stakeholders, youth, students and local government officials can enhance resilience in coastal communities. Strengthening the long-term monitoring, evaluation and reporting of the project can provide lessons for conservation of coral reefs in tourist hotspots influenced by climate change, especially coral bleaching events.

P-2243-17

Perspectives of planners on adaptation to climate change in Indonesia

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This paper focuses on understanding what knowledge local planners at city, regional, and provincial levels have regarding climate change adaptation (CCA), and what informs their perceptions and understanding. Four main themes were investigated: their perception of climate change impacts on local communities; the level of CCA policy development; the extent of CCA mainstreaming in the development agendas of local governments; and the level of planning for CCA. The findings were derived from the perspectives and insights of 26 local planners, working for local governments from seven different Indonesian coastal cities. Several significant factors that need to be addressed in order to plan for and implement effective CCA and disaster management at local levels in Indonesia were identified. These included increased climate change awareness at local levels; the level of coordinated efforts of government and non-governmental organisations required to enable CCA; increased capacity development to enhance community resilience; access to financial incentives and programmes; and greater motivation to address climate change impacts to enable CCA development.

2244 - Climate Change Biodiversity and Human Well-Being : illustration from forests and agro-forests systems

ORAL PRESENTATIONS

O-2244-01

Exploring causes, risks, and consequences for ecosystem services of tipping points in Latin American forests - the role of biodiversity

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This paper presents some key findings from the EU-FP7 funded projects AMAZALERT and ROBIN (Role of Biodiversity in the Climate Change Mitigation), both focusing on the effects of future climate change and land use change on ecosystem services provided by tropical forests in Latin America. New research has demonstrated that a complete dieback of the Amazon rainforest within the 21st century caused by climate change alone is unlikely; however a risk of forest dieback or other forms of irreversible ecosystem degradation on a lower spatial scale still exists. Because of the potentially severe consequences of such ecosystem degradation for the many important services they provide, on various spatial and temporal scales, it is wise to be prepared for the unexpected. Joining the outcome of the two projects, we will present a map of risk of ecosystem degradation, the main factors involved and most useful monitoring and warning mechanisms. We will evaluate the role of biodiversity in degradation as well as its potential to provide critical indicators of ecosystem decline.

Our models show forecasted changes in the biophysical state and the ecosystem services that the environment provides, under future scenarios. These allow us to compare severity of climate change, the influence of socio-economic context, and the implementation of different levels of policy protection of biodiversity and ecosystem services in alternative futures. The models suggest that there may be difficult trade-offs to take into account among ecosystem services, carbon and biodiversity, under these contrasting scenarios.

In combination, climate change (warming, drying, extreme events) and land use change (deforestation, fragmentation) could have a profound effect on the ecosystem, changing carbon cycle, water cycle, nutrient cycle and biodiversity in an irreversible way: from a wet, high biomass high biodiversity system to a much drier low biomass low biodiversity system. As trees and precipitation are bound together in a positive feedback loop (trees cause precipitation, trees need precipitation - in a hydrological cycle with evapotranspiration) and trees and fire in a negative feedback loop (intact rainforest is fireproof, dry forest and savannah are prone to fire causing more tree mortality), the system has multiple steady states and a critical transition from one state to another would be hard to reverse. If and when such degradation would occur, an Early Warning System (EWS) that would detect the imminent change would help to minimise its impacts.

Although earlier work suggested that early warning signals might exist, such that the onset of large scale dieback could be detected and potentially halted before irreversible critical transitions could occur, current work suggests that there is uncertainty whether critical degradation would show any critical 'tipping point' behaviour, and whether such change would be associated with detectable early-warning signals, such as enhanced but slowing down variability in variables ahead of thresholds that are associated with the change. Because of this, monitoring for early detection and warning of change is essential, both on the ground and using satellite images, as monitoring is prerequisite for finding solutions and early adaptation. Due to time lags between the system reaching adverse conditions and the response of the system to these adverse conditions (ecosystem degradation) we might be able to reverse the process before it becomes irreversible.

Since much of any critical change would occur through changes in the hydrological cycle, river levels, rainfall amount, soil moisture and temperature range appear among the most important candidates for monitoring, along with biomass, carbon exchange and energy budgets, but monitoring needs may differ according to the specific risk in a subregion. Local communities will be the first to notice subtle change in processes in their home territories, e.g. changes in ecosystem services provision, so combining high tech knowledge like satellite imagery with low tech on the ground observations should be the most promising way forward.

Actions against ecosystem degradation include reforestation, agroforestry production systems without burning, and agricultural no-tillage system.

O-2244-02

Threat to Farmland Riparian Biodiversity in Tankwidi Agroecosystem in the Sudanian Savanna of Ghana – Implication to Managing Risks to Climate Change

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Riparian forests (RF) are integrative part of the agroecosystem as they improve water quality and serve as habitat for fauna such as birds, insects and other organisms that are essential for crop pollination, seed dispersal and nutrient cycling. Despite their importance, RF are under the threat of deforestation from agricultural intensification in catchment areas. In order to ascertain the impact of the deforestation on the riparian area, this study used remote sensing techniques and field inventorying to assess riparian forests diversity on communal farmland (FA) and protected forest reserve area (FR) along Tankwidi rivercourse in the Sudanian savanna of Ghana. The paper also discusses the findings of the research in the light of managing risks of climate change effects on farmland riparian biodiversity in the savanna zones of Ghana.

Post-classification analysis of Landsat images revealed a reduction in forest cover from 1985 (23%) to 2013 (7%) in the river catchment. This forest loss is likely to affect elements such as light and wind leading to changes in the microclimatic conditions of the forest remnants to exert a strong effect on biodiversity in the catchment.

Further, a ground survey of sixty randomly selected plots (500 square meters per plot) equally divided between

FA and FR along the river in a 50m buffer zone showed a reduction in the number of woody species (diameter ≥ 5cm) from FR (40) to FA (19). Anogeissus leiocarpus and Mitragyna inermis were the most abundant species in both FR and FA. Shannon-Wiener Index for woody species diversity reduced from FR (2.5±0.09) to FA (1.8±0.14). This diversity decline is an indication of the degrading quality of the farmland riparian habitat and could have negative effect on the ecosystem services expected from the entire riparian biodiversity for sustainable food production.

Within the FR in particular, there were more species (58%) in the lower diameter class (5-15cm) than the other higher diameter classes (15-50cm) suggesting successful regeneration. The reverse was observed in FA where the individuals in the lower diameter class were fewer (26%) than the higher diameter classes. This indicates that the RF on farmland is not being reproductive and therefore, may not be able to sustain the ecological succession of the riparian woody vegetation for the perpetuity of their functions.

The observed reduction in woody species density from FR (17.7±1.1) to FA (7.3±0.53) is likely to increase the surface exposure of the riparian area in farmland. This will increase grassy fuel loads, decrease relative humidity, increase temperature and wind speed to heighten risks to savanna fires. Managing this risk on farmlands will not be possible unless a conscious effort is made to educate farmers on the roles of riparian forests, replant to enhance the diversity and density or area excluded from farming for the full recovery of riparian woody vegetation as climate change adaptation strategy.

O-2244-03

Impact of climate change on vulnerability to bushfires in Côte d'Ivoire

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In Côte d'Ivoire, climate variability related to changes in rainfall patterns since the droughts of the 70s contributed to the impoverishment of rural areas and environmental degradation (Dje, 2009). Faced with these climatic disturbances, it is imperative to study the causes of these changes and evaluate their impact on the socio-economic human activities. One consequence of these changes is the proliferation of bushfires with its attendant degradation of ecosystems in place. Bushfires are hazards that disproportionately affect the tropics. By their heterogeneity in biomass, these areas face triggers fire. Indeed, from December to mid-March each year, the Harmattan blows over northern Côte d'Ivoire. The grasses become dry and the bush easily converts fuel in the presence of a spark. Increasingly, the practice of fires for land spares no region of the country given the growing techniques characterized by extensive farming has resulted in the destruction of large forest areas. Most fires are voluntary, criminal or originate carelessness and not in dry countries (Kouakou, 2013).

In Côte d' Ivoire, the lights are mostly man-caused mostly for hunting «small game» and agricultural activities during periods of soil preparation. The wildfire is an uncontrolled fire caused by the fires to burn weeds and other vegetation covering the crop land, pasture renewal fires for fodder for cattle, the production of charcoal, imprudence like cigarettes lights, camping shepherds or deliberately caused fires by bandits and cattle rustlers (Decleire, 1999). The bushfires have for this purpose more disadvantages than advantages (SODEXAM, 2006). In Cote d'Ivoire, 120 deaths and more than 5,000 km2 of land and forests were destroyed by bush fires between 2004 and 2014, twice the size of Luxembourg (Orange CI, 2014). Before the armed conflict of 2002, bushfires destroyed 450,000 hectares of forest, 250,000 hectares of food and cash crops burned a loss of more than 89.5 million CFA francs (Euro 135 877) 350 property and loss of life (Bayo, 2014).

From the socio-economic data (the map of localities, population density and the general census of population and housing (RGPH) of the Cote d'Ivoire in 1998), climate (rainfall, temperature air and the average relative humidity) for 14 synoptic stations of the meteorological network of Côte d' Ivoire and vegetation data (NDVI and map of the dominant vegetation of the country), lights vulnerability indices have been calculated from bush. According to the results in synthetic form from the GIS map, periods favorable to bush fires and exposed areas are identified with determining the level of risk for each locality.

O-2244-04

Pluviometric deficit and impact on wood-energy in climate changes context in the south of Senegal

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In Senegal, as in most sahelian countries, wood is still used as a primary energy source. The majority of rural households do not have access to new energies. Wood ensures for the case of Senegal, about 20% of national energy coverage. This figure shows the significant contribution of forest resources to meet the energy needs of the country. Much of the wood energy is provided by forest in southe of Senegal.

Best climate conditions in the past, contributed to maintain forest because of the presence of water. The development of the forest is dependent on the occurrence of water in the forest basin of Casamance.

The importance of forest explains the production of wood energy (firewood). The abuse of forest resources causes a degradation of these and whose lower rainfall has exacerbated the drought of 70 years. Indeed, climate change has disrupted production systems including agro-forestry systems. Consequently with water deficit, the production of wood energy remains uncertain in long term to meet future needs.

This contribution tries to demonstrate the relationship between water deficit resulting from climate change and the availability of fuel wood in Casamance. It attempts to answer the question, how the reduction of rainfall over a long period affects energy production systems?

O-2244-05

Rakhal (Yew) benefiting the knowledge of Biodiversity in Neeldhar (Pangi Valley) in the context of Climate Change for Sustainable Development

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This paper constitutes a first attempt representing the relationship between Climate Change, Biodiversity, and Ecosystem services, with a specific emphasis on Rakhal (Yew), Neeldhar forest, Pangi valley, Chamba district, Himachal Pradesh. Firstly, we took Rakhal (Yew, Endangered plant) as biodiversity indicator that integrates changes in biodiversity due to some of its interesting novel populations in Neeldhar. Secondly, this indicator's novel populations are integrated into two simultaneous situations to capture the marginal impacts of changes in Biodiversity (i.e. Yew population decline) in Pangi Valley and on the value of ecosystem goods and services (Taxol) due to Climate Change. Our results confirm these novel populations play a role of Biodiversity as a nature-based policy solution for Climate Change mitigation, involving local community in Neeldhar for human livelihoods and Sustainable Development. We conclude, nature-based mitigation policies are more cost-effective and better at coping with the ethic and inequality issues associated with distributional impacts of the policy actions.

O-2244-06

Fostering forest system resilience through managing biodiversity : the case of Mediterranean forests

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Mediterranean climate regions are considered as a hotspot for biodiversity, with many endemic species adapted to their hot dry summers and mild winter conditions. There, human societies have for centuries adapted their socio-economic systems to constrained climatic conditions and related risks (drought, fire, etc.) that now, under most climate change scenarios, are expected to expand rapidly at a larger scale. Thus, Mediterranean climate regions are a reservoir of resources and experience of potential interest for adaptation to climate change in other areas.

Mediterranean forests provide multiple goods and services for multiple users, including water cycle regulation and carbon sequestration at national and global level, fuelwood, forage and other products that contribute significantly to the income of the local human population that. However, climate change is expected to be particularly severe at these latitudes and, furthermore, climatic fluctuations have a higher impact in those fragile areas : tipping points can be crossed with low fluctuation. Therefore, advancing on the understanding of the resilience mechanisms of Mediterranean forest social-ecological systems is a general concern but also a potential relevant source of information.

Mediterranean forests resilience results from the interplay between human decisions and actions and natural processes. Considering the context of change, facing increased hazards and uncertainties, a new paradigm emerges where adaptation and long term preservation of options are both needed, following a more flexible approach to managing forests. Biodiversity is not only a reservoir of living forms with different hierarchical levels (individuals, populations, communities) but also a set of processes that permanently puts the diversity in evolution. Thus, nature-based solutions should combine exploration, exploitation and dynamic conservation of diversity and processes.

Aiming to propose solutions to foster resilience of Mediterranean forest systems through managing biodiversity, the research project INFORMED (INtegrated research on FOrest Resilience and Management in the mEDiterranean), funded by the ERA-Net FORESTERRA, is conducted by a multidisciplinary consortium of 21 research groups from 10 countries, representing both the Northern and Southern Rim. Mediterranean forests are viewed as complex social-ecological systems where management, ecological and socio-economic processes operate at different spatial-temporal scales and interact, determining their response to disturbance and disturbance regime scenarios.

INFORMED relies on a process-based approach that integrates knowledge (i.e. data and models) issued from a broad range of case studies representing various forest types, socio-economic assets and global change scenarios found in the area, from Northern Africa to the Mediterranean margins of temperate forests. The project aims to (1) produce global change scenarios specifically dedicated to the Mediterranean forests, (2) develop quantitative assessment of biodiversity and functional response of Mediterranean forests to disturbance and management, (3) develop integrated assessment of ecosystem services and their dynamics based on ecosystem functions and their economic evaluation, and (4) evaluate adaptive management strategies, policy and governance options for their expected impact on resilience of Mediterranean forests.

To illustrate this original multidisciplinary research, we present the overall interdisciplinary conceptual framework where different mechanisms of flexibility are considered jointly, and the first evidence deriving from the past work on resilience in the selected case study areas.

2244-POSTER PRESENTATIONS

P-2244-01

Current status and potential impacts of climate change on the distribution of consumed plants species by the endangered western derby eland (Taurotragus derbianus derbianus) in its last wild refuge Niokolo Koba National Park, South-Eastern Senegal

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Within the last decades, biodiversity became an important topic of social, political and scientific discussion because of its essential role in human well-being and survival. However, biodiversity is facing increasing threats, leading to its loss, caused by different factors among which climate change. It is urgent to take action to ensure its sustainable use and conservation. The Western Derby Eland (Taurotragus derbianus derbianus Gray, 1847), the biggest antelope worldwide is recorded as endangered species even close to extinction. Endemic to West Africa its wild habitat is shrunk nowadays to Niokolo Koba National Park (NKNP) Southeast Senegal with Soudano-Guinean climate, where an exponential decrease of its population is noticed. Conservationists in hope of preserving its genetic pools established the first breeding herd worldwide to an ex-situ conservation site, the Bandia reserve Centre West with a Sahelo-Soudanian climate. Researches have been carried out on derby eland in wild but they had a narrow-scope, mainly oriented on aerial and ground survey in the national park. Until today, very few is known on the wild eland in its last natural refuge. Previous studies have defined Boscia angustifolia, Grewia bicolor, Hymenocardia acida, Strychnos spinosa and Ziziphus mauritiana as consumed woody species by eland. A step to maintain and allow the population increase of Eland within the NKNP is to assure the presence of these woody species in the area. Therefore, knowledge on their current and future distribution within the NKNP is important for the perpetuity of the eland in its last wild refuge. The aims of this present work are to (i) identify the current potential distribution of eland's consumed plant species with climatic and land-cover variables as predictors and (ii) predict the future distribution of these species based on different climate models and scenarios for decision makers and rangeland managers. To achieve these aims two types of dataset are necessary: species occurrence and environmental data. Occurrence points of each woody species were obtained from field observations and additional records from herbaria of natural collection downloaded from GBIF website (Global Biodiversity Information Facility). Environmental variables were downloaded from Worldclim database for climate data and from the Global Landcover database for land cover variables. Possible impacts of climate change on the distribution of Eland consumed plant species in the Park were analyzed based on three climate models (CNRM-CM5, HadGEM2-ES, and MPI-ESM-LR) and two climate scenarios (RCPs 2.6 and 8.5), at two periods of time (2050 and 2070). Current and future potential distributions of suitable habitats for the woody species were determined at a spatial resolution of 30 arc-second using the Maximum Entropy (MaxEnt) approach.

Preliminary results of the ongoing analysis show a good potential distribution of consumed plant species by eland in the NKNP in general. Three out (Grewia bicolor, Hymenocardia acida, and Ziziphus mauritiana) of the five woody species are found almost everywhere within the park. In contrary, Strychnos spinosa has is range restricted to the central part while Boscia angustifolia is confined in the eastern part. Projections illustrate a negative impact of climate change on the consumed plants by the eland, with a severe loss of suitable habitats for most of the species, except from Hymenocardia acida and Ziziphus mauritiana which will likely remain within the NKNP.

The loss of suitable habitats for the consumed species by eland will have negative impacts on his maintenance in the park. We therefore recommend the development of strategies for a good conservation of these remaining plant species by reducing for example human actions.

P-2244-02

Climate change adaptation for the Amazon basin: how can ecosystem-based solutions be multiplied?

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Land use change has meant to date a reduction of nearly 20% of the natural cover of the Panamazonian region, which comprises eight Amazonian countries and one overseas territory. There are projections suggesting that if the current pace of deforestation is not halted soon, climatic conditions will become drier and the system may turn into an opener and drier one, where fire risks are higher and precipitation and humidity lower. This ´savannization´ would potentially have large-scale impacts on climate, biodiversity and livelihoods locally, as well as globally.

The latest IPCC assessment report pointed out a set of sub-national and national initiatives of climate change adaptation in the Amazon that are based on ecosystems. Ecosystem-based adaptation (EbA) refers to practices that reduce human vulnerabilities by harnessing the capacity of nature to buffer human communities against the adverse impacts of climate change. The Amazon region simultaneously holds the largest continuous green tropical cover of the planet and a population of more than 30 million habitants, many of which live in poverty. The poorest are the most vulnerable people to climate change. Then, these characteristics turn the Amazon into a key geography to implement and learn from practices related to ecosystem-based adaptation and sustainable development. Protected area networks, indigenous territories, community management, conservation incentives and forest restoration are all practices that can be considered EbA as long as they reduce societies´ vulnerability to climate change by protecting natural resources and improving livelihoods.

In this paper we review some of the existing national and sub-national policies and practices taking place in the Amazon that can be classified as EbA. Mapped cases include from national-level policies (such as those related to low carbon development or conservation agreements) to local level initiatives (such as sustainability policies at municipal level or community management of areas under protection). We analyzed the selected cases on the basis of the following criteria: resilience potential, risk reduction, cost-effectiveness, emissions reduction, replicability, and scalability. We emphasize the need to showcase, measure and share success stories to favor dissemination of solutions across the region. Main conclusions are that 1) protected areas networks and indigenous lands that add up to more than 45% of the total cover the Amazon need further consolidation; 2) national and sub-national conservation incentive mechanisms need further assessment but have a high potential for replication across the region; 3) efforts aiming for sustainability at sub-national level must be measured and understood for potential replication or even to inspire the design of new policies; 4) adaptation to climate change in Amazonia will be predominantly ecosystem-based, but planning requires regional level integration and exchange of policies and practices between national and sub-national actors.

P-2244-03

Climate Change impact of loss Agro-biodiversity in Georgia

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Climate change is occurring more rapidly than anticipated and the increase in extreme weather events threatens more disruptive effects to agriculture. Existing technologies and current institutional structures seem inadequate to achieve the mitigation needed to adequately slow climate change effects, while also meeting needed food security, food safety livelihood and sustainability goals in Developing Countries especially like Georgia. Identifying actions that are science-based, utilize knowledge systems and technology transfer in new ways, and provide resilience for food systems and ecosystem services in agricultural landscapes despite the future uncertainty of climate change and extreme events. Recognizing the urgency, Association for Farmers Rights Defense, AFRD organzing the Training Programs for its member farmers on this important topics: Climate Smart Agriculture, Mitigation and Adaptation, Conservation of Agrobiodiversity and creation of in-situ, ex-situ, in-farm and on-farm collection of seeds and species of must threatened Agro bio-diverse endemic plants in Georgia. We also know that the most diverse ecosystems will be the most resilient and adaptable in the face of changing climates. Every species has a role to play in a functioning ecosystem, and conserving ecosystems is therefore an important way of conserving species. However, in order to ensure effective conservation, climate change management strategy of our NGO will require reliable scientific data both on the nature of climate change and on its potential impact on plants and plant communities.

P-2244-04

Traditional Knowledge in the Use and Management of Forest Ecosystem for Livelihoods and Food Security in Nigerian Savanna

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Indigenous traditional knowledge and biodiversity are complimentary phenomena essential to human development and sustainable resource management. The rural communities have a significant role to play in maintaining the integrity of ecosystems to ensure that it continues to support livelihood activities. This paper discussed traditional knowledge in the use and management of forest resources in the Nigerian savanna and how this knowledge has been used to improve the livelihhods of the people. It combines focal group discussions, key informants interviews and household survey in 11 communities across 10 local councils with vegetal surveys. The results of this study revealed that people in the area possess considerable knowledge of the natural resources they use and how to ensure the sustainability of some these resources to ensure that they continue to support their livelihoods. Strategies and programmes that are more likely to succeed will require integration of coordinated efforts aimed at poverty alleviation and food security with measures to combat land degradation, reduce loss of biodiversity and ecosystem services. Such integrated measures must be science-based but community driven to ensure its sustainability and synergy.

P-2244-05

Bio-Diversity, ecosystem functioning, and human wellbeing in changing landscapes: Future challenges

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Climate change affects the living world, including people, through changes in ecosystems, biodiversity, and ecosystem services. Ecosystems entail all the living things in a particular area as well as the non-living things with which they interact, such as air, soil, water, and sunlight. Biodiversity refers to the variety of life, including the number of species, life forms, genetic types, and habitats and biomes (which are characteristic groupings of plant and animal species found in a particular climate). Biodiversity and ecosystems produce a rich array of benefits that people depend on, including fisheries, drinking water, fertile soils for growing crops, climate regulation, inspiration, and aesthetic and cultural values. These benefits are called "ecosystem services" - some of which, like food, are more easily quantified than others, such as climate regulation or cultural values. Changes in many such services are often not obvious to those who depend on them.

The future of humanity depends on whether or not we have

a vision to guide our transition toward sustainability, on scales ranging from local landscapes to the planet as a whole. Sustainability science is at the core of this vision, and landscapes and regions represent a pivotal scale domain. Themain objectives of this paper are: (1) to elucidate key definitions and concepts of sustainability, including the Brundtland definition, the triple bottom line, weak and strong sustainability, resilience, human well-being, and ecosystem services; (2) to examine key definitions and concepts of landscape sustainability, including those derived from general concepts and those developed for specific landscapes; and (3) to propose a framework for developing a science of landscape sustainability. Landscape sustainability is defined as the capacity of a landscape to consistently provide long-term, landscape-specific ecosystem services essential for maintaining and improving human well-being. Fundamentally, well-being is a journey, not a destination. Landscape sustainability science is a place-based, use-inspired science of understanding and improving the dynamic relationship between ecosystem services and human well-being in changing landscapes under uncertainties arising from internal feedbacks and external disturbances. While landscape sustainability science emphasizes place-based research on landscape and regional scales, significant between landscape interactions and hierarchical linkages to both finer and broader scales (and externalities) must not be ignored. To advance landscape sustainability science, spatially explicit methods are essential, especially experimental approaches that take advantage of designed landscapes and multi-scaled simulation models that couple the dynamics of landscape services (ecosystem services provided by multiple landscape elements in combination as emergent properties) and human well-being.

Keywords: Sustainability _ Landscape sustainability science _ Landscape sustainability spectrum _Ecosystem services _ Human well-being _ Key research questions and approaches

P-2244-06

Building Resilience at Sub National level Using Climate Resilience Framework

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Nepal's ecosystems generate various goods and services for its people. Climate change with its direct consequences on the hydrological cycle can impact ecosystems, lives and livelihoods seriously and adversely. These changes will lower the resilience of ecological and infrastructural systems as well as the functioning of water, food and livelihoods services. Ecosystem based adaptation as an element of an overall strategy can help educe the vulnerability of ecosystems and build people's resilience in the face of the adverse impacts of climate change. This paper will present the use of climate change vulnerability in wake of changing climate taking into account the role of ecosystem services using the climate Resilience Framework (CRF). The CRF conceives climate vulnerability to be highest when increased exposure intersects with fragile systems, social marginalization and constraining institutions. Drawing on findings of research conducted in Nepal's Western Development Region the paper will discuss the use of both top down and bottom up approach to assess risks and develop strategies for building resilience at sub national levels.

2245 - Modelling the complexities of the Earth System

ORAL PRESENTATIONS

K-2245-01

Why do we use Earth System models ?

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Not communicated.

O-2245-01

Mitigation delay sensitivity of temperature, sea level and ocean acidification

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With annually increasing anthropogenic carbon emissions, the commitment to climate change and its impacts continues to grow. A policy-relevant metric for this growth is the mitigation delay sensitivity (MDS), measuring the additional commitment per decade until emissions start to decrease. For the peak temperature increase ΔT, MDS can be estimated analytically using idealized emission scenarios (Allen and Stocker, 2014; Stocker, 2013). Here, we use an Earth System Model of Intermediate Complexity to evaluate the MDS of ΔT, steric sea level rise (SSLR), and two ocean acidification impacts following Steinacher et al. (2013). We examine the dependance of the MDS on the rate of increase (r) and subsequent decrease (s) in annual emissions, for three different equilibrium climate sensitivities (ECS) of 1.5, 3.0 and 4.5 K. The modeled MDS is in good agreement with analytical estimates for ΔT and SSLR, except for scenarios with very high cumulative emissions. For standard parameters (ECS = 3.0 K, r = 2% and s ranging from 5% down to 0.5%), MDS amounts to 0.3-0.7 K/decade for ΔT and 7-20 cm/decade for SSLR by 3000 AD. With regard to ocean acidification, we find that partial Aragonite undersaturation of the Southern Ocean surface (by 2100 AD) may be avoided with sufficiently early and stringent mitigation. MDS is 15-17% of the Southern Ocean area per decade for standard parameters, but for s>3% no undersaturation occurs if emissions start to decrease before 2030. Further loss of strongly supersaturated ocean surface areas (associated with coral reef habitats) is virtually unavoidable, but can be substantially reduced by mitigation. For standard parameters, we are already committed to a loss of roughly 30-90% of these areas by 2100 AD, even with immediate mitigation (with respect to preindustrial); MDS amounts to an additional loss of 22-66% of the remaining area per decade.

O-2245-02

Do ENSO modeling discrepancies affect the climate-carbon feedback?

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The El-Niño/Southern Oscillation controls most of global climate variability on inter-annual time-scales. In particular, ENSO affects temperature and precipitation patterns in South America and Southeast Asia, although its influence extends to remote regions and latitudes.

ENSO is also known to play an important role in the carbon-cycle, influencing a large fraction of variability in atmospheric CO2 growth rate, mainly due to its impact on terrestrial ecosystems in the Southern Hemisphere. During El-Niño events, lower than average precipitation and warmer temperatures are registered in most of northern and central South America, South Africa and most of Australia, leading to reduced CO2 uptake by vegetation, and to increased fire activity. During the cold phases (La-Niña), the patterns are approximately reversed and the land-sink is enhanced.

Although Earth-System Models (ESMs) in CMIP5 do include representation of the ocean-atmosphere coupling processes that produce ENSO, they still present difficulties in modeling some of the most relevant features of the phenomenon, such as the temporal evolution and recurrence periods of warm and cold phases .

It has been shown that the difference between model estimates of future CO2 concentration are related to their biases in representing present atmospheric CO2. Moreover, the larger disagreements of future CO2 uptake are due to

uncertainty about the future response of the land-sink to climate change. It has been further shown that part of the uncertainties in future estimates of CO2 storage on terrestrial ecosystems are related to the differences in the climate forcing from the global circulation models (GCMs).

Here we investigate whether the discrepancies between observations and modeled ENSO may explain biases in the modeled present land-sink in CMIP5 ESMs. We evaluate the performance of ESMs in reproducing, for the period 1959-2011, a set of temporal features, such as the intensity, spatial configuration, and spectral properties of ENSO. Subsequently, the ability of ESMs to reproduce the global land-sink strength and variability was evaluated and compared to the relationship between the modeled ENSO and variability in the modeled land-sink. We find that biases in the land-sink are related to the way ESMs simulate the response of terrestrial ecosystems to ENSO variability and that this, in turn, is mainly dependent on the spectral properties of the modeled ENSO. The ESMs that mis-represent the peak periodicity of ENSO in the 3-7 years band tend to present larger errors in the modeled land-sink characteristics. The nature of this relationship between ENSO discrepancies and land-sink biases was studied by evaluating the influence of discrepancies in ENSO frequency on temperature and precipitation patterns within each model.

The analysis was further extended to the future RCP4.5 and RCP8.5 scenarios, by evaluating the influence of the discrepancies of the present terrestrial CO2 uptake on the future land-sink and the role played by ENSO in these discrepancies.

O-2245-03

Spread of ocean heat uptake efficiency in CMIP models

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During transient climate change, the ocean heat uptake efficiency, quantified by the ratio between the rate of ocean heat uptake N and surface global-mean temperature change DT, can quantitatively measure how effectively the heat is vertically transported in the deeper ocean, thus moderating surface transient change. Among models of the Coupled Model Intercomparison Project (CMIP) framework, the spread in the values of k varies by about a factor of 2. The spread in k affects the model spread in projections of ocean heat uptake and thermal expansion, therefore contributing to the uncertainty in model future projections of transient climate change. We investigate potential sources of model spread in kappa by using a set of 23 CMIP models with CO2 increasing at a rate of 1% per year. In the set of models we analyse, in line with previous studies, the models with the strongest AMOC have the strongest CO2-induced AMOC reduction. We find that the models with the strongest AMOC, and consequently the models with the strongest AMOC reduction, have the strongest ocean heat uptake efficiency. Despite the strong correlation with AMOC, the largest portion of the ocean heat uptake efficiency and of its spread comes from the Southern Ocean. By further analysing the detailed process-based heat budgets in three models, HadGEM2, GFDL-ESM2M and MPIESM-LR, which have k values from the low, middle and high part of the kappa spread, we find that the spread in these three models mainly arises from changes in advection. The dominant part of the advective ocean heat uptake takes place in the Southern Ocean. We explore potential physical mechanisms that link the Southern Ocean advective heat uptake, hence the Southern Ocean overturning, with the AMOC and the ocean heat uptake efficiency.

O-2245-04

Forest Mortality, Economics, and Climate

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Forests in western North America provide critical economic and environmental services including watershed protection, timber production, and carbon sequestration. Recently this region has experienced widespread forest mortality attributed to droughts, fires, and regional warming. Forest mortality rates doubled in the Pacific Northwest between 1990 and 2010 with bark beetles killing trees across 11 million hectares in B.C and the western U.S. The complex interactions among climate, ecosystem response, and economic factors govern the impacts these stressors will have on terrestrial ecosystems in the future. To examine how major forests will function under future climatic and land use regimes we couple an improved forest mortality model to NCAR's Community Land Model (CLM4.5) incorporating a predictive model of mountain pine beetle outbreaks and a forest product economic model. The economic model estimates the values of private forest investment, wood products, recreation, and water. Annual harvest levels, silvicultural investments, and forest management strategies feedback into CLM. This methodology will elucidate feedbacks among climate, land use, forest ecosystems, carbon sequestration and ecosystem services. To assess uncertainty in the simulated forest response to climate change a dynamic vegetation model (TRIFFID operating within the Hadley Centre Earth System Model) is used to generate a super-ensemble of simulations using crowd sourced computing (climateprediction.net). This novel form of evaluating intrinsic variability allows for thorough investigation of model sensitivity to parameterization. Outcomes of this work will provide policy makers and resource managers with tools for developing adaptive strategies for responding to projected warming, drought, insects, and economic factors.

O-2245-05

Modeling and visualization of the marshes vegetation

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This paper deals with a mathematical models of the vegetation growth in the marshes of the Gulf of Mexico. It is a spatial-temporal model of multi-species competition presented in the form of the system of partial differential equations. Analysis of the behavior of such a system is studied through simulation and visualization tools. The objective of the study is to find the impact of fresh water releases and precipitations on the vegetation cover of marshes so it can be used for future preservation of the marsh ecological system.

Coastal marshes are important ecosystems that provide many benefits to human health and well-being including: protecting the inland areas from storm surge, storing water, removing nutrients that flow in from watersheds, and providing nursery habitat for key commercial and recreational fisheries. Yet, marshes are under extreme pressure from development and 50% of the marshes nationwide have disappeared since the founding of the United States.

The Texas coast is flat, hot, and windy; which makes coastal marshes very susceptible to effects of climate change and water resource development. Climate change can have three effects: sea-level rise, water cycle alterations, and temperature alterations. The main effects will be to drown marshes during rising water levels or dry them out as evapotranspiration rates increase during droughts. Water resource development has decreased water delivery to marshes in the Nueces Delta by 45% over the last 40 years, which has led to marsh degradation.

There is a need to understand the dynamics and the interactive roles of climate and water cycle changes in order to predict changes in salt marshes in the future. This information is critical for resource management. However, few tools exist to forecast effects of human activities on marsh function. Results and models of this

ongoing research could be extended to coastal estuaries in other regions of the world.

2245-POSTER PRESENTATIONS

P-2245-01

Optimal climate policy under socio-economic scenario uncertainty

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The role of uncertainty in the field of climate change has been widely discussed in recent years. A focus has been on the role of uncertainty in the climate sciences part of climate change, in particular uncertainty about the magnitude of climate change due to greenhouse gas emissions, e.g., as measured by the famous climate sensitivity parameter. In applied policy analysis, integrated assessment models (IAMs) can be used to assess the costs and benefits of climate change policies. Besides the crucial climate parameters and impact estimates, these models require the specification of a baseline population and GDP growth scenario along which optimal climate policies are studied.

Here, we study the role of uncertainty about these baseline assumptions to contribute to the literature about how and how much uncertainty does affect the optimal policy. We make use of a new set of socio-economic development scenarios that the IAM community currently works on , called socio-economic shared pathways (SSPs). These scenarios will serve as a reference to explore the long-term consequences of climate change and the climate policy strategies. They can serve at least to assess the range and hence uncertainty of future baseline growth and population assumptions for the context of climate change, which is what we aim for in this work.

We focus on the role of socio-economic uncertainty to address three research questions that come up in this context. Firstly, we ask what is the optimal climate policy and how robust is it in the presence of socio-economic uncertainty. Notably, we estimate the cost of this uncertainty and how different decision rules for finding the optimal climate policy when the baseline is unknown can be derived including making use of recent developments in the context of robust decision making. Secondly, and related, we discuss how measures of the costs of climate change and climate policies can be measured and compared when different baselines are considered. Given that policy costs and other measures such as impacts are typically expressed relative to a baseline, comparing those values with different baseline projections is not trivial as we show. Thirdly, we more broadly discuss how scenario development exercises can inform decisions under uncertainty taking into account the different "worlds" described.

P-2245-02

Evaluation the accuracy of post processing approaches on RegCM4 outputs in forecasting precipitation(Case study: North West of Iran)

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The seasonal forecast of precipitation which is generally presented qualitative and probabilistic can be used for decision makings in agriculture, water resource management and hydropower production to alleviate the adverse effects of extreme events like drought and flood. The Earth Systems Physics (ESP) group of the Abdus Salam International Centre for Theoretical Physics (ICTP) maintains and distributes a state-of-the-science regional climate model called the ICTP Regional Climate Model (RegCM), which has been successfully used in different regions of the world for diverse range of climate-related studies. This study was conducted with two aims: Evaluation the performance of RegCM4 dynamic model in forecasting monthly, seasonal and annual precipitation in four selected stations in North West of the Iran namely Tabriz, Ardabil, Khouy and Urumia and testing the accuracy of stepwise regression for post processing the outputs of model, in a 30-years period from 1982 to 2011. The required observed weather data of study stations for running regional climate model RegCM4 were collected from Iran Meteoroligcal Organization (IRIMO) archive and rest of the data were adopted from ICTP database, with NetCDF format including three sets of weather data NNRP1 with a 6-hour-time step and a horizontal resolution of 2.5 2.5 on the reanalysis data of National Center of Environmental Prediction of United States, sea surface temperature, (SST) with a horizontal resolution of in 1 from the type of (OISST) belonged to National Oceanic and Atmospheric Administration and surface data (SURFACE), which were consisted of three topographic data (GTOPO), the vegetation or land use of (GLCC), and the soil type data (GLZB), with a horizontal resolution of 30 30 seconds from United States Geological Survey, for the period 1982 to 2011. To determine suitable rainfall scheme, the normal year of 2009 was selected for running the model using different schemes Accordingly, Kuo scheme with the minimum bias, comparing to observed precipitation amounts in the entire 36 synoptic stations of the region, was chosen as the main scheme. The time interval was set as 24-hour, spatial resolution of 30 30 km2, and the number of grid points were 152 in longitude (iy) and 168 in latitude (ix) during the study period of 1982 to 2011. Geographical area center was placed at 30.5◦ (N) and 50 ◦ (E), respectively. The outputs of the model are three types; atmospheric (ATM), surface (SRF) and radiation data with the format of NetCDF, each containing a large number of meteorological variables. By excluding the precipitation (tpr) from the model outputs, the nine significant variables with the highest correlation with precipitation were determined as: q2m □ t2m □ps □v1000 □v500 □u1000 □u500□ omega1000, omega500.For post-processing the outputs of the model, the multiple linear regression (MLR) approach was used. Except for the warm month, the output of RegCM4 showed a wet bias and overestimation. Applying multivariate linear regression equation, (and in some cases two-variable) on the output of the model led to a better agreement between observed and simulated values of precipitation such that, in 75% of the cases, the bias and relative error decreased for the monthly, seasonal and annual forecasts. At all stations except for Urumia, performing the post processing improved the accuracy of RegCM4 output at all time scales. Further scrutiny is recommended for explaining the variations among the stations

P-2245-03

Regional Arabian Peninsula Modeling Findings and Integrated Climate Change Programme

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AGEDI launched a follow-up to this initial study of Climate Change in the UAE in 2011 with the aim of establishing a climate change work programme that could build upon, expand and deepen the understanding of vulnerability to the impacts of climate change as well as identify practical adaptive responses at the local, national and regional levels. A 5-stage stakeholder consultative process involving nearly 100 stakeholders helped define the overall scope of the programme, and establish the types of outputs considered to be the most useful for future policymaking at the multiple scales envisioned.

The first-of-its-kind effort in the Arabian Gulf, the project represents a timely and strategic initiative that can help regional leaders, innovators and decision-makers better understand critical stakes and the range of options available to them across the 5 key thematic areas. The 12 integrated sub-projects also represent an organizing framework to engage partners from across the region on issues that are widely considered to be high priority, while also involving several international organizations to facilitate replication in other regions of the world.

The first two subprojects on high resolution modeling for both atmosphere and the Arabian Gulf are now complete and being openly shared. The findings create the foundational information for the remaining projects of the programme. Interestingly, the results towards modeling

of sea level change and what are its current limitations as opposed to scenario building have create rich dialogue which has helped bridge the disconnect between the science- policy interface.

The modeling has occurred in a nested configuration to cover the Arabian Peninsula at a 12km grid and a 4km grid over the UAE as well as part of Oman and Saudi. 4km is extremely computationally heavy and substantially more robust than the previous studies undertaken by EAD etc. The Oceans Modeling is also run at 1 km resolution which is also incredibly precise in comparison to global modeling which we also used for past studies in the region.

Regional Ocean Models (ROMs) are essential for understanding how future climate change will affect specific locations within the world's oceans. Such models are a significant improvement over coarse resolution ESMs because they more realistically capture local oceanographic processes and characteristics, such as sea surface temperature profiles, circulation patterns, fresher simulations of the Earth's climate.

The ROM for the Arabian Gulf has been developed, based on ESM boundary conditions and local data, and used to make climate change projections out through the late 21st century. The outputs of the study provide a Gulf specific basis on which to conduct the subsequently planned vulnerability assessments of the programme regarding marine biodiversity and socioeconomic systems, as well as be an asset to researchers in the region regarding future climate change and the marine environment.

Regional atmospheric modeling is essential for understanding how climatic conditions will change at specific locations within the region. Such models are a significant improvement over global models because they more realistically represent local to regional meteorological dynamics, such as orographic precipitation, land-ocean wind breezes and circulations, surface heating and evaporation, on-shore and off-shore wind patterns, and other factors that influence current and future climate.

The primary goal of the regional atmospheric modeling using WRF was to develop projections of regional climate for the Arabian Peninsula at fine spatial and temporal scales. The modeling effort builds off and reflects the large-scale features and temporal trends from GCM simulations based on the IPCC's 5th Assessment Report (AR5). The modeling was conducted on the NCAR-Wyoming Supercomputer or "Yellowstone".

The outputs of the study provide a Gulf region-specific basis on which to conduct subsequent planned vulnerability assessments under the programme regarding terrestrial biodiversity, water resources, coastal zones and socioeconomic systems.

P-2245-04

Southern Ocean wind response to North Atlantic cooling and the rise in atmospheric CO2

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Southern Ocean, believes to be a CO2 sink (Takahashi, 2012), remains a mystery player in understanding the global carbon cycle and in predicting future climate change. Key evidence from marine proxy record indicates intensification of wind-driven upwelling in the Southern Ocean during the late Pleistocene glacial terminations and suggests that the anomalous southern hemisphere midlatitude westerlies were forced by North Atlantic cooling via atmospheric teleconnection (Anderson et al., 2009). In this study, we investigate the response of Southern Ocean climate to North Atlantic cooling using an AGCM coupled to a reduced gravity ocean to link the empirical observation with climate theory. In comparison between our cooling and basic state experiments, we observed a nearly 25% increase in the Southern Ocean midlatitude westerlies in particular in the Pacific sector during austral winter. We propose a two-step mechanism of the north-south climate connection: (1) the response of the tropical ITCZ to North Atlantic cooling; (2) the resulting effect of the altered Hadley circulation on the Southern Ocean winds. In light of the vital role of the Southern ocean ventilation to atmospheric CO2 concentration, we forced an earth system model with dynamical biogeochemical cycle by anomalous wind field observed in the AGCM and found a ~20 ppm atmospheric pCO2 rise in equilibrium state. The model results support the hypothesis that the Southern Ocean wind-driven upwelling was susceptible to intensive North Atlantic cooling under a glacial climate. We emphasize the intimate coupling between the northern and southern hemisphere climate via atmospheric teleconnection mediated by tropical climate system.

P-2245-05

Climatic sensitivity of the Brazilian Earth System Model integration submitted to abrupt CO2 change

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This work analyzes the climatic sensitivity response of the Brazilian Earth System Model (BESM-version 2.5) when exposed to abrupt CO2 changes. We will calculate differences between two, 30 years experiments of the BESM model, from 2007 to 2036 (30 years), both of runs start from a 150 years spinup, but one run has atmospheric CO2 constant concentration at preindustrial values (280 ppmv) and the other has constant and abrupt 1200 ppmv ("4xCO2"). The work analyzes the differences of abruptly changed integrations (1200 ppmv) and not abruptly integrations (280 ppmv), more precisely, calculating 12 Climate Extreme Indices using the fields of precipitation, maximum and minimum temperature over South America. The difference of 4xCO2 and 280 ppm integrations for Constant Drier Days (CDD-CLIMDEX index) are showing 60 days of increased CDD over northern South American continent. Note that both of the Northeast as the Southeast and southern Midwest regions of Brazil are showing similar characteristics in magnitude of CDD between 5 and 30 days.The BESM model Total Precipitation (PRCPTOT-CLIMDEX index) indicates an increase from 50 to 200 mm on the South, Southeast of the Midi West of Brazil. The Constant Wet Days (CWD-CLIMDEX index) are decreasing 20 days over the great part of North Region of Brazil. When comparing BESM Frost Days (FD-CLIMDEX index) with FD of the Community Climate System Model (CCSM4), there is a very similar pattern but the BESM showed elevated number of FD. When comparing Summer Days (SU Climdex index) between BESM and CCSM4 models, both of models showed very similar profile of Summer Days, but the CCSM showed smaller values than BESM. Finally, these results showed that the model BESM has a good climatic sensitivity response.

P-2245-06

A theoretical Basis for Integrated Assessment Models

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A mathematical model that couples structural change of countries and flows' dynamics has been developed. It proposes a comprehensive representation of the socio-economic structure. The model introduces an explicit description of three processes: GDP growth, the mitigation of damages from uncertain impacts in economic activities, and socioeconomic adjustments that bring about the adaptive capacity. It also holds a representation of resilience. The model makes explicit the endogenization problem that needs to be solved. Working out this problem will allow the numerical assessment of resilience. It also paves the path to the harmonization of metrics relating resources, economic flows and social welfare.

P-2245-07

Photochemistry of ozone at the surface of cloud water droplets: insights from computer simulations

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Atmospheric reactions in condensed media such as water droplets, organic aerosols, soot, sea salt particles, etc., are thought to play significant roles in the troposphere. Reactions at surfaces have attracted special attention, in particular those occurring at the air/water interface of water droplets since clouds represent about 7% in volume of the troposphere. Typically, water droplets exhibit a high surface area to volume ratio and this is certainly a determining factor for surface reactions to compete with bulk reactions. The molecular properties of compounds interacting with an aqueous interface have been often considered as being intermediate between the properties in the two bulk phases but there is now compelling evidence that chemistry at the air/water interface may be quite different from both the gas and the bulk.

However, the experimental study of chemical processes at aqueous interfaces is not straightforward. To get further insights in this domain, in the last few years, we have developed a computational strategy that combines quantum chemistry methods, classical molecular mechanics models, and computer simulations based on the molecular dynamics approach.

In this communication, we report recently obtained results for the photochemistry of ozone at the surface of cloud water droplets. Photolysis reactions are central to atmospheric chemistry. Ozone in particular, absorbs UV and visible light and photodissociates to produce molecular and atomic oxygen either in the ground or excited states. Atomic oxygen can then react with water or methane molecules to form the highly reactive hydroxyl radicals, often referred to as the "detergent" of the troposphere. These processes have been widely investigated in the gas phase but when ozone is adsorbed at the surface of cloud water droplets, the ozone-water interactions modify the spectral signatures, and the mechanism and the kinetics of the photolytic (and subsequent) processes are presumably different and deserve to be investigated in further detail.

Indeed, our computer simulations predict that the hydroxyl radical formation rate at the air/water interface is enhanced by four orders of magnitude, suggesting that clouds can influence the overall oxidizing capacity of the troposphere on a global scale.

3301 - Climate Intervention: Evaluating its Risks, Benefits, and Potential

ORAL PRESENTATIONS

K-3301-01

Climate Intervention: A Summary of the U.S. National Research Council Report on Geoengineering

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Climatologically, humans are in unfamiliar territory. Failure over the last few decades to adopt substantive climate mitigation strategies has continued to stress the planet in ways that present some well-understood and some poorly understood risks that pose a threat to human livelihood across the globe. These risks, which continue to increase as greenhouse forcing proceeds unabated, have raised some important questions about the viability of climate intervention (often referred to as geoengineering) as a means to avoid or reduce some of the consequences of climate change. Strategies for such intervention fall into two categories, representing two very different approaches to addressing the climate challenge. The first is carbon dioxide reduction - the removal from the atmosphere and reliable storage of carbon, which has elements of a mitigation approach in that it seeks to reduce the amount of CO2 that enters or remains in the atmosphere. The second is albedo modification, which seeks to increase the amount of sunlight reflected from the Earth, thus reducing the surface incident radiation.

There is a pressing need for a careful and clear scientific foundation that can inform ethical, legal, and political discussions surrounding climate intervention. Toward that end, the National Research Council (NRC) of the U.S. National Academy of Sciences undertook a study to assess the current state of knowledge associated with climate intervention, which resulted in a set of recommendations to inform future decisions on possible climate intervention research and deployment. This talk will present the NRC committee's findings and recommendations, which speak to: the state of readiness of climate intervention methods and the associated challenges, their value in the context of mitigation and adaptation strategies, research needs for advancing our understanding of climate intervention approaches in order to make informed decisions on their deployment, and governance considerations for such research.

Climate intervention is fraught with a wide range of risks and uncertainty. The key question that underpins the need for and approach to research is whether climate change may push society to a state in which the risks associated with non-intervention may outweigh the risks of intervention. Making such an assessment requires a foundation of knowledge and understanding.

K-3301-02

Volcanic Eruptions as an Analog for Stratospheric Geoengineering

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In response to the global warming problem, there has been a recent renewed interest in geoengineering "solutions" involving "solar radiation management" by injecting particles into the stratosphere, brightening clouds or the surface, or blocking sunlight with satellites between the Sun and Earth. No systems to conduct geoengineering now exist, but a comparison of different proposed stratospheric injection schemes, using airplanes, balloons, and artillery, shows that using airplanes to put sulfur gases into the stratosphere would not be expensive. Nevertheless, it would be very difficult to create stratospheric sulfate particles with a desirable size distribution. While volcanic eruptions have been suggested as innocuous examples of stratospheric aerosols cooling the planet, the volcano analog also argues against geoengineering because of ozone depletion, regional hydrologic responses, and other negative consequences. Volcanic eruptions are an imperfect analog, since solar radiation management proposals involve the production of a permanent stratospheric aerosol layer, while volcanic layers are episodic. Nonetheless, we can learn much from the volcanic example about the microphysics of stratospheric sulfate aerosol particles; changes in atmospheric circulation, producing regional climate responses, such as changes to the summer monsoon; atmospheric chemistry; changes of the partitioning of direct and diffuse insolation; effects on satellite remote sensing and terrestrial-based astronomy; and impacts on the carbon cycle. There are 26 reasons why geoengineering may be a bad idea, and five reasons why it might be a good idea. Some of these can be evaluated with climate modeling, and some using the volcanic analog. Observations of the next large volcanic eruption will help to understand the evolution in stratospheric sulfate aerosol size distribution over the first few months after the eruption. Much more research is needed before we can quantify each of these, so that policymakers in the future can make informed decisions about whether to ever implement stratospheric geoengineering. Given what we know today, global efforts to reduce anthropogenic emissions and to adapt to climate change are a much better way to address anthropogenic global warming.

K-3301-03

The governance of solar geoengineering

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This talk will give an overview of past developments in the governance of solar geoengineering research, contextualize these developments within broader debates on research governance, and conclude with an outlook on how the early governance of solar geoengineering research is relevant to potential future dynamics of international conflict and cooperation on solar geoengineering. Solar geoengineering research has proven fertile ground for calls for and adoption of understandings that reflect new characterizations of science (for example, as 'post-normal'), new ways of assessing scientific results (for example, through 'extended peer review' or 'technologies of humility'), and new processes for conducting research (for example, 'transdisciplinarity' or 'mode 2 science'), which aim to foster cooperation between broader sets of stakeholders and thereby to accommodate their values and beliefs into the research process. Whether these can be put into practice or not will set precedents and norms that are carried forward into negotiations over future activities, including those that may be deployment-related.

O-3301-01

Studying the limitations of stratospheric aerosol injections by microphysical processes and interaction with radiation using the IPSL climate model

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Current studies assessing climate engineering by stratospheric aerosols injections (SAI), like those performed in the framework of GeoMIP, reveal numerous risks and undesirable side effects of this method. But they largely rely on the assumption that increasing radiative forcing by greenhouse gases can be counterbalanced by sufficiently large aerosol injections, at least on a global scale. However, there are various processes that might have the potential to severely limit the efficacy of SAI, but which are not considered in most of the participating earth system models. Among them, there is coagulation of aerosol particles leading to an increase in particle size, which reduces scattering efficiency and stratospheric

lifetime through sedimentation. Interaction with infrared radiation, i.e. the aerosol's own greenhouse effect, can also limit the desired cooling effect.

In order to get a better estimate of the cooling potential of SAI from global climate simulations, all these processes were implemented in the IPSL climate model using an aerosol bin scheme. A new radiative transfer scheme is used to account not only for solar, but also for terrestrial infrared radiation. Results from climate model experiments showing the influence of each one of the relevant microphysical and radiative processes on the cooling potential if SAI will be presented.

O-3301-02

Cirrus cloud thinning: Do the right conditions exist, and how can it be tested with observations?

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This presentation will describe recent scientific developments on a climate intervention (CI) method sometimes called cirrus cloud thinning, addressing (1) new evidence that supports its underlying physical assumptions; (2) a means of field testing the CI method without affecting the environment (i.e. without cloud seeding); and (3) how to reduce uncertainties concerning its radiative and climate impacts.

While GCM testing of cirrus cloud thinning suggests it has some advantages over stratospheric aerosol injection, cirrus CI will not work when ice is primarily formed through heterogeneous nucleation for T < -38°C. Field campaigns have shown that ice in cold cirrus is generally produced heterogeneously, but these campaigns have not addressed the cirrus at high latitudes that would determine the effectiveness of cirrus CI.

A new understanding of thermal absorption in two split-window channels has rendered a reinterpretation of a standard CALIPSO satellite retrieval (the effective absorption optical depth ratio, or βeff), and a tight correlation between βeff and the N/IWC ratio has been demonstrated, where N = the ice particle number concentration and IWC = ice water content. When applied to cold semi-transparent cirrus clouds having emissivities between 0.4 and 0.8, we find that (1) polar cold cirrus (T < -38 C) occur much more often during winter than during summer and (2) N/IWC is relatively high at high latitudes during winter, suggesting that homogeneous nucleation occurs frequently there. Homogeneous nucleation is further supported by the fact that high N/IWC values tend to coincide with regions of low mineral dust concentration as predicted by CAM5 (Storelvmo and Herger, 2014, JGR). This high N/IWC during winter (and probably from Dec. - April) is likely to have a strong greenhouse effect that may increase high latitude temperatures by 2-5°K relative to cirrus conditions where heterogeneous nucleation dominates (Storelvmo et al. 2014, Philos. Trans. A, Royal Soc.). Thus, implementing cirrus CI at high latitudes (in both hemispheres) only during the months when noontime solar zenith angles are very low or when the sun never rises (i.e. seeding only 15% of the planet) may have a comparable cooling effect at high latitudes where global warming is most severe, and may have a mean global cooling of 1.4°K as shown in Storelvmo et al. (2014, Philos. Trans. A, Royal Soc.). These satellite findings indicate that cirrus CI is a real possibility.

These N/IWC satellite retrievals also show that N/IWC at high latitudes during summer is relatively low and characteristic of heterogeneous ice nucleation. This may be the result of higher mineral dust concentrations, expected to be higher during summer at high latitudes. This apparent changing of ice nucleation mode from winter to summer may provide a natural means of field testing the cirrus CI method, without any need of cloud seeding from aircraft. The DOE ARM program is considering a field program for sampling wintertime Arctic cirrus (T < -40°C) in response to these satellite retrievals due to their importance to climate science. In situ measurements of wintertime cold Arctic cirrus would enable their microphysical properties to be parameterized (i.e. cloud temperature related to effective diameter De; De related to mass-weighted ice fall speed) and contrasted with microphysical properties/parameterizations associated with cirrus formed at similar temperatures through heterogeneous ice nucleation. GCM simulations using these parameterizations would then be able to evaluate the actual potential climate impact of cirrus cloud seeding (i.e. cirrus CI) at high latitudes, thus reducing various uncertainties associated with cirrus CI such as its cooling impact.

If a large scale CI field experiment were ever conducted on winter high latitude cirrus, this satellite method could be used to monitor these clouds and to determine whether the CI method was working (i.e. seeding with efficient ice nuclei was changing the nucleation mode).

Finally, it is noteworthy that cirrus CI appears to be the only radiation management CI approach that preferentially cools the Polar Regions where the effects of global warming are most severe.

O-3301-03

Low-cost low-risk space-based geoengineering - is it possible?

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Space-based geoengineering is often discarded as an approach to geoengineering on the basis of cost and feasibility. The Angel approach is to launch modular component spacecraft into the Sun-Earth L1 point forming a solar shield to reduce the amount of solar energy incident on the Earth. The cost and feasibility constraints generally revolve around the issue of launch capacity from the Earth's surface. The proposed American lunar Resource Prospector Mission (PRM) slated for launch in 2018 offers another approach - the robotic use of lunar resources to bootstrap the feasibility of lower-cost space missions by reducing the amount of launched material. We present a preliminary feasibility and technological development assessment to manufacture the modular spacecraft required to realise a modular solar shield concept. The RPM mission will be investigating the extraction and processing of lunar soil - in particular, ilmenite (FeTiO3). It may be extracted magnetically and ilmenite grains are preferentially enriched in volatiles. Although dominated by hydrogen - itself a useful reductant as well as propellant with oxygen - these volatiles include carbon compounds that may potentially be manufactured into plastics (silicone plastics in particular to conserve the carbon inventory). These volatiles may be evolved by heating the ilmenite grains to ~600oC using a simple fractional distillation column. The ilmenite is further heated to >900oC with recycled hydrogen (from lunar water ice or recovered volatiles) to yield oxygen, wrought iron and titania ceramic/glass: FeTiO3 + H2 → TiO2 + Fe + O2. Although the primary interest for RPM is in the recovered oxygen to support human lunar colonisation, our interest is in the iron to form the basis of a robotic industrial infrastructure. As well as iron, cast lunar basalt offers the possibility of compressive material as sacrificial structures to conserve iron for incorporation into manufactured spacecraft structures - wrought iron is a perfectly adequate structural material. The Moon exhibits a hostile thermal environment so thermal control materials will be essential in any infrastructure as well as the spacecraft modules. TiO2 is an excellent thermal (and electrical) insulator which may be formed into fibreglass. As well as thermal conduction, thermal conduction material is required - fernico, an alloy of iron, nickel and cobalt, is an excellent thermal and electrical conductor. Both Ni and Co may be sourced from mass concentration regions of the Moon, marking the locations of iron meteorite material. Semiconductor material - silicon - is available from lunar silicates minerals. From these materials, we have the basic elements we require to build a spacecraft mechanically, electrically and thermally. The only Earth-imported reagents required for isolation of these materials are Na and Cl which nevertheless are recycled. The materials must be formed into useful structures, components and parts. The advent of 3D printing offers a versatile means of manufacturing that can handle plastics, metals and ceramics. Selective laser sintering is an approach that uses lasers to thermal fuse particles into layers, thereby building 3D structures that cannot be manufactured in any other way. Electronics without solid state manufacturing techniques represents a particular challenge though progress has been made in printed plastic electronics. Another option is to use 3D

printing to manufacture vacuum tube-based electronics for simple control systems. This approach is favoured because it relies on ceramics and metals already extracted. Indeed, thermionic emission with vacuum tubes offers a viable form of electric energy generation from thermal sources. My group has been exploring how to 3D print electric motors using multiple lunar-derived materials - core of iron plates, insulating plates and bobbins, and conducting wire - to construct a 3D printable universal motor. If successful, this offers the prospect that 3D printing could manufacture further manufacturing tools - lathes, milling stations, etc to perform further manufacturing functions. Furthermore, electromagnetic launchers are derivatives of electric motors arrayed linearly rather than radially (different scale of course). This offers the prospect of launch with minimal fuel use. Indeed, 3D printers could potentially manufacture complete robotic devices - manipulators for assembly of parts, rovers for geological surveying and 3D printers themselves for self-replication. A corollary to this capability is that such 3D printing systems could manufacture the spacecraft modules required to implement a solar shield with a modest inventory launched from Earth.

O-3301-04

Climate Engineering and Policy Interaction Networks: The Challenges of Regulating a Complex System

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The global climate is a complex system. Among other things, this means that a complete analysis of the climate as a whole involves attending to the ways in which various geophysical and biological subsystems influence and constrain one another's behavior. This fact is widely appreciated. Less widely appreciated is the fact that climate policy design and analysis involves very similar considerations. Global policy initiatives like climate engineering will not be implemented in a social vacuum, and the emerging consensus is that climate engineering would be best employed as part of a multi-faceted strategy that also involves mitigation and adaptation programs. In light of this, it is vitally important that we think about the ways in which different climate-related policies might influence and constrain one another before we begin to implement any significant global policy.

While feasibility analyses and impact studies exist for many proposed climate engineering programs, very little attention has been paid to the ways in which such programs might interact with and constrain other international and national climate policies. This paper explores this "interaction problem" from an interdisciplinary perspective, focusing on a detailed hypothetical case study in which a solar radiation management by stratospheric aerosol injection program is combined with a global system of economic carbon credits. The conjunction of these two programs raises practical, theoretical, and ethical concerns that don't appear when either policy is considered alone, and which might significantly alter the effectiveness and feasibility of both programs. This incomplete picture, arising from analyzing climate engineering proposals in isolation, is a potentially dangerous oversight as we move closer and closer toward possible implementation.

3301-POSTER PRESENTATIONS

P-3301-01

Response of Indian Subcontinent to the Geoengineering of Climate: The effect of SRM on Cloud Area Fraction and Rainfall

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The objective of this paper is to study the effects of Solar Radiation Management (SRM) on the climate over the Indian Subcontinent, particularly how it changes the cloud area fraction and total precipitation over the region. Cloud area fraction and precipitation are highly model sensitive parameters which depend greatly on other parameters like surface air temperature and evaporation. These parameters play a major role in governing small and large scale weather activities in any area and a small change in them can trigger repercussions on a much larger scale. As such it becomes extremely important to analyze closely the effects of SRM on our climate before implementing it in reality. The data for five important and interdependent variables: cloud area fraction, total precipitation, precipitable water, evaporation and surface air temperature was studied exhaustively for nine models namely BNU-ESM, CCSM4, CanESM, CAM5.1, GISS-E2-R, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM and MPI-ESM-LR, for a period of 50 years and the graphical results for the changes in these parameters was plotted using NCAR Command Language (NCL). The results obtained from these plots were indicative of the fact that cloud area fraction and precipitation, particularly over the Indian Subcontinent, are indeed highly model sensitive parameters; where a small change in the solar radiation caused changes as high as 30% in these parameters. With the given uncertainty in the simulated parameters, it becomes crucial to have more robust modeling before implementing any decision, particularly for a country like India where the economy is largely driven by monsoon dependent agriculture and even a small change in the climate can affect severely the livelihood of millions of people. Therefore any decision, big or small, must be pondered upon carefully, to analyze the risks and the benefits being derived from it, before implementing it on a local, regional or global scale.

P-3301-02

Climate Engineering Research Trends - Results from an Expert Survey

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As international climate change mitigation efforts are progressing relatively slowly, climate engineering (CE) has been controversially discussed for several years now and often viewed with scepticism. In August 2014, the so far largest transdisciplinary conference on climate engineering CEC14 took place in Berlin, and assembled over 350 participants from 40 countries who discussed a multitude of questions associated with technical interventions in the climate system. More than one third of this expert group participated in a subsequent online survey about future research trends in CE. The presentation will summarize the outcomes of this survey and thereby give an overview of the current state and diversity of the CE debate, motivations to engage with the topic and expected future research trends. Some general results are summarized below. In the talk, the data will be presented in more detail and with regard to specific sample subgroups and technologies as each technological approach raises specific challenges.

1. Working backgrounds, motivations, hopes and concerns with regard to CE research. The vast majority of respondents named countries in Europe or North America to be their country of origin and current office location. Despite the global relevance of the topic and various attempts to increase geographic representation, scientific expertise and awareness remains very much centred in the Global North. Academic backgrounds of people working on CE cover various aspects of natural science, as well as social sciences and humanities. Social scientists seem to work more broadly on the concept of CE, whereas natural scientists focus more on specific technologies. Motivations to engage with CE are manifold, such as 1) concern about climate change and pessimism about mitigation activities, 2) a search for options to counter climate change, 3) concern about CE consequences, 4) scientific interest in the topic reaching from modelling and impact assessment to governance and policy implications, philosophical questions of decision making, to reach a robust scientific footing for decision making. Throughout the survey, participants highlighted concerns about various risks of CE technologies.

2. Expected trends in CE research. Despite the widely shared opinion that methods to remove carbon dioxide from the atmosphere (CDR) would be safer and should be researched, many of the conference participants seem to expect that research will focus on solar radiation management (SRM) in the future although they see many risks associated with SRM-techniques. Technologies that should be researched most according to the participants were for CDR: (Bioenergy with) Carbon Capture and Storage, and Direct Air Capture; and for SRM: Stratospheric Aerosol

Injections and Marine Cloud Brightening. CDR techniques are seen as currently not effective enough, too slow and too expensive. Asked for which aspects of research should get more attention, answers differed for CDR and SRM in the way that for CDR participants identified technical research and development and economics among the main aspects; for SRM, climate effects, governance and ethics where highlighted; environmental effects and impact assessment scored high for both approaches.

3. Opinions about Field Research and Governance. Whereas several participants were in favour of no field research at all, others expected field tests for CDR and/or SRM. However, the focus of research differed: For CDR, field tests were mainly suggested to test feasibility, efficiency, safety, impacts, solutions for carbon storage and recycling. For SRM, the main questions were related to atmospheric physics and chemistry, specifics of particles, engineering tests, delivery technology, impact assessment and critical factors. With regard to governance that should be in place before field testing, opinions differed from no governance and that existing governance is sufficient, to the need for an international convention or legal framework and a global body, as well as the application of national laws. Furthermore, environmental and social impact assessments (EAI and SIA) were suggested and the need for public participation in decision making and ensuring transparency was highlighted.

On a general note, most survey participants hope that CE won't be necessary at all and emphasized that climate change mitigation should be heavily intensified.

P-3301-03

Geoengineering, Preferred Climate States, and Climate Policy in the Anthropocene

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Many social, ethical, political, environmental, and other objections to geoengineering have been raised since the taboo on public discussion was broken a decade ago. One of the key criticisms, though often unstated, is focused on the fact that geoengineering would necessarily entail making conscious, deliberate decisions about desired climate states. These states might be implicit or explicit, and might be defined in terms of temperature, radiative forcing, rate of change, atmospheric concentration, or some other metric, but choosing to intervene in the climate system is inextricably linked to choosing what the climate ought to be. This feature of geoengineering has been criticized on the grounds that it is arrogant, hubristic, unnatural, corrupt, and/or unwise. There may be merit in such criticisms, yet this line of argument overlooks the reality that, in the Anthropocene epoch, any climate policy is unavoidably premised on a preferred climate state. Mitigation rests inherently on targets, whether general (climate stability, preindustrial, Holocene) or specific (°C, ppm, GtC). From a philosophical point of view, any such target is ultimately arbitrary, in the sense that nature does not endorse one goal over another. The same is true of adaptation. Every potential climate state entails some combination of winners and losers (human and non-human), and the ethical dilemmas this presents cannot be avoided simply by excluding geoengineering as a climate policy option. The mere fact of making decisions about preferred climate states is an insufficient and unsound basis for objecting to geoengineering, and only serves to obscure the tough choices about future climate that must be made whether or not geoengineering is on the policy agenda.

P-3301-04

Geoengineering: Existing State Specific Laws and impacts upon Human Health, the Eco-system & Economics

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An overview, examples of and analysis thereto of currently in effect state statutes on air pollution and how any proposed geoengineering, solar radiation management and/or climate intervention plans or programs would have a legal impact and effect upon associated risks such as human health, the Eco-system and state economies.

P-3301-05

Atmospheric consequences of disruption of the ocean thermocline by ocean pipe technologies

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Technologies utilising vertical ocean pipes have been proposed as a means to avoid global warming, either by providing a source of clean energy, increasing ocean carbon uptake, or storing thermal energy in the deep ocean. However, increased vertical transport of water has the capacity to drastically alter the ocean thermocline. To help bound potential climate consequences of these activities, we perform a set of simulations involving idealised disruption of the ocean thermocline by greatly increasing vertical mixing in the upper ocean. We use an Earth System Model (ESM) to evaluate the likely thermal and hydrological response of the atmosphere to this scenario. In our model, increased vertical transport in the upper ocean decreases upward shortwave and longwave radiation at the top-of-the-atmosphere due primarily to loss of clouds and sea-ice over the ocean. This extreme scenario causes an effective radiative forcing of ≈15.5-15.9W m-2, with simulations behaving on multi-decadal time scales as if they are approaching an equilibrium temperature ≈8.6-8.8°C higher than controls. Within a century, this produces higher global mean surface temperatures than would have occurred in the absence of increased vertical ocean transport. In our simulations, disruption of the thermocline strongly cools the lower atmosphere over the ocean, resulting in high pressure anomalies. The greater land-sea pressure contrast is found to increase water vapour transport from ocean to land in the lower atmosphere and therefore increase global mean precipitation minus evaporation (P-E) over land; however, many high latitude regions and some low latitude regions experience decreased P-E. Any real implementation of ocean pipe technologies would damage the thermal structure of the ocean to a lesser extent than simulated here; nevertheless, our simulations indicate the likely sign and character of unintended atmospheric consequences of such ocean technologies. Prolonged application of ocean pipe technologies, rather than avoiding global warming, could exacerbate long-term warming of the climate system.

P-3301-06

Perspectives of Climate Engineering Adoption in Africa: Analogies from International Environmental Agreements, Conventions and Treaties

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Global warming is steadily threatening ecosystems and their biological lives across the globe. Though life in the equatorial and tropical regions is associated with hot temperatures rather than cooling, the drastic decrease of forest cover and major vegetations in the last century may be an argument for adoption of the principle of large-scale Climate Engineering (CE). Whether through Solar Radiation Management (SRM) or through Carbon Dioxide Removal (CDR), this strategy might only be acceptable as a «plan B» to climate mitigation and adaptation. CE research and technology may be scaled up to supplement African governments' efforts to reduce planned greenhouse gases (GHG) emissions and avoid suicidal climate mitigation and adaptation strategies. These schemes are cheap and effective climate "mitigation" options but may be dangerous, the safest options being expensive or simply useless. Besides, most of the countries in the African continent do not have the ability to invest in what are considered as "harebrained schemes, which impacts are yet to be ascertained". Hence, African countries will recourse to several principles found in the UNCCD, UNCBD and UNFCCC treaties and conventions, the REDD+ agreement, and the 1997 UN Convention on International

Watercourses to elicit their position vis-à-vis CE research and deployment. This paper focuses on the Intra- versus intergenerational equity and sustainability of the CE technology, the precautionary principle, the moral hazard principle linked to mitigation efforts and the binding principles of no-harm and compensatory damages. It simulates analog responses to CE research and deployment adoption based on the practice of international law in Africa.

P-3301-07

Simulating the potential impacts of reforestation on extreme rainfall over West Africa in future

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This study investigates the impacts of reforestation on characteristics of extreme rainfall over West Africa, with a focus on the widespread extreme rainfall events (WEREs) in Savannah, under the RCP 4.5 future climate scenario. For the study, two regional climate models (RCMs: RegCM4 and WRF version 3.5.1), forced with global climate models simulations (HadGEM2 and ECHAM6 respectively), were applied to reproduce the present-day climate (PRS), and to project the future climate (2031-2064) with and without large-scale reforestation in Savannah (FUT and REF, respectively). To validate models, we compare the PRS simulations with the Global Precipitation Climatology Project (GPCP) and Tropical Rainfall Measurement Mission (TRMM) observation datasets. To examine the impacts of reforestation on future extreme rainfall events, we compare the FUT and REF simulations. The results show that, the two RCMs give credible simulations of extreme rainfall threshold (95th percentile of daily rainfall in the past climate) over West Africa. However, RegCM4 reports lower values over the Sahel and the Western Savannah, and both models simulate more WEREs than observation (TRMM) over Savannah. Both model project an increase in the occurrence of extreme rainfall events over the Guinean coast and a decrease over the Savannah and Sahel in the future. However, they show that reforestation would increase the frequency of extreme events over the Savannah, but lowers it over the Guinean coast. Results from this study may guide decision makers on climate change mitigation and adaption options in West Africa.

P-3301-08

Public perceptions of climate engineering and field test proposals in Japan

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There is a growing call for research on climate engineering, the deliberate intervention in the Earth's climate, particularly stratospheric aerosol injection (SAI), one of the methods of so-called solar radiation management (SRM), given the presumed inadequacy of global efforts to reduce greenhouse gas emissions and a possibility of "climate emergency". Such a call for research on SAI includes proposals of conducting small-scale outdoor experiments or field tests in the natural environment with controlled emissions of aerosols.

However, there are strong disagreements and controversies among scientists on whether and how such field tests should proceed, and importantly such debate is mainly based not on technical but social, political and ethical concerns. Advocates claim the urgent need for field tests due to concerns over "climate emergency" while critics worry about "moral hazard" caused by field tests and argue that once research was initiated, SAI would fall down a "slippery slope," eventually leading to its deployment. These concerns are relevant to broader public deliberation, and should not be confined only to debate among experts.

In this poster, we report the results of a recent online survey with Japanese citizens (N = 3000), focusing mainly on SAI field tests. Our survey design was intended to elucidate the key social, political and ethical concerns of the public regarding SAI. The respondents read a short description of SAI and answered their opinions.

The survey results show a high rate of the "unsure" or "don't know" (DK) responses — about one-third of the respondents chose DK response to the questions regarding attitudes toward SAI. At least three reasons can be considered as sources of DK response: first, lack of knowledge and awareness of SAI, as nearly two-thirds answered "neither heard of nor know at all SAI"; second, little understanding of the provided information of SAI, since about two-fifths of the respondents answered "cannot understand so much" or "cannot understand at all"; and third, the omission of middle scale option such as "neither agree nor disagree" in our survey instrument, since it might have caused those who have ambivalent or ambiguous views on SAI to be difficult to answer, resulting in a DK response. Thus, our survey results can be deemed to show the public's undecided opinions on SAI.

Nevertheless, the respondents demonstrated discernible attitudes toward SAI in some respects. First of all, a great majority of the the respondents clearly favor mitigation to SAI, and think that considering SAI before pursuing all efforts to reduce CO2 emissions is undesirable. In addition, the respondents exhibited (conditional) support of SAI research, but differentiated different modes of research. They demonstrated preference of indoor research activities such as computer simulations and lab work over outdoor field tests. The support for the deployment was limited, which is consistent with the findings of previous surveys. The respondents also showed a relatively serious concern over the risk of unpredictable side-effects of SAI and political consequences of research, i.e. the possibility of "slippery slope", although a majority of them thought that the prospect of "moral hazard" is unlikely. Regarding the governance issues on field tests, the respondents strongly favor the public consultation before field tests, the open disclosure of the results including negative information, and the international regulation of field tests instead of scientists' self-regulation. The respondents seem to endorse the importance and significance of 'Oxford Principles' of climate engineering research governance.

In our survey we controlled the information of SAI and split the sample into one with and without the "climate emergency" frame. Previous research suggests that framing of information provided to the respondents (especially, emergency framing) may influence, and therefore bias the public perception of SAI, though the results of our survey did not yield such framing effects on respondents' attitudes toward SAI with any statistical significance. We thus have reported all the results, collapsing the two groups into one.

We believe our survey results can bring important and non-Western perspectives into the wider public debate on climate engineering.

P-3301-09

The Carbon Dioxide Removal Model Intercomparison Project (CDR-MIP)

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Continued anthropogenic greenhouse gas emissions are changing the climate threatening "severe, pervasive and irreversible" impacts. Inadequate emissions reduction is resulting in increased attention on Climate Intervention (CI) - deliberate interventions to counter climate change that seek to either modify the Earth's radiation budget, or remove the primary greenhouse gas from the atmosphere - Carbon Dioxide Removal (CDR). The majority of future scenarios that do not exceed 2°C warming by 2100 include CDR methods. At present, there is little consensus on the impacts and efficacy of the different types of proposed CDR. In response, the Carbon Dioxide Removal Model Intercomparison Project (or CDR-MIP) is proposed. This project aims to bring together a suite of Earth System Models (ESMs) and Earth System Models of Intermediate Complexity (EMICS) in a common framework to explore the potential, risks, and challenges of different types

of proposed CDR. At present the proposed simulations for CDR-MIP include: Direct-air capture simulations, Afforestation and Ocean alkalinisation as well as a modified Diagnostic, Evaluation, and Characterization of Klima (DECK) experiment. These experiments are designed to answer key questions related to quantifying efficacy, feedbacks, response time scales, and potential side effects of specific CDR methods, as well as questions of climate "reversibility". Here we present details on the proposed experiments, and encourage feedback from the community on their design and implementation. It is anticipated that this will be the first stage of a continuing project exploring CDR, and as such we strongly encourage interested modeling groups to participate. CDR-MIP aims to commence in September 2015.

3302 - Key Energy Technologies for Low Carbon Pathways

ORAL PRESENTATIONS

K-3302-01

The Role of Technology for Achieving Climate Policy Objectives: Overview of the EMF27 Study

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Low-carbon technologies in the energy system have been identified as a key element for mitigating climate change. The relative importance of mitigation technologies depends not only on their techno-economic characteristics and how they develop in the future, but also on the competition with other energy technologies, the development of future energy demand and the climatepolicy architecture. Since all of these factors are interconnected and surrounded by large uncertainty, it is important to investigate technology strategies from a system perspective and under a variety of assumptions.

This presentation gives an overview of results from the Stanford Energy Modeling Forum Study 27, an inter-comparison of 18 energy-economy and integrated assessment models. The study investigated the importance of individual mitigation options such as energy intensity improvements, carbon capture and storage (CCS), nuclear power, solar and wind power and bioenergy for climate mitigation. Limiting the atmospheric greenhouse gas concentration to 450 or 550 ppm CO2 equivalent by 2100 would require a decarbonization of the global energy system in the 21st century. Robust characteristics of the energy transformation are increased energy intensity improvements and the electrification of energy end use coupled with a fast decarbonization of the electricity sector. Non-electric energy end use is hardest to decarbonize, particularly in the transport sector. Technology is a key element of climate mitigation. Versatile technologies such as CCS and bioenergy are found to be most important, due in part to their combined ability to produce negative emissions. The importance of individual low-carbon electricity technologies is more limited due to the many alternatives in the sector. The scale of the energy transformation is larger for the 450 ppm than for the 550 ppmCO2e target. As a result, the achievability and the costs of the 450 ppm target are more sensitive to variations in technology availability.

K-3302-02

Innovation in Renewable Energies and their contribution to combat climate change

P. Frankl (1)
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Not communicated.

K-3302-03

Is nuclear energy part of the solution?

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At least 80% of the world's electricity must be low-carbon by 2050 to keep the world within 2°C of warming, according to the IPCC. This is a massive global challenge that requires the use of all available low-carbon energy technologies. Nuclear energy is recognized by the IPCC as "an effective greenhouse gas mitigation option" with life cycle emissions "comparable to most renewables".

We need to take immediate steps towards reducing greenhouse gas emissions, as the world has already used up most of its carbon budget. Nuclear energy is low-carbon, available and competitive in the timeframe required. It has avoided the release of 56 gigatonnes of CO2 since 1971, two years' worth of emissions at current rates. Additional nuclear energy capacity can be built up in the world's largest emitting countries: there are more reactors under construction today than at any time in the last 25 years, with BRICS countries leading the way[i]. Existing nuclear power plants are the largest low-carbon electricity source in OECD countries. Operating them for longer is one of the most effective ways to keep greenhouse gas emissions down. Moreover, nuclear generation can operate with renewables energy in order to adapt generation to electricity demand, taking into account variability of certain renewable energy sources.

As countries are pursuing different energy policy goals, with different constraints, they should be free to choose from the full portfolio of energy technologies, including renewable energies and nuclear energy, to reduce CO2 and meet other energy objectives. Very few scenarios have been investigated with mitigation requirements to limit warming to 2C and implemention of a nuclear phase out. While they need the largest portfolio now, countries will also need the largest portfolio tomorrow: nuclear research should receive support to develop future reactors(generation 4) that will make better use of the Uranium resources, will operate in a safer way, and produce less waste. Renewable energies and Nuclear have to be considered together as part of the electricity mix on the low carbon pathways

3302-POSTER PRESENTATIONS

P-3302-01

Ocean Thermal Energy Conversion, the potential impact on microplankton of bottom water discharge at subsurface

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Part of the solar energy can be harvested and used in different processes. Taking advantage of the natural temperature gradient between the surface and the deep ocean, the Ocean Thermal Energy Conversion (OTEC) process achieves this goal. However, the artificial upwelling created by the release of deep water flowing out of an OTEC plant into the sub-surface layer (whose temperature and biogeochemical composition are quite different) could locally induce alterations in ecosystem structure and functioning. The anticipated effects on the microphytoplankton were studied on a scheduled pilot site off Martinique (Caribbean Sea), within the framework of the IMPALA project.

The biogeochemical processes that participate in the artificial upwelling were addressed by simulation of the discharge using in situ microcosm experiments immersed

for 6 days. Mixing of deep water with sub-surface waters was achieved at different depths (maximum of chlorophyll and bottom of the nutricline) and mixing rates (0%, 2% and 10% of bottom water). Analyses of pigments (HPLC), picophytoplankton abundance (flow cytometry), and nutrients were performed in the microcosms and the surrounding waters to assess the natural variability of the phytoplankton assemblage and the potential shifts induced by rich deep water supply in a nutrient poor surface water.

Similar evolution over time of the phytoplankton communities was observed in the natural environment and in the microcosm without deep-water input, suggesting that microcosms can be used to assess the impact of bottom water discharge at sub-surface. The enrichment of sub-surface waters by 10% of deep seawater induced a significant shift in the phytoplankton assemblage towards the development of diatoms. This could have biogeochemical and ecological consequences since diatoms are major drivers of the biological carbon pump in the ocean.

P-3302-02

The potential of nuclear energy to mitigate climate change

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In the 2014 IPCC report, Working Group 3 discusses several scenarios that are consistent with RCP-2.6, with the objective of limiting the global mean surface temperature increase to less than 2 degrees. All these scenario rely on massive Carbon Capture and Storage (CCS), at the ≈10 GtC level while the few existing experiments are at the MtC level. It may appear unreasonable to assume that the geological, technology and cost requirements associated to CCS will be met.

We focus on the scenarios IMAGE, developed by the NEAA, Netherlands, and MESSAGE developed by IIASA, Austria. Both propose three sub-scenarios: (i) "Supply" that assumes a high energy consumption compliant with the needs of economic and social development. (ii) "Efficiency " which assumes a 45% smaller consumption, and (iii) "MIX" which is intermediate. All 6 scenarios assume a massive development of PhotoVoltaic (PV) energy together with a large increase of biomass. In the supply scenario, 7000 nuclear reactors are put in operation between 2060 and 2100. We suggest that the urgency of climate change argue for such development as early as 2020.

We shall describe in detail the potential and limitations of such massive nuclear development. The technology for a massive nuclear development is much more mature than that of CCS, does not suffer from the intermittency limitations of PV and wind energy, and necessitates far less material extraction than these. It requires however the generalization of breeding reactors of which only a few units currently exist. The necessity for Plutonium availability requires a partial shift from Pressurized Water Reactor (PWR) to CANDU-like reactors together with the development of fuel processing facilities.

A wide development of nuclear energy, at a pace comparable to its development in France during the 70s and 80s would allow the stabilization of atmospheric CO2 concentration at a level compatible with RCP-2.6, while providing enough energy for a growing population and without the hypothetical massive development of CCS. It makes possible a near-total ban of coal use well before the end of the century.

P-3302-03

Analysis of substitution trade-offs among selected bioenergy pathways for different end-uses

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The environmental concerns (local and global) as well as the depleting reserves of the conventional energy sources have forced us to seek fuel efficient and greener alternatives for many of the traditional energy consumption approaches. Bioenergy is the traditional source of energy with renewed interest due to its carbon mitigation potential assuming CO2 neutrality, need for diversification of energy sources and the renewable nature of feedstocks. A bioenergy system or bioenergy chain / route consist of a series of conversion steps by which raw biomass feedstock is transformed into a final energy product (heat, electricity, or transport biofuel). There are many bioenergy chains as a result of the wide range of raw biomass feedstocks (wood, grass, oil, starch, fat, etc.), broad spectrum of conversion technologies and a variety of possible end-uses.

Bioenergy alternatives offer significant carbon mitigation potential (CMP), provided that the resources are utilized sustainably and that efficient bioenergy systems are used. Certain current systems and key future options including use of biomass residues and wastes and advanced conversion systems are able to deliver 80 - 90% emission reductions compared to the fossil energy baseline [IPCC, 2012].

The CMP associated with specific bioenergy options depend on intrinsic factors such as design of the bioenergy system and extrinsic factors such as source of biomass and fossil fuels they are replacing. Many bioenergy pathways can be used to convert a range of raw biomass feedstock into a final energy product. The choices we make today will affect the amount of GHGs we put in the atmosphere in the near future and for years to come.

In order to assess and compare the economic and environmental sustainability of modern bioenergy systems, there is a need for comprehensive assessment of each bioenergy pathway for cataloguing attributes of various proposed bioenergy feedstocks and conversion technologies.This article analyzes the substitution trade-offs among selected bioenergy pathways for different end-uses.

P-3302-04

The hydrogen economy: a failed concept or the future for our energy system?

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Hydrogen has been proposed since the 1970s as a clean alternative to carbon-based fuels, particularly for the transport sector. This paper examines recent developments in the use of hydrogen in transport, heat provision and energy storage, and considers policy initiatives that are designed to introduce hydrogen-powered technologies into existing energy systems.

After much hype in the early 2000's, a perceived lack of progress led many to deem fuel cell vehicles (FCVs) a failure; research programmes were cut and attention switched to battery vehicles, encompassed within a broader view of predominantly electrically-powered energy systems. Yet many automotive manufacturers have continued developing FCVs, particularly in Asia, and have pushed in recent years for hydrogen-fuelled vehicles to have an important role in the future, for example through the publication of the McKinsey-coordinated "Power-trains" study [1]. It has had a significant impact, with government-industry H2Mobility programmes set up in several European countries to facilitate the introduction of FCVs. When combined with the recent launch of the first commercial FCV in Korea, and the unexpectedly poor sales of battery vehicles, it appears that FCVs will soon appear in many countries.

Another potential use of hydrogen that has received little attention is to decarbonise heat provision, particularly in those countries using natural gas combusted in boilers. Natural gas is difficult and expensive to decarbonise because the emissions cannot be captured and alternative technologies (for example, electrically-powered heat pumps) are much more expensive to buy and operate,

take more space within houses and provide an inferior customer experience. Hydrogen, on the other hand, uses a similar boiler and is carbon-free. We have examined the potential for hydrogen to be supplied to homes using existing gas network infrastructure, which would greatly reduce the cost of a heat transition and would avoid such infrastructures becoming stranded assets. We have identified the circumstances in which hydrogen could replace 20-100% of existing gas heating.

A third use for hydrogen is to support low-carbon electricity generation. Power-to-gas uses excess renewable generation to produce hydrogen that is injected into existing gas networks to partially decarbonise the gas supply, so acting as a form of energy storage. Such systems are already been tested in Germany. We have assessed the value of power-to-gas to support wind generation in the UK, compared to other novel energy storage technology options.

The "Hydrogen's Value in the Energy System" project has been assessing the value of hydrogen in all of these markets. Hydrogen is unusual as it is a zero-carbon alternative energy carrier to electricity. Our techno-economic energy system models have shown that the trade-offs between using electricity and hydrogen depend on the relative generation costs and on the net CO2 emissions from hydrogen production. We will demonstrate the importance of these trade-offs in this talk.

Innovation theory has shown that most novel technologies require support in the early stages of commercialisation in order to develop supply chains and reduce manufacturing costs through "learning by doing". Most hydrogen production and fuel cell technologies are currently unable to compete economically with incumbent energy technologies, but could do so in the future if further cost reductions are achieved [2]. One obstacle to government support for these technologies is the perception that while hydrogen is zero-carbon, the processes that produce hydrogen lead to CO2 emissions that are incompatible with the transition to a low-carbon economy. The lack of a UK definition of "green" hydrogen is a particular obstacle to policy support. We will conclude with an overview of how such a standard could be defined.

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[2] Anandarajah et al (2013) Decarbonising road transport with hydrogen and electricity: Long term global technology learning scenarios.

P-3302-05

Renewable Technologies in Karnataka: Jobs Potential and Co-benefits

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Green technologies provide an essential starting point towards transformation for resource efficiency and a more socially inclusive low-carbon economy. As their share in the economy increases, it can hasten the required transition towards a low greenhouse gas (GHG) emissions development-path in a cost-efficient manner (UNFCCC, 2011). Beyond making the case for early climate change mitigation policy through the development and deployment of green technology, an assessment of co-benefits emphasises the potential of integrating climate change mitigation policies with other socio-economic targets such as improved health and social inclusion (Stern, Kattumuri and Rydge, 2012). Thus there are great opportunities and benefits to investigate, invest for innovation and development of green technologies in emerging economies.

This study, based on empirical study of examples of off-grid solar, wind energy and a few household sources of energy in Karnataka state in India, assesses the key opportunities and challenges presented by the transition to a low-carbon economy by accounting for both the creation of green jobs and the co-benefits arising from the development and deployment of renewable energy technologies in the state. In line with UNEP's recognition that the "greening of economies has the potential to be a new engine of growth" (2011:16) we find that a green economy may provide the necessary stimulus for a more socially inclusive development path (ADB, 2013) where co-benefits are crucial. Our research, is the first of its kind in India. It is based on primary data from households, private companies and NGOs based in Karnataka, derives estimates for jobs potential using local employment factors in Karnataka and shows strong evidence of opportunities for jobs potential.

The main objectives of the study are:

1. Identify specific renewable technologies being developed and deployed in Karnataka

2. Review the potential for green jobs in some renewable energy sectors through quantitative analyses of case studies

3. Analyse the potential co-benefits of these renewable technologies

4. Discuss the scope of these renewable technologies and further activities that could enable sustainable and inclusive development and contribute its share to national greening economy targets.

Our analysis highlights the ways in which the development and deployment of green technologies facilitate reductions in inequality through social co-benefits that are necessary for transformation at the economic and social levels, in addition to the environmental co-benefits that drive this transition. The analyses based on the state of Karnataka can provide learnings for other states in India and elsewhere.

P-3302-06

The learning curve for wind energy in China- Lessons for climate finance

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Reducing greenhouse gases emissions is a two-way street that bridges finance and technology. The key issue of global climate finance is to unlock and scale up additional and predictable capital. Meanwhile, promoting renewable energy is a distinct part of the global climate regime. It is then natural to ask how climate finance interlinks with technology policy to achieve long-term environmental and energy targets.

The theory of the learning curve suggests that the cost of renewable technology falls along with knowledge accumulation based on learning-by-doing and research and development (R&D). Understanding the drivers of this endogenous technological change has important climate policy implications in two aspects. First, the optimal abatement path may vary depending on the channels of technology cost reduction. The existing literature concludes that when knowledge is gained through R&D investments, some abatement is shifted from the present to the future, but if the channel for knowledge-growth is learning-by-doing, the impact on the timing of abatement is analytically ambiguous (Goulder and Mathai 2000). Second, governments need to investigate how, if at all, climate finance can be structured in a way to provide investment subsidy necessary to make renewable energy deployment competitive with an incumbent technology.

In this study, we first assess the learning rate of China's wind energy by considering two sources of learning effect – cumulative installed capacity and technology efficiency improvement. Then, we extend the learning curve model to investigate the amount of additional capital subsidies needed to achieve grid parity of wind electricity and the distribution of this learning investment, depending on three factors – learning rate, cost target, and deployment speed. Finally, we estimate the implicit abatement cost accordingly.

Our contribution is mainly two-fold. First, we contribute to the learning rate estimates with an empirical analysis of wind energy in China. Ek and Söderholm (2013) and Del Rio and Tarancon (2012) provide a literature review on the learning rates of wind energy. Overall, the exiting literature provides few uniform conclusions. A doubling of the cumulative wind power capacity could induce cost reduction from 33% to 3%. All these studies are focused on industrialized countries. To our knowledge, only one study estimates the learning rate of wind energy in china, using the bidding electricity prices of national wind project

concession programs from 2003 to 2007. Relying on a more comprehensive panel dataset from 2004 to 2011, our study looks at the capital cost of wind projects.

Second, our quantitative analysis contributes to the current debate on a post Kyoto regime of global climate finance. We propose a new mechanism by which upfront learning investment sets up a consistency between climate finance and technology target, and thereby the leverage role of climate finance can be monitored at the sectoral level. This proposal can address two main challenges of climate finance. Uncertainty of carbon revenue calls into question the result-based approach of climate finance, which only intervenes at the project operational stage, and therefore does not generate upfront financing, much needed notably in the developing world. Another feature of global climate finance is to balance the fairness of effort sharing. Moral hazard can generate perverse incentive for firms and governments to delay or relax environment and energy policies (Millard-Ball and Kerr 2012). In fact, the debate on the additionality of climate finance has been triggered with respect to China's wind power projects supported by a policy mix including feed-in tariff (FIT) and Clean Development Mechanism (CDM) (Liu 2014). Actually, new market mechanisms for Post-Kyoto shift towards a sectoral approach of cooperation with most of developing countries (WFC 2013; Deutsche Bank 2011). Most of these initiatives are still at a conceptual level, while our analysis is quantitative and evidence-based, and thus provides a useful support to these initiatives.

P-3302-07

Electrochemical systems for a circular energy economy and carbon reuse: the SOFCOM pilot plant

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In the framework of the EU project SOFCOM (FCH JU Grant agreement no: 278798) POLITO has developed a proof-of-concept devoted to demonstrate the high interest of electrochemical systems based on high temperature fuel cells to operate as the core of future energy systems with renewable fuels and multi-product configuration, with particular care on CO2 management through C re-utilization in different processes (electrochemical, chemical, or biological as in SOFCOM).

The proof-of-concept SOFC system, installed in Torino (IT), operates with biogas produced in an industrial waste water treatment unit (WWTU) in CHP configuration, and with the CO2 separation from the anode exhaust sent to a section of CO2 recovery for Carbon reutilization in a photo-bio-reactor for C storage in form of algae (CO2 sink).

Therefore, the proof-of-concept demonstrates a poly-generation system based on the use of renewable fuels (biogas) in high efficiency electrochemical CHP generators, with complete CO2 recovery and Carbon re-use. The four products are:

1. High efficiency electric power from SOFC;
2. Thermal recovery from SOFC and other processes in the plant;
3. Clean water from photo-bio-reactor;
4. Algae: carbon stored and recovered in form of biomass.

From a more strategic point of view, the proof-of-concept demonstrates how electrochemical-based systems could represent an important cornerstone of future energy systems based on renewable fuels, with the highest achievable energy conversion efficiency, and the total recovery of main energy-related atoms (C, H, O) possibly towards a material closed cycle.

The concept of completed energy and material recovery (in particular, Carbon recovery) points towards a concept of circular economy of energy, with negative CO2 emissions: the Carbon atom is completely recirculated in the system, and its re-utilization can be looped virtually for an infinite time.

The concept demonstrated by the proof-of-concept is completely replicable in similar context, or in completely new context in which the Carbon recovery will become a must. The impacts are now at the local level (where the demonstration is applied) but in principle the impact of thee typologies of systems (with complete Carbon reuse) could be at global level once adopted.

The concept, and its proof-of-concept, will be discussed in the presentation.

P-3302-08

Hydrodynamic modeling of the hydraulic threshold El Haouareb

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Groundwater is the key element of the development of most of the semi-arid areas where water resources are increasingly scarce due to an irregularity of precipitation, on the one hand, and an increasing demand on the other hand. This is the case of the watershed of the Central Tunisia Merguellil, object of the present study, which focuses on an implementation of an underground flows hydrodynamic model to understand the recharge processes of the Kairouan's plain groundwater by aquifers boundary through the hydraulic threshold of El Haouareb.

The construction of a conceptual geological 3D model by the Hydro GeoBuilder software has led to a definition of the aquifers geometry in the studied area thanks to the data acquired by the analysis of geologic sections of drilling and piezometers crossed shells partially or in full. Overall analyses of the piezometric Chronicles of different piezometers located at the level of the dam indicate that the influence of the dam is felt especially in the aquifer carbonate which confirms that the dynamics of this aquifer are highly correlated to the dam's dynamic. Groundwater maps, high and low-water dam, show a flow that moves towards the threshold of El Haouareb to the discharge of the waters of Ain El Beidha discharge towards the plain of Kairouan.

Software FEFLOW 5.2 steady hydrodynamic modeling to simulate the hydraulic threshold at the level of the dam El Haouareb in a satisfactory manner. However, the sensitivity study to the different parameters shows equivalence problems and a fix to calibrate the limestones' permeability. This work could be improved by refining the timing steady and amending the representation of limestones in the model.

3303 - Decarbonizing Electricity/Electricity Transition

ORAL PRESENTATIONS

O-3303-01

Does climate change threaten the future of the PV sector in Europe?

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The bet on renewable energies is a key aspect of the mitigation strategies aimed at abating climate change, in which Europe is a world leader. In particular, PV power has been receiving large investments and its future deployment is expected to be spectacular, specially in southern countries. However, development plans remain widely blind to the potential impacts of a hereafter changed climate on renewable energy resources. In order to shed light on this issue, this study makes use of a new generation multi-model and multi-scenario ensemble of high-resolution climate simulations spanning up to the end of this century to assess changes in both PV power generation potential (PVpot) and actual production (PVprod) considering a future scenario with a high penetration of PV installations. Results show that the projected increase in the surface air temperature adversely affects the projections for PVpot, as it acts to diminish the efficiency of the PV cells. Thus, while surface solar radiation is projected to slightly increase in southern regions, PVpot is not. In the most extreme scenario considered (RCP8.5), PVpot would diminish in the range 5-15% (from South to North within Europe) by the end of this century according to the ensemble mean. In terms of production, significant changes are not expected southward but for a plausible reduction of the daily variability of the PVprod series, which would indeed be beneficial. However, further north, worse projections, with the Scandinavian region holding robust reductions in the mean production (about -10% under the RCP8.5) and uncertain projections regarding its future variability. In any case, all signals depict limited impacts indicating that climate change does not seem to pose a serious risk for the PV sector in Europe.

O-3303-02

Advances in multi-scale models to shed light on the plausibility of longterm scenarios

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Given the complex international situation, mitigation strategies to tackle energy-related issues need effective normative tools to deal with the different types of constraint (e.g. climate-related, financial, legal, political, technical). Various scenarios are now available to provide an insight into the challenges of energy transition under environmental constraint. However, the regional, technological and social conditions that trigger this transition require developing tools to identify the policy mixes needed for new directions in technical systems and modes of development. And this is more stringent in the electricity sector.

In particular, the aim is to reconcile and connect different scales (temporal, spatial, social) in order to understand:

- The political implications that necessarily take place at several levels, from global to local,
- The impact of phenomena with different dynamics (several decades versus seconds), and
- The central role of people (for whom the future must be acceptable and desirable, i.e. compatible with aspirations and behavior).

This multi-scale integration brings up significant methodological obstacles that we propose to examine in three stages to understand the needed reconciliation of long-term approaches employed in prospective exercises at different scales:

1. Short-term/long-term temporal scales : reconciliation involves examining the "inertia" of systems, e.g. urbanization or the composition of current mixes, versus the "instantaneousness" of usage (e.g. mobility using electric vehicles or smart grid solutions, energy efficiency) as well as the technical conditions for operating systems (i.e. network reliability, availability and stability);
2. Spatial scales : different levels of spatial issues will be tackled such as top-down versus bottom-up pledges for emerging countries, centralized versus decentralized networks, managing intermittent electricity production sources and integration into the network;
3. Societal scales : this will involve discussing the assessment of different development paradigms (degrowth/growth) and the integration of behavior as relevant modeling characteristics.

Each issue will be illustrated using specific examples.

O-3303-03

Using big data to make decisions in the electricity sector under deep uncertainty

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Creating resilient, reliable, and low-carbon electricity systems to help mitigate the effects of greenhouse gas emissions (GHG) and adapt to a changing climate remains a critical global challenge.

Electricity consumption accounts for a large portion of greenhouse gas emissions worldwide, making it one of the key sectors for climate mitigation strategies. Decarbonizing the electricity system becomes an even more daunting task given about 17% of the world population does not yet have access to energy services.

Changes in the electricity sector to move towards a low carbon energy system leave to important trade-offs in terms of costs to the overall energy system, how such costs are distributed, how to address issues related to fuel security and diversity, how to improve the level of energy services provided, and environmental consequences.

While decisions regarding different strategies to decarbonizing electricity systems may be done under deep uncertainty, in recent years the emergence of very detailed data - i.e., the big data revolution, paired with big data analytics - provides the ability to draw new insights and new ways to approach decisions.

This talk will focus on the ability to make decisions in the electricity sector under deep uncertainty in the United States. In the United States, the data from the Continuous Emission Monitoring System (CEMS), which is collected and made publicly available by the U.S. Environmental Protection Agency, provides data regarding the hourly power generation, and emissions from GHGs and criteria air pollutants, for every single fossil fuel based generator in the United States that is larger than 25MW. This data, coupled with air quality models and health and environmental valuation models, allows us today to estimate the regional effects of different interventions in the U.S. grid (such as increasing renewable (Siler-Evans et al., 2012; 2013), building codes (Gilbraith et al., 2014), storage (Hittinger and Azevedo, 2015) in a way that was not possible before. Similarly, on the consumption side, the deployment of smart meters coupled with information on energy efficiency and demand side management programs provides a new way to use big data analytics to assess whether the intended goals of the programs have been achieved (Azevedo, 2014).

In this session, we will (1) provide an overview of some of the recent big data analytics efforts that have been pursued to improve decision making under uncertainty in decisions aiming at the decarbonization of the electricity sector in the United States; (2) provide a map of data needs for several regions across the world that would be critical for one of the able to perform systematic international comparisons; (3) provide a research roadmap of the critical research questions we believe need to be addressed to make better decisions under uncertainty in the electricity sector.

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O-3303-04

Integrated pathway to decarbonizing electricity in China

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1. Background: Economy, electricity and carbon mitigation in China

The momentum of economy growth is strong. i) urbanization; ii) poverty; iii) all-round Open-up and Reform policy; iv) 6.5-7.5% growth rate during 2016 to 2020.

Power industry faces rigorous environmental challenge. Per capita electricity is 3510 KWH and will continue to rise sharply. Energy-intensive industries are backward, which results in low energy efficiency. As 78% electricity comes from fossil fuel, CO2 intensity remains 0.514-1.246 tCO2e/MWH. Power industry discharges 39% CO2 and still appears upward trend. Pricing and universal services are far from perfect; moreover, institution has CO2 lock-in weakness.

Carbon mitigation achievements in power industry. Energy intensity per unit GDP dropped by 20.7%, reducing 1,967 million tCO2e. Non-fossil energy accounted for 8% of primary energy consumption, saving over 600 million tCO2e annually. China eliminated 80 million KW small thermal power units, reducing 166 million tCO2e every year. What more, innovation of generating technology and reformation of institutional arrangement contributed to huge CO2 abatement.

2. A big deal: China-U.S. Joint Announcement on Climate Change

Benefits and protocol. Smart action on climate can promote economic growth and broad benefits. China-U.S. will jointly propose a protocol under the COP21.

Post-2020 actions. The U.S. targets to reduce CO2 by 26-28% in 2025. By 2030, China will peak CO2 emission and increase the share of non-fossil fuels to 20%.

Technology cooperation. China-U.S. have a robust program of energy technology cooperation and will jointly invest more in clean technological innovation.

Policy dialogue and practical cooperation. The two sides announced additional measures to strengthen and expand practical cooperation in climate change.

3. Integrated pathway option: Decarbonizing electricity in China

Decarbonizing electricity goal. Chinese electricity need follow a path featuring high efficiency, less pollution as well as satisfying economy growth. At 2015 energy intensity will drop by 16% and CO2 decrease by 17%. At 2020 non-fossil energy will take 15% and CO2 lower by 40-45%.

Demand side management. China adopts key actions in electricity-saving among industry, building and transportation; actively transforms economy into capital- and technology-intensive mode. It lists technologies of energy-saving and sets energy intensity standard. China encourages green building, improves heat-supply as well as electricity-saving by public building. It also promotes green transportation, electricity-saving education; therefore, fosters a green lifestyle.

Develop renewable electricity. Renewable power is to take 30% by 2015. Hydropower will get 290 million KW, half of its potential. Currently nuclear power is 1.8%; thereafter China will endeavor to reach 40 million KW. It stresses intensive and distributed exploiting wind power; corresponding capacity will get 100 million KW. China develops diverse patterns of solar power; thereafter solar collection will exceed 400 million m2. It also actively exploits biomass electricity.

Promote clean fossil electricity. China emphasizes coal washing, shuts small thermal units, speeds up supercritical- and ultra-supercritical- technology, encourages thermoelectricity cogeneration as well as IGCC generation; actively develops circular economy. It expands power transmission from western to eastern; strengthens ultra-high voltage as well as smart grids. It will construct many CCS projects; thereafter, set up platform of national technology innovation.

Optimize institutional arrangement. China is to reform legal regime as well as regulations on electricity; especially separate transmission from distribution, revise pricing mechanism, and extend international cooperation. It will deepen electricity market and carbon market, improve CO2 auditing, diverse mitigation approaches; meanwhile, coordinate mitigation and power generation.

3303-POSTER PRESENTATIONS

P-3303-01

High-Resolution Modeling of China's Power Sector with a Particular Focus on Advanced Nuclear Technologies

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Today, China's electric power sector accounts for 50% of the country's total greenhouse gas emissions and 12.5% of total global emissions. The transition from the current fossil-fuel-dominated electricity supply and delivery system to a sustainable, resource-wise system will shape how the country, and to a larger extent, the world, addresses local pollution and global climate change. While coal is the dominant primary energy source today, rapid ongoing technological changes coupled with strategic national investments in transmission capacity and new nuclear, solar and wind generation demonstrate that China has the capacity to completely alter the current trajectory. For the past decades, the country's nuclear fleet has consisted in a dozen coastal water-cooled nuclear reactors using an open fuel cycle. In addition to strong nuclear research and development programs, China's increasing deployment of renewable energies and ambitious environmental targets towards sustainability make the extent and the nature of the role of nuclear in the power sector more unclear than ever. We present an integrated model of the Chinese power sector to analyze the prospects of implementing various energy transition scenarios. SWITCH, a high resolution modeling tool under development at the University of California, Berkeley, is used to analyze least-cost generation, storage, and transmission capacity expansion pathways for the electricity mix. Using the recent announcement made by President Xi Jinping to bring the country's carbon emissions to a peak by 2030 as a framework to assess potential future profiles for the energy mix, we show that building up to 380 GW of nuclear capacity by 2030 is part of the optimal, least expensive trajectory for the power sector. While the construction of such a large fleet of reactors in about 15 years might be challenging, it proves that nuclear cannot be excluded from discussions regarding long-term planning of the electric power sector in China. Using SWITCH, we also find that a carbon price of ~$40/tCO2 would achieve the 2030 carbon peak. Such a figure has a direct impact on the level of renewables and nuclear deployment in the country and, as a consequence, on the specific reactor technologies and fuel cycle options to be developed. In particular, we investigate the role of fast-neutron reactors as part of a national plan to close the nuclear fuel cycle and present resulting pathways

for Generation IV technology deployment, according to different trajectories for CO2 emissions reduction targets and costs evolution by 2050, and different levels of variable renewable energy integration.

P-3303-02

The System Effects and Electricity Market Impacts for Germany and the EU of the Energiewende Policy in Germany

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This energy policy, which is even internationally referred to as the "Energiewende", is based on the long-term vision of renewable energy being the primary source of future energy supply and the decarbonisation of the energy system . The road towards the new energy era is described by a set of targets: a specific share of renewables in the gross electricity generation and in the gross final energy consumption as well as an overall greenhouse gas reduction target of 80 to 90% till 2050 compared with 1990. In this context, a Pan-European TIMES energy system model (short: TIMES PanEU) points out the broader system effects and the impacts on the total costs of electricity supply and storage requirements which result from a further deployment of renewables. TIMES PanEU contains all countries of the EU-28, plus Switzerland and Norway, and covers on country level all sectors connected to energy supply and demand like the supply of resources, the public and industrial generation of electricity and heat and the sectors industry, commercial, households and transport. The scenario analysis shows that the total system costs will be more than doubled by an increasing share of renewables. The reasons for the higher total electricity supply costs are the low capacity credits of variable renewable power plants, the increased need for capacities from dispatchable power plants and the additional costs for transport and distribution. Under the current market environment ("energy only market"), it is unlikely that dispatchable power plants can be operated profitably when the share of variable renewable is increasing. New remuneration schemes would be required for the necessary balancing and capacity services. Additionally, the integration of large shares of variable renewables requires large electricity storages, power to heat, Electromobility and power to gas capacities. Thereby it is possible to map the interactions between electricity, heat and gas sector in TIMES PanEU. To this it will be examined, which temporal resolution is required for mapping different scenarios with different expansion targets of renewable energies? At first the necessary temporal resolution for mapping the availability of fluctuating renewable energies (wind and solar energy) will be determined. This is followed by an enlargement of description of energy demand and energy storage technologies. Besides, import and export and therefore energy storage requirement are affected by the temporal resolution. In this connection the error, which occurs by a lower temporal resolution, will be identified.

P-3303-03

Impact on the CO2 emissions of an increasing share of renewable energy in the French electricity mix

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The French electricity power mix is dominated by Nuclear as it provides about 75% of the total consumption. Hydroelectricity is the second main source of electricity production in France. The combination of these two decarbonized electric productions, complemented by fossil fuel power plants, leads to typical CO2 emission of less than 50 gCO2/kWh, an order of magnitude smaller than that of many other industrialized countries. Thus, the contribution to climate change of the current electric production in France is small. Yet, there is a strong ongoing debate to reduce the share of nuclear energy while increasing the share of renewable electric production such as wind and solar. It appears necessary to quantify the impact of such change in the power mix.

Although wind and solar are promising techniques to provide clean electricity, their production is intermittent. Photovoltaic electricity is null during the night and significantly smaller in winter than in summer, which is anti-correlated with the demand. Wind electricity is very much dependent on the wind, and production variations of a factor more than 100 have been observed at the French national scale. The intermittent nature of PV and wind production may necessitate the availability and use of backup solutions to insure a production in line with the demand. Yet, the requirement for backup power sources that are used at a fraction of their capacity has a direct impact on the overall production cost. In addition, to follow the intermittency of renewable energy production, it may be necessary to use CO2-emitting techniques, such as gas power plants.

We have developed a model that analyzes the electricity demand and production at the French national scale. The model accounts for the fixed and variable cost of each electricity production mean: The fixed cost does not depend on the actual production, while the variable costs are proportional to the MWh production. Similarly, the CO2 emissions have both a fixed (plant construction) and a variable component.

The model is used to estimate the impact of a larger share of renewable energy on the electricity mix at the French national scale on the overall cost and the CO2 emissions. The intermittency of PV and wind energy imposes the development of backup power that has an impact on both the cost and the CO2 emissions. The latter can be evaluated as an additional cost (such as a Carbon Tax). The optimal energy mix depends on the assumed "cost" of CO2 emitted to the atmosphere.

P-3303-04

Degrowth through the prism of prospective macroeconomic modeling: investigating a paradigmatic change for France

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About three decades ago, the Brundtland commission released its famous report entitled "Our common Future". As an attempt to conciliate development and the environment, the term "sustainable development" was coined for the first time, as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." [Brundtland, 1987]

Almost thirty years later, climate change, along with biodiversity losses, disruption of natural cycles (nitrogen, phosphorous, water), non-renewable resource depletion, and others, remains a critical issue, and seriously questions the sustainability of the intensive economic metabolism of industrialized societies. As a way out of this multifaceted crisis, many take a stand in favor of a "green growth", focusing on the idea of technology-related limitations, and with the hope that technological progress will eventually enable a decoupling of energy and material throughput and environmental burdens from economic growth. Others instead put the spotlight on the question of the "needs", and advocate for a transition towards sustainable "post-growth societies". With the Degrowth movement, the call for such a transition is consolidating into a complex and multifaceted political project. For the "wealthiest" countries, where the ecological footprint per capita is greater than the global sustainable level, this project may be envisioned as a voluntary, socially sustainable, equitable, smooth downscaling of production and consumption, and thus throughput, to an environmentally sustainable level, "that increases human

well-being and enhances ecological conditions at the local and global level, in the short and long-term''[Kallis and Schneider, 2008].

However, current literature still falls a bit short of providing detailed investigations of possible macro-socioeconomic and biophysical outcomes that may result from taking in such paths. Several questions remain unanswered. In particular, we would like to focus here on the following issues: what concrete proposals could initiate such a transition? What could such paths induce in terms of employment, public debt, energy consumption, waste and GHG emission mitigation? What structural or institutional obstacles must be overcome and how? Etc.

Using a detailed dynamic input-output simulation model of the French monetary economy, we explore different scenarios of transition towards post-growth societies. These scenarios seek to reflect contrasted "visions of sustainable societies and lifestyles", inferred from a survey conducted amongst different social groups - including in particular actors within the Degrowth movement. They involve structural and behavioral changes in consumption patterns, and integrate proposals and strategies issued from the Degrowth movement. We investigate the possible outcomes of these scenarios in terms of employment, poverty, public debt, energy consumption, waste and GHG emissions and discuss the potential strengths and weaknesses of the different visions they reflect. Our results highlight in particular the importance of cultural, social, behavioral and "non-technical" factors, and recall the critical need for the collective elaboration of a societal project.

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P-3303-05

Integrating household behavior and heterogeneity into long-term energy planning models: The TIMES-Households framework

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The importance of household behavior in energy consumption is regularly raised in literature. The need to take household behavior into account and to introduce heterogeneity into economy-energy models is also generally pointed out, underlining the limitations of classic models that represent energy demand by a single mean household[1][2]. In their well-known "energy paradox" article, Jaffe & Stavins[3] single out household heterogeneity as one of the main "market barriers" to energy efficiency. Similarly, heterogeneity orientates the dispersion of household behavior in terms of energy consumption and equipment purchases. Thus in order to provide useful insights to public policy debates using prospective studies, we should also consider this household heterogeneity as a kind of "model barrier" that could prevent modelers from correctly apprehending reality.

Nevertheless energy-economy long-term planning models still often represent energy demand by a single mean household and thus fail to capture household behavior. Indeed, many models developed using the TIMES modeling framework[4] are often technology oriented and provide a very detailed list of equipments on the supply side. Whereas the demand side generally consists in a single mean household with a unique level of demand for energy services. This lack of detail on the demand side usually leads to unrealistic results, especially in terms of technology diffusion. Indeed in these models small price increases may then lead to no impact or sudden technological change, sometimes called "bang-bang" effects.

We here describe the original modeling approach developed within the MARKAL-TIMES model framework in order to take household behavior and heterogeneity into account: the TIMES-Households model. This model depicts both household daily energy consumption and equipment purchasing behavior and focuses on the French residential and transport sectors. We show the importance of taking household heterogeneity into account in long-term planning models within the comparison of two energy price scenarios applied to two different models. Thanks to the highly disaggregated representation of households and their behavior in the model, we address the problem of unrealistic technology diffusion pathways often obtained when using an optimization bottom-up model. We also are able to address burden sharing issues which are very common and major issues related to the implementation of decarbonized sustainable pathways. Indeed our model helps quantifying the impact of energy polices such as carbon taxes, tax rebates or bonus/malus systems on household budget in term of investment expenditures and energy bill.

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P-3303-06

Opportunities and challenges for decarbonisation with electricity generation from nuclear energy

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Generation of electricity from nuclear generation is a major global contributor to decarbonisation. Currently, nuclear generation meets around 11% of global electricity demand with very low lifecycle greenhouse gas emissions, avoiding in excess of two billion tonnes of carbon dioxide per year, compared to coal fired generation. Its high capacity factor and predictable output is advantageous compared to some low carbon electricity generation options.

Increased use of nuclear generation is a feature of a number of long-term climate change mitigation proposals. This presentation will review the projected emissions savings from nuclear generation, based third party studies and our own research. It will also review assessments of the lifecycle emissions of nuclear generation and how these compare to other generation options.

The presentation will examine the impact of different nuclear build scenarios on the nuclear fuel cycle, including global demand for uranium ore, uranium enrichment and fuel fabrication. It will identify where additional mining, processing and fabrication capacity may be required in these separate stages of the nuclear fuel cycle.

The presentation will also examine the scope for increasing global nuclear generation. This will include options for increasing and extending generation from existing reactors. It will also include options for new reactor technology to improve performance and better utilise the uranium resource.

Given these conditions the presentation will project what the potential contribution of nuclear generation to global greenhouse gas mitigation could be and what technical, economic and political challenges there would be to realising this contribution.

P-3303-07

The energy security implications of a low-carbon transition

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In order to meet legislative targets for mitigating climate change, future energy systems will need to become secure, affordable and low-carbon - the so-called 'trilemma' of sustainable energy policy (Boston 2013). In Western Europe, the trilemma has received growing attention as energy security concerns rise up the political and public agenda, driven by declining indigenous fossil fuel reserves and increasing concerns over anthropogenic climate change (MacKerron 2009; Winstone et al 2007). As part of a growing body of research into energy security and low-carbon energy transitions, this paper assesses the future security of the UK electricity system in a low-carbon context. A new indicator framework for security of both supply and demand has been developed with the specific aim of making projections of the security of a low-carbon electricity system. Drawing upon recent research recommendations, the framework utilises a 'dashboard' approach to security analysis which is capable of identifying potential red flags for the future security of a low-carbon electricity system (Mitchell et al 2013). The paper emphasises the importance of timescales of reference when addressing energy systems, and thus focuses on assessing both short-term 'shocks' and long-term 'stresses' to the electricity system (Boston 2013; Energy and Climate Change Committee 2011). As such, the future security of the UK electricity system is assessed under four key themes: Availability (long-term), Reliability (short-term), Affordability, and Sustainability.

The security assessment framework has been applied to a set of three transition pathways, all of which aim to reduce carbon emissions from the electricity sector by 80% by 2050. The three transition pathways have been chosen to reflect the importance of the overriding governance logic and normative goals which could lead to different energy pathways. One pathway envisages deregulation and market-centrism, one envisages large-scale centralised control, and the third pathway envisages a decentralised, small-scale electricity system controlled by civil society and consumers. As such, the analysis seeks to compare the future security of some of these contrasting governance options, in an attempt to flag up areas of concern and to highlight the major trade-offs which may emerge when seeking to balance security, affordability and carbon goals in energy policy.

This presentation will introduce this new methodology for assessing the energy security of low-carbon transition pathways. Results from the empirical analysis will be presented, along with the implications of these results for the energy security of a low-carbon transition. The presentation will offer some insights of the key measures for improving low-carbon electricity security, and the key trade-offs which could emerge between the security, carbon and affordability aspects of the trilemma.

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P-3303-08

An analytic framework to explore low-carbon energy pathways in Kosovo

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Kosovo's power sector suffers from poor reliability and rising costs. The World Bank and other potential donors have proposed construction of a new 600 MW lignite based coal-fired power plant in 2017, despite a pledge to no longer finance coal projects except for extreme and rare circumstances. Kosovo has extensive coal resources, but also hydropower, wind, solar and biomass potential. Examination of the available options and the need to act quickly on the investment portfolio for Kosovo are critical for the local population and economy. At the same time, the financing of a coal plant in Kosovo serves as a pivotal test on the international stage for future financing of coal projects worldwide, especially in China and India. We investigate alternative low-carbon energy pathways to building the lignite coal plant and find a range of scenarios that all meet Kosovo's energy needs at lower cost than a new coal plant. We developed an analytic platform to model the electricity grid and constructed multiple scenarios for sensitivity testing. Our analytic platform looks at the cost, options, and impacts of different decarbonizing energy pathways—including a view into different energy efficiency measures, combinations of solar PV, wind, hydropower, biomass, and the introduction of natural gas. We find that a $30/ton carbon price increases costs associated with the new coal plant by at least $330 million USD (Kittner et al., under review). We find that the lignite coal plant remains the costliest option based on finances alone, even before considering the cost of carbon, health impacts, and job creation impacts. We introduce both a deterministic modeling platform to explore scenarios for Kosovo and for neighboring countries, and provide a LEAP platform version for policy makers and other interested parties to use in comparing costs, energy access, reliability, and environmental impacts of energy futures.

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P-3303-09

Decarbonizing the UK electricity sector by 2030: progress and outstanding challenges

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The UK's Governments' statutory advisors on climate change - the Committee on Climate Change (CCC) - have advised that near-complete decarbonisation of the power sector by 2030 is part of the low cost path to meeting long term emissions targets. Through the Energy Act 2013, Parliament has now recognised the need for rapid decarbonisation of the power sector as a priority.

This talk will cover progress towards power sector decarbonisation and outstanding challenges.

Recent developments include updates in the policy framework through Electricity Market Reforms (EMR) and a step change investment in low-carbon capacity (particularly wind). The underlying emissions intensity of the UK's electricity grid - meaning the intensity that could be achieved if the grid were operated to minimize emissions - has dropped by around 40% since 2007.

However, outstanding challenges include a lack of certainty beyond 2020, which is an issue for the supply chain and investment with long lead times and the CCC recommend a legislated 2030 carbon intensity target to address this. An innovation strategy is also required for promising but currently expensive technologies (e.g. offshore wind and CCS) to clarify that there will be a market for these technologies if cost reductions can be achieved.

P-3303-10

Supplying reliable renewable electric power from desert regions to meet the electricity needs of growing economies

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If we are to avoid dangerous climate change, the electricity systems of the world must be largely decarbonized by mid-century. Renewable electricity sources are carbon-neutral and the resource base is, globally and on each continent, large enough to satisfy any conceivable electricity demand, however, their utilization faces numerous challenges. First, renewable sources like solar and wind are intermittent and demand-controlled, while fossil fuel power technologies are supply-controlled and can supply base load power. The intermittency of solar and wind power may cause problems when integrating these sources in the power systems. Power sources that are both renewable and supply-controlled, therefore, are of high importance. These sources are hydropower, biomass, geothermal and concentrating solar power (CSP) equipped with thermal storage. Hydropower and some bioenergy systems, however, are dependent on water availability and can increase land- or water-use competition, among other several sustainability concerns. Second, all renewable power needs extensive areas of land due to its low energy density of the primary resource, increasing concerns regarding land-use conflicts and costs for land also for solar and wind power. This is a barrier to renewable power expansion in densely populated regions, in regions with high or rapidly increasing electricity demand, and in regions competing for land for agriculture. Renewable dispatchable sources like CSP that can be deployed at large-scale in remote regions or on land with non- or low-competing land-use for agriculture would be particularly valuable.

Desert regions are, therefore, potential suitable land for CSP expansion in terms of low competition for land use and the high levels of solar irradiation. Research shows that a dispersed and coordinated fleet of CSP plants equipped with thermal storage can supply large amounts of reliable power at reasonable costs, in some desert regions around the globe (Pfenninger et al., 2014). These regions, however, are far from centres of demand where power would be consumed, requiring large transmission lines to connect generation plants to the centres of demand (Trieb et al., 2012). We therefore examine the potential of a fleet of CSP plants to supply and transport reliable renewable electric power to large centres of demand, which are large cities worldwide. The desert regions in focus are located in China, India, the United States, and North Africa and the Middle East; this last region produces solar power both for its own needs and for electricity exports to the European Union. We conduct the analysis in three steps. First, we identify the best CSP generation sites in the desert regions by means of geographic information system (GIS) analysis, applying geographical restrictions to land to minimize impact on biodiversity, soils, infrastructure due to natural hazards, and on land-use and land-cover change. Second, we identify the routes of the optimal transmission corridors from the generation plants to the centres of demand, by means of a GIS-based algorithm that minimizes economic, social and environmental costs. Third, we investigate with a multi-scale energy system model the optimal configuration and operation of the CSP plant fleet to provide reliable electric power, and calculate the costs of generating and transmitting this power to the centres of demand. Our results will show to which degree renewable reliable electric power can be supplied from CSP plants fleets in desert regions, and what the cost of this power is at the points of demand. In addition, we will show in detail the optimal siting and design of the transmission lines from the deserts to the major cities. We expect to find that the potential for desert regions to supply reliable CSP to the consumption regions in focus is large, despite the vast distances.

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P-3303-11

Spatial optimization of an ideal renewable energy system a answer to the intermittency of renewables energies ?

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The share of renewable energies in the mix of electricity production is increasing worldwide. This trend is driven by environmental and economic policies aiming at a reduction of greenhouse gas emissions and an improvement of energy security. It is expected to continue in the forthcoming years and decades. Electricity demand is related to weather and climate factors such as the diurnal and seasonal cycles of sunlight and wind, but is also linked to less predictable variability on longer time scales. The intermittency and the lack of medium to long-range predictability of the renewable electricity production (solar, wind power) could eventually hinder their future deployment. Intermittency is indeed a challenge as demand and supply of electricity need to be balanced at any time. This challenge can be addressed by the deployment of an overcapacity in power generation (from renewable and/or thermal sources), a large-scale energy storage system and/or improved management of the demand.

The main goal of this study is to provide a spatial optimization of an ideal renewable energy system at the French and European scales. We use ECMWF (European Centre for Medium-Range Weather Forecasts) ERA-interim meteorological reanalysis and meteorological fields from the Weather Research and Forecasts (WRF) model to estimate the potential for renewable energies. Electricity demand and production are provided by the French electricity network (RTE) at the scale of administrative regions for years 2012 and 2013.

Firstly we will show how the simulated production of renewable electricity compares against the measured production at the regional scale. Simulated renewable energies production (wind and solar) will then be clustered in order to highlight the temporal complementarity (or lack of) between different regions and energy sources.

Secondly, we will present preliminary results from an optimization procedure that aims to minimize the cost of an ideal system composed of renewable energies, thermal plants and increased storage, as a function of a hypothetical carbon emission penalty. The optimal spatial distribution of renewable wind and solar energy systems will be assessed at the French and European scales under the constraint of a balance between demand and supply.

P-3303-12

Decarbonising China's electricity sector: the prospect for biomass power generation

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China is struggling to accelerate its economic development transition to a lower carbon intensity trajectory. The decarbonised electricity system plays a determining role in low carbon growth in China as it has become the largest power generator in the world and power generation contributes to nearly half of the country's carbon dioxide emissions. More than two-thirds of existing electricity generation are coal-fired, making China's electric power sector the most carbon intensive in the world. Total installed generating capacity would more than double over the next 20 years. Therefore the development pathway of China's power sector has tremendous implications for global carbon emissions reduction and temperature increase stabilisation. Biomass power generation offers a promising window of opportunity to address multi-objective challenges (economic, social and environmental) in the context of fast economic and demographic growth in large emerging economies. Bioenergy can also bring about macroeconomic and environmental cobenefits such as enhanced security of energy supply, better balance sheet, improved local labour market and social welfare through green jobs creation, poverty alleviation and greenhouse gases and air pollutions mitigation. Built on lessons drawn

from the markedly rapid development of wind and solar power over the last decade, this paper attempts to shed light on the status quo, achievements, opportunities and underlying challenges of scaling up biomass-fuelled heat and power generation in China. Our analysis focuses on the strengths and weaknesses of large-scale development of biomass power generation in China's electricity market, from both technological and institutional perspective. It is emphasised that cost-effectiveness aspect needs to be mainstreamed in biomass power industry planning and development, this in return will contribute to optimising the portfolio of decarbonising China's power sector for the next decades. The paper first discusses the main achievements and prospects for China's power sector. It then investigates the role of biomass in mitigating power generation associated GHG emissions and analyses the challenges in scaling up biomass power generation in China. Drawing lessons from wind and solar power, the analysis will proceed to address the economic efficiency of biomass power by investigating the prospect of incorporating power sector in the emerging carbon markets in China to achieve cost-efficient GHG emissions mitigation. The last part offers some concluding remarks and policy implications for decarbonisation in China's electricity sector.

P-3303-13

Asian perspectives in governing the deployment of smart grids

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Climate change concerns, rising energy costs, and risks of nuclear power have heightened the urgency of a transition to a low-carbon future worldwide. Smart grids represent one of the most revolutionary developments in energy management: by integrating advanced information technology as a way to modernize existing electricity networks, smart grids have the potential to accelerate the deployment of more decentralised electricity supply systems (e.g. renewable energy) and demand-side measures. Smart grid technologies are increasingly being tested and adopted in developed and developing economies (e.g. the U.S., the U.K., Japan, and China).

Although smart grids have become an emerging theme in the energy literature, critical understandings on how and why smart grids have been developed in the ways as we observe have been lacking. The literature has also largely been based on advanced, industrialised societies in the West. The extent to which and how smart grids have been deployed in Asia, a continent of crucial importance in global energy governance, has yet been adequately addressed.

This paper aims to provide insights on the ways smart grids may evolve and enhance sustainable energy transitions in Asia. Based on preliminary results of an on-going project, we will examine the emerging interactions between the state, utilities/business, and electricity consumers, as well as the associated implications on the developments of smart grids in China and Japan. Our analysis will focus on three policy themes: (1) the development of a new regulatory framework (for rectifying utilities' disincentives to renewable energy and energy efficiency); (2) business model innovation (to develop business strategies to achieve economies of scale, cost effectiveness, and risk sharing), and (3) engaging electricity consumers. The Asian perspectives of our analysis will provide better understanding of the extent to which unique political and socio-economic conditions in some Asian countries may lead to the emergence of distinctive forms of smart grid deployment pathways that may set them apart from those in the West.

P-3303-14

Carbon issues for power systems: a french-US crossed contribution

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Spurred by the need to address climate change while promoting economic vitality and sustainability requires a new class of energy system models that facilitate a dialog between mathematical approaches to economics, public policy and strategic thinking. This approach ideally affords a platform to integrate equally technical and social perspectives on energy systems, something that has proven particularly difficult in the past for a variety of data, analytic, and conceptual reasons. While models are inherently inaccurate representations of natural and social processes, we have found considerable value in comparative 'model complements' where different approaches are brought into dialog. To accomplish this, our two teams, based at the Ecole des Mines de Paris and at the University of California, Berkeley have initiated this comparison and conversation. The two platforms TIMES and SWITCH respectively permit different visualizations of energy choices and scenarios. These prospective modelling tools are a heritage of a long tradition of tools first created in the 1960's from the dialogue between mathematicians and economists and based on a concept of optimality. The way they support the scoping of policies on energy and climate is based on the following: a vision of transforming technical systems with the idea of an optimal timetable for employing technologies in decreasing order of merit. This can be skewed by the introduction of the internal cohesion of the energy system at technical level and, as a result, inertia, the technological barriers to remove, the benefits in endogenous learning and the macroeconomic costs of support policies are addressed.

This contribution aims to bring together parallel developments of a prospective landscape dedicated to the power sector, considered as the first GHG emitter across the world. This will bring first elements to understand to what extent technological solutions can be brought as global solutions across regions and over the long term: namely the potential of smart grid solutions as demand response, flexibility options, spread of renewable energy, and what could be their limits, if some exist.

This approach is particularly relevant to go beyond opposing theses, either for instance considering that renewable energy sources should only be used when they are competitive, or setting ambitious short- and mid-term penetration targets to bring down the cost of renewables based on technical and institutional learning processes.

This comparison will allow a greater understanding of the way long term prospective models developed in the US and in France, envisage the way countries face energy and climate long-term issues.

P-3303-15

Power system prospective: From deep within the material to the power grid scale

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To address the abysmal lack of efficiency of the electrical system (73% of losses, 45% of worldwide CO2 emissions!), an energy efficient description of electrical systems lying on a reversible interpretation of the Faraday's law is presented.

As matter of fact, the free current density flowing in the whole power grid exhibits well-split scales allowing mean-field hypothesis where the global condition of reversibility is replaced by embedded minimizations on the various scales involved by the power electrical system. Following a thermodynamic viewpoint, various scales were explored from deep within the material to the power grid scale.

At the power management level, the electromagnetic energy coupling acts to enforce synchronism - usually f = 50Hz or 60Hz - between all generation plants supplying the power grid. An X-Y lattice model is adopted to describe the interaction between the magnetic momentum carried by the rotor of a given machine and the magnetic mean-field resulting from all the others [1]. Provided a large enough resistant electrodynamic torque - simulated with a strong enough correlated lattice or actually a suitable voltage plan -, synchronism is kept under admissible load fluctuation and the kinetic energy embedded in the whole power system acts as a global and huge inertia against frequency deviation which therefore may only occur on several periods.

Given that energy conservation results from the uniformity of time for any isolated system [2], this upper-aggregated scale provides two dynamic energy-based invariants specifically shaped for power systems and suitable to address the question of reliability, namely the kinetic- and the magnetic- energies embedded in the whole power grid. Conversely, following dynamically these energy-based invariants provides a way to perform a space-aggregation and a time-reconciliation of all the scales involved in the power management of the electromagnetic energy.

Hence, a dynamic reliability constraint on kinetic energy was endogenized in the technical optimum TIMES model. Dedicated to La Reunion island:

- The potential contribution of electrochemical storage technology to the power dynamics and the reliability has been demonstrated; and
- A high share of variable renewable plants (around 50%) can be considered without jeopardize power transmission.

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P-3303-16

Costs and benefits of a greener alternative for the development of Vietnam's power sector

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To explore pathways for Vietnam's power system until 2040, two scenarios are developed in the current study: (1) a scenario based on current trends (BAU); (2) a greener alternative with more renewable energy and higher energy efficiency (ALT). The authors estimate that the external costs of CO2, NOx, SO2 and PM10 in the power sector in Vietnam are 7-20, 1 328, 2 047 and 1 460 US$/ton, respectively. We find that the ALT scenario is more sustainable than the BAU scenario in all aspects. In the ALT scenario, the price of electricity and the domestic trade balance are less sensitive to fluctuations in the international price of coal than in the BAU scenario because imported fuel accounts for only 39% of total generation capacity in 2040, as opposed to 60% in the current policy scenario. The total costs accumulated from 2010 to 2040 would be lower in the greener alternative: 632 billion US dollars compared with 974 billion US$. This difference arises from several factors: lower investment in new capacity (226 compared with 306 billion US$); lower local pollution costs (73 compared with 137 billion US$); lower CO2 emissions; and lower expenditures on imported fuels (57 compared with 115 billion US$). The outcomes of the ALT scenario are in accord with the targets for the power sector in the most recent Green Growth Strategy of Vietnam (GGSV).

P-3303-17

Institutional change and market conditions for low-carbon electricity transition in Vietnam

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The rapid expansion of the industrialization and urbanization processes over the last two decades has dramatically increased the demand for electricity in Vietnam. The challenges of developing new resources, enhancing high-voltage transmission lines, and reducing transmission and distribution losses imply an improvement of the current electricity system.

Considerations related to low carbon transition make part of this general context. Meanwhile, because of complex interwoven interests, major players as the powerful holding EVN (Electricity of Vietnam) seem more interested to pursue the development of fossil/fuel based power plants than to favor renewable resources. As a consequence, a low carbon transition implies a fundamental transformation of the current Vietnamese electricity system. Focusing on the institutional and governance issues, such a transition needs "actions to remove the barriers" (IEA, 2012) and "high levels of social and political innovation" (Global Carbon Project, 2010). Indeed, the institutional environment of the energy sector has its roots in the 'Doi moi' policy (1986), but also in the systemic features of Vietnam combining centralisation and fragmentation: centralisation of political power and weight of the political elite, hierarchy and informal networking, progressive decentralisation of economic management, and weak civil society.

The paper proposes a mesoeconomic approach of the low-carbon electricity transition in Vietnam. We argue that political will is a necessary but not a sufficient condition for such a change. The transition process depends on interdependent organizational decisions inside the electricity sector and implies a fundamental transformation of the stakeholder's positions and relations. In particular, it necessitates the existence of a critical mass of initiating actors perceiving the benefits of investing in renewable sources and having levers to redefine the rules of the game, modifying therefore the institutional framework and enabling the constitution of new structural interdependencies inside the electricity system. In this perspective, we proceed to the identification of key players, and point out the institutional and structural characteristics of the electricity market. Then, we propose an analytical grid to apprehend the change path by following the evolution of some focal variables. Concerning specifically wind electricity generation, wholesale market price and subsidies to the single buyer indicate the balance of power between the major stakeholders and reflect the stages of the transition process.

Our work sheds further light on the processes that determine the transition to low carbon electricity in Vietnam but several limitations should be noted given the complex multilevel/multifactor character of the game. Indeed, in-depth knowledge of vertical (government to enterprise) and horizontal (enterprise to enterprise) bargaining process or of the way foreign stakeholders intervene and interact with local actors could usefully complete the analytical grid developed here. More, we focus on the single onshore wind power as an illustration of the conditions influencing low carbon transition. The method to monitor the change process could be further improved by integrating more detailed data on electricity selling prices, as well as incentives and counter-incentives for all renewable and fossil resources.

We propose a comprehensive analysis of the factors shaping/preventing the transition to low carbon electricity in Vietnam - especially those related to interest settlements, actors' strategies, principles of governance and institutional framework - in a political economy perspective. Concerning specifically wind electricity generation, wholesale market price and subsidies to the single buyer indicate the balance of power between the major stakeholders and reflect the stages of the transition process. In addition, the paper provides a methodological contribution for the measure of structural/institutional change in the energy sector.

P-3303-18

Feasibility of a decentral renewable power system in Europe

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The global transition of the power sector towards clean and renewable technologies is well underway. The worldwide average annual growth rate for installed wind and solar photovoltaics (PV) capacity since the year 2000 have been about 25% and 45%, respectively, with installed capacities in 2013 reaching almost 320 GW for wind and 140 GW for solar PV. Hand-in-hand with the rising importance of renewables, the idea of a more local, decentral electricity supply has gained increasing prominence and ideological support. Amongst advocates of a renewables-based electricity system, this is pitching proponents of a centralized renewables deployment (e.g.

based on large-scale desert solar power with a continental, or intercontinental, transmission system) against those who argue for decentralized generation and distribution (e.g. based on rooftop PV and small-scale wind combined with smart demand management).

The rapid deployment of both wind and PV in countries like Germany has seemingly brought this possibility of a radically different electricity system than the one we have today closer than it has ever been. Some of the potential advantages of such a decentralized system include more energy independence for individual countries or even municipalities, and more economic benefits accruing to the local communities where power is both produced and used. However, critics point to the fact that such a system would be more costly, for example, due to inefficiencies caused by the large local generation overcapacities needed to maintain system stability, the increased storage requirements, and the loss of returns to scale effects by having many small power plants instead of few large ones. Furthermore, there is the question of how technically feasible the decentralized power paradigm is for heavily populated areas, such as those found in large parts of the European Union (EU), and particularly large metropolitan areas like Paris or London.

Here, we examine the degree to which a completely decentralized power supply based on a combination of renewable energy technologies across the EU is in fact possible, answering the question of how small the smallest self-sufficient areas can be and how much interconnection (especially around cities) is needed in order to supply all electricity needed and keep the system balanced. We do this by simulating wind and solar power generation and analyzing the degrees of aggregation, interconnection and storage needed for the smallest-possible set of independent "electricity islands» across the EU to support themselves for most or all hours of the year. To do so, we use high-resolution wind and solar power plant simulations based on satellite and reanalysis data and validated against real sites across Europe, with a spatial resolution between 5 and 50 kilometers, and a temporal resolution of one hour. Using this input data, we apply the multi-scale energy systems modeling framework Calliope to determine optimal deployment scenarios for these electricity islands.

The results will show the spatial distribution of viable energy islands in Europe, how different storage and demand response availabilities influence the structure of these energy islands as well as the resulting electricity costs at different levels of supply reliability.

P-3303-19

Energy Transition in Europe. The role of communities and city-regions – some comparisons between Britain and Germany

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How can city-region level public authorities in the UK help drive a low carbon energy transition? In addition, how might such a transformation of the energy regime also involve shifts in economic, social and political power?

When the energy transition in the UK is compared with the energiewende in Germany, one salient feature stands out: In Germany, new actors from local cooperatives to city authorities have become key players in the growing renewable energy sector. This may even threaten the centralised 'utility' model of the incumbent players. The UK by contrast, has historically had a more centralised political system with fewer powers for cities and regions. It has also had a more centralised energy system, along with more centralised visions for energy transition.

However, two significant recent developments may be changing this situation in the UK. First, there are the moves to devolve some central government powers to newly enhanced 'city-regions'. Secondly, comes a new government community energy strategy, which signals encouragement of the community energy model.

This paper explores the dual processes of city-regional devolution and energy transition in the UK. Drawing on early findings from a current EDF-IEA Paris Transitions énergétique study, it examines the potential for a new 'civic energy sector' in the UK, and ongoing moves by UK city-regions around this question. Drawing on theories from transition studies, the sociology of technology and urban geography, this work analyses and addresses the contested questions of scale – between community, city and region – to explore the shifting, multiple and contested pathways to energy transition. How might community and city level players reconfigure the energy transition? What limits are placed on this process – including by incumbent actors in the energy sector and government? How can we understand the different strategies and visions of energy transition today, with their different imagined scales of transition and distributions of political, economic and electrical power? The conclusions drawn can help us to understand the key role played by communities, cities and regions in the transition to a low carbon society and energy regime.

P-3303-20

Techno-economic analysis of carbon mitigation options for the fossil fuel fired power plants in India

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In response to the global climate change problem, the world community today is in search for an effective means of carbon mitigation. Coal based power plants in India, with an installed capacity of over 149 GW, account for more than half of the energy production and 66% of electricity generation in the country. These plants emit approximately 665 MtCO2 annually i.e. 37.5% of the total greenhouse gas (GHG) emissions of the country. With a large number of new coal power plants (~ 500 plants with about 600 GW capacity) being proposed, the problem of GHG emissions is far from being solved.

A variety of options exist for reducing the carbon dioxide emissions from the existing coal-fired power plants in India – which are mostly sub-critical units. The most feasible approaches include fuel switching (use of low-carbon fuels such as natural gas and biomass), and efficiency improvement (by better O&M conditions – by using better quality coal which may have to be imported from outside the country, or by adoption of supercritical and ultra-supercritical or IGCC technology). Carbon Capture and Storage (CCS) is the process of extraction of Carbon Dioxide (CO2) from large-point industrial and energy related sources, transport to storage locations and long-term isolation from the atmosphere. It is being considered as a promising carbon mitigation technology, especially for large point sources such as coal power plants.

The main objective of this paper is to carry out a techno-economic analysis of the several carbon mitigation options for the fossil fuel based power plants in India. The following options would be considered:

1. refurbishing/ repowering of the existing sub-critical units with SC/USC/IGCC,
2. using imported coal with better combustion properties
3. using CCS to capture and reduce a substantial fraction of the emissions
4. a combination of any of the above strategies

However, CCS is accompanied by a huge economic and energy penalty. In case of post-combustion CO2 capture using solvents like amine and ammonia, part of the steam from the steam cycle is lost for solvent regeneration. Thus, the gross electric output of the plant is lowered. This issue can be addressed by using an auxiliary natural gas boiler. Thus, we have one more potential variant of the list of carbon mitigation options listed above.

While India has substantial coal reserves, natural gas reserves are quite low. However, recently there has been a great deal of interest in unconventional gases like shale gas and coalbed methane (CBM) in India. If shale gas and CBM can be aggressively deployed, they can serve in several avenues including in auxiliary natural gas boilers for CCS retrofits. Obviously, pricing of gas versus coal shall be an important determinant for such deployment. Moreover, if the availability and pricing of natural gas

become more favorable, then Natural Gas Combined Cycle (NGCC) plants may also be considered as a suitable option. In that case, NGCC can also be coupled with CCS.

Thus, a large number of carbon mitigation options will be analyzed so as to estimate the carbon mitigation potential as well as the associated cost of mitigation. The modeling of the plants would be done by using the Integrated Environmental Control Model (IECM-cs) developed at the Carnegie Mellon University, USA. This modeling framework enables a comparison of performance as well as the costs associated with these various plant options on a consistent basis. Sensitivity of all these scenarios towards some key parameters such as the varying levels of fuel prices, plant capacity factor and fixed charge factor on the capital investment will also be studied so as to understand the policy implications of such interventions.

P-3303-21

The drivers of investment in cleaner energy production

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The ability to match future economic growth with reduced pressure on the environment is inextricably linked with the deployment and diffusion of low carbon technologies. An important sector that needs to be decarbonised to supply sustainable energy for all while reducing pressure on the environment is that of centralized electricity and heat production, which is among the major emitters and whose demand is project to increase significantly over the next decades, especially in developing countries (IEA, 2014).

Many "clean" technologies for electricity production are already available, but their use is hindered because they are not cost-competitive with "dirty" technologies. Such price wedge is due to at least three reasons. First, some technologies are relatively immature, and lower costs will materialize only in the future. Second, the price of dirty technologies does not internalize the cost of pollution. Third, the energy sector is characterized by long-lived capital stock and significant sunk investment in existing (dirty) plants.

The academic debate regarding the decoupling of economic growth from polluting energy sources (decarbonization) is often framed assuming a clear-cut distinction between what is clean and what is dirty and the theoretical possibility of completely substituting dirty inputs with clean ones (Acemoglu et al. 2010). Both assumptions are very strong when referring to aggregate energy systems, and more specifically to the power sector. First, emissions reductions in electricity generation can be achieved using either renewable energy resources or improving the energy (and hence carbon) efficiency of fossil-based technologies. Second, if one sets aside nuclear due to proliferation and safety considerations, there is no carbon free technology that can nowadays fully substitute fossil-based energy. Specifically, renewable energy sources strongly depend on the natural endowment (ocean, hydro, wind), are highly intermittent and seasonal (solar, wind), do not have the generation potential to meet the current demand for energy alone (wind, geothermal) or are manufactured using rare metals whose availability cannot be taken for granted (solar). Moreover, centralized electricity and heat production are peculiar in that the goods they produce (electricity and heat) are difficult to store in an economically viable way or to transport over great distances, and need to be used by consumers at the time they are produced (Battarchaya chpt10).

In this paper, we explore the implications of the peculiarities of the power sector and of available clean energy technologies. We focus on the degree of complementarity between clean and dirty electricity investment. We use data for 27 Organization for Economic Cooperation and Development (OECD) countries over the years 1990-2007 to show that to meet energy demand when the sun does not shine or the wind does not blow investments in renewable energy generation have been combined with investments in capacity of fossil power generation technologies. Specifically, our analysis confirms that systems that promote a high penetration of renewables require some backup generation capacity that is quick to react and most likely utilized under capacity for most of the time. Older coal power plants and base load plants are not good candidates in this respect, given their high capital costs, low operating costs, the inverse relation between efficiency and size and the long time needed for them to be brought on and off line. Conversely, high efficiency (gas) plants and technologies, which can be brought into operation relatively quickly and allow modular use since efficiency does not fall significantly with size, are installed to quickly compensate renewable intermittency (Battarchaya chpt10).

The implications emerging from our findings are manifold. First, at present there is no evidence that in the power sector technical change can be solely directed towards the clean input without important implications for the reliability of energy supply, energy access and energy security. Second, absent major breakthroughs in storage and grid technologies, the diffusion of renewable energy technologies may not be economically viable even if costs significantly fall due to need to balance demand and supply instantaneously. Lastly, the necessity to install peak load capacity which compensate intermittency is a further burden that is often not considered in the estimation of renewable energy costs.

P-3303-22

Global Energy and Climate Outlook: Road to Paris -Assessment from an energy system perspective of Low Emission Levels under World Action Integrating National Contributions

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On 25 February 2015, the European Commission has set out its Communication, «The Paris Protocol – a blueprint for tackling global climate change beyond 2020" in the EU's Energy Union package. This paper presents the modelling work undertaken in the context of the abovementioned EC communication regarding the energy system related impacts of post-2020 global climate change mitigation policies. The analysis presented here mainly lies on results from the energy systems model POLES for the purposes of the EC preparation for the global climate negotiations. It focuses on possible ways to stay below 2°C through processes established in the run-up to Paris COP21 by studying a combination of domestically determined mitigation targets for the period beyond 2020.

The POLES model is a global sectoral simulation model for the development of energy markets. It operates on a yearly basis up to 2050, with a very recent data update. Main exogenous inputs are economic growth and demographic projections for each region. POLES model provides comprehensive energy balances (demand, transformation, and supply) for the 57 countries / regions covering the world and detailed oil and gas productions for 80 countries. Energy demand in 15 sectors is driven by income and derived activity variables as well as short- and long-term energy prices.

In the POLES Baseline population and economic growth projections are based on the UN and OECD and the evolution of the energy markets, as driven by its own dynamic of production, supply and demand, is consistent with IEA projections. The projections do not consider the impacts from unabated climate change. In this Baseline scenario, global emissions would increase at unsustainable levels: from 48 GtCO2e in 2010, 61 GtCO2e in 2030 to 68 GtCO2e in 2050. Along such trajectories, the world is at risk to experience a global temperature increase of +4°C, with sizeable impacts on sustainable growth and vulnerable groups in all regions. The Global Mitigation scenario is in line with staying below 2°C, with global GHG emissions peaking in 2020 and reaching about 43 GtCO2e in 2030, still higher than in 1990 (+20%) but lower than in 2010 (-10%), and world average emissions reach 1.5 tCO2e per capita (50th percentile is 2 tCO2e per capita), roughly the level of the least emitting regions in 2010.

The modelling confirms that all regions can define domestic mitigation goals in line with 2°C, based on their current policy experiences, and that the institutions and

mechanisms put in place under the Climate Convention framework can be mobilised to deliver enhanced climate and economic benefits, especially for the countries with less capabilities. A significant transformation of the energy system is required, including energy savings, decarbonising the power sector with renewables, nuclear and fuel switching and actions to cut non-CO2 emissions in agriculture, industry or waste. It is found that Carbon Capture and Storage (CCS) becomes an important mitigation option after 2030. Europe and Asian countries see their imports in volume and monetary value decreasing substantially, North America presents a balanced energy trade and fossil fuel energy producers have to adapt to improved energy use at global level. Nonetheless, Sub-Saharan Africa and Latin America remain net fossil fuel exporters, Gulf countries and Russian Federation remain the world's dominant suppliers, and energy trade remains an important source of their income. The global investment patterns in power production are substantially modified by the introduction of ambitious GHG mitigation policies and by the related major changes in the energy mix towards renewable sources representing 40% of primary energy in 2050. Investments shift away from fossil fuels towards the power sector to tap capital-intensive mitigation opportunities. These investments enable to reduce other costs that would be required if abatement was not undertaken largely by the power sector but also by expenditure on fossil fuel imports and subsidies.

3304 - Climate change, carbon budgets and energy sector regulation

ORAL PRESENTATIONS

K-3304-01

The implications of 2°C carbon budgets for global energy systems

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The IPCC's fifth assessment reports (AR5) have been widely heralded as delivering unequivocal and stark messages to policy makers. Of particular relevance to this paper is the inclusion, for the first time in the IPCC's history, of explicit carbon budgets for differing probabilities of meeting a range of twenty-first century temperatures rises, from 1.5°C to 4°C. These carbon budgets provide a clear and quantifiable framework against which to assess technical and socio-economic policies for delivering the requisite rates and timeframes of mitigation.

With specific focus on CO2-only emissions from the energy system, this paper will revisit the framing of the mitigation challenge in accordance with the AR5 carbon budget range for a "likely" (66%), "likely as not" (50%) and "not likely" (33%) probability of maintaining the rise in global mean surface temperature below the 2°C characterisation of dangerous climate change. New estimates of the process-carbon emissions from the cement industry, combined with a revised carbon budget estimate for deforestation will be used to determine what CO2-only budget remains for the energy sector.

The paper will demonstrate that even assuming an unparalleled agreement at the Paris Negotiations in December 2015 (COP 21), alongside highly ambitious policies for reducing emissions from cement and deforestation, the energy-only budget of CO2 post-2020 will be radically more challenging than implied in AR5's post-2011 budgets. For a "likely" chance of 2°C, and assuming global emissions peak in 2020, mitigation of energy-only CO2 would need to rise rapidly to well over 10% p.a. by 2025 and be maintained at that rate until the virtual elimination of CO2 by 2050. The story for a 50:50 chance of 2°C though slightly less dramatic, is nonetheless beyond anything yet countenanced by policy makers and only seldom referred to in the literature.

Whilst the implications of such 2°C pathways are interpreted by some as highly regressive, this paper seeks to outline a positive solutions-oriented agenda. The scale of the challenge in the twenty-first century, with globalisation and an increasing population, demands moving beyond the reductionist disciplinary tools of the twentieth century. A systems-oriented and interdisciplinary approach designs infrastructure and develops institutions to offer resilience and facilitate iteration; a radical departure from abstract and theorised optimisation. Set within this context of unprecedented rates of mitigation and rapidly shrinking timeframes, it is this intellectually more exciting agenda, that informs the papers quantitative, technical and social-science content.

K-3304-02

Factoring Strategic and Sustainability considerations into energy sector policy and regulation: Insights from UK experience

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The UK is widely seen as a pioneer of market liberalisation, and the UK regulator was initially established with a primary duty to promote competition, which was subsequently amended to a focus on protecting the interests of consumers. The 2000s saw growing tensions between the renamed Office of Gas and Electricity Markets (Ofgem) and the government over strategic dimensions - particularly escalating concerns about investment adequacy (for security), and decarbonisation. This paper outlines the UK development of policy and regulatory structures in support of decarbonisation, explaining the extent to which energy market structures and their regulation cannot be separated from the wider definitions of objectives and responsibilities.

Economic principles which fit one set of conditions and lead to one set of reforms may not be adequate in themselves when conditions or the balance of objectives change. Attempts to give the regulator an explicit primary duty relating to either security or the environment did not succeed. However the 2008 Energy Act 'clarified' its primary duty as being "to protect the interests of both existing and future consumers." In effect, this achieved the same thing: it gave the regulator an explicit duty to consider the longer-term implications of energy sector developments. The defining struggle within Ofgem was then its Project Discovery (2009), the findings of which were simultaneously lambasted from different camps as heresy, or derided as Ofgem finally "discovering the real world."

The conclusion that the UK electricity market structure could not guarantee security and could not deliver the scale of low carbon investment required led directly to the government developing the UK Energy Market Reform bill, which radically changes the economic structure of the UK electricity system. This paper outlines the main rationales, components and sketches the inevitable new challenges which arise.

Ofgem also underwent internal changes, setting up a Division of Sustainable Development charged in part with ensuring that the concerns of future consumers are represented at the table of regulatory decisionmaking. Analysis of the issues at stake - and practical experience - led to the conclusion that attempts to aggregate the interests of present and future consumers (and potential trade-offs) through aggregate monetised cost/benefit appraisal was unworkable and potentially obscured rather than informed good decisionmaking. Following a 2-year process of research and consultation, in July 2013 Ofgem's Board agreed a major restructuring of its Impact Assessment framework. This paper articulates this

new framework and the thinking behind it and outlines challenges in its implementation going forward.

O-3304-01

National Plans for Utilization of Renewable Energy in Egypt

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Egypt has various opportunities for applying renewable energy and energy efficiency technologies. Thus to achieve sustainability in Egypt's energy sector it is important to develop an overall national energy strategy that incorporates renewable sources and acts as an umbrella for the existing renewable energy and energy efficiency plans.

This strategy should be involved in the Egyptian development plan in all sectors, as this will help to overcome the existing barriers whether institutional, technical, financial, market, awareness and information or technological barriers.

The government, the Industrial Modernization Centre (IMC) and the Ministry of Scientific Research shall allocate funds for Research and development of RE & energy efficiency technologies. Four bodies may be responsible to establish collaborative work programs for 1) RET, RE systems component design and development, 2) Human Resources Training and development and 3) National innovation on near- commercial technologies and niches.

All sectors in Egypt should be integrated with this overall strategy for harmonization in actions, hence it became necessary to raise awareness on the vital importance of Renewable Energy (RE), Research and Development (R&D), and the need to rationalize energy use in homes, factories, and various production sites and services; to make this awareness and rationalization as a rule for behavior and the lifestyle in Egypt.

O-3304-02

Present and future complementarity of wind power production in EU-28

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The amount of wind energy injected in the European electricity transmission system is expected to increase in next decades following the energy transition triggered by Directive 2009/28/EC.

Nevertheless, both absolute amounts and time patterns of wind electricity supply are different in each European country because of non-homogeneous meteorological conditions, Europe being large enough to span several different climatic areas.

Indeed, different types of weather are often simultaneously present in different areas of the continent, and any planned pan-European electricity transmission grid aimed at dispatching electricity production throughout the continent has to face the challenge of balancing in real time differently intermittent and strongly inhomogeneous resources such as the wind production is.

In this study, the long term (90 years) on-shore potential wind power supply for European countries is simulated with a daily time resolution, on the basis of the wind fields provided for the period 1961-2050 by 12 regional climate models involved in the ENSEMBLES model intercomparison project.

Thanks to this data base a long term view of the evolution of potential wind power deployment will be provided. In particular, the time complementarity of wind energy production originating from different countries will be analysed with a special attention to the implications that such a complementarity is expected to have for the needs for international electrical interconnections transporting electricity from high production areas to high demand areas.

O-3304-03

Tackling Offshore Oil & Gas GHG Emissions – Brazil's Experience

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There is growing evidence that human pressure is substantially raising the risks of crossing planetary thresholds, such as safe CO2 concentrations in the atmosphere. A viable future depends on mitigation and adaptation efforts in multiple fields and of special importance is the energy supply sector (IPCC, 2014). Estimates for the year of 2011 account for approximately 140 billion cubic meters of natural gas being vented or flared worldwide (GGFR, 2013). Although this is a decrease of almost 20% since 2005, there is still much space for further reduction and this downward trend is in danger of being reversed by a number of factors, including increase in oil production in several countries such as Brazil (GGFR, 2013). Only a few countries have introduced detailed secondary legislation regarding flare and vent emissions, such as codes and guidelines, even though it is paramount to effectively regulate this activity (World Bank, 2004). It is also a topic that interests the private sector (CDP, 2014). This work presents the experience of a Brazilian environmental unit (CGPEG) in building such legislation and mitigating GHG emissions from offshore oil and gas exploration and production.

CGPEG is a unit of IBAMA (Brazil´s federal environmental agency) that is responsible for analyzing environmental authorization requests for seismic activities, drilling, and oil and gas production offshore. Since 2010, it has been working on climate change mitigation, limiting or requesting compensation for flare emissions – a common GHG source in offshore oil and gas production projects. Flares burn gas, mainly composed of methane, that remains after: power generation on the platforms; gas injection and/or gas lift in the wells; or gas export to land facilities – chiefly through sub-sea pipelines. In 2013, CGPEG issued a guideline regarding procedures for mitigating GHG emissions, with detailed legislation and current requirements in the environmental authorization process. Two main conditions are normally made for high emitting activities: flaring limits (daily or for another stipulated period – such as the reckoned time necessary for oil production platform's commissioning); or compensation, which may be direct (e.g. reforestation projects) or indirect (financial contribution to climate funds, such as the Amazônia Fund). As a result, over less then five years, estimates indicate that at least 225.552 tCO2eq emissions have been avoided and 3.024.160 tCO2eq compensated (equivalent to ~85,9x106 m³ of gas), generating over R$10 million funds for actions related to climate change. The industry has accompanied these developments, making gas and CO2 injection, closed flares and better commissioning plans a reality. Still there is a lot to be done towards more efficient energy practices.

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O-3304-04

Design and Construction of Domestic Jatropha Oil Pressure Cooker

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Household energy for cooking accounts for a big part of overall energy consumption in developing countries such as Zimbabwe. In Zimbabwe 70% of total energy consumed is used for cooking purposes and in general wood is mainly used. The use of fire wood is resulting in deforestation of large areas creating severe ecological and environmental problems. Smoke from incomplete combustion poses health risks to humans and the environment.The Jatropha oil which is environmentally friendly is readily available in parts of Zimbabwe and can be used for cooking instead of the use of firewood, gas or electricity which are not readily and affordable to the ordinary Zimbabwean.

This work deals with the design and construction of Jatropha Oil Pressure Cooker. The design consists of the frame, piping system and air cylinder. By using the principles of Fluid Mechanics this work established the power of the cooker as 170kW and the cooker would burn 1 liter of Jatropha Oil in 4 minutes giving an energy value of 35.2MJ when operating at a constant pressure of 1.2mPa

O-3304-05

Remarks on electricity sector regulation in India

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An invited introduction or presentation on the challenges of regulation major emerging developing economy with top priorities of basic regulatory reform and connection

3305 - Energy efficiency as a core means to decarbonize demand

ORAL PRESENTATIONS

K-3305-01

Energy Policy, Greenhouse Gas Reduction, and Climate Negotiations

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Nations have legitimate interests in the health and growth of their economy, in their domestic and international security, and in the environment. These are summarized as the "energy policy triangle." International agreements must respect these legitimate interests and nations are unlikely to comply with policy proposals that do not respect these interests. Nations must address both energy supply – expand low carbon energy sources – and energy consumption – reduce energy use per unit of economic activity.

There are at least seven classes of strategies to motivate energy efficiency and reductions in energy intensity: 1) Normal processes of economic innovation, 2) Information provision, 3) Nudges, 4) Stochastic rewards, 5) Financial incentives, 6) Competitions, 7) Regulation. There is no "silver bullet" for energy efficiency. This presentation will discuss these classes.

These options suggest recommended directions for international agreements: Each nation should 1) set a goal of economy-wide annual energy intensity reduction; 2) set a stronger goal of economy-wide annual carbon intensity reduction; 3) conduct/support energy efficiency and clean energy RD&D and promote open, broad communication of findings; 4) adopt some energy-efficiency behavioral incentives. Specific incentives will differ among nations, but should include among others: labeling of all major energy using equipment offered for sale; feedback of energy use to consumers; elimination of all subsidies for CO2-intense energy; internal carbon price applied broadly throughout economy.

K-3305-02

Industry: The Gordian knot of decarbonisation on the demand side?

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The industry sector lies at the heart of the many governments decisions regarding the maintenance of wealth and the creation of employment. On the other hand, the industry sector accounted for over 30% of global GHG emissions in 2010. When compared to the major energy-end use sectors (transport, buildings, AFOLU), industry is currently the largest emitter of greenhouse gas (GHG) emissions. The key energy intensive material-conversion sectors (cement, iron and steel, chemicals, pulp and paper and aluminium) dominate the energy use and emissions in industry. Most scenarios envisage a continuing rise in demand for materials, by between 45% to 60% by 2050, relative to 2010 production levels.

The transition from current patterns of industrial production to a future in which goods are produced sustainably requires a holistic view that goes beyond energy efficiency. From the perspective of climate change mitigation, opportunities can be found over the whole supply chain. Although currently sometimes difficult to quantify, there are significant potentials for reduction in emissions mainly through emissions efficiency (e.g. fuel switch), material efficiency in manufacturing (through reducing yield losses, re-use of materials and recycling of products), material efficiency in product design (less material per product), product-service efficiency (in transport through car sharing) and last but not least sustainable consumption patterns.

Against this background – as we move towards the question of how to achieve sustainable development goals – a more efficient use of energy, materials and products is without alternative in the sector and has to be addressed through appropriate global and sector specific policies.

However, implementation of existing measures is not a self-dynamic process and faces various challenges, even political trade offs. This holds true particularly for more ambitious long-term decarbonisation efforts as they might require not only improvements in existing production structures, but in addition a shift to low carbon electricity, carbon capture and storage or even implementation of completely new approaches (e.g. hydrogen based steel making) or radical product innovations (e.g., alternatives to cement) which might go hand in hand with persistence forces.

The presentation addresses the portfolio of options available, gives a brief overview of their technical and economic potentials, reflects synergies and tradeoffs that mitigation in the industry sector can have with other policy objectives. Discussion of long-term decarbonisation pathways are specifically addressed as they might play a crucial role for solving the Gordian knot.

The presentation will be mainly based on recently published industry chapter of the IPCC WG III report:

Fischedick, M. et al., 2014. Industry. In Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O. et al (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2014

O-3305-01

Decarbonising demand by energy efficiency and material efficiency – why it is at the core of climate policy and how it could be achieved

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Decarbonising energy supply is not sufficient to achieve sustainable, low carbon energy systems. A highly efficient use of energy has to be tackled much more serious if mitigation shall leed to successful decarbonisation. Only if energy demand can be stabilised or reduced there will be a realistic chance to convert supply towards sustainable sources.

Final energy demand stabilisation needs high exploitation of potentials in all sectors by low energy buildings, highly efficient appliances and vehicles as well as mainstreaming best available technology all over industry. Basic materials production – which is responsible for a significant share of energy demand, however already operates close to physical limits of current processes in many countries. Here new processes and break through technologies will be needed to achieve significant reductions of energy use. Further, on a global scale means of more efficient use of basic materials such as material effciency as well as recycling will be indispensable.

All these challenges do need concerted action on a more streamlined policy for significantly increasing energy efficiency as well as decarbonising basic industry.

O-3305-02

A long-term, integrated impact assessment of alternative building energy code scenarios in China

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Building energy demand continues to increase globally, generating an unprecedented amount of CO2 emissions from the sector. The trend is not likely to wane anytime soon as a less developed part of the world grows at a rapid pace demanding the standards of living that its predecessors have experienced.

China is already the world's second largest building energy user. Building energy consumption in China is expected to grow at least for the next several decades, as the country undergoes rapid income and population growth, requiring continued expansion of building floorspace and installation of energy-consuming devices. This poses substantial challenges for the Chinese government to maintain adequate supply of energy and for international society to address global climate change.

Development and implementation of building energy codes in China may be a sensible domestic strategy to fulfill building energy demand in an economically efficient way while at the same time reducing CO2 emissions. Building energy codes intend to promote energy performance of buildings by setting legal requirements on building design and their compliance provisions during construction period. They usually include standards for thermal properties of building envelope and may also cover heating, ventilation, and air conditioning, lighting, electrical power, renewable, and building maintenance. The Chinese government has implemented building energy codes since 1980s with the particular focus on the improvement of envelope insulation. All new urban residential and commercial buildings are currently required to comply with Chinese building energy codes in both design and construction stages.

This paper investigates the potential long-term impact of China's building energy codes on building energy use and CO2 emissions based on a detailed building energy model nested within the Global Change Assessment Model (GCAM). In particular, the model represents the influence of building code implementation on the improvement of buildings shell efficiency and resulting energy demands. The model disaggregates Chinese buildings into 12 different sectors—three building types in four climate zones. Specifically, the impact of building energy codes is captured through a building stock module that describes the expansion of building floorspace as a result of new construction and retirement at the regional level, as well as the interaction of the building stock with building energy codes in place, code compliance, and the degree of retrofits. This modeling approach allows for assessing the effect of building energy codes on building energy demand and associated CO2 emissions in a consistent manner, while at the same time capturing the effects of regional differences in socioeconomic development, code implementation, climate impact, and fuel choices.

In this study, we focused on the long-term impacts of various types of building energy codes that are being contemplated or could be implemented by the Chinese government. Four distinct but interrelated scenarios of Chinese building energy codes were taken into account to span possible futures of the building sector, to provide broader policy insights, and to guide the development of building codes at the regional and national level. By examining the influence of two major policy variables--the coverage by building type and the stringency of the energy codes--we suggest the pathways that next generation building codes in China are advised to take.

This study draws three important conclusions. First, the implementation of building energy codes may substantially reduce overall building energy consumption in China, and this finding remains unchanged with global climate change, modest assumptions of voluntary technological improvement, and economy-wide carbon policy. Second, the Chinese government can see significant impacts from expanding its efforts to improve building shell efficiency beyond new buildings in urban centers. In particular, promoting retrofits of poorly performing buildings and expanding building energy codes to rural areas may result in earlier and more drastic energy savings. Finally, the potential impact of building energy codes will differ by region and sector. The greatest energy savings will accrue in urban residential buildings, particularly those located in cold regions.

O-3305-03

Directed Technological Change and Energy Efficiency Improvements

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This paper applyies the Directed Technical Change (DTC) framework to study improvements in the efficiency of energy use. We present a theoretical model which (1) highlights the drivers of innovative activity in energy intensive sectors and technologies and (2) examines the impact of such activity on the aggregate demand for energy. We then estimate the contribution of these channels through an empirical analysis of patents and energy data. Our contribution is fivefold. First, we show that information about energy expenditures, knowledge spillovers and the parameters governing the R&D process are sufficient to predict the R&D effort in efficiency-improving technologies. Second, we pin down the conditions for a log-linear relation between energy expenditure and the R&D effort. Third, the estimation of the model provides clear evidence that the value of the energy market as well as international and intertemporal spillover play a significant role in determining the level of innovative activity. Fourth, we show that innovative activity in energy intensive sectors shifts down the (Marshalian) demand for energy. Fifth, we show that due to the streamlined modelling framework we adopt, the point estimates from our regression can potentially be used to calibrate any model of DTC in the context of energy consumption.

O-3305-04

Half the material for twice as long

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The energy intensive industries, which produce that bulk materials that sustain all contemporary living, are the most energy efficient in the world. They have always paid heavily for energy, so regardless of climate or other environmental concerns, they have pursued efficiency motivated only by cost and have been very successful: the opportunities for future energy efficiency gains in the energy intensive industries are limited.

However, precisely because of their efficiency, the bulk materials are made very cheaply, and in particular are very cheap compared with labour costs in the supply chains which determine their use. As a result many decisions in construction and manufacturing are taken to minimise labour costs at the expense of increased material use. For example, in the UK we build commercial buildings with around twice the material required to meet the safety standards of the Eurocodes, and on average we replace buildings after just 40 years, when their structural integrity is absolutely sound. Our research is developing extensive evidence that we could live well by designing our buildings, infrastructure and goods to be made with half as much material and keeping them for twice as long. These two strategies, which would reduce demand for new bulk materials by 75% would be sufficient to achieve most industrial carbon mitigation targets, regardless of any future changes in the energy intensive industries themselves.

The talk will present our evidence about how to live well with much less new material, and present our current understanding of the costs of this change: as the supply chain is already seeking to optimise costs, it will cost more labour to use less material. Policy has not as yet addressed this point, but it may well prove to be a more effective mechanism for reducing industrial emissions than focusing solely on the emissions of material production.

The background to this talk is summarised in:

(1) Allwood, J.M., Cullen, J.M. and Milford, R.L. (2010) Options for achieving a 50% cut in industrial carbon emissions by 2050, Environmental Science and Technology, 44(6) 1888-1894. This paper sets out the evidence that there is limited future potential for energy efficiency in the energy intensive (bulk materials) industries.

(2) Allwood, J.M., Ashby, M.F., Gutowski, T.G, Worrell, E. (2011) Material Efficiency: a White Paper, Resources Conservation and Recycling, 55, 362-381. This paper provides a survey of the opportunity to live well with less new material production.

(3) Allwood J.M. and Cullen J.M. (2012) Sustainable Materials: with both eyes open, UIT Cambridge, England, pp 384. This popular science book, which can be downloaded for free at www.withbotheyesopen.com, sets out the detailed case for using less new material, based on a 5-year 8-person project with a 20-partner industrial consortium.

The talk will report the evidence gathered since these three publications about the implementation of Material Efficiency, in business, government and with final purchasers.

O-3305-05

"Joint crossing of the valleys of death" Exploring the need and options for formal collaboration between US ARPA-E and EU ETS' NER 400 to accelerate the commercialisation of low-carbon breakthrough technologies in the energy and industrial sectors

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This paper seeks to demonstrate that there exists a policy complementarity between the US ARPA-E and the EU Emissions Trading System (New Entrants Reserve 300) funding programmes for energy innovation. Both programmes seem to be addressing two different technology market gaps. The next step is to assess if and how this complementarity could be turned into a joined opportunity for the US and the EU to accelerate the commercialisation of low-carbon breakthrough technologies in the energy and (energy intensive) industrial sectors.

Achieving decarbonisation of the EU and US economies over the next decades will require an accelerated improvement and wide-scale deployment of low-carbon energy and industrial technologies. There are two important market gaps that can impede the further development of promising breakthrough technologies. These gaps are know as the early stage "Technological Valley of Death» and the later-stage "Commercialisation Valley of Death". These barriers are strongly present in the energy sector. (Jenkins, Mansur 2010, p.3)

In 2007, the US Congress authorised the establishment of the Advanced Research Project Agency - Energy (ARPA-E). The ARPA-E, modeled on the Defence Advanced Research Projects Agency (DARPA), seeks to advance high-potential, high-impact energy technologies that are too early for private-sector investment. Since 2009, ARPA-E has funded over 360 potentially transformational energy technology projects, including projects that aim to significantly reduce energy use and greenhouse gas emissions in energy intensive industries (e.g. the non-ferrous metals and chemical sectors). However, while successfully moving technologies across the early stage valley of death to the prototype or small scale demonstration stage, the ARPA-E does lack the means to enable the commercialisation of breakthrough technologies that are emerging from its programmes (Bonvillian, Van Atta 2011, p. 471-472).

In 2008, as part of the legislative review of the EU ETS for the period 2013-2020, a new entrants reserve containing 300 million allowances (NER 300) to be auctioned under the EU ETS New Entrants Reserve was established. The revenues generated through this reserve have the goal to finance low-carbon energy demonstration projects. The programme is conceived as a catalyst for the demonstration of carbon capture and storage (CCS) and innovative renewable energy (RES) technologies on a commercial scale within the European Union. Hence, the EU ETS NER is tackling the second "commercialisation" stage of the technological valley of death. In October 2014, the European Union's head of state and government agreed to continue this NER after 2020 and to expand it to 400 million allowances and to energy intensive industrial sectors. Successful implementation of this NER 400 will depend on the availability of promising energy and industrial low-carbon breakthrough technologies at pre-demonstration stage. This is relevant since there appears to be a first stage technology market gap in the EU or at least a gap in the development of first stage low-carbon breakthrough technologies in the EU compared to US based developments and in particular the ARPA-E programmes.

These «commercialisation» and «early stage» technology market gaps, identified respectively under the ARPA-E and the EU's NER 300, can become a policy opportunity if both programmes start working together. Technologies emerging from ARPA-E could make use of the NER programme to enable full-scale commercialisation and vice versa, the EU's NER could secure a broader (and maybe lower risk) project pipeline from promising low-carbon breakthrough technologies fostered under the ARPA-E. A bilateral «technology» agreement between the U.S. government and the EU's institutions could be considered. Such agreement will need to address some specific issues, such as the use and sharing of intellectual property rights and the introduction of a waiver under the ARPA-E' s U.S. manufacturing requirement. The latter element is crucial since ARPA-E requires inventions developed under ARPA-E funding agreements to be substantially manufactured in the United States.

Jenkins, J., & Mansur, S. (2010). Bridging the clean energy valleys of death. Power.

Bonvillian, W. B., & Van Atta, R. (2011). ARPA-E and DARPA: Applying the DARPA model to energy innovation. The Journal of Technology Transfer, 36(5), 469-513.

O-3305-06

Challenges for decarbonising basic industry: Sustainable transition of industries under competition

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Decarbonizing the energy intensive production of basic materials such as steel, cement, petrochemicals, and aluminum pose specific challenges.

This session presents the specific challenges for the global basic materials industry in light of the evolving global clime policy framework and discusses the opportunities that material and energy efficiency along the value chain can have. However, we also highlight the long term need for more radical shifts in energy carriers and feedstock changes that an ambitious climate policy will induce.

The energy-intensive production of basic materials are traded on a global market and the production is highly exposed to increasing energy and carbon costs. At the same time, the global framework for climate policy suggest that a level playing field in terms of a global carbon price cannot be expected the short to medium term, if ever. This fact limits the possibilities for policy makers to effectively address industrial emissions with a "price-only" approach.

The demand for basic materials are set to increase substantially with increasing material standards across the world. Recycling and material efficiency can reduced the demand growth for virgin materials. The circulation in the economy of recycled materials will offer some efficiency gains and change the energy carriers (towards eklectricity). However the production of basic materials from recycled feedstock but will still be considered an energy-intensive industry.

The energy-intensive industry is also unique in that investment cycles are very long, usually spanning over 20 to 40 years between reinvestment opportunities in core process steps.The 2 C target and the year 2050 is thus only 1 to 2 major investment decisions away. Thus, in order to make more substantial changes to process design, a long term strategy is needed.

In order to manage a smooth and both socially and politically acceptable transition for both industrialized, transitional and developing countries, we suggest that focusing on material- and energy efficiency as a win-win option. Efficiency has the potential to boost competitiveness and overall economic performances if implemented properly and should thus be at the center of a global strategy. However, efficiency has to be complemented with a technology strategy focusing on more radical changes that requires major innovation efforts and eventually new investment decisions in new basic process designs such as electrowinining, bio or electro-plastics, CCS in industry e.t.c.

3305-POSTER PRESENTATIONS

P-3305-01

Future pathways to a low carbon steel industry - The case of Germany till 2035

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We analyse the diffusion factors which give explanations for innovation behaviour of individual firms in the German iron and steel industry. First, we analyse the diffusion of three energy efficient technologies for primary steelmaking (EET) from their introduction until today (top-pressure recovery turbine (TRT), basic oxygen furnace gas recovery (BOFGR) and pulverised coal injection (PCI)). We derive the uptake of these technologies both at the national level and of individual firms. Second, we analyse the impact of drivers and barriers on the decision making process of individual firms whether or not to implement these technologies. Thereby we focus on the impact of current policies (e.g. European Emission Trading System, levy for renewable energy, European Emission Directive). We give a short insight into site specific factors which shape the economics of the selected EETs. Our analysis ends with summary and conclusions.

P-3305-02

The role of the Construction Sector in decreasing global energy needs

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A key European employer and contributor to quality of life and a major energy

consumer and CO2 provider

Worth at least EUR 1.2 trillion of yearly turnover (2011), the European construction sector, including its extended value chain (e.g. material and equipment manufacturers, construction and service companies), is the largest European single activity (9.6 % GDP) and biggest industrial employer (14.6 million direct operatives, 30.7 % of industrial employment, 43.8 million indirect workers). The built environment affects the quality of life and work of all EU-citizens.

Buildings use 40 % of total EU energy consumption and generate 36 % of greenhouse gases in Europe. The construction sector is on its critical path to decarbonise the European economy by 2050, reducing its CO2 emissions by at least 80 % and its energy consumption by as much as 50 %. As the replacement rate of the existing stock is very small (1-2 % per year), acceleration is urgently needed.

Strategic and general objectives

The vision of the construction sector is to drive the creation of a high-tech building industry which turns energy efficiency into a sustainable business. Connecting construction industry to other built environment system suppliers and stakeholders would be the decisive step to reach economic, social and environmental goals. By creating and fostering a research driven paradigm shift, the construction industry would become competitive on a global level in the design, construction and operation of the built environment while sustaining local economies through job creation and skills enhancement, driven by the vast majority of SMEs active in the value chain. In this framework, the strategic objectives of the sector are to:

- Develop technologies and solutions enabling to speed up the reduction in energy use and GHG emission, e.g. through a higher renovation rate of the building stock at lower cost and to meet regulatory needs;
- Develop energy efficiency solutions in order to turn the building industry into a knowledge-driven sustainable business, with higher productivity and higher skilled employees;
- Develop innovative and smart systemic approaches for green buildings and districts.

This would ultimately create a solid foundation for continuous innovation in the building sector through sustainable partnerships, fostering an innovation eco-system across value chains, which is not project based with episodic innovation activities as current practices.

The Public-Private Partnership on Energy Efficient Buildings (PPP EeB)

The Energy-efficient Buildings (EeB) Public Private Partnership (PPP) is a joint initiative of the European Commission (EC) and the Energy Efficient Buildings Association (E2BA). This initiative aims to promote research on new methods and technologies to reduce the energy footprint and CO2 emissions related to new and retrofitted buildings across Europe. The EeB PPP was set up under FP7 and recognises the importance of research in Europe to achieve Europe's targets of job creation and competitiveness, and to maintain leadership in the global knowledge economy. During Horizon 2020, a contractual PPP has been agreed between the E2BA and the European Commission to continue investing in research and innovation.

The research projects respond to EU priorities for new technologies, tools and systems, materials, information

and communication technologies and retrofitting and renovation methodologies in order to achieve energy-efficient buildings. The projects demonstrate scientific and technological excellence across all levels from early stage conception through to demonstration of the potential for commercialisation.

110 projects have been funded so far through the EeB PPP under the 7th Framework Programme (FP7) for 2010, 2011, 2012 and 2013.

P-3305-03

Determination of Optimum Imbibition for the Milling Process in Sugar Factories with Consideration of Trade-offs among Sugar Extraction, Power Production, and Water Use

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Manufacturing of raw sugar from sugar canes requires many processes. From energy viewpoint, three important processes are milling, steam generation, and evaporation (which includes crystallization). Milling is the process in which juice is extracted from shredded sugar cane. The outputs of the milling unit are sugar juice and bagasse. Juice is sent to the evaporation process, in which, eventually, water is separated from raw sugar. Bagasse is used as the fuel in the steam generation process, which produces steam needed to evaporate juice in the evaporation process. Since the amount of bagasse required for producing process steam is much smaller than the amount of bagasse produced from the milling process, most sugar factories install high-pressure boilers so that high-pressure steam can be used to produce power in either back-pressure or extraction-condensing turbines. Low-pressure steam from turbines is then used in the process. Electrical power obtained from the cogeneration system usually exceeds the demand for internal use in the factory. The excess power is, therefore, exported to the national grid.

In order to increase juice extraction in the milling process, imbibition water is added to the milling unit. More imbibition water results in more thermal energy required to evaporate diluted sugar juice in the evaporation process. Furthermore it results in bagasse with more moisture. Combustion of wet bagasse leads to not only less production of power because some of the thermal energy from combustion is required to evaporate the moisture in bagasse but also more water loss because evaporated moisture is eventually exhausted to the environment with flue gas. Most sugar factories focus only on sugar extraction when selecting the amount of imbibition. Previous investigations have pointed out that the amount of imbibition should be reduced in order to attain the optimum mix of sugar production and power production. In fact, in terms of profit generation, imbibition should be less as the ratio of the profit from sugar production to the profit from power generation decreases.

In the current study, conservation of water is also considered, along with production of sugar and power. The direct effect of the amount imbibition on water use in form of imbibition water is apparent. It also affects water indirectly through the amount of water required to grow sugar canes. Conservation of water has rarely been taken into account by sugar factories. However, as climate change causes scarcity of fresh water in certain part of the world, sugar factories located there will eventually find it necessary to attach economic value to water, and the results of the current study will be of benefit to them. The main objective of this study is to determine the amount of imbibition that will yield the optimum mix of sugar production, power generation, and water use. To reach this objective, mathematical models of milling, steam generation, evaporation, and power generation units are developed, along with interactions between them through mass and energy balances. Results of simulation are presented in charts that show variations of optimum imbibition with important parameters.

P-3305-04

The role of energy efficiency in meeting UK carbon targets

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The United Kingdom was the first country to legislate ambitious climate change targets through its 2008 Climate Change Act. The Committee on Climate Change was set up to advice on the level of the carbon targets and on specific opportunities to achieve them.

This presentation will examine the role of energy efficiency in the Committee's carbon budget advice, focusing on the buildings sector. Buildings account for 37% of UK greenhouse gas emissions and with an ageing building stock, there is much scope for efficiency improvement. Furthermore, improving buildings energy efficiency has various co-benefits, including the alleviation of fuel poverty. This is of particular importance as the decarbonisation policies are expected to raise energy prices. Energy efficiency therefore plays a crucial role in keeping bills affordable.

The presentation will cover both analytical and policy issues. On the analytical side, we will discuss how the Committee estimates abatement potential from energy efficiency, what data limitations we have encountered and what work is underway to overcome them. We will also present our estimates of the impact of decarbonisation policies on energy prices and bills, and the scope for energy efficiency to offset these.

On the policy side, we will look at the UK Government's current energy efficiency policy for buildings and assess what further action is needed to meet carbon budgets. We will highlight the importance of a holistic approach to energy efficiency and heat decarbonisation.

P-3305-05

Energy Sufficiency in Rural Areas - The example of French TEPOS

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Scholars and policy-makers have now widely acknowledged the key role of local governments and local initiatives in tackling climate change. In fact, for a long time climate change was seen as a global issue, ignoring the fact that its impacts are actually experienced at the local level. Yet thanks to the activities of audacious and resourceful cities as well as to the establishment of powerful transnational networks, the activities of local governments slowly got the attention of policy-makers and researchers.

In governance studies, several theoretical frameworks can be used to discuss the activities undertaken by local governments. The oldest is led by prof. Ostrom who developed with her colleagues, the concept of polycentric governance systems (Ostrom 2010, 2014). The idea is that solutions lie at the local level in the interactions of a multitude of stakeholders, public and private. Multi-level governance theories (Jordan et al. 2012; Schreurs 2008; Corfee-Morlot et al. 2009; Schroeder and Bulkeley 2009) focus on local governments and cities as important players through their responsibilities in the provision of services and infrastructures. Authors highlight the importance of the cooperation of these local authorities through transnational networks.

A common question addressed by these various theories is the relevant scale of action to address climate change. A lot of studies now report cities initiatives, a relevant field of studies because of their important contribution to greenhouse gases (GHG) emissions. Yet smaller local governments and rural authorities are also taking action. The aim of this presentation is precisely to explore what is being done in rural territories to address the challenge of climate change.

This presentation therefore introduces TEPOS ("Positive Energy Territories" or in French "Territoires à energie positive"). These are rural areas, "territories", which intend to achieve energy sufficiency. The "territory" can refer to a single commune, a group of communes or higher level of local governments' associations such as "pays"or national

parks.

The main goal of TEPOS is to increase energy efficiency and to cover the entire local demand through renewable, locally produced, energy. They have a systemic approach considering environmental benefits along with social and economic ones. The purpose is to start a transition towards less fossil-fuel energy use, involving all the stakeholders present on the territory (citizens, companies and businesses but also representatives of national and other public authorities). Excess in energy production may be delivered to other units, in particular urban areas, creating an interesting rural-urban partnership.

A network of TEPOS allows awareness-raising and sharing experiences between TEPOS and other local stakeholders. TEPOS are also part of a European network called 100% RES communities.

Many lessons can be drawn from this innovative experiment. On the basis of cases examples, I will address the following questions:

- What are the drivers of the TEPOS projects?
- What concrete measures are taken to mitigate GHG emissions?
- What concrete measures are taken to adapt to climate change?
- What legal tools (in particular what kind of companies: public ownership, semi-public, private or citizens ownerships) are used?
- How rural and urban authorities cooperate?
- How influent is the participation to a peer network?

Answers to these questions will hopefully help identifying good practices, inspiring for other stakeholders in different contexts.

P-3305-06

Impacts of Energy Efficiency Improvements in Transportation Sector on Future Emissions and Air Quality in Thailand

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As other developing countries in Asia, Thailand is accomplishing rapid economic growth during the last decades. The expanding economic activities have resulted in significant increase of energy consumption and carbon dioxide (CO2) emissions as well as heavy air pollution. Transportation, especially related to on-road, has been recognized as the top energy consuming sector since the beginning of 1990s. Also, it has been forecasted that energy efficiency improvements in this sector would contribute to the highest energy saving, up to more than 16,000 ktoe in 2030, and consequently to a significant national petroleum oil import reduction.

In this study, we evaluate the impacts of current and possible future on-road transport emissions on air quality in Thailand from 2010 to 2050. Ozone (O3) and particulate matter (PM) are selected as indicators of air quality, because they are recognized as the two major air pollutants both in urban and rural areas in the country. To this end, we first developed the Thailand's emission inventory of all sources using the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)-Model. We develop two possible scenarios of future emissions: a scenario where technologies and legislations are the same as those applied in 2010 (BAU), and a scenario where energy efficiency improvements are applied following the national Energy Efficiency Development Plan 2012-2035 (EEDP). The EEDP scenario has been selected as it constitutes the latest policy formulated by the Thai government, and consequently represents the case that would possibly occur in 2030 onward. In order to analyze and evaluate the national air quality response to on-road transport emissions in 2010, 2020, 2030, and 2050, we set up an air quality modeling system using the Weather Research and Forecasting model coupled with Comprehensive Air Quality Model with Extensions (WRF/CAMx).

We will evaluate the model 2010 results with observations obtained from the 64 air quality monitoring stations operated by the Pollution Control Department (PCD), Ministry of Natural Resources and Environment (MONRE), Thailand. The emissions of carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), primary particulate matter with diameters lesser than 10 microns and 2.5 microns (PM10 and PM2.5), and their components including black carbon (BC) and organic carbon (OC) in 2010 will be analyzed versus those found for BAU and EEDP in 2020, 2030 and 2050. The emission reductions from BAU to EEDP scenarios will be described and discussed to assess the effectiveness of energy efficiency measures put in place. Changes in O3 and PM from 2010 to 2050 will be presented and discussed to evaluate the impacts of future emissions on the air quality improvement.

P-3305-07

Sustainable building: Passive House combined with renewable energy

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This contribution will highlight the importance of energy efficiency as most important measure to address the impact of buildings on climate change. It further explores the correlations between energy efficiency and renewable energy in the context of sustainable use of available resources. Specific project examples and regional approaches will be presented to illustrate the potential impact, e.g. experiences from the EU-wide project PassREg supported by Intelligent Energy Europe.

Over a third of the total energy consumed in developed countries is required for operating buildings, especially to heat them. This consumption can be reduced by up to 90 % using Passive House technology, and the remaining demand can be met sustainably using renewable energy. The Passive House (PH) has proven itself as a reliable building standard with significant energy savings in a range of climates with more then 50 000 units built worldwide. Hence, the Passive House Standard is not just an attractive solution for the energy transition; combined with renewable energies it is also a blueprint for the Nearly Zero-Energy Building (NZEB) stipulated in the European Buildings Directive, which will come into effect in 2021.

In order to provide reliable guidance for the combination of energy efficiency and renewable energy (RE), new assessment categories are being introduced by the Passive House Institute:

- PH Classic: The established Passive House Standard
- PH Plus: Increased level of overall energy efficiency and some RE production
- PH Premium: Very high level of overall energy efficiency and significant amounts RE production

The approach for the assessment of PH classes specifically does not promote the simple annual offset of on-site energy demand and energy production in context only of the individual project. Direct offsetting disregards important aspects such as energy losses due to storage and space availability for RE production. The Passive House assessment is thus based on a contextualised methodology, which anticipates the energy transition and considers the building in an environment where only renewable energy is used. In this scenario, primary electricity is produced only from renewable sources. Some of this electricity can be used directly; storage capacities are however needed to buffer surplus RE energy so that it can be used during time periods with less RE availability. This temporary energy storage always implies losses, especially if it needs to bridge long-term energy compensations, e.g. seasonal effects from surplus RE supply during summer to cover RE shortfall during winter. Depending on the type of energy application as well as on the locally available RE resources, the amount of required storage varies, and thus the associated losses. Based on these interrelationships, new weighting factors are being introduced: the so-called PER factors (Primary Energy Renewable). The PER factor for domestic electricity use, for example, is comparatively low because the demand is fairly constant throughout the year and thus the share of electricity that can be used without

intermediate storage is high. Energy demand for heating, on the other hand, occurs only in winter, which calls for seasonal energy storage and thus results in a high PER factor.

The assessment approach emphasises the importance of efficiency when it comes to heating energy, which is exactly what the Passive House Standard stands for. Efficiency in this sector has the highest potential of putting energy resources (e.g. renewable electricity) to use responsibly and thus mitigating the impact of buildings on climate change.

P-3305-08

Integration Assessment of China's Energy Efficiency: Index Decomposition and Frontier Approach Applications

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Policies for improving energy efficiency are one of the most effective ways to solve the contradiction between supply and demand of energy and to relieve environmental pressures for the Chinese Government. Because of several indicators to measure energy efficiency, resulting in different evaluation effects of policy implementation. First, this paper compares the energy efficiency measures from the supply side and demand side of energy, that is, a single element of energy efficiency and energy efficiency based on total factor productivity (TFP) estimates. In order to study the effects of energy efficiency change and its driving factors, the paper adopts index decomposition models and frontier approach, the former implies that production is effective, and the later provides a variety of frontier estimation methods, including non-parametric estimation of data envelopment analysis (DEA) and parameter estimation of stochastic frontier analysis (SFA). Based on China's latest available statistical data, the paper applies Divisia index decomposition to two different definition of energy intensity, e.g. final energy consumption per unit value added of industries, per capita residential energy consumption; then, using DEA of the total factor productivity estimates across-sector energy efficiency and empirical research on the driving factors of energy efficiency. Finally, based on model results, it presented energy efficiency policy implications at macro and industry level.

Taking into account the final energy consumption does not include the intermediate conversion process energy consumption, compared to the total energy consumption, this paper argues that final energy consumption can be used to more accurately reflect the energy efficiency of various industries, defines industrial energy intensity as ration to final energy consumption to industrial value added. Since only 6 industries have detailed statistical data on energy consumption by fuel type, this article analyzes only 6 industries energy efficiency; for residential energy, the average residential energy consumption defined as household energy efficiency. Energy balance tables of 1996-2012 in China energy Statistical Yearbook and other data, 6 industry and residential energy efficiency used Divisia index AMDI model decomposing, results showed that economic policy and energy policy factors in different periods on energy efficiency change play different roles with different contribution rates. In terms of per capita residential energy, economic development and the improvement of building energy efficiency play a major role.

Total factor energy efficiency, that evaluates energy efficiency during economic production process, is considered energy as one of production elements input with labor, and capital together, while also considered «bad» outputs, such as CO2, wastewater, that is, model development is under environment regulation of constraint. The paper uses directional distance function of DEA method to estimate industrial energy efficiency, and empirical analysis on effects factors of energy efficiency. Preliminary results show that overall China's energy efficiency tends to decline, but with the implementation of energy-efficiency policies in recent years, beginning in 2007 on energy efficiency has gone up. From the perspective of industry, increased industrial energy efficiency is quite obvious, while transportation, agriculture showed a downward trend. Analysis the economic development and foreign direct investment (FDI) of influencing factors shows a significant positive impact on total factor energy efficiency, while endowment structure has a negative effect, reflecting the disadvantages of excessive capital input. Industrial structure, energy prices and environmental regulation have the negative effects on energy efficiency, due to the imbalance of regional development in China, as well as the energy market is not perfect, this section needs further in-depth analysis.

Acknowledges: This paper was based on work supported by National Basic Research Program of China under Grant No. 2012CB955801, and Scholar Program of Innovation Project in Chinese Academy of Social Sciences (2014-2018).

P-3305-09

How to achieve climate stability in cultural heritage buildings despite climate changes

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In future we cannot afford any longer our energy bills especially in museums, castles and other historic buildings with need in climate stability especially under negative auspicious of climate change, which means warmer outdoor climate in future.

So far our one-dimensional thinking in 'repairing' wrong development by big machinery is no longer a suitable method because of lack of money and common cutbacks of energy budgets for cultural heritage.

As past has shown very old and unique artifacts in historic buildings have overcome very long periods of about 500 to 900 years - also with very warm periods - without any technical support or cooling units what so ever. The exceptional 'Altar of Verdun', a masterpiece of enamel work of 1188 in Stift Klosterneuburg, close to Vienna, as well as the unique collection of all kinds of artifacts of Carl Gustav Wrangel in the Swedish Castle of Skokloster and Ambras Castle, Innsbruck, with its famous painting gallery are best examples how big building masses keep valuable masterpieces in constant climate conditions in the sense of preventive conservation.

Big masses of historic buildings mostly give best shelter against summer heat. Hot summer outside temperatures mostly will be compensated by colder nights and the buffering capacity of huge walls. Often summer night cooling through natural ventilation will improve this sustainable effect.

In order to reach moderate summer indoor temperatures natural ventilation as well as best possible outside shading in accordance with monument authority's prescriptions will reduce indoor heat achieving acceptable indoor conditions when indoor loads also will be reduced accordingly.

Also winter heating in historic buildings could be reduced similar to low energy consumption buildings with pure radiation heat by warming up building masses. With pure radiation heat energy bills in historic buildings could be cut to half. Also with warm shell negative consequences of rising damp, mould or condensation on cold walls could be avoided as the following famous examples proof vividly:

Einsiedeln Monastery with an underground store room for precious, historic books and an old library, heated by waste heat of electronic data processing;

Museum of Fine Arts, Vienna, showroom IV, got rid of mould and cut energy bill by half;

Academy of Fine Arts, Vienna, and store room in the basement, heated by pure radiation heat got best indoor climate stability;

Church in Gerling in the country of Salzburg got a pure, damage preventive heating with solar support

Chapel in Schönbrunn Castle, Vienna, during EU project 'SMooHS' got simple wall heating, dry walls and indoor climate stability with only small winter heating.

Keywords: sustainability, energy-saving, indoor climate stability, museums climate, preventive conservation

P-3305-10

Promoting Renewable Energy in India for Sustainable Agriculture:Issues and Challenges

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Agriculture and its allied sectors constitute as the largest livelihood provider to and also contributes to 18 per cent of GDP. India accounts for 17% of the world population but has only 4 % share in energy consumption and within this very less share of renewable energy usage.(Pillai and Banerjee 2009). The state of Punjab occupies less than 2 per cent of geographical area but accounts for 17 per cent of wheat and 11 per cent rice production in national pool. Inspite of green revolution, desertification, land degradation in the form of depletion of soil fertility ,reduction in groundwater table and furthermore less supply of electricity and wider gap in demand and power supply of power had aggravated the problems of the small and marginal farmers.

The statistical facts regarding degradation of land and non-availability of continuous power supply depicts the volatile picture of crumbling agriculture sector and its impact on sustainable livelihood. In order to address the problems, Government of India has formulated many policies and programmes at Union level and State level like National Mission on Energy Efficiency, Biomass Energy for Rural India, Solar and Wind Energy Projects .It had also set up various institutes and organisations i.e The Solar Energy Centre ,A Centre for Wind Energy Technology and Solar Energy Corporation of India. These institutes works for promotion of renewable energy resources and works with collaboration with State Governments and other allied departments.

An Attempt has been made in this paper to assess the implementation of various initiatives of Government of India to address the complex problem of degradation of environment and promotion of renewable energy resources. This Paper is written by using secondary sources. The data is collected from Annual Reports of Ministry of New and Renewable Energy, Government of India, Bureau of Energy Efficiency and Annual Reports of State Governments, books, journals, internet, websites of agencies who are involved in Energy Conservation in India. SWOT is used to assess the implementation of Promotion of Renewable resources in India.

The finding clearly reflects that Innovations for use of renewable energy must be promoted through community based financial organizations(CBFOs), co-operative societies and in order have to make access to these programmes to farmers. Well organised programmes must be organised at village level in order in increase awareness and access of the farmers. Building communication between people can only help in dissemination of techniques for using wind and solar energy for energy generation

Strategical interventions by the state through policies and programmes for use of renewable energy and active participation of farmers in implementation will pave the way towards the sustainable agriculture by using renewable resources of energy generation.

P-3305-11

Toward a Development and Co-Benefits Focused INDC for India

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India's response to global climate change is rooted in meeting the country's development needs, and aspires to be consistent with its sustainable development objectives. This is articulated as a co-benefits approach in the Intergovernmental Panel on Climate Change and in India's National Action Plan on Climate Change. The approach emphasizes measures which promote development objectives such as the ability to provide sufficient energy, ensure access to quality energy for all, address energy security and local environmental concerns such as air pollution, land and water use, while also yielding co-benefits for addressing climate change effectively. In light of this context, our paper examines recent projections for India's possible energy and climate futures by synthesizing and comparing the outcomes of seven policy salient modeling studies from India. The analysis illustrates the limited extent to which the available studies inform an achievement of co-benefits, that should underpin India's energy and emissions approach. It also identifies the basis for focusing on key areas of mitigation potential and those of uncertainty that require further analysis. The range of projections is assessed, including the reasons for the range. Based on an assessment of recent energy studies, the second part of the paper develops a methodology to overcome the existing limitations of the studies with respect to characterizing co-benefits. We delve into a single sector and use the case of energy efficiency in India's buildings, which has amongst the highest mitigation potentials, to showcase an approach to operationalizing co-benefits. A multi-criteria decision analysis framework is used. The results are based on a range of stakeholder views and a detailed evaluation of trade-offs (economic, technological, institutional) which can be required when selecting between different policy options. Approaching mitigation options using the showcased framework makes policy actions comparable and also takes into account questions of implementation and feasibility, which model results alone are not able to address. In examining the building energy efficiency case, the paper provides a proof-of-concept of operationalizing co-benefits which can be extended to other sectors. Importantly, it demonstrates how India's climate commitment in the form of an Intended Nationally Determined Contribution can be built around a bottom-up analysis of various domestic sectoral actions that achieve multiple objectives of development. In conclusion, this work presents an approach to climate and development for India that is a combination of an economy-wide metric (which does not rely on only one modeling output), and a set of analytical sectoral actions with a consideration of co-benefits and resulting tradeoffs. Such an approach lends robustness and credibility to India's domestic and international climate and development stance. The paper is amongst the early studies that attempts to further the literature beyond co-benefits conceptualization to its actual operationalization in the context of low carbon planning.

P-3305-12

ICT is part of climate change ! Can we reduce its impact and apply good practices and tools to others society domains ?

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Information Communication and Technology comprises a variety of heterogeneous technical products : datacenters, networks and myriads of fixed and mobile terminal equipments.The power world consumption of ICT was around 112 GWatts in 2013 (divided between in near equivalent datacenters, networks and end-users equipments). The amount of dispersed CO2 is considered as equivalent to the aviation industry. This pollution and associated energy consumption is constantly and rapidly growing. As any other industrial technology and product, ICT equipments face a complex lifecycle from the design (with rare metals), transport, to the usage and (possible) recycling. This worldwide lifecycle is responsible to consequent greenhouses gases production.

This oral contribution will follow and present a complete life cycle approach applied to ICT :

- Most of numerical models do not take into account greenhouse gases production during design and transport phase. This talk will explore technological issues of an eco design of ICT equipments. The usage of rare metals and their impact on planet level must be taken into account. Potential impact for extended product life and repairing possibilities will be discussed. A focus will be provided on relevant examples from eco-aware industry.

- A lot of research initiatives (academic and industrial) are currently focused on energy efficiency during usage phase. This talk will review the most relevant ones and present their potential of impact at large scale. We will review

the challenges in energy monitoring of large distributed computing systems(from clouds to networks supporting BigData scenarios) and proposed associated metrics, code of conducts and best practices examples. Some rebound effects will be explored. Major hardware and software based energy saving capabilities will be analyzed and discussed.

- Worldwide, most of current ICT equipments are not (even partially) properly recycled. But properly processing electronic waste is mandatory if we want to efficiently influence ICT lifecyle. This talk will present some examples and explore the effect of applying good practices in recycling.

As second part, this presentation will also explore potential energy savings provided by ICT which can impact other society domains at large scale. From visio conference to social networking, ICT can support new range of services helping to reduce their potential impact on climate change. But these services must be carefully exposed and analyzed in order to support a full understanding of their benefits.

P-3305-13

An ex-ante quantification of the Energy Efficiency Gap

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This work presents a methodology for estimating ex-ante the energy efficiency gap and key related energy system parameters. An ex-ante quantification of the, 'energy efficiency gap' is defined as the difference between market and techno-economic potentials. The ex-ante market potential is estimated from coefficients established with a top-down (econometric) modelling of energy demand using data from the period 1970 to 2005 (Ó Broin et al, 2015). The ex-ante techno-economic estimates are made using a bottom-up building stock model (ECCABS) that assesses the effects and cost-efficiency of various energy efficiency measures (Mata et al, 2013). We implement the method for the case of useful energy demand for space and water heating in the Swedish residential sector up to 2030.

Background: The true size of the energy efficiency gap remains unclear (Gillingham and Palmer, 2014). Findings from research on the energy efficiency gap could help policy makers generate social and private benefits from accelerating the diffusion of energy-efficient technologies (Gerarden et al., 2014). Although the general thrust of contemporary research on the energy efficiency gap is focusing on empirical studies that describe decision making among heterogeneous energy-users (Gillingham and Palmer, 2014) the authors of this work believe that there is also a need for system-level or sector-level studies which can give insights into key system-level parameters affecting the adoption of efficiency technologies, such as energy prices and discount rates. Furthermore, although the historical failure of the techno-economic energy efficiency potentials to be realised has been well documented ex-post, few, if any, studies have undertaken an ex-ante measure of potentials with the intent of learning from the comparison of the market and techno-economic potentials.

Results: In comparison to the level of energy use in 2005 (74 TWh), the top-down model predicts for 2030 reductions in demand of 21 TWh. The bottom-up model predicts corresponding reductions in demand of 31 TWh. Thus, there is an energy efficiency gap calculated of 10 TWh in 2030. An implicit discount rate of 10% would render the results from the bottom-up modelling identical to those from the top-down modelling. Conversely a doubling of the historic rate of support for technology diffusion and conservation through, for example, support schemes and regulations, would render the results from the top-down modelling identical to those from the bottom-up modelling.

Increasing energy prices as a policy measure, as implemented in this work, does not lead to significant additional savings, as shown by the top-down model. The combination of high energy prices and a long-term price elasticity of -0.29 would ceteris paribus result in a decrease in demand of only 4 TWh by Year 2030 as compared to a low energy price scenario. This suggests that while higher energy prices may achieve a global carbon target or cover the requirements of a Pigovian tax, at the residential sector level they are not so effective. The findings of this work i.e. the magnitude of the implicit discount rate; the price elasticity; and the size of efficiency gap; provide useful guidelines for policy formulation to meet individual country and regional climate and energy goals.

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P-3305-14

A design matrix for energy sustainability of buildings with double skin envelopes in warming climates in the tropics

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Adapting buildings to extreme temperatures due to climate change, demands a collaborative effort to deal with climate, occupants and buildings. A current technology to assist with this approach is called "bio-climatic design approach". It is seen as an appropriate basis for climate responsive design which involves the way buildings filter the climate for occupants' comforts. This approach has gained recognition for the application in medium scale buildings in moderate climates. However, this is less researched and problematic due to indoor overheating potential in warm humid climates. Thus needs to be investigated in the effort of adapting buildings to warming climates.

The project will contribute to establish that building design can play a key role in combating extreme temperatures involving a shift towards new bio-climatic design solutions focusing on passive climate control with form and fabric of buildings. The method used in this research reviews trends in predicted climatic behaviors in tropics, and evaluates critical practice exemplars found in local climatic zones in Sri Lanka. The project presents a generalized matrix of evidence-based interventions from associations that publicize case studies and literature exploring the potential for adapting buildings to predicted extreme climates. Use of onsite investigations, and advanced computer-based Design-Builder simulations for assessing and predicting adaptive capabilities of buildings will become essential components of the method.

Innovative potential of envelope dependency, which optimizes the building-climate interplay for reducing the need for energy in building operation, is highlighted with the matrix. This is more complex and critical when envelope dependency is not fully resolved in buildings located in the tropics where environmental loads external to the buildings contribute more significantly to the thermal load profiles of buildings. Unresolved envelop dependency contributes to indoor overheating in many ways. The paper takes this challenge by developing a cross-dimensional performance approach of buildings focusing on the dependency of the microclimate, plan form, sectional form and envelope.

An integrated characterization of energy sustainability of buildings is proposed based on the matrix, which is a conceptualization of built environment as a building-climate-occupancy system. The matrix aims at strengthening envelope dependency of a building considering it as a bio-climatic entity contributing to

sustainability and low emission building practices. One holistic performance indicator is used for evaluating such contribution, so expressing the climate modification – the reduction from ambient to internal air temperature. Discussion on the efficacy of the matrix shows that it works as an empirical tool supporting to gaining an insight in resolving any dualities associated with performance within the envelope dependency.

The research found that most certified green buildings in the country are either of core dependent or envelope dependent but highly energy intensive. Methodology involved few field investigations of selected certified green buildings using data loggers that collected air temperature, radiation, wind flow and envelope surface temperatures and the use of a computer based Design-Builder simulation program. Empirical findings showed the criticality of the problem and unresolved duality associated with envelope dependent forms – heat gain Vs passive influence. The buildings are found to be highly energy intensive with an Energy Utility Index around 196-260-KWh/m2/a although they are certified either as Gold or Platinum. Research further showed indoor-overheating situations when buildings were allowed to run free without air conditioning.

The simulation program used to redefine the energy sustainability of the most critical case building introducing resolved envelope dependency involving a high thermal mass double skin external envelope and a vertical atrium for thermal buoyancy effect. Calibrated simulation results provide evidence of passive cooling with internal air temperatures in all multi levels of the building moving 2-3.5 degrees C below the ambient levels due to improved and resolved envelope dependency with heat removal, stack force and night ventilation. Findings showed a reduction of EUI up to 98 KWh/m2/a suggesting that the matrix can play a positive role in innovating envelope dependency for emission reduction.

P-3305-15

The importance of the sun as clean source of energy in the design of cold storage for health care facilities in africa

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Sun is the main source of energy to several planets, especially to the Earth and its inhabitants. It lightens the surface of the Earth free of charge, and its energy is clean.

However, we do not fully benefit from the sun's energy which is precious to the humanity and can be used as the best source of electricity. The solar energy that the Earth's atmosphere, seas, forests and soils benefit is more than billions of Joules per year.

Africa is a place of hope and has a better position in term of climate change but its population, in majority, is poor and exposed to variable viruses, diseases and threats which are still killing due to lack of access to cure and drugs of quality.

In laboratories where medicines are manufactured and in hospitals where human bloods are collected and stored to both improve and better the conditions of patients, we need their good preservation either in transit or in storage.

In rural and urban areas, solar powered cold room units would be of wide benefit to the healthcare facilities.

This study is based on theoretical analysis and calculations of Solar Powered Cold storage for healthcare facilities in Africa, as well as some comparisons made between different sources of energy to keep thermolabile medicines and blood bags in good conditions according to the pharmaceutical guides and health standards.

As the future of the Earth depends on its ecosystem, the gratuity of the solar energy is the precious fuel which led our design project.

The methodology used in the present study employs both qualitative and quantitative research techniques.

P-3305-16

Strategic policy packages to deliver energy efficiency in buildings – theoretical analysis and international evidence

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Energy efficiency in buildings and appliances has the potential to halve the energy consumption and greenhouse gas emissions from that sector by 2050, despite growth in building and appliance stock. However, this potential will not become reality without policy support, due to complex market chains with many types of actors, and a plethora of barriers they face. What are, then, effective packages of policies and measures to stimulate energy efficiency in new and existing buildings, and appliances? In recent research, we have addressed the question in a systematic way – by combining theoretical evidence on what policy support markets need, and an international comparison on which packages of policies have worked well.

On the theoretical side, the analysis starts with the barriers but also market-inherent incentives that the different types of market participants face. This enables to derive a recommended package combining the types of regulatory, economic and other policies and measures the actors need to overcome all these barriers and strengthen incentives. On the empirical side, evidence on model examples of good practice for policy packages has been collected and their design and impact compared, to check if advanced countries have indeed used the combination of policies we derived from the actor-centred analysis. Finally, the model examples, lessons learned, and the preconditions for their transferability are used to validate the generic policy package identified in the theoretical analysis.

In this way, we found that the recommendable policy package for new buildings is similar to the well-known one for appliances, but with the objective to mainstream nearly zero energy buildings. By contrast, the task for existing buildings is two-dimensional – increasing the depth of renovation first, to savings of 50 to 80%, and then the rate of energy-efficient renovation to 2% or more p.a. – and so the policy package needs more emphasis on individual advice, incentives, and financing. The paper will present the recommended packages as well as a comparison of existing national policy packages from Denmark, Germany, Singapore, Tunisia and California (USA) and what we learned from it for effective packages and implementation.

P-3305-17

Solutions for the improvement of energy efficiency in historic buildings and districts preserving their heritage value

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Buildings have a significant impact on energy use and environment. Growth in population, increasing demand for building services and comfort levels, together with time spent inside buildings, assure that the upward trend in energy demand and CO2 emission will continue in the future. This situation is strongly related to the emissions from existing buildings, as 50 million buildings throughout Europe are 50 years old or more. Europe can become the leader in CO2 emission reduction by applying innovative energy efficient solutions to its built historic and cultural heritage. However, most of the current developments in energy efficiency typically address new constructions and individual buildings without considering on one hand the unique problems of historic structures and on the other hand the urban dimension.

These issues are faced within the research project EFFESUS (Energy Efficiency for EU Historic Districts' Sustainability), funded by the European Union 7FP (Grant Agreement no.

314678). Its main objectives are: i) the study of measures and tools to improve the energy efficiency of historic buildings and districts whilst protecting and preserving their cultural and historical values; ii) the development of new technologies as well as a software tool to support decisions on improvement measures. In particular a methodology is being developed for assessing the impact of implementation and selecting the most proper energy efficiency interventions in historical buildings and districts whilst ensuring the compatibility with their heritage values. This methodology is based on indicators, i.e. qualitative and/or quantitative information associated to the retrofit process under observation, which allows to verify the accomplishment of the goal or the related impact. These indicators are evaluated on a five point scale both for the initial conditions of the existing stock and for the conditions after the implementation of the interventions. The main output will be a Decision Support System (DSS), where the possible retrofit measures are prioritized in function of their potential impact, with the aim to assist stakeholders in decision-making. The DSS will be based on real data including also climatic change predictions.

The applicability of the technological developments, as well as the suitability of the DSS are being demonstrated in five case studies. In particular the following innovations are being tested: new thermal insulating mortars for use as plaster and render in Benediktbeuern (Germany); radiation selective coatings for outdoors in Istanbul (Turkey); blown-in aerogel for use in cavities behind existing wall finishes in Glasgow (United Kingdom); windows with improved insulation and ventilation, as well as intelligent indoor climate solutions through energy management algorithms in Budapest (Hungary); implementation of new control strategies to decrease the primary energy demand in historic buildings and districts in Santiago de Compostela (Spain).

The preliminary results of the performance assessment of the new technologies developed in EFFESUS will be presented mainly in function of the indoor environmental conditions and operational energy indicators on the basis of the monitoring activities carried out in the above mentioned five case studies. These activities have been launched in function of the readiness of the developed technologies and are now running for several months. The parameters, defined in function of the technology to be validated, are currently being measured simultaneously in a test area and in an equivalent reference area for reasons of comparison. The only exception is in Benediktbeuern where the comparison is performed before and after the application of the thermal insulating mortar. In particular the thermo-hygrometric conditions (temperatures, relative humidity, and air flow) and the energy related parameters (heat flows, energy consumption, associated cost of the energy, etc.) are being studied. These data are being used to assess the performance of the innovative solutions in terms of: indoor comfort expressed as PMV and PPD values (EN 15251), air quality (CO2 levels, ventilation rate), percentage of reduction of primary energy demand, reduction in energy consumption per m2, Kg CO2 emissions/m2, contribution of RES to the districts and buildings energy demand for heating/cooling, district heating contribution to the buildings/district energy demand.

P-3305-18

Fixing or transferring environmental problems in the transport sector?

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Worldwide, the transport sector produced 7.0 GtCO2eq of direct greenhouse gas (GHG) emissions, which corresponds to approximately 23% of the total energy-related CO2 emissions. Regionally, such as in the EU, the transport sector was responsible for 25% of the energy-related GHG emissions. Although the recently adopted EU target is to reduce GHG emissions levels by 80%-95% from 1990 levels by 2050, the European Commission stated that the goal for the transport sector is 60% because of its complexity. From 1970 to 2010, the direct energy use associated with transport has grown by 250% worldwide—a growth rate that is higher than any other sector.

Based on the above it is evident that the current transport systems are not sustainable. Without a substantial change in governmental policy, this trend will continue. The scope of the thesis is to examine how rich countries, such as the U.S as well as in countries and regions in the EU and the (OECD), can achieve sustainable mobility, taking into account the problems related to various transfer effects. A reason that sustainable mobility has not been achieved could be that transfer effects have not been fully understood by policy makers nor in the sustainable mobility discourse (Holden, 2012). For example, increased technological efficiency and innovation are frequently discussed as strategies to mitigate climatic gas emissions and energy use in the transport sector. However, the idea of a technological and policy quick-fix is highly problematic because often a proposed solution by policy, innovation or technology only transfers the environmental problem to other life cycle stages, to other emissions categories, to other countries, or to increased demands across levels from the micro to the macro level and this situation is a paradox that needs to be addressed in future planning.

This abstract examines three «transfer effects»: 1. Rebound effects, 2. Environmental trade-off effects and 3. Geographical transfer effects. The following research questions are addressed in the covering essay:

- Are transfer effects the reason of why energy use and Greenhouse gas (GHG) emissions in the transport sector keep raising?
- What are the similarities and differences between the transfer effects?
- Why have such effects been overlooked in policy making?
- What could be done to mitigate them?

Studying rebound effects addresses how efficiency measures taken at the micro level do not necessarily lead to society-wide reduction. Despite improvements in intensity of grams of CO2 per kilometer for passenger cars in the EU and US, energy reduction has been outweighed by increased total kilometers travelled and sales of larger vehicles (Holden, 2012). This might be explained by rebound effects concerned with systemic and behavioral responses. For example, the cost savings from buying a fuel efficient car could be used to drive farther (a direct rebound effect) or to purchase other energy consuming activities. To fully understand rebound effects, I argue that it is necessary to take an interdisciplinary approach.

Life-cycle and energy-chain analyses, which could be considered studies of indirect rebound effects, look at products from cradle-to-grave. Both compare products at the micro level and identify environmental hotspots during production and could be used to study fuels and transport systems or to compare transport systems.

How we account for environmental transactions affects transport-emission results. Currently, international air transport of people and goods and international transport by ships are omitted from GHG-emissions inventories. They are based on the so-called Kyoto protocol way or national demarcation of accounting for GHG emissions. This implies that some of the fastest growing areas are overlooked in available GHG-emissions statistics, which are based on national territories.

P-3305-19

Reducing Methane Emissions Using a Fixed Bed Reactor Under Dynamic Condition

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The production oil and gas is the largest human-made source of methane emissions in Indonesia and the fourth largest human-made source of methane emissions globally. Methane is referred to as a potent greenhouse gas because it has a Global Warming Potential, GWP of 21. This means that methane is 21 times more powerful than CO2 at trapping heat in the atmosphere over a 100-year period. Methane emissions primarily result from normal operations, routine maintenance, leaks and system upsets from connections between pipes and vessels or to valves and equipment. Reducing these emissions can have significant environmental and economic benefits.

The catalytic treatment is one of the most reliable alternatives to reduce of methane emissions. However, due to the concentration of emitted methane is low,

the flow rate changes over time and the temperature is ambient. The conventional treatment using once-through direction of fixed bed reactor operating under steady state conditions is less appropriate. For the methane content of 0.5%-v, the adiabatic temperature rise is approximately 115oC. As a result, extra external energy is required to increase the temperature of the feed gas. Reverse flow reactor was applied to overcome this problem. To increase of methane conversion may be induced by changes of the reaction rate over Pt/g-Al2O3 catalyst surface due to dynamic system operated at proper time scale. Therefore, there are two important aspects to be considered; (1) reactor design and (2) operation method. The aim of this study was to develop a new method in order to determine the reaction mechanism and rate-controlling step that occur in one dynamic cycle. The model reaction used was methane oxidation using 0,3%-wt Pt/γ-Al2O3 operated under dynamic conditions. At which the pattern of the reverse flow reactor was approached using a once-through direction of fixed bed reactor with composition modulation. It was based on the similarity of the reactor's response measured at the outlet, which is usually used for sampling.

The method used in this study was a steady state approach consisting of 4 stages; (1) the first stage was to determine the homogeneity of the continuum model of a fixed bed reactor that will be used to validate the model reaction mechanism and the rate-controlling step in dynamic conditions. (2) The second was determination of the model reaction mechanisms and rate-controlling step of the steady state condition. (3) The third was to identify the influence of the perturbation on response of the reactor in term of conversion in the dynamic condition. Furthermore, the validation of the model reaction mechanism obtained at steady state on methane conversion obtained in the dynamic operation was performed. (4) The fourth one was to establish the model reaction mechanisms and rate-controlling step that occurs in the dynamic conditions. This identification was accomplished by taking some perturbation points in term of CH4/O2 feed gas concentration ratio involved in the dynamic range to be performed the steady state experiment. The result of this identification was subsequently conducted the segmentation in order to obtain the mechanism change plots and rate-controlling step in one cycle period. Furthermore, the validation of the model reaction mechanism and dynamic kinetic parameters with dynamic experimental data were indispensable.

The influence of the perturbation on response inducing the dynamic conditions in the reactor can be expressed by the ratio of the feed gas concentration of CH4/O2 with methane conversion obtained. The use of the model reaction rate of Langmuir-Hinshelwood on pseudo-homogeneous model of mass for 1-D could not fully describe the characteristics of methane conversion obtained through experiments in the dynamic conditions. The deviation in term of error obtained was very large, i.e. 40%. In one cycle of dynamic operation, there were three mechanisms of reaction involved, i.e. the total oxidation of methane to CO2 and H2O, the partial oxidation of methane to CO2 and H2, and the decomposition of methane to C and H2O. The transition of reaction mechanism in one cycle of dynamic operation was based on the ratio changing of the concentration of CH4/O2 due to feed composition modulation applied.

P-3305-20

Mapping and Modelling multiple benefits of energy efficiency and emission mitigation in China's cement industry at the provinces level

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China's cement industry is the second largest energy consumer and key emitter of CO2 and air pollutants. It accounts for 7% of total energy consumption in China and 15% of CO2, 21% of PM, 4% SO2 and 10% of NOx of total emissions, respectively. Provincial disparities in energy consumption and emissions of CO2 and air pollutants in China's cement industry are rarely quantified. In this study, an integrated assessment model including provincial energy conservation supply curves (ECSC) (which can shows the cost-effective and technical energy saving potential per province), the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model (which can be used to calculate air pollutant emissions), and ArcGIS (a geographical information system (GIS) with elaborated spatial functions) is developed and used to assess the potential of energy savings in terms of emission mitigation of CO2 and air pollutants and multiple benefits of energy efficiency measures at the provincial level during the period 2011-2030. The results show significant heterogeneity across provinces in terms of potential of energy saving as well as emission mitigation of CO2 and air pollutants (i.e. PM, SO2, and NOx) in the next two decades. Seven provinces (i.e. Shandong, Sichuan, Jiangsu, Guangdong, Zhejiang, Henan, Hebei), six of which are located in the central- and east- China, account for 47% of the total energy saving potential, equivalent to 26% of baseline energy use in 2030. The energy efficiency measures can help decrease 38% of CO2, 23% of SO2, 33% of NOx, and 26% of PM emissions in these seven provinces by 2030. This indicates that the multiple benefits should be considered when local policy makers or end users make decisions whether to use energy efficiency measures to solve environmental issues.

3306 - Transitioning from fossil fuels and avoiding lock-ins

ORAL PRESENTATIONS

K-3306-01

The role of fossil energy in conventional and carbon-constrained worlds

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The transition between today's fossil-dominated energy system and one based on low-carbon supply sources will be a decades-long process. Getting from here to there will present a number of challenges, not least of which are phasing out of the ubiquitous fossil fuel infrastructure that has been built up over the past century and a half and providing the necessary incentives for foregoing the ample deposits of fossil energy lodged within the Earth's crust. In this regard, future advancements in fossil technologies, fossil resource endowments and the long-term development of fossil fuel prices are important factors that will critically influence the nature and direction of the global energy system.

This talk will summarize recent literature emanating from the global integrated assessment modeling (IAM) community which has explored the role of fossil energy (coal, oil, and natural gas) in its various energy and emissions scenarios for the twenty-first century (both in low-carbon pathways and in fossil-dominant counterfactuals). The studies to be discussed principally include those from multi-model inter-comparison projects, such as EMF27 (Energy Modeling Forum), AMPERE (Assessment of Climate Change Mitigation Pathways and Evaluation of the Robustness of Mitigation Cost Estimates), LIMITS (Low climate IMpact scenarios and the Implications of required Tight emission control Strategies), and RoSE (Roadmaps towards Sustainable Energy futures), among others.

The diverse modeling frameworks employed in these studies highlight large uncertainties in the likely development of fossil resource consumption, trade, and prices over the course of the twenty-first century and under different climate policy frameworks. A seemingly robust finding across the suite of IAMs is that the upper end of cumulative fossil fuel consumption foreseen by the models is well within the bounds of estimated recoverable reserves and resources. Hence, fossil resource constraints are, in and of themselves, unlikely to limit future GHG emissions this century. And while a vast amount of unconventional gas resources have recently become cost-competitive and could alter the future energy landscape,

the climate may be no better off because of it, given the emissions impacts elsewhere in the energy system. Further, analyses show that globally agreed mitigation policies could lead to a major reallocation of financial flows between regions, in terms of expenditures on fossil fuels and carbon; carbon leakage could become an issue in fragmented policy environments; and carbon lock-in and the eventual premature retirement of fossil infrastructure are realities to be mindful of if major mitigation efforts are delayed beyond 2020.

K-3306-02

The market and lock-in effects of new fossil fuel infrastructure, and the need to integrate supply- and demand-side climate policies

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Climate policy and analysis often focus on energy production and consumption, but seldom consider how fossil fuel supply and transportation infrastructure shape energy systems. US President Obama, among others, has recently brought these issues to the fore, stating that he would only approve the Keystone XL pipeline, connecting Canadian oil sands with US refineries and ports, if it does not significantly increase global greenhouse gas emissions. In this presentation, based on our paper in Nature Climate Change (doi:10.1038/nclimate2335) we show how such infrastructure investments, through market effects, could affect fuel use and global GHG emissions on a scale similar to national policies aimed at reducing fossil fuel consumption and GHG emissions. We contend that in order to increase the effectiveness and efficiency of meeting climate protection goals in the coming decades: (1) examination of supply-side investments and their implications for fuel markets, consumption, and emissions, needs to be undertaken widely and systematically; and (2) policies addressing the supply side need to be considered and integrated with more typical, demand-side climate policy. The presentation will synthesize insights from recent literature (e.g., Erickson and Lazarus 2014, Collier and Venables 2014, Faehn, Hagem, et al 2013, McGlade and Ekins 2015), and suggest areas for further inquiry and action for research and policy communities.

K-3306-03

Commitment accounting of CO2 emissions: long-term consequences of current investments

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Any limit on future global warming is associated with a budget of cumulative CO2 emissions, such that annual global emissions must ultimately approach zero. Yet, unless retrofitted or retired early, currently new and existing fossil fuel-burning infrastructures commit us to future CO2 emissions over their expected lifetimes. I will highlight the results of two recent publications, Davis and Socolow [1] and Raupach et al. [2], which together describe trends in 'committed' emissions related to energy infrastructure and how these commitments compare with the remaining budgets of emissions under different climate targets and the options for sharing this budget among nations. Next, I'll show how the expansion of economic fossil fuel reserves (e.g., by exploration, innovative extraction methods, or improved transport infrastructure), may also represent commitments to extract and burn these fuels [3]. Finally, I'll discuss the required carbon intensity of new investments given the constraints of a cumulative carbon budget and existing capital stock, with explicit comparisons to a range of top-down energy-emissions scenarios. The combination of such top-down global scenarios and bottom-up appraisals of real-world trends may inform policies that minimize international carbon leakage and carbon lock-in (or stranded assets).

[1] S. J. Davis, R. H. Socolow, Commitment accounting of CO2 emissions. Environmental Research Letters, (2014).

[2] M. R. Raupach et al., Sharing a quota on cumulative carbon emissions. Nature Climate Change 4, 873 (2014).

[3] H.D. Matthews, A growing commitment accounting to future CO2 emissions. Environmental Research Letters, (2014).

O-3306-01

A global abundance of natural gas increases the challenges of climate change stabilisation

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The US economic gains and carbon emission reductions associated to the recent US shale gas boom are frequently mentioned to portray natural gas as a bridge technology to a low-carbon future. Having half the carbon footprint of coal, natural gas seems indeed an attractive carbon mitigation option. As a result, several countries including China, India, Mexico, Poland and the UK are seeking to take advantage of the late technological improvements (e.g. hydraulic fracturing, horizontal drilling ...) and replicate the US development. If successful, this collective endeavour could bless the world with a global abundance of natural gas that would lead to a ''golden age of gas''. Regular upward revisions in natural gas resources - and decline in associated extraction costs - support the possibility of such future. However, should global warming be limited to below 2°C with high probability, this global gas bonanza would have to occur simultaneously with a global energy transition aiming at reducing worldwide greenhouse gas (GHG) emissions to zero or below by 2100.

Economic theory suggests that the global energy transition can be efficiently orchestrated by setting a global price on carbon emissions. Nonetheless a global carbon price regime is still subject to fierce debates during climate negotiations and will most likely be implemented with a several year delay. Currently, the climate political landscape consists of a mosaic of regional carbon markets and national technology policies. In this context, can a global abundance of natural gas facilitate the global energy transition by reducing its costs, fostering the deployment of low-carbon technologies and reducing CO2 emissions?

We address this question by generating various scenarios with a global model of the energy-economy-climate system. These scenarios differ along two dimensions: the degree of natural gas supply and the delay to implement a global carbon price consistent with a 2°C target. Our results show that seeking to expand natural gas supply whilst trying to protect the climate would bring short-term benefits such as higher GDP, lower electricity prices and reduced short-term mitigation costs. However it would also increase medium- and long-term mitigation costs substantially, owing to larger CO2 emissions and hence higher CO2 prices. Differences in aggregated discounted consumption losses over 2011-2100 between an abundant-gas and a conventional-gas world amount to more than 0.25 percentage points.

Interestingly, living under a "gloden age of gas" increases the opportunity costs of climate change mitigation, partially because of lock-ins in natural gas technologies. This can be seen by looking at differences in GDP growth reduction. Even though GDP growth is only marginally reduced by an increase in natural gas supply over 2015-2030, this reduction becomes much larger over 2031-2050. More importantly, a delay in comprehensive climate policies leads to more than a quadrupling in GDP growth reduction over 2031-2050 compared with immediate climate action. Consequently not only climate change stabilisation becomes more challenging to achieve in a gas-abundant world but it is even more difficult when climate proection is delayed.

O-3306-02

South Africa's planned coal infrastructure expansion: drivers, dynamics and implications for carbon emissions

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South Africa has both domestic climate mitigation objectives and has pledged internationally to reduce its

emissions by 34% and 42% below a business as usual baseline by 2020 and 2025 respectively. The peak of this emissions trajectory has already almost been reached. While mitigation policy has filtered into electricity planning processes, limiting demand for coal in the longer-term, both the state and private actors are at the same time investing (or planning to invest) in supply side coal-related sectors. Besides Eskom's large-scale coal-fired power plants currently under construction and the possibility of extending the lives of Eskom's older coal-fired plants, a coal-based independent power producer procurement programme has recently been announced. This power infrastructure depends on maintaining security of coal supply.

Geological factors, domestic market impacts of past high coal prices and other cost increases in the Central Basin (where most coal is currently mined) have lead, however, to serious security of physical supply and affordability concerns for Eskom in the medium to long-term. Coupled with political support for expansion of the coal sector both domestically and for export, new investments in the Waterberg coalfield are widely viewed by Eskom, the coal industry and parts of the state as the long-term future of the South African coal industry.

The presentation will briefly outline the implications of planned supply side fossil fuel investments in South Africa, using the results of an extraction-based emissions analysis of the coal industry's South African Coal Road Map scenarios.

Under these scenarios it is likely that South Africa will exceed its carbon budget to 2035. Furthermore, meeting coal demand depends on several upstream investment decisions that are being taken without consideration of either the direct impacts on emissions or the indirect effects on domestic or export coal prices, in particular new rail investment decisions. Such decisions result in increasing economic and financial lock-in of current supply systems.

Coal has historically been, and remains, key to the political economy of South Africa. Part of the explanation for the support for the Waterberg coalfield expansion lies in economic arguments put forward by the industry, which has argued that coal from the Waterberg is significantly cheaper than current and future supplies in the Central Basin. However, evidence for this claim remains limited. More broadly, political support remains important; both in supporting coal-fired electricity, liquid fuels and upstream coal mining in general, and for the Waterberg expansion in particular.

Both the major mining houses and several junior miners are connected to the new political elite; either through large-scale Black Economic Empowerment (BEE) deals, or through direct ownership interests in smaller firms. BEE policies, including Eskom procurement and rail and port access designed to encourage black-owned junior miners, contribute to linking the industry to actors in the ANC and to actors in government who are supportive of BEE as an economic policy. The Waterberg coalfield furthermore provides new investment opportunities for the mining industry, thus providing a focal point around which rail, BEE and coal interests have coalesced and leading to socio-political lock-in.

There is a mismatch between the political economy of the coal (and broader energy) sector and the mitigation efforts of certain parts of the state (based on the implementation of a carbon tax and on sectoral carbon budgets to be imposed on the economy). Despite numerous technical assessments of demand-side policy options to reduce emissions, current institutional arrangements reflect the power of coal-based economic and political interests in Eskom, Transnet, the state and politically connected elites. It appears that transformational energy policy that reduces the extraction of coal is limited by the political make-up of post-apartheid South Africa. Without the integration of supply side investment decisions with future carbon constraints, the country runs the risk of further exacerbating the systemic lock-in of South Africa's high emissions trajectory.

P-3306-01

Unconventional Gas in the Context of Annex 1 Climate Policy

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Recent work has illustrated the geographic distribution of 'unburnable' fossil fuel reserves under climate policy constraints (McGlade and Ekins, 2015). Natural gas is often referred to as a transition fuel but typically with little specific qualification of quantities of consumption, rates of transition and end point targets. All of these aspects can be informed by a national cumulative emissions budget approach (e.g. Friedlingstein et al, 2014). We therefore consider national and temporal dimensions of unconventional oil and gas production and consumption taking the UK case of shale gas development as an illustrative example. Recoverable quantities are found to be susbtantially lower than anticipated in UK energy policy discourses. The evidence and arguments presented are largely applicable to other unconventional gas resources such as coal bed methane (CBM), underground coal gasification (UCG) and shale oil, in other Annex 1 (industrialised) nations.

Shale gas and shale oil are fossil fuels produced by hydraulically fracturing, 'fracking', impermeable shale strata. Gas and oil residing in these and similarly impermeable reservoirs, such as coal measures, are termed "unconventional" resources. Technological developments in this area have substantially increased expectations of recoverable fossil fuel resources (McGlade et al 2013). The scope for unconventional oil and gas production and consumption in Annex 1 countries to contribute efforts to avoid the 2°C characterisation of dangerous climate change has been outlined to date (Broderick and Wood, 2014). Under reasonable assumptions of national and sectoral apportionment, the simple arithmetic of emissions budgets make it clear that Annex 1 nations require a transition to a low carbon energy system in the next two decades (Anderson and Bows, 2011). This limits the time available over which unconventional resources may be extracted and combusted and hence quantities likely to be recovered under a stringent climate regime. We quantitatively illustrate this in relation to existing UK regulations, structured by the Climate Change Act (2009), and the emissions budgets arising. Conditions for oil and gas export, including a quantitative assessment of the prospects for carbon capture and storage (CCS), are then discussed in relation to global emissions budgets and recent developments in the US energy industry.

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P-3306-02

Energy security and climate policies: An unequal marriage

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The quest for energy security and concerns over climate change caused by greenhouse gas emissions are top energy policy priorities worldwide. To complement the growing body of literature on energy security implications of climate change mitigation, this paper examines the two-way interaction between pursuing energy independence and reducing greenhouse gas emissions. Using 5 state-of-the-art energy-economy models and 6 long-term global scenarios, our analysis calls for closer and more thoughtful coordination between these policy priorities. First, we show that the pursuit of ambitious yet realistic energy independence targets would result in an insignificant reduction of greenhouse gas emissions (5%-15% over the 21st century compared to the Baseline) that will not be sufficient for achieving even the current modest climate pledges. In other words, the climate will not be saved as a 'side-effect' of energy security policies. Second, fulfilling the existing climate pledges would not significantly affect energy imports of major economies though pursuing stringent climate stabilization targets would radically reduce these imports. Third, the modeled energy independence targets could be achieved at policy costs comparable to those of the current climate pledges but ten times lower than those of the stringent climate policies. In other words, advocates of cost-efficient energy independence may have little reason to support either stringent climate policies (because of their significantly higher costs) or current climate pledges (because of their relatively minor impact on global energy.

P-3306-03

Key Issues in Energy, Climate Change and Environment

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Policies that respond to climate change and other environmental issues will increasingly impact the development of the global energy sector. The transition to low-carbon economies will need to be carefully managed, as the provision of secure, affordable energy is critical for economic growth and social development. More than ever, there is a need for a fuller understanding of the opportunities to promote synergies between energy, environmental and climate policies.

Energy, Climate Change, and Environment: 2014 Insights helps address this need with indepth analysis of selected policy questions at the energy-climate interface, including:

- How can we accelerate the transition from (i.e., "unlock") existing high-emissions infrastructure?
- What are the best ways to design cost-effective emissions trading systems that fit with national circumstances?
- What are some alternative energy-specific metrics that support near-term emissions reductions and long-term decarbonisation of the energy sector?
- And, in the special focus of this report, can curbing local air pollution help reconcile energy priorities with environmental sustainability, including greenhouse gas mitigation?

Addressing these questions will help inform decisions that can boost decarbonisation of the energy sector while taking into account security and economic objectives. This report also features an update of key energy and emissions statistics for ten world regions that should interest energy practitioners and climate policy makers alike

P-3306-04

The 3 CRISIS: EEE (ENERGY, ECOLOGY AND ECONOMY)

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Our common future is conditioned by three World crisis: Energy, Ecology and Economy ones. To face them it is necessary to implement an inter disciplinary approach capable to find the interlink of these three issues. The present paper wants to apply system Σ approach to discover the possible connections among energy, ecology and economy disciplines. Those linkages should be able to propose change and unveil possible hidden interlinks.

System approach implies define, operation and control of overall and global Σ system defined by its structure SΣ, its specific parameters PΣ and its variability VΣ. The system Σ depends upon EEE: Σ = f (E, E, E,). Out of the three crisis , the first and most important one is the energy that has a urgent need for real and right definition of cost, relation, availability, and proportion among fossil (oil, gas and coal), renewable and nuclear sources. Second one is the ecology with an holistic approach to the ecosystem services and their importance in the sustainability due to its inherent importance in different climate scenarios.

The third one is the economy. In this global context, paramount is the economy deception that acts and works as director. Knowledge and information economy appears to be the most probable way to cope with common future overcoming the economy deception phase and present difficulty. Quality of life has been improved according to almost exponential pattern during past ages. However, human quality of life is nowadays strongly influenced by the Standard Environmental Impact Factor I = PxAxT, in different Countries (super-developed, developed and under-developed and so on) of the World. Same approach is valid for all the biodiverse beings. There is a strong need of interlinks among these three main concepts of EEE. From the history point of view the classical main causes of World degradation, by starting with population reduction, have been wars, pestilences and famines. To cope with a better future, these main causes can and must be avoided, starting with a strong improvement of science, knowledge and information among people.

Consequently, the solution for an appropriate common future is to build a new economy based upon undeceived energy and ecology (including biodiversity) knowledge and information among people all over the World. To these purposes and to get over the EEE crisis, the holistic approach i.e. the system Σ approach has to be applied in order to delete deceptions anywhere and anytime.

3307 - Negative emissions for climate change stabilization & the role of CO2 geological storage

ORAL PRESENTATIONS

K-3307-01 (part1)

The concept of negative emissions

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Future warming is contingent on the cumulative CO2 emissions until 2100. A maximum of 1,200 GtCO2 can be emitted from 2015 onwards in order to stabilize climate below a global average of 20C above pre-industrial conditions by 2100 with a probability of 66%. At the same

time, emissions from fossil fuel combustion and cement production have increased substantially over the last decade – to 61% above their 1990 level. Reaching 2°C in a cost-effective way will demand strong mitigation action across all sectors. The further we delay mitigation, the greater the challenges will be in the future. One strategy that is currently widely discussed is the deliberate removal of CO2 from the atmosphere by human intervention; that is, not merely going carbon-neutral, but even carbon-negative. Negative emissions in the majority of Integrated Assessment Model (IAM) scenarios aiming at keeping warming below 2°C in the IPCC's Fifth Assessment Report (AR5) are mostly achieved through the production of sustainable bioenergy with carbon capture and storage (BECCS). Some scenarios also feature afforestation for carbon dioxide removal. Other options under discussion involve biochar, enhanced weathering and direct air capture. Indeed, by including negative emissions (mostly from BECCS) into our mitigation portfolios, we could effectively double the carbon quota of about 1,000 Gt CO2.

In this keynote, the concept of negative emissions will be introduced and their role in current stabilization pathways will be illustrated and discussed. Most 430-480 ppm and many 480-720 ppm CO2eq scenarios feature net negative emissions in the second half of this century. However, negative emission technologies are often deployed earlier, even if it does not lead to a net negative balance. An overview of the challenges that the reliance on negative emissions brings with it will serve to frame the individual contributions in the rest of the session. The focus here will be not only on potentials, but also on the implied tradeoffs e.g. with other policy objectives. Clearly, it is not only important to understand when negative emissions will be needed and in which form they can be sustainably and cost-effectively achieved in theory, but it also needs to be put into the context of where such options would be deployed. For example, in the case of BECCS, huge amounts of biomass will be needed as feedstock, yet the most productive areas to produce this biomass might have other policy priorities than climate change mitigation and other mitigation options such as protecting forests might be more popular for their perceived co-benefits.

K-3307-01 (part2)

Limits to negative emissions technologies

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Despite two decades of effort to curb emissions of carbon dioxide and other greenhouse gases, emissions grew faster during the 2000s than in the 1990s, and reached an all-time high of ~50 thousand million tonnes of carbon dioxide equivalents in 2010. Given this level of emissions and growth trajectory, it will be challenging to meet the international goal of limiting climate warming to less than 2°C. Because of this, carbon-negative solutions – technologies that remove carbon dioxide from the atmosphere – are being proposed. In this paper I give an overview of the carbon-negative solutions available, before looking at some of the environmental and economic implications of their widespread implementation. I show that carbon-negative technologies differ greatly in their costs and n their potential environmental impacts. For example some, such as direct capture of carbon dioxide from the air by engineered chemical reactions, have limited environmental impact but are extremely expensive, while others, such as use of biomass burning to replace fossil fuels in energy production with the capture of the carbon dioxide produced by combustion (known as BioEnergy with Carbon Capture and Storage; BECCS), are inexpensive but potentially use a lot of land, putting pressure on land currently used for food production or biodiversity conservation, with a wide range of potential environmental impacts. I conclude by looking at some of the opportunities presented, and risks posed, by reliance on carbon-negative technologies for climate stabilization.

K-3307-02

Latest developments, opportunities and challenges for CO2 storage

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Carbon dioxide Capture and Storage (CCS) is recognized in the IPCC's 5th Assessment Report as part of the mitigation technology portfolio that must be deployed in order to reduce CO2 (carbon dioxide) emissions and keep the global average temperature change to less than 2 °C relative to pre-industrial levels. Underground storage of CO2 captured at plants in the fossil-fuel energy, bioenergy and industrial sectors is a promising option to reduce emissions into the atmosphere by returning the initially extracted carbon back into the ground, and may also be used to remove CO2 from the atmosphere.

The CCS concept to mitigate emissions from fossil-fuel and biomass fired power plants and from the processing and cement industry consists of three main components; the capture installation, transport infrastructure by pipeline or ship and geological storage structures in the deep subsurface. Promising geological storage media are deep saline aquifers and depleted oil and gas fields. In Europe, the North Sea region which is rich with oil and gas reservoirs, offers a promising area for CO2 storage. Several countries around the North Sea are developing plans for CO2 storage activities including the United Kingdom, Norway, the Netherlands and Denmark. Demonstration of CCS is developing at great pace in North America. Recently, the large integrated CCS project Boundary Dam started to operate in Canada.

Inventories of storage potential presented in atlases and Geographical Information System (GIS) databases and maps have been performed in many areas of the world including the USA, Australia and Europe showing that there is great potential for CO2 storage. Storage potential in Europe has been estimated at 360 Gt CO2, 244 Gt of which is available in the offshore region (GeoCapacity project, 2009). The challenge is to test the effective storage capacity of promising geological storage media through detailed characterisation and field testing, moving from a resource estimate towards a reserve estimate.

The technology for CO2 storage is largely derived from the oil and gas industry including evaluation of reservoir performance and drilling technology. Underground storage of natural gas in diverse media is a widespread and common practice in many regions of the world. Since the nineties several storage projects have been developed e.g. the large-scale storage of CO2 in the Norwegian offshore. On land, several CO2 storage pilots, in different stages of development are present e.g. in Spain and Germany. The challenge is to demonstrate large-scale CO2 storage integrated into a full CCS chain project. Several projects for large-scale demonstration of CCS in the offshore sectors of the UK and the Netherlands are in the preparation phase.

The cost of CCS is estimated at 60 to 90 Euro per tonne CO2 in the demonstration phase (reference year 2015) which could drop to 30 to 45 Euro for projects at an early full commercial scale stage (reference year 2030; McKinsey, 2008). The costs of storage in the early commercial phase range from 4 to 12 Euro per tonne CO2 depending on the location and the type of storage structure (Mckinsey, 2008). Lowering the costs of the capture installation is the biggest challenge. Financing of CCS projects is currently faced with the low price of emission allowances of less than 7 euro per tonne CO2 (EEX, 10 March 2015). An effective CCS enabling policy with a mature emission trading market is needed.

Containment of the injected CO2 in the reservoir is a prime requirement for CCS to be an effective CO2 abatement technology. For this reason modelling and monitoring of the CO2 in the subsurface receives a lot of attention. The European CCS Directive addresses the key aspects of safe and environmentally sound CO2 storage. The current Directive seems to be fit for purpose but needs more extensive testing in real-life CO2 storage projects.

The public at large is not well informed on CCS technology and its objective of abating CO2 emissions. In onshore settings, people sometimes have shown resistance towards this new technology, like in some initiatives in Germany and the Netherlands. In other instances, like for the CO2 storage pilots near Hontomin in Spain and near Ketzin in Germany, the local people show a positive interest in these activities. Participation of the public from an early stage of project development onwards is key to making people aware of CCS and getting them engaged in these projects.

O-3307-01 (part1)

Enhanced weathering and BECCS - are carbon dioxide removal technologies complements or substitutes?

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In its fifth assessment report, the IPCC stated that scenarios which "are consistent with a likely chance to keep temperature change below 2°C relative to pre-industrial levels [...] are characterized by [...] emissions levels near zero GtCO2eq or below in 2100» (Edenhofer et al., 2014, Summary for policymakers, IPCC Fifth Assessment Report of Working Group III). To reach such low CO2eq emissions, net negative emissions will be necessary in some sectors to compensate for e.g. CH4 and N2O emissions from the land-use sector or industry process emissions. There are at least four options to achieve net negative CO2 emissions: The combination of bioenergy with carbon capture and storage (BECCS), afforestation, direct air capture, and enhanced weathering of rocks.

Enhanced weathering (EW), the deployment of finely ground minerals over forests and crop lands, could be used to remove CO2 from the atmosphere. It faces neither the technological nor the social risks of the other options. However, olivine, the mineral that is best suited, might be contaminated by potentially harmful trace elements. Other sources like basalt can have lower harmful element concentrations, but show lower CO2 sequestration potential.

Our research questions are: What are the optimal design parameters for EW? How does EW as a mitigation option interact with BECCS?

An important parameter that determines costs as well as carbon removal rate is the grain size. We first calculate an optimal grain size that maximizes profits, taking the dependency on carbon removal rate and costs into account. Second we use the calculated parameters for the implementation in the integrated assessment model REMIND and show preliminary results of EW as a mitigation option.

When EW is available as a mitigation option, it provides net negative CO2 emissions which allow for higher CO2 emissions earlier in the century. The slower reduction of CO2 emissions results in a lower CO2 price and therefore lower mitigation costs. We will analyze under which conditions EW is used as a substitute or complement to BECCS. In addition, we analyze scenarios where CCS is not available. In combination with a stringent climate target, these scenarios often show very high mitigation costs or become unachievable. We will investigate to what extent EW can substitute BECCS in this case.

O-3307-01 (part2)

Addressing technical and resource challenges in delivering negative emissions

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Approaches that remove carbon dioxide from atmospheric air are likely to be an essential enabling 'backstop' technology for a world that has to keep within a fixed carbon emissions budget to avoid dangerous climate change. Such technologies must be available to be scaled up if necessary to deliver the required carbon dioxide (and other greenhouse gas) emission trajectories.

Present technology can deliver carbon dioxide removal (CDR) or 'negative emissions' using biomass with 'conventional' CO2 capture and storage (BECCS). BECCS is probably the best way to use most types of available biomass. For example, battery electric vehicles using BECCS electricity production provide a highly efficient route for using a wide range of biomass materials in transport compared to conversion to liquid fuels. Adding carbon dioxide capture and storage would give a further negative CO2 emission of about 125 g/km to set against other lifecycle emissions. In buildings, rather than using biomass directly for heating, the same amount of fuel can give similar results if used to generate electricity that can then power heat pumps, plus give negative emissions when combined with CCS.

Although BECCS can make a useful contribution to mitigating the risk of dangerous climate change it cannot be regarded as a robust backstop technology. Especially in a climate-stressed world it cannot be assumed that sufficient amounts of biomass will be available for this to be the only route. Here Direct Air Capture (DAC) by engineered systems that can be multiplied as required using mass-produced standard components appears to be an essential option for many societies.

In a number of cases DAC facilities are likely to be combined with power plants with CCS. They can share CO2 transport and storage facilities and hybrid technologies would be used also to reduce residual CO2 emissions from the fuel in the power plant to very low levels. DAC technologies can also, however, be located elsewhere. For example, developers could choose to locate DAC facilities close to CO2 storage sites to minimise time and cost associated with establishing CO2 transport infrastructure and also to optimise the use of global storage resources.

Costs for DAC technologies currently being proposed may appear high, but in the context of cancelling out emissions from hard-to-avoid liquid fuel use (as an offset or via fuel synthesis) estimated additional costs are of the order of 1 euro per litre. Some or all of this cost may be offset against reductions in oil prices if there is no other way this oil can be used. Also, when hydrocarbon fuels are used in power plants that operate in a high-renewable electricity system at low average load factors the cost of abatement using power plant CCS can increase significantly. Ultimately this can mean that power plant CCS loses its cost advantage when compared with DAC plants capturing the same amount of CO2 over an extended period of time that are able to choose to operate all of the time.

Getting to zero, or negative, global emissions is becoming accepted as the challenge the world must overcome. This paper will demonstrate that delivering carbon dioxide removal technologies beyond BECCS is key to researchers and industry helping to deliver a successful response to this challenge.

O-3307-02

The use of carbon capture and storage in mitigation scenarios – an integrated assessment modelling perspective

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Carbon capture and storage (CCS) plays an important role in the model-based scenarios consistent with stringent targets published in the literature, as emphasized in the IPCC 5th assessment report. In scenarios, CCS is partly used in combination with fossil fuels as a mean to reduce greenhouse gas emissions. CCS is also combined with bio-energy (bio-energy-and-CCS, BECCS) to create negative emissions. In the presentation, we will look at the existing literature and discuss 1) total use of CCS and associated use of storage capacity in the different scenarios, and 2) look into the use of negative emission technologies. The AR5-DB offers the opportunity to provide an in depth analysis of CCS technologies are employed for different climate targets and other assumptions. The results show that CCS is increasingly used in combination with bio-energy for increasing stringency of mitigation targets. It also shows that CCS use can be substantial in some IAM scenarios, providing a challenge from storage and transport, land use (for BECCS) and public acceptance perspective.

O-3307-03

Assured capacity for geological storage of carbon dioxide

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This presentation will consider the latest scientific developments in two key issues for carbon dioxide (CO2) storage; how can sufficient and accessible CO2 storage capacity be assured prior to any investment decision for a large-scale CO2 Capture and Storage (CCS) project; and how can CO2 storage be implemented in a manner that is safe for humans and the environment? Assured geological storage capacity that is accessible on the required timescale is a key concern for reaching a positive Final Investment Decision; storage capacity is fundamental to the success of a CCS project. There are a number of recognized methods for estimating storage capacity, ranging from simple volumetric calculations to flow models. Each of these has advantages and disadvantages in terms of accuracy, data requirements and cost. Typically, accuracy of capacity estimates increases throughout the project from screening through geological characterization to site development and operation as more data becomes available. Any uncertainties in estimated storage capacities need to be communicated effectively to stakeholders. Data is one of the key issues in assuring storage capacity; the more data defining reservoir characteristics that are available, the more accurate the assessment of storage capacity. Strategies for optimizing the use of available data for storage assessment are emerging from recent projects. Assured capacity also has a regulatory and financial dependency; the cost for accessing the storage capacity needs to be affordable (e.g. with a relatively small number of injectors and located such that the transport distance is not excessive) and storage needs to be permitted by regulations. Flexible storage solutions also raise interesting regulatory issues, for example, how will stacked storage be permitted? Strategic planning for CCS is required, assessing the national and international energy landscape and considering how to satisfy the requirements of society for affordable, dependable and sustainable energy sources with low greenhouse gas emissions. Strategic planning for geological storage of CO2 is also required to ensure the most efficient use of the subsurface. Early demonstration projects have highlighted the need to allocate sufficient time upstream for thorough geological characterization such that storage sites are available when needed; geological assessment of the potential storage site needs to start during the very early phases of the project and this in turn needs to be built on early, strategic, national assessments. Ensuring that CO2 storage is carried out in a safe manner requires actions at all stages of the CO2 storage lifecycle from thorough pre-injection risk-led geological site characterization to effective monitoring, measurement and verification (MMV) of the site during injection to understanding of long term storage site evolution during the post-injection phase. Models of the storage site are iteratively updated as new data and new techniques become available. Thorough site characterization includes testing the reservoir and seal response to CO2, for example, the threshold (capillary entry) pressure for CO2 to enter the cap-rock needs to be determined. Best practice recommendations on understanding how risks to storage site security can be mitigated have been produced by recent projects. Demonstrating the site is behaving as expected through MMV is key to ensuring the CO2 storage site is safe. New (low cost) monitoring tools specifically designed for use at CO2 storage sites have been developed and new techniques are being tested at lab-scale. For example, techniques and technologies for rapidly detecting and confirming leakage (if it occurs) are being developed and tested as are mitigation and remediation measures. Practical experience gained at pilot and test injection sites allows demonstration of innovative monitoring technologies and strategies as a first step towards new techniques that will be ready for market in the future. Experiments at natural analogue sites are also important in understanding longer-term processes and potential impacts of leakage. Onshore CO2 storage pilot projects offer an opportunity for public engagement as they are relatively easy to access, this can include communication with the general public on the safety of geological storage of CO2 and the role of CCS as a key greenhouse gas mitigation option. Pilot sites also offer the opportunity for site-specific communication activities to interact with the local community, improving public outreach strategies. Communication on geological storage of CO2 is one of the main activities undertaken by CO2GeoNet in its role as a pan-European research Association.

3307-POSTER PRESENTATIONS

P-3307-01

How much negative emission is physically needed to keep global warming below 2°C?

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RCP 2.6 is the only representative climate change scenario produced for the IPCC Fifth Assessment Report that likely limits global warming to less than 2°C above preindustrial levels. Following such a scenario needs a strong reduction in the net amount of fossil CO2 released into the atmosphere by humankind. This reduction can be achieved by a combination of «conventional mitigation», i.e. decreasing global fossil-fuel consumption, and «negative emissions», i.e. engineered removal of atmospheric CO2 (be it through on-site capture and storage, direct air capture, enhancement of natural carbon sinks, etc.). As part of the current debate on the role negative emissions might play in reaching the 2°C target, we quantify the trade-off between conventional mitigation and negative emissions in RCP 2.6. We use a three-step approach to do so. First, we take fossil CO2 emission trajectories estimated to be compatible with this scenario using Earth system models. Second, we make assumptions about maximum feasible pathways of conventional mitigation, covering a wide range of possible futures. Third, for each of these pathways, we deduce the gross negative emissions as the complementary amount of carbon that needs to be captured when conventional mitigation alone is not enough to follow the pathway compatible with the RCP2.6 scenario.

If conventional mitigation starts in 2015 at a -5% yearly rate (our best case), a maximum removal rate of 5 GtCO2/yr and a storage capacity of 550 GtCO2 are required. If conventional mitigation starts in 2030 at -1% per year (worst case), those requirements are 33 GtC/yr and 4800 GtCO2 respectively. The latter figures range from 25 to 40 GtCO2/yr and from 3500 to 6000 GtCO2 respectively, when accounting for our lack of understanding of the carbon-climate feedback. However, the ultimate product of our study is an abacus where one can make assumptions on future conventional mitigation and read the negative emission requirements - and associated uncertainty - compatible with maintaining global warming below 2°C, as estimated by state-of-the-art Earth system models.

When comparing our mass-balance estimates of gross negative emissions to those by Integrated Assessment Models (IAMs), ours fall in the lower end of the range. This logically follows our approach of always choosing conventional mitigation over negative emissions when the mitigation potential allows it. Our approach thus provides a physical lower bound of negative emission requirements for a given mitigation potential. Conversely, in integrated assessments negative emissions may be chosen over conventional mitigation at any time, depending on which

is found more economical to develop under assumed costs and technological potentials. Here, our study does not rely on assumptions about technologies and costs (but on the assumed mitigation potential). Another major difference with studies using IAMs is that ours rely on state-of-the-art Earth system models. Despite the drawback of having to set some drivers exogenously, it allows a comprehensive assessment of the uncertainty related to the future response of the carbon-climate system. Here, we show this uncertainty can be greater than the results between two different mitigation floor assumptions. It emphasizes that the uncertainty surrounding any policy decision related to negative emissions primarily comes from our lack of understanding of the future behavior of the Earth system.

To conclude, we find that negative emissions are required at significant levels (i.e. >1 GtC/yr) even for very aggressive mitigation floors. Given that negative emission technologies are still at an early stage of development, this pleads in favor of developing (financial) mechanisms to put them on a technological learning trajectory. But then, in all but the most optimistic cases, we also find negative emission requirements that have not yet been shown to be achievable: be it the flux of removal or the storage capacity. Following others, this study suggests that negative emissions alone are unlikely to be the panacea that will limit global warming below 2°C, and that conventional mitigation should remain a significant part of any climate policy aiming at this target.

P-3307-02

Negative emissions - interactions with other mitigation options

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Many scenarios in IPCC's recent Assessment Report (AR5) find that there is a need for negative emissions in order to stabilize at concentration levels consistent with 2°C above pre-industrial levels. This demand is under present technology assumptions largely covered by combining bioenergy with carbon capture and storage (BECCS). One major concern is that high feedstock potentials are supposed to be located in forests of the southern hemisphere, i.e. in the tropics, which is where at the same time forests are most vulnerable to deforestation. Consequently, a land-based mitigation option such as large-scale bioenergy production (w/o CCS) will interfere with options that are popular for their large co-benefits such as reduced emissions from deforestation and degradation (REDD+). Thus, based on a multi-scale bottom-up modeling approach (using an integrated land use model coupled with a global forestry model), this study aims to identify and quantify possible tradeoffs (i.e. land use-based mitigation options compete for the same land) and synergies (i.e. both options provide incentives to keep an intact and sustainably managed forest) between REDD+ and BECCS. The global results elicit the system interactions. However, they do not necessarily shed much light on the situation on the ground. Thus, a regional analysis will be carried out, zooming into Indonesia as an important tropical basin that is assessed with respect to REDD+ and BECCS interactions. This country has been chosen as a pilot region for REDD+BECCS because it looks back at decades of heavy deforestation, has established a strong palm oil sector and its remaining forests face high pressure from agriculture and a relatively developed infrastructure network. Our analysis shows that avoiding deforestation can have many implications for the establishment of sustainable bioenergy. It is therefore imperative to align REDD+ and BECCS strategies in the future for achieving optimal mitigation potentials.

P-3307-03

Incentives for the Research, Development and Deployment of Greenhouse Gas Removal Techniques

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Climate models that achieve the policy objective of limiting warming to less than 2°C do so by assuming not only extremely fast reductions in emissions, but also the deployment of technologies that remove greenhouse gases from the atmosphere at a massive scale. Yet there is no substantive research to validate the assumption that such proposed Greenhouse Gas Removal (GGR) techniques could be deployed at the scale implied.

This presentation will address the issue of the incentives required for researching, developing and deploying GGR techniques. It will examine the reasons for the current absence of such incentives and explore how the development of a technology that could safely, scalably and economically remove CO2 from the atmosphere and sequester it permanently could result in a rational, moral and global carbon price.

P-3307-04

Negative emissions in sustainable transition : Which role for bioenergies and CCS?

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Carbon Capture and Storage (CCS) is a technology that aims to capture CO2 coming from static emitters such as coal-fired electric plants, then to transport it by pipelines until a geological reservoir (e.g. saline aquifers), where the CO2 is stored definitively. It is then an "end-of-pipe" technology, so it avoids to release pollution in the environment, but does not change the production process itself, contrary to renewable energies or improved energy efficiency. Besides, CCS needs additional energy - named energy penalty - and could reinforce the current technological lock-in in fossil energy. However, CCS could also allow a rapid decline of emissions on existing production facilities by the end of the century, when alternatives (such as renewable energies) will be fully deployed. In this case, the current sociotechnical regime based on fossil energies could be maintained for a while.

BECCS (Bioenergy and Carbon Capture & Storage) is a CCS niche that adds a CCS process on a bioenergy production unit.. Industrial sectors such as biofuels, electric generation from biomass (or coal and biomass) or paper production are concerned. BECCS could change our point of view on the CCS role into the sustainable transition, as it could provide negative emissions, which means that more GHG emissions are avoided than emitted during a production process. Instead of being released into the atmosphere during biomass transformation, carbon is definitively stored. If biomass transformation is assumed nearly carbon neutral, BECCS should effectively lead to negative emissions. This has been checked in a few cases in academic literature (IEA GHG, 2009; Laude et al., 2011). In addition, a synergy between BECCS and geothermal energy recovery has been recently explored in the CO2-DISSOLVED project (Kervévan, Beddelem, & Neil, 2013). This process is adapted to small or medium emitters, like BECCS emitters are in most cases. It could reduce significantly the energy penalty due to CCS.

The aim of this paper is then to investigate the specific role of BECCS into the sustainable transition, and more precisely its impact on its timing. This issue has been discussed mainly through Integrated Assessment Models (IAM), which compute the evolution of the worldwide energy system under climate constraint until the end of the century. IAM modeling is one of the main tools used by IPCC for its forecasts and recommendations. It is then widely considered that CCS and BECCS could be key technologies to keep temperature increase below 2°C, especially if worldwide actions are delayed.

We use here a different point of view to deal with this issue: the Multi-Level Perspective (MLP). This conceptual framework analyses transition as a mutation process from one sociotechnical regime to another, under the pressure of macro-level forces (named the landscape), and the emergence of market niches that could provide the basis of the new regime (Geels & Schot, 2007). Here, climate change could be seen as a macro pressure (with economic and social aspects), that requires a deep change of the global energy system, i.e. the socio-technical regime. It is important to point out that both CCS and BECCS remain technological solutions, even if they require policy incentives and social acceptance. According to the

typology of Arundel, Kareva, and Kemp (2011), they belong to the "techno-fix" innovations, while other solutions are available, grounded on changes in user, market, and institutional practices, as Social Innovation (change in social uses) or Transformative Innovations (both changes in social uses and technology). On the contrary "techno-fix" innovations allow preserving past habits and institutional practices through the development of new techniques, and so could contribute to the lock-in effect.

Unlike CCS, BECCS competes no more with renewable energies and could help to get a low-carbon society. Actually, BECCS is likely to become available in the second part of the century. If mitigation is delayed, it could be used to fix an overshoot of CO2 emissions in the first part of the century, thanks to negative emissions. Given the uncertainties regarding CCS and BECCS development, this last strategy could be a dangerous bet (Fuss et al., 2014). Moreover, BECCS concerns involve also biodiversity damages and the risk of higher biomass and food prices. This contribution will discuss more deeply the challenges connected to BECCS until 2100.

P-3307-05

Development of Hybrid Coal with Bio-fuel Derived from Non-edible Resources and its Process

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The Korean government has implemented energy policies such as RPS and ETS to raise the share of renewable energy sources since 2012. Among the renewable sources, carbon-neutral biomass, particularly solid fuel, is immediately applicable in coal fired power plants, so a number of approaches to utilize bio-fuel by co-combustion with coal have been investigated. Hybrid Coal by Korea Institute of Energy Research (HCK) is a novel fuel for existing coal-fired power plants to cope with implementation of RPS, and we have published several articles related to the diversification of bioliquid to secure its feasibility. Many hydrophilic and hydrophobic bioliquids such as glycerol, bio-oils, and oil residues have been applied to saccharide substitutable substances, however crucial limitations of each bioliquid were found. For examples, glycerol having hydrophilic property is eligible to be impregnated in coal pores, which is primarily derived from ash, but moisture readsorption cannot be inhibited since Hybrid Coal with glycerol is not allowed to treat at desired temperature (250℃) for hydrophobicity as our previous work. Also, hydrophobic bioliquids like bio-oils and oil residues, unlike hydrophilic ones, cannot penetrate into hydrophilic coal pores, then most of them only coat the surface of coal or partially remain among coal particles. This may cause a decrease in thermal efficiency due to the heat imbalance and higher unburned carbon ratio in a power plant boiler from the difference combustion behavior between coal and biomass, consequently we have concluded saccharide is the best substance to produce Hybrid Coal. However, an ethical problem related to an edible substance might arise if a sugar cane-derived bioliquid is used. In the present paper, Hybrid Coal with bio-fuel (bio-ethanol process) derived from non-edible resources is first investigated to promote its feasibility.

P-3307-06

Can we bet on negative emissions to achieve the 2°C stabilization target even under strong carbon cycle feedbacks?

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Given the narrowing windows of opportunities to stay below 2°C, negative emission technologies such as Bioenergy with Carbon dioxide Capture and Storage (BioCCS) play an ever more crucial role in meeting the 2°C stabilization target endorsed by the Cancun Agreement (Fuss et al. 2014). Negative emission technologies - if deployable at a sufficiently large scale during the second half of this century - would make the 2°C target more feasible in the midst of the slow political progress and might allow current emissions unchecked for some time if stakeholders are in the process of converging to a platform to abate emissions globally. However, such technologies are currently at their infancy and their future penetrations may fall short of the scale required to stabilize the warming (Scott et al. 2013). Furthermore, the overshoot in the mid-century prior to a full realization of negative emissions would give rise to a risk because such a temporal but excessive warming above 2°C might amplify itself by strengthening climate-carbon cycle feedbacks, which are known to be positive albeit with large uncertainties (Friedlingstein et al. 2006). When one considers other classes of carbon cycle feedbacks including those with permafrost thawing and wildfire, such a risk could be even higher. It has not been extensively assessed yet how carbon cycle feedbacks might play out during the overshoot in the context of negative emissions, while the literature on carbon cycle feedbacks has burgeoned in recent years.

This study explores how 2°C stabilization pathways, in particular those which undergo overshoot, can be influenced by carbon cycle feedbacks and asks their climatic and economic consequences. We compute 2°C stabilization emissions scenarios under a cost-effectiveness principle, in which the total abatement costs are minimized such that the global warming is capped at 2°C. We employ a reduced-complexity model, the Aggregated Carbon Cycle, Atmospheric Chemistry, and Climate model (ACC2) (Tanaka et al., 2013), which comprises a box model of the global carbon cycle, simple parameterizations of the atmospheric chemistry, and a land-ocean energy balance model. The total abatement costs are estimated from the Marginal Abatement Cost functions for CO2, CH4, N2O, and BC, which are derived from Azar (2013).

Our preliminary results show that, if carbon cycle feedbacks turn out to be stronger than what is known today, it would incur substantial abatement costs to keep up with the 2°C stabilization goal. Our results also suggest that it would be less expensive in the long run to plan for a 2°C stabilization pathway by considering strong carbon cycle feedbacks because it would cost more if we correct the emission pathway in the mid-century to adjust for unexpectedly large carbon cycle feedbacks during overshoot. Furthermore, our tentative results point to a key policy message: do not rely on negative emissions to achieve the 2°C target. It would make more sense to gear climate mitigation actions toward the stabilization target without betting on negative emissions because negative emissions might create large overshoot in case of strong feedbacks. Our simple approach illuminates a need for investigating this issue further by using a range of models including coupled Earth System Model (ESM)-Integrated Assessment Models (IAMs) to serve for the framework to be agreed upon in COP21 and maintained beyond.

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P-3307-07

Developments, opportunities and challenges for Bio-CCS in order to achieve negative emissions

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Carbon Capture and Storage (CCS) is the only way to decarbonize fossil fuel. Large scale, full-scale demonstration projects such as the one in Boundary Dam Canada prove that this is an effective technology. A

similar technological approach can be taken in the cases of (Co-)firing biomass, biogas production and other biofuel applications, all of which can contribute significantly to a more sustainable energy mix, increased security of supply and a reduction of CO2 emissions. Both combustion and gasification routes to biomass conversion can be equipped with CCS which will result in most cases in a negative CO2 foot print.

First generation biofuels have some crucial limitations. By applying a thermochemical treatment process those limitations can be largely reduced. Typical thermochemical routes include pyrolysis, gasification, torrefaction and biochemical treatments. The products obtained are in most cases a combustible gas, solid char and CO2. The options for electricity and the scale of emissions generated reflect the biomass type and conversion route. Currently the main focus is to improve operational performance such as: efficiency, power flexibility and a (further) reduction of the emissions.

Large scale biomass combustion is mainly developed for the power companies, as a substitution for coal. Also standalone 250MWe CHP based on biomass pellets has been scrutinized by those companies. So far co-feeding of biomass in coal fired power station has been successfully accomplished at a level of 10-20% weight bases. Biomass polygeneration is based on partial oxidation (indirect gasification). The resulting syngas can be used as a raw material for the production of special chemical products or the production of hydrogen. The syngas can also be used to generate electricity and heat.

The integration with CCS brings with it specific challenges. Clever process integration is required as well as understanding the specific functional requirements. The use of Biomass required specific process conditions and material properties. In addition the use creates new types of impurities in the process and flue gas that :

- causes an increase corrosion (which in its turn affect amongst others the warrantee of the power plant);
- change the generic grid code requirements and more local grid requirements regarding ancillary services (power flexibility);
- have an effect on the requirements of the CO2 capture solvent;
- have a severe impact on the economics and
- finally the different operation modes compared to traditional fossil fuel large scale power plants has an implication on the downstream CO2 infrastructure, transport, use and storage.

The EERA joined program on CCS serves as platform to share the outcomes of research of the leading research entities in Europe and their program leads the way in the future joined development of Bio-CCS.

P-3307-08

From scenarios to reality - key issues with upscaling BECCS

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Substantial amounts of biomass energy with carbon capture and storage (BECCS) are used in the majority of emissions scenarios directed at limiting climate change to 2°C. The feasibility of these scenarios is an important concern for climate policy. We used an expert elicitation methodology to explore the key explicit and implicit assumptions that underlie these scenarios' use of BECCS to deliver so-called negative emissions. The process highlighted key interlinked issues surrounding land availability, land use and land policy; timing of technology and infrastructure developments; and policy incentives, verification and social acceptability. Whilst there was agreement over the potential for BECCS to remove CO2 from the atmosphere and produce energy, claims to its capacity are potentially being over-relied upon and overstretched under the policy pressure to generate emissions scenarios that meet a 2°C limit.

3308 - Fiscal Reform

ORAL PRESENTATIONS

K-3308-01

A balance of 'bottom-up' and 'top-down' in linking climate policies

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'Top-down' climate negotiations embodied by the Kyoto Protocol have all but stalled, chiefly due to disagreements over targets and objections to financial transfers. To avoid those problems, many have shifted their focus to linkage of 'bottom-up' climate policies such as regional carbon markets. This approach is appealing, but we identify four obstacles to successful linkage: different levels of ambition; competing domestic policy objectives; objections to financial transfers; and the difficulty of close regulatory coordination. Even with a more decentralized approach, overcoming the 'global warming gridlock' of the intergovernmental negotiations will require close international coordination. We demonstrate how a balance of 'bottom-up' and 'top-down' elements can create a path toward an effective global climate architecture.

K-3308-02

Do Chinese provinces successfully implement climate mitigation policies? A political economy approach

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China is expected to be a major actor in the design of a new global climate architecture. Its non-participation could lead to a substantial increase in GHGs concentrations by the end of 21st century (Paltsev et al. 2012). China has already managed to cut CO2 emissions in several energy intensive industries and is now endowed with good technological and scientific capacities (Rock et al. 2013). The central government has fostered the implementation of environmental policies which are now a priority of the new Chinese growth model. It has been however recognized that China's climate governance can further be improved regarding the coordination of national and provincial levels (Richerzhagen & Scholz 2008). This paper precisely intends to add to the debate between top-down and bottom-up approaches of climate mitigation policies in the context of China.

Indeed, the efficiency of climate policies in China is challenged by strong spatial i.e. provincial disparities. Provincial environmental characteristics are very different considering climate, geography, population densities, as well as urbanization and for instance, there is a very large diversity of energy intensity between provinces. The geographical distribution of China's energy intensity exhibits a characteristic of progressive increases from the eastern coastal provinces to the western provinces (Yu 2012). One of the most striking features of China is its decentralized organization and the strong power devoted to provincial governments. The leading officials have mainly focused on economic growth targets (Combes, Renard, Tapsoba, 2015) but environmental objectives are written in their responsibility contracts for few years. Local leaders sign individual responsibility contracts that embed energy or emission reduction requirements for their localities. The central government gives priorities at the national level and then assigns specific targets for the different levels (Kostka 2014).

This paper contributes to the understanding of provincial

climate mitigation policies and its aim is twofold. First an original index of climate regulation is calculated. It is devoted to the measurement of "revealed" efforts made by provinces aiming at downsizing GHGs emissions. This effort index is estimated by eliminating the impact of structural factors of CO2 emissions through a standardization equation. Second, an econometric analysis allows to a better understanding of the determinants of provincial climate policies. Policy implications are related to the need for more coordination between bottom-up and top-down policies to increase the efficiency of current practices. As the burden on provincial and national budgets may be very heavy, the choice of the level of implementation is a strong political constraint and need information on the provinces' efforts.

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K-3308-03

A public finance perspective on climate policy: Six interactions that may enhance welfare

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Climate change economics mostly neglects sizeable interactions of carbon pricing with other fiscal policy instruments. Conversely, public finance typically overlooks the effects of future decarbonization efforts when devising instruments for the major goals of fiscal policy. We argue that such a compartmentalisation is undesirable: policy design taking into account such interdependencies may enhance welfare and change the distribution of mitigation costs within and across generations. This claim is substantiated by analyzing six interactions between climate policy and public finance that are insufficiently explored in current research: (i) reduced tax competition in an open economy, (ii) portfolio effects induced through climate policy, (iii) restructuring public spending, (iv) revenue recycling for productive public investment, (v) greater intragenerational equity through appropriate revenue recycling and (vi) intergenerational Pareto-improvements through intertemporal transfers. We thereby structure the hitherto identified interactions between climate change mitigation and public finance and show that jointly considering carbon pricing and fiscal policy is legitimate and mandatory for sound policy appraisal.

K-3308-04

Environmental Tax Reform and Heterogenous Labor Markets: Can the Trade-Off between Environmental Quality, Efficiency and Income Distribution been Avoided?

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This paper investigates the distributional and efficiency consequences of an environmental tax reform, when the revenue of the green tax is recycled by a variation of labor tax rates. We build a general equilibrium model with heterogeneous imperfect labor markets, pollution consumption externalities, and where poor households spend relatively more on polluting goods than rich households (Stone-Geary preferences). We characterize the necessary conditions for the obtainment of the environmental and welfare dividends and we analyze the distributional properties of the green tax. We show that even in the case where the reform appears to be regressive, the gains from the double dividend can be made Pareto improving by using a redistributive non-linear income tax if redistribution is initially not too large. Moreover, the use of a non-linear income tax acts on unemployment and can moderate the trade-off between equity and efficiency. We finally provide simulations highlighting the room for manoeuvre for environmental tax reforms for the French case.

K-3308-05

A Carbon tax and the Risk of Inequity

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This paper aims at clearing up some misunderstandings about the social impacts of carbon taxes that proved to be a decisive obstacle to their further consideration in public debates. It highlights the gap between the cost of a carbon tax reform as it is spontaneously perceived by the taxpayers and the reality of its ultimate consequences: the real impact on households' poverty and inequalities is not mechanically determined by the initial burden of energy on consumption budgets and by the capacity of households to alleviate it, but also depends upon the use made of the tax proceeds and its general macroeconomic impacts. The comparison of five tax-recycling schemes highlights the existence of trade-offs between maximising total consumption, reducing unemployment, maximising the consumption of the low-income classes and reducing income inequality.

K-3308-06

Modelling of distributional impacts of energy subsidy reforms: an illustration with Indonesia

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Indonesia highly subsidises the consumption of electricity and oil products for both households and firms, and in 2011 was ranked the 10th country in the world in terms of total government expenditures on fossil fuel consumption subsidies (IEA, 2012). The energy subsidies represent a burden for government budget, a source of vulnerability for the economy and perform badly in terms of redistribution. Furthermore, fuel subsidies, by encouraging fossil-fuel burning, increase GHG emissions and local air pollution. This paper provides a quantitative assessment of fossil-fuel subsidy phase out in Indonesia, both at macro and micro level, with particular attention to distributional effects on households heterogeneous in terms of income structures and expenditure patterns. On this purpose, we combine a micro-level representation of households' incomes and consumption with a macroeconomic model. We enhance the dynamic global and multi-sectoral computable general equilibrium model, OECD ENV-Linkages (Chateau et al., 2014), by directly integrating a module describing the behaviour of more than 10,000 representative household groups for Indonesia. In the other regions, the final consumers are portrayed by a single representative household. The characteristics of the representative household in terms of preferences and endowments are based on national accounting data. The multi-household representation for Indonesia is based on integrating and reconciling this macroeconomic information with data from the fourth edition of the "Indonesia Family Life Survey" (IFLS4) realised in 2007 (Strauss et al., 2009).

The baseline scenario follows the macroeconomic projections of the OECD Economic Outlook and the

corresponding long-term projections (Chateau et al., 2014). All the energy policies included in the Current Policy Scenario of the World Energy Outlook 2013 (IEA, 2013) are considered except the reforms to the consumers' energy subsidies that remain at their 2011 levels. In the policy scenarios, we assume that, between 2012 and 2020, Indonesia unilaterally realises a gradual phase out of electricity and fossil fuel subsidies for households and firms. The scenarios differ by the budget-neutral compensating scheme for households they assume: cash transfers, subsidies on food products, and labour income support. An additional policy scenario envisions a global multilateral subsidy phase out and a cash transfers compensating scheme.

All the scenarios give way to positive impacts on GDP at the 2020 horizon (+0.4% to +0.7% in 2020 with respect to the baseline) due to a decrease in the deadweight loss associated with the subsidies and also, in some scenarios, to higher savings and investment. The cash transfer scenario (both unilateral and multilateral) determines the highest GDP outcome. The gains in terms of Equivalent Variation are even higher due to trade improvements consecutive to the reform, and range between 0.8% and 1.4% in 2020. The distributive direct effect of fuel price increase is regressive for households. The effects through labour and non-labour incomes are more or less distribution neutral. However, the redistribution schemes can make the total effect of the reform progressive and pro-poor. The cash transfer scenario is the most progressive among the scenarios investigated. The budget redistribution using food subsidies is less progressive than with cash transfers. Transfers proportional to labour income, as used in the labour support scenario, are regressive because the incomes from formal labour represent a higher proportion of total incomes for high-income households than for low-income households. The reform outcomes are also heterogeneous across rural and urban areas: the cash transfer and the food subsidy scenarios are more beneficial to rural than to urban households due to the lower share of energy expenditures in rural areas. The labour support scenario, in contrast, is less beneficial to the rural households, because of the greater importance of the informal sector in these areas.

The phase out of energy consumption subsidies contributes to reduce in energy-related CO2 emissions (between -10% and -12%) and GHG emissions (between -7.3%and -8.3%) in 2020 compared with the baseline. The emission reduction is mainly driven by a decrease of household energy consumption.

3308-POSTER PRESENTATIONS

P-3308-01

Optimal Environmental Taxation with Capital Mobility

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Climate policy exemptions for energy intensive sectors are often justified with distributional concerns. One concern is that households employed in energy intensive sectors might be affected disproportionally due to capital mobility. We find that when workers cannot move freely between sectors, a uniform carbon tax causes more inequality between the sectors when capital is mobile than when it is not. Since households benefit more directly from sector-specific labor taxes, than from carbon tax exemptions, the former are more effective in addressing the distributional wedge caused by capital mobility. In addition, we find that the differential effect of capital mobility depends on the government's degree of inequality aversion: Redistribution is more expensive when capital is mobile, so that highly inequality averse governments might even be better off without capital mobility.

How should a government take capital mobility into account when designing climate policy? There is a strong concern that climate policy affects energy intensive sectors disproportionally when capital is mobile. This motivates policy exemptions for these sectors. Papers considering exemptions usually consider one representative household. They find that exemptions are not optimal and conclude that carbon taxes should be uniform across sectors. In this paper we consider sector-specific policy as a means of addressing the sector-specific distributional effects created by the interaction of climate policy and capital mobility.

We build a model with two sectors of different energy intensity. To reflect the distributional concern we assume sectoral rigidity in labor mobility. The government maximizes a social welfare function which aggregates utility of the households working in the two sectors. The environmental objective is to reduce domestic carbon emissions, motivated for example by the objective to fulfill a carbon reduction target. We then compare the effect of environmental policy with and without capital mobility. We find that indeed climate policy introduces a bigger difference in utility of the households employed in the two sectors when capital is mobile. Based on this we determine the optimal policy package for reconciling distributional and environmental objectives. We find three major results.

The first result is that sector specific labor taxes are the most suitable instrument to redistribute among the sectors. Sector specific carbon taxes can indeed be justified, but the difference should be very small. In optimum, redistribution between sectors is mainly achieved through relatively large differences in labor taxes. When labor taxes are optimally differentiated between sectors, the difference between utility of the households employed in the different sectors is much smaller than in the case where labor taxes are constrained to be uniform.

The second result is that the reaction of the government depends strongly on its inequality aversion. A utilitarian government achieves a higher welfare under capital mobility since it benefits from the gains of (capital) trade. A strongly inequality averse government faces high cost of countering the inequality increasing effect of climate policy under capital mobility. The cost of redistribution might be so high that it could even be better off without capital mobility.

The third result is that climate policy creates a greater difference between capital and labor income under capital mobility than in autarky. The government's ability to counter this shift through labor tax cuts is weakened through capital mobility since the reduced demand for pollution means that carbon tax revenues are lower under capital mobility than in autarky.

3309 - Costs and benefits of adaptation: Lessons from developed and developing countries

ORAL PRESENTATIONS

K-3309-01

The Cost and Benefits of Adaptation in Developing Countries: Updated Review and Insights for Policy

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This paper presents the findings of a major review and synthesis on the costs and benefits of adaptation in developing countries, undertaken by the ECONADAPT project, funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 603906*, and with co-funding from the UK Department for International Development and by the International

Development Research Centre**.

While recent reviews (IPCC, 2014) have identified a low evidence base in this area, the last few years have seen a growing number of national initiatives and risk and sector specific studies. Over 500 relevant studies have been identified, and a growing number of these are in developing countries. The paper presents a review of this evidence base, focusing on estimates and insights for least developed and middle income countries. It starts with a mapping of studies, both geographically and by risk. This shows the coverage of adaptation costs and benefits has increased when compared to previous reviews. The geographical coverage now includes Africa, South and Central America and Asia, though there remain some important regional gaps. The coverage of risks has also increased: there is a very large literature on coastal zone adaptation, and increasing studies on water management, floods and agriculture. Major gaps remain, however, for ecosystems and business/industry.

The paper then summarises a detailed review of this evidence base and draws some policy lessons , using examples. From a policy perspective, there are now three distinct set of studies, using different methods. The first uses scenario-based impact assessment (I-A) and focuses on technical adaptation. The second uses investment and financial flow analysis (IFF) and considers likely mark-ups for adaptation. The final use the more recent focus on iterative risk management, low-regret options and decision making under uncertainty. The outputs of these approaches are very different in terms of framing and importantly the types of adaptation options. They also produce very different estimates of the costs (and benefits) of adaptation, which is of particular importance in relation to National Adaptation Plans and international climate finance. A key finding is that IFF studies indicate higher costs in the short-term, due to the consideration of the existing adaptation deficit, while policy orientated studies indicate higher adaptation costs in the medium- to longer term, due to the consideration of multiple risks, uncertainty, existing policy objectives and standards, and additional opportunity, transaction and policy costs.

The paper concludes with some key policy findings and future research needs. The latter includes the need for more empirical evidence at multiple time and spatial scales, and economic analysis of adaptive capacity, non-technical measures, opportunity, transaction and policy costs, cross-sectoral/cross-cutting effects and the limits of adaptation. Further work is also needed to understand transferability of existing estimates. A key priority is to further encourage the sharing of information and good practice.

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*The views expressed in this paper are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission. The European Community is not liable for any use made of this information.

**Co-funding was provided by: i) UK DFID, as part of the project 'Early Value-for-Money Adaptation: Delivering VfM Adaptation using Iterative Frameworks and Low-Regret Options' - this project has been funded by UK aid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies: ii) IDRC as part of the project 'The Economics of Adaptation and Climate-Resilient Development' - however the views expressed are entirely those of the study team and do not necessarily reflect the views of IDRC.

K-3309-02

Climate change adaptation: linking policy and economics in OECD countries

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This presentation will summarise the key findings of a forthcoming OECD publication on the Economics of Adaptation in OECD countries (released end May 2015), including a survey of these countries. By drawing upon policy-makers' experiences to date, this presentation will examine how economic analysis has informed policy development to date, and priority areas for further data gathering and tool development.

OECD countries are increasingly taking action to prepare for the effects of climate change. As of 2014, more than three-quarters of them have published, or are currently developing, national strategies for climate change adaptation. In preparing for climate change, countries are faced with the challenge of responding to a broad range of uncertain risks. The common element of their response is the emphasis on mainstreaming adaptation into government policies, with a focus upon capacity building. Based on the analysis in this paper, the following priorities emerge for evidence development and improved tools for economic analysis:

- Reducing barriers to usage: Increasingly sophisticated approaches have been developed to account for uncertainty about climate impacts, often in the context of large infrastructure investments. However, countries' experiences show that mainstreaming requires integration with existing appraisal systems for decision-making, and "light touch" approaches that are proportionate to the scale of the decision at hand.
- Achieving sufficient breadth of coverage: The evidence base on costs and benefits has significantly improved in recent years, as sectoral and national coverage has increased. However, major gaps remain in sectoral coverage. For example, impacts on businesses and ecosystems remain poorly understood. Modelling of macroeconomic interactions remains at an early stage. More evidence on these areas is needed to develop coherent responses to a changing climate
- Accounting for the distributional and normative dimension of climate change: Economic analysis provides an important input into the decision-making process, but it is also necessary to account for people's perceptions of the risks from climate change. In part, this is because decisions on how to respond to the risks from climate change frequently involve trade-offs between different values. In addition, the impacts of climate change will be felt most severely by the poor and the marginalised. Few studies based on OECD countries have accounted for these impacts to date.

K-3309-03

Global challenge and regional analysis - Germany's vulnerability and adaptation to climate change

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Overview
Although climate change is a global challenge, the effects occur locally and differ by region. The large timespan and the globality of climate change often obscure rather than clarify the discussion. Germany is located in a moderate climate zone; nevertheless it is vulnerable to disruptions due to its economic dependence on high-tech production sites. The largest disturbances come from extreme weather events. Global warming not only changes the climate conditions, but its effects also challenge the way we are used to model economic development and economic growth. Dealing with this calls for climate change adaptation, and adaptation of our models to be able to simulate climate change effects as well. A feasible adaptation strategy will be developed by local decision makers, and thus needs to assess regional impacts of climate change and the socio-economic effects resulting from changing climate conditions. This contribution is based on findings from a study within the German Framework Programme "Economics of Climate Change".

Methods
The authors have applied an input-output-based macro econometric-model, adjusting it to cope with the (1) challenges of damages from extreme weather events and (2) adaptation measures. Infrastructure damages, shifts from domestic production to imports, low levels of productivity due to heat waves, and adaptation measures

are some of the topics the paper deals with. Crude data is the largest challenge we have to cope with. Results are obtained by a comparison of three scenarios – one with and one without considering extreme weather events, and finally a third one allowing for adaptation measures. These results are differences in the values of macroeconomic variables, such as GDP, exports, investment and employment as well as sector specific variables. For instance employment on the level of different economic sectors is an important indicator for the design of the appropriate adaptation measures.

Results
Extreme weather events exert slightly negative effects on economic sectors and Germany's economy as a whole. These effects intensify over time and hurt the economy. Adaptation measures reduce the damages and pay off, but the economy is still worse off with climate change. The paper provides details for economic sectors and the total economy.

Conclusion
The research on the feasibility of the IO type macro econometric model for the analysis of extreme weather events has shown that it is necessary to rethink some of the empirical evidence on reaction equations in a time series based model to model extremes in the future.

Given that Germany is in a moderately affected region, the larger challenges for an open economy as the German, will lie in climate change along the international value chain. A German adaptation strategy must consider this.

O-3309-01

Economic evaluation on the impact and cost effectiveness of climate change adaptation strategies in crop production systems (using Structural Ricardian and Decision model): Case of Northern Shewea, Ethiopia

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Introduction and problems: To respond to the possible impacts of climate change smallholder farmers have been using different adaptation strategies. some of the major adaptation strategies in the Woreda include use of improved variety/early maturing, use of disease tolerant crops, use of irrigation, increased use of fertilizer, use of soil and water conservation techniques, water harvesting, constructing flood control, building wind breaks etc (ibid). However, we hardly know about the economic impact of climate change adaption strategies in smallholders many of the literatures. In addition, given the limited coping capacity and resource constraint to further make investment on different adaptation strategies, we know very little about cost effectiveness of climate adaptation strategies in smallholder's crop production system. The significant part of literature on climate change adaption focus on the determinants of adaption strategies rather than the economic impact of adaption strategies and their cost effectiveness at farm level.

Objectives: The general objective of this study is to identify policy relevant issues about the impact and cost effectiveness of climate change adaptation strategies among smallholders and by way to contribute to climate resilient agricultural development. The specific objectives of the study are: 1) To assess the economic impact of climate change adaptation strategies in the selected study area 2) To conduct cost effectiveness analysis on climate change adaptation strategies in smallholder's crop production system.

Methods: The data for the research was obtained from the survey of 350 Households in two districts of North Shewa Zone in 2014. The sample households were selected randomly. The sample size in each district was determined based on probability proportion to size. The districts included in the survey were Yaya Gullel, Hidha Abote and Derra districts. The specific study sites within the districts were 18 Kebeles. A structured questionnaire was used to interview the farmers. In addition, the research employed review of secondary data at zonal level (cliamte data, agriclture production data etc).

Economic Models and result: A Decision support model and a structural Ricardian model were used to estimate the economic impact of climate change adaption strategies on smallholders and the cost effectiveness of different adaptation strategies. Thus, a comparison was also made between different adaptation strategies practiced by smallholder farmers.

The econometric results of the analysis show that adaptation to CC plays significant role in boosting food production and farm level income. In addition, the fact that the adaptation variable is positive and significant in the estimates of production model indicates that adoption of yield related adaptation strategies have vital importance in terms of ensuring food security of rural households. On the other hand, the cost effectiveness analysis (cost effectiveness ratio) using the decision support model show that while some strategies like rain water harvesting, river diversion, use of disease tolerant crops are economically preferred strategies others are not.

Recommendation:

- If the interest of the farmers lay on the achieving Climate change at the 'least cost', then provision of rain water harvesting, river diversion, use of disease tolerant crops would be the preferred cost-saving strategy
- If the farmers objective focused on "averting climate change impact ", then increasing the acceptance rate of "the provision of improved crop varieties and fertilizer use " to 62% and more should be the economical preferred strategy as compared to the other alternatives
- National adaption programs should be designed and local adaptation measures should also be contextually be introduced at smallholder's level so as that adaptation strategies can improve food production and farmers income under climate.

O-3309-02

Climate Change and China's Agriculture: Impact and Adaptation

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China's agricultural sector is expected to face challenges in the future mainly due to rising food demand and constraints of land and water, which will be worsened by impacts of climate change. Understanding the impact of and adaptation to climate change on agriculture is critically important for climate change policy. Acknowledging the large number of studies on climate change in the literature, the overall goal of this paper is to provide additional evidence on the impacts of and adaptation to climate change on agriculture in China.

Both econometric analysis and general equilibrium modeling are applied to analyze the direct and indirect impacts of climate change. The direct impacts on major crop yields are empirically estimated using provincial data collected over the past three decades. The impacts of severe drought and flood from extreme weather events on grain production are estimated based on a large scale farm survey in 9 provinces. The indirect impact of climate change on market price response is simulated using an integrated impact assessment model under different scenarios. We identified adaptation measures taken by local governments, communities, and farmers for reducing climate risk based on primary surveys that include 3330 households from 330 villages in 9 provinces, and assessed which are the major factors that facilitate farmers to implement these measures. We also assessed the effectiveness of different measures in reducing climate risk on crop production.

Econometric results show that the effects of temperature and precipitation on crop yields are statistically significant though they differ largely among crops. Increasing temperature has a negative impact on the yield of several major crops such as wheat, rice, cotton, and sugar, though it also has a moderate positive impact on maize and rapeseed yield. However, decreasing precipitation reduces the yields of most crops. The simulation results show that overall impact of climate change on agricultural production is negative, but much less so than the direct

impact, because of responses from producers and consumers to changes in agricultural prices due to climate change. Moreover, if we consider the impacts of climate change in the rest of the world that affect China's trade and therefore domestic production, climate change impact on China's agricultural production will be further reduced.

Empirical results also show that there is a wide range of measures that can reduce climatic risks. Most of these measures are related to the water sector (e.g., water infrastructure) and farm management (e.g., crop or variety diversification, irrigation practices, adjusting field operation, etc.). Econometric analysis shows that public extension service (e.g., the provisions of early warning and prevention information), policy support (e.g., financial and technical support) against extreme weather events, and household assets such as households' social capital and wealth can improve the ability of farmers in adapting to climate change. Several major measures in the water sector and farm management significantly reduce average crop yield loss and variance of crop yield due to extreme weather events.

This study concludes with several policy implications. While China's agricultural sector will face greater challenges under climate change, there are a number of measures –particularly those related to the water sector, farm management, and agricultural markets– that can reduce the impact of climate change. As most of these measures are not new, enhancing the above measures in crops and regions that are adversely affected by climate risks and including this enhancement as one of major investment priorities in agricultural development programs are critically important in developing climate adaptation plans and policies.

3310 - Climate finance at scale: emerging opportunities?

ORAL PRESENTATIONS

K-3310-01

Climate finance at scale: Overview of issues

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Climate finance is essential to reducing climate risks, and is at the heart of the UNFCCC's climate regime. Engagement with the private sector goes beyond the expectation of finance for public funds or protection against expected losses and damages. Transformation of climate resilience requires leadership in a range of private sector forms of investment and sustainability. Emerging examples of how research has informed improved access to climate finance address fundamental questions. How can research inform private sector investments in adaptation? What are the barriers limiting the scaling up of successful pilot interventions? How can adaptation plans of implementing entities be informed by research? What is the business proposition for private sector investment?

O-3310-01

Climate finance at scale: emerging opportunities?

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Climate finance is essential to reducing climate risks, and is at the heart of the UNFCCC's climate regime where developed countries have pledged to mobilize US$100 billion of climate finance per year from 2020 onwards. In parallel this year, the Post-2015 process to negotiate the Sustainable Development Goals, the Financing for Development Conference in Addis Ababa, and the Third United Nations World Conference on Disaster Risk Reduction will also agree on new financial commitments and/or principles for providing support to developing countries. While the question of how to mobilise funds is crucial, the equally important question of how to ensure their effective use has been given far less attention. At present, these different flows are governed and delivered separately, across a fragmented finance architecture, and this among other factors creates problems for using limited financial resources effectively. There is scope for much greater alignment of international public finance for development, climate change and other goals (such as for disaster risk reduction or environmental management), and yet also challenges to achieving greater alignment. What are the opportunities for post-2015 governance of climate finance in this broader context?

O-3310-02

Climate finance at scale: emerging opportunities?

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(1) IIASA, Risk, Policy, Vulnerability, Laxenburg, Austria; (2) IIASA, Risk, Policy, and Vulnerability Program, Laxenburg, Austria

Climate finance is essential to reducing climate risks, and is at the heart of the UNFCCC's climate regime where developed countries have pledged to mobilize US$100 billion of climate finance per year from 2020 onwards. In parallel this year, the Post-2015 process to negotiate the Sustainable Development Goals, the Financing for Development Conference in Addis Ababa, and the Third United Nations World Conference on Disaster Risk Reduction will also agree on new financial commitments and/or principles for providing support to developing countries. While the question of how to mobilise funds is crucial, the equally important question of how to ensure their effective use has been given far less attention. At present, these different flows are governed and delivered separately, across a fragmented finance architecture, and this among other factors creates problems for using limited financial resources effectively. There is scope for much greater alignment of international public finance for development, climate change and other goals (such as for disaster risk reduction or environmental management), and yet also challenges to achieving greater alignment. What are the opportunities for post-2015 governance of climate finance in this broader context?

Engagement with the private sector goes beyond the expectation of finance for public funds or protection against expected losses and damages. Transformation of climate resilience requires leadership in a range of private sector forms of investment and sustainability. Lessons learned in working with both large companies and SMEs highlights emerging good practise as well as major challenges for public-private cooperation.

The Warsaw Loss and Damage Mechanism holds high appeal for transforming both adaptation and mitigation, yet requires solid science-based information to become actionable. Research around the concept of climate risk management focuses on: (i) climate justice for the Loss & Damage Mechanism; (ii) climate risk management from different perspectives (objective, perceived, idealized risk), and the implications for the Loss&Damage debate; (iii) the potential for risk layering as a framework for operationalizing climate risk management, including insurance and a possible extreme climate risk layer; and (iv) attribution of losses to anthropogenic climate change and potentially robust results.

Emerging examples of how research has informed improved access to climate finance address questions such as: How can research inform private sector investments in adaptation? What are the barriers limiting the scaling up of successful pilot interventions? How can adaptation plans of implementing entities be informed by research? What is the business proposition for private sector investment?

O-3310-03

Impact Investing and unlocking Private Sector finance for climate change adaptation in Sub-Saharan Africa

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There is growing consensus that with even the most rigorous of efforts to mitigate climate change it is likely that we will have to adapt to a changing climate, and that the countries least responsible for causes will bear the greatest burden. The cost estimates for adaptation vary, with more recent estimates indicating a three-fold increase in the finance required. Despite the variance, it is clear that current sources of public finance fall far short of the required resources, and that the private sector has a role to play in providing some of the required finance.

The private sector however has its own requirements for investment and many adaptation projects will not be able to respond to the return on investment, stage of development or scale requirements of investors. CTI PFAN, the Climate Technology Initiative's Private Finance Advisory Network has shown its ability to raise private sector finance for climate change mitigation, having raised in the region of $600 million to date. It is now trying to replicate this success for adaptation, supported by IDRC, and at its last Investor Forum in Johannesburg in November 2014, was able to showcase adaptation projects from Africa which have the ability to respond to some of the demands of private sector finance, with projects from multiple sectors, including water, agriculture, real estate, tourism and microfinance, at various stages of development, and various scales. Twelve projects were showcased to investors, each of which represents both public and private goods, but with in-built social and environmental credentials.

There are trillions of dollars being invested annually by the private sector and the growing call for responsible investment is part of the stimulus for the growing sector of Impact Investing. Organizations such as "100% Impact," have shown that pure impact investments have the ability to match the returns of conventional investments. Whether the investment community is aware of project categorization as mitigation, adaptation or just good development is a moot point.

The Impact Investment community represents a high potential source of private sector finance for supporting adaptation actions if the adaptation projects can demonstrate their ability to quantify their impact. The current CTI PFAN adaptation work is thus paired with a research component, managed by the Frankfurt School, which, amongst other issues such as an assessment of the policy environments and risk analysis is also looking at the metrics of adaptation.

To secure some of these private sector funds for adaptation activities, the relationship between adaptation projects and the impact investment community needs to grow, and there are four key issues which the current CTI PFAN project aims to address to achieve this:

1. The development of a pipeline of investment grade projects;
2. The leveraging of public funds to generate investment tipping points and to create a market of these types of investments;
3. Mechanisms to bring these projects into view so that they become part of the available options for investment;
4. Developing metrics for assessing adaptation activities.

O-3310-04

Private finance for adaptation: do private realities meet public ambitions?

P. Pauw (1)

(1) German Development Institute, DIE, Bonn, Germany

The private sector's role in climate finance is increasingly subject to political and scientific debate. Yet there is poor empirical evidence of private finance for adaptation and its potential contribution to the industrialised countries' mobilisation of USD 100 billion of annual climate finance from 2020 onwards to support developing countries to address climate change. Building on earlier research (e.g. on the private sector's role in adaptation in NAPAs and Zambia's agricultural sector), we will present a paper on an analysis of 101 case studies of private sector adaptation under the Private Sector Initiative (PSI) of the UNFCCC Nairobi work programme. The case studies are examined against ten 'adaptation finance criteria' that were distilled from UN climate negotiation outcomes.

Results show that private adaptation interventions complement public adaptation activities all over world, including in priority sectors in developing countries such as water and agriculture. Yet the ten adaptation finance criteria are not met, which demonstrates that the diplomatic UNFCCC conceptualisation of adaptation finance is dissonant from the private sector reality. For example, only a minority of the case studies takes place in the `prioritised' most vulnerable developing countries. And while the case studies' investments are 'new and additional' to Official Development Assistance (ODA), their 'predictability' remains unclear. And despite some commitment for 'up-scaling', plans and associated costs for doing so remain undisclosed. Developed countries' role in 'mobilising' private financial resources under the PSI seems limited.

The presenters will provide options for minor improvements to bring the private realities closer to public ambitions. Yet it is unrealistic to expect that the UNFCCC alters existing adaptation finance criteria to suit private initiatives better, or that the private sector aligns its initiatives to meet the UNFCCC criteria. We therefore advocate strict monitoring and reporting only of private investments that principally aims to finance adaptation. This practical way forward would allow private finance to meet criteria such as predictability, transparency, and mobilisation, but would drastically reduce the amount of private investment that could contribute to reaching the USD 100 billion climate finance target, which would have major political implications.

3310-POSTER PRESENTATIONS

P-3310-01

Missed Targets, Missed Opportunities! Lessons from tracking Adaptation Financing for Zambia

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Who funds and who benefits from climate change adaptation (CCA) funds in Zambia? This was main question that a study commissioned by the Zambia Climate Change Network wanted answered. The study set out to map, track and analyze both domestic and foreign financial flows to CCA, as part of the global Adaptation Finance Tracking Initiative (AFTI). The goal was to improve CSO advocacy for transparency, accountability, participation and ownership of programming and financing for CCA and resilience in Zambia and help address identified institutional and structural constraints to the effective delivery of climate finance to intended beneficiary constituencies. The experience would be used strengthen tools to track and monitor adaptation and resilience finance flows from a multitude of sources down to the local level and for South-to-South learning. The study focused primarily on seven sectors which are targets of climate proofing and the extent to which these funds trickled down to the beneficiary target groups. The methodology involved review of secondary data sources including the National Budgets (Yellow Book), and sought primary information through interviews with ZCCN members, stakeholders, community leaders and local people and community based organizations at district level.

The study established three windows of financing CCA programmes in Zambia: 1. National resources; 2. Donor funds through budget support; 3. Direct programme or project support from the donors: and, 4. CSO funds from donors either through the Civil Society Environment Fund (CSEF) or through bilateral agreements between a donor or donors and a particular NGO.The study notes that funding for CCA is donor driven, with government contributing less than 1% of the total expenditure to the seven sectors; lack of prioritization for CCA; negligible and fluctuating funding; and, less CCA funds compared to mitigation. Variations between budgeted and/or pledged funds and actual disbursements is noted, including among donor finances. Lack of government policy on climate

change affects climate change financing, resulting in budget variations from year to year and lack of a budget line specifically for CCA especially for grass-root activities. Most funds go to upstream activities - salaries, workshops, etc - and CCA is lumped together with environment and other CC interventions, such as mitigation, in the national budgets. This makes it is difficult to track CCA funds and it explains why there are no visible CCA activities on the ground. The study also notes rigidity in budget lines to accommodate emerging issues, such as CCA and limited absorptive capacities among recipient sectors, resulting in variances between disbursed and utilized funds.The study found that stakeholders and ordinary people, especially at the local level, are not involved at any of the three key levels of the budget process: 1. Preparation of the budgets; monitoring expenditures from the allocated funds; and, reviewing the impact of the funded programmes, hence apparent mismatch between what the government does and what the people see as their main priorities. Further, stakeholders and local communities lack civic education about the budget and its processes and about their own rights in national resource allocation; therefore weak in demanding financial accountability and effective participation in tracking government expenditures.The study also established that the budgeting process and budgets themselves are too complicated for ordinary citizens, even professionals responsible for budgets at local level, to understand. Many people are often put off by the size of the Yellow Book and the difficulties in accessing the financial and Auditor General's reports. Further, tracking and budgeting for CCA funds is hampered by lack of knowledge of CCA funds coming into Zambia by heads and staff of government departments, stakeholders and local communities and their leaders. The study also notes lack of synergy and collaboration, especially at local level, among organizations, including CSOs that are involved in CCA in one way or the other. This weakens their capacity in advocacy.The study acknowledges the existence of various methods and tools of tracking finances for specific interventions. It recommends a cocktail of tools of tools. It recommends focused advocacy towards priortisation of CCA financing through domestic resources, more social accountability, transparency and community and stakeholder ownership participation in allocations and disbursements.

3311 - Climate mitigation policies - learning, evaluating and comparing national experiences

ORAL PRESENTATIONS

O-3311-01

Climate Policies across Africa: Increasing Interactions and Building Resilience

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In its quality of a worldwide well-attested phenomenon, climate change will spare no continent. This being said, Africa has started to host climate-related global conferences, such as the World Summit for Sustainable Development in Johannesburg in 2002 and the 17th Conference of the Parties (COP17) in Durban in 2011, both cities being located in South Africa. In addition, African climate-related bottom-up initiatives have played a growing role in climate negotiations, notably by shifting the climate change mindset from an environmental challenge to a development one. As a result of this more comprehensive view of climate change, numerous actions now speak to the increasing number of integrated public policies in different sectors and attempt to bridge the gap between policy development and implementation.

However, few African countries have developed comprehensive climate-related policies. More often, these policies focus on responding to extreme events on one side and managing resources on the other. For example, after Mozambique was forced to appeal for international help to rescue its people during the 2000-2001 massive floods related to the passage of several cyclones, the National Centre of Disasters Management (INGC) was created with the task to evaluate, response and adapt Mozambique to these changes. On a different note, recent provincial plans promulgated by the Democratic Republic of Congo (DRC) have mentioned the importance of including adaptation and mitigation strategies to fight climate change impacts and protect this country's environment. In South Africa, the National Climate Change Response has been conceived as a process, which provides room for stakeholders comments and scentific inputs via dialogues. This diversity of responses reaffirms not only how diverse the national contexts (notably risks and priorities) are, but also how unique the stakeholders' interactions and the locally-built initiatives have become to tackle climate change challenges.

Against this background, this paper presentation aims to provide an overview of the numerous climate-related policies that exist across African countries in order to analyse their political motives and responses to climate change. This, in turn, will contribute to develop and implement more interactive policies, which could be further scientific-and initiatives-informed at the national and regional level. Given the importance of natural resources for development and the expected global impacts of climate change on water, energy, forestry, among others, climate-related and resources-based policies would arguably become strategic components of state security. Interconnections between climate change and resources management policies already exist and cannot be ignored, when they demonstrate states' growing interests in linking future adaptation and mitigation plans with environmental concerns across Africa.

O-3311-02

Policy Instruments to Overcome Energy Efficiency Barriers in Designated Buildings under Thailand's Nationally Appropriate Mitigation Actions (NAMAs)

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(1) National Institute for Environmental Studies, Tsukuba, Japan; (2) THAMMASAT University, Sirindhorn International Institute of Technology, Pathumthani, Thailand

Thailand pledged its Nationally Appropriate Mitigation Actions (NAMAs) at UNFCCC COP20 in Lima, Peru, following ongoing discussions since 2012. Improvement of energy efficiency in designated buildings is one of the main countermeasures under the proposed NAMAs. Data collection on the actual energy consumption of the buildings plays a key role in determination of the scope of countermeasures as NAMAs and implementation of Measurement Reporting and Verification (MRV). However, the issue of how these countermeasures will be implemented in the context of the unsatisfactory progress of existing policy instruments, particularly the Building Energy Codes (BEC) and energy management reporting system as specified in the 2007 Energy Conservation Promotion (ECP) Act and the Energy Efficiency Development Plan (EEDP) over the period of 2011-2030 remains to be addressed.

The objective of this study is to examine the potential of policy instruments and energy-saving measures to overcome the existing barriers. Firstly the literature is reviewed, with discussion of theory-based policy instruments for building energy efficiency in order to analyze the situations and gaps in policy instruments adopted in Thailand. The means of enforcement and implementation of alternative policy options are also examined. The study also incorporates interviews with relevant stakeholders involved in the NAMA process as well as in EEDP in order to compensate for limitations in the literature available on Thailand's situation. Furthermore, good practices implemented in other countries were considered for their suitability for application in Thailand.

The necessity of addressing legal and institutional barriers in order to overcome the information barriers was clearly evident in Thailand. The literature shows that regulatory measures have been implemented since 1995 under the ECP Act. However, these have only been implemented

on an ad-hoc basis. In the case of existing buildings, there is no benchmark to identify electricity consumption involved in conducting the required energy management in each designated building. There are also limitations in the availability of information on technologies and technical information contribution to energy savings and operational management. The in-deep interviews indicated that BEC for the construction of new buildings and third-party energy audit have not as yet been implemented. The limitations in human resources and capacities to implement verification and monitoring of the submitted reports have prevented the consolidation of regulation measures as well as the revision of energy efficiency performance standards. Hence, this has given rise to a paucity of sufficient and credible data and made it difficult to achieve the understanding of the existing situation, future projections, and impact of policy instruments.

Results show that the targets of EEDP and Thailand's NAMAs will not be effectively achieved without improvement in the means of achieving compliance levels in the existing ministerial regulations. Progress on this front will be achieved through improved awareness of energy efficiency and co-benefits of implementing the actions through the development of benchmarking and information disclosure for buildings' energy performance, and providing tailor-made solutions. It is necessary to initiate process-oriented, interactive policy-making, with intensive technical training on the ground in order to enhance the credibility of governmental decisions and activities, and to collect and accumulate reliable data and information for energy efficiency toward the achievement of NAMA objectives.

O-3311-03

Climate policies : learning from a comparison of different national experiences

P. Mallaburn (1)

(1) Climate Policy Journal, Welwyn Garden City, United Kingdom

Peter Mallaburn will give an introductory speech to the session, questioning how a comparison between different national experiences of developing climate policies can be operated, and what are the challenges we face when trying to organise a learning process between these various experiences.

O-3311-04

Price and Prejudice: The politics of carbon market establishment in Turkey

AC. Gundogan (1) ; E. Turhan (2)

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Despite increasing number of studies on carbon trading's inefficiencies and self-contradictions, it has been continually presented as the most effective climate change mitigation option and has become a huge global business. On the other hand, governments' endless support to the carbon markets has been criticised since the emission trading balloons exploded numerous times. Being an EU-accession country with no access to EU ETS (Emissions Trading Scheme) and an Annex-I country with no access to flexibility mechanisms under now defunct Kyoto Protocol, Turkey is a latecomer to the game. While being a country whose greenhouse gas emissions increased by %133 between 1990-2013 showing the highest rate of change among OECD members, Turkey's climate politics are increasingly drawn into market based climate policies particularly in the dawn of a new global climate agreement that is set to be signed in 2015. As a result of the external pressure from institutions like World Bank and private sector driven processes, Turkey has started lay down limited policy and legislative ground work in pursuit of setting up an emission trading system which then expected to be linked to the international carbon markets. However, implementation of the emission trading mechanism has never been widely discussed in Turkey hence making it a highly non-transparent process. Potential environmental and socio-economical impacts of the market-based instruments in the framework of combatting climate change are being watered down by politicians, industrialists and technocrats while illusive promises of the carbon markets are presented as the centerpiece of Turkey's position in the new climate regime. This paper critically analyzes the perceptions, promises and discourses of the emerging emission trading system in Turkey from a political ecology lens by scrutinizing different actors' (including representatives of environmental justice movements, state bureaucrats, private sector and international organizations) statements. By doing this, this research aims go beyond dominant voices on carbon market establishment in Turkey, by revealing power relations, preferential treatment of some top-down policy options and the influence of multilateral finance organizations. Such critical approaches suggest that policy preference towards carbon markets vis-à-vis carbon tax in Turkey are not necessarily a rational process lack scientific substance as well as public buy-in.

O-3311-05

Climate legislation in the UK: the Climate Change Act and the Committee on Climate Change

S. Smith (1)

(1) Committee on Climate Change, London, United Kingdom

The UK has traditionally been a progressive nation in calling for action on global warming. In 2008 it passed a Climate Change Act with strong backing from all the major political parties.

The Act set a target for national greenhouse emissions to be at least 80% below 1990 levels by 2050, created a system of 5-year carbon budgets to get there, and set a programme for adapting to climate change. It also created an independent Committee on Climate Change (CCC) to advise on these aims and monitor progress towards meeting them.

This talk will cover the Act, the role of the CCC and the various factors (such as climate science, economics and international circumstances) that inform the UK emission targets. It will show how the 2050 target is achievable, highlighting the key technologies likely to be needed and the cost involved. We will also see what policy progress has been made in the 7 years since the Act was passed and take a critical look at whether or not the UK is on track to meet the first few carbon budgets.

3311-POSTER PRESENTATIONS

P-3311-01

"Climate change adaptation strategies and disaster risk management in Bangladesh"

AMH. Akhand (1)

(1) Bangladesh Energy Regulatory Commission, Govt of Bangladesh, Joint secretary, gas and regulations, Dhaka, Bangladesh

Bangladesh is one of the most climate-vulnerable countries in the world and innocent victim, experiencing changing weather patterns of irregular temperature, rainfall and winter season-that affecting people's lifestyle. Bangladesh is already affected by climate change impact, increasing temperature of 2° C and sea level rises of 7.5 cm causing 29% higher returns of disasters (i.e. flood with permanent phenomena which is major causes of crop devastation almost every year, cyclone, storm surges, heat and cold waves, drought). Bangladesh is now suffering in water salinity, water logging, soil salinity, human health diseases, shortage of fresh drinking water and food security.

The Global Climate Risk Index 2014 covering the period 1990-2013 finds dangerous climate change affects on Bangladesh, estimates that on an average 8,241 people died each year, while the cost of damage is around US $ 1.2 billion per year and loss of GDP is 1.81%. Bangladesh is projected to face 2.0% loss of annual GDP by 2050 and more than 9% of GDP by 2100 and would experience a net increase in poverty of approximately 15% by 2030 due to climate change impacts. After the 1988 flood and 1991 cyclone, Bangladesh Government has given emphasis using satellite data to face climate change impacts. Bangladesh Space Research and Remote Sensing Organization connect the international satellite stations. Satellite images help for better prediction, and tracking

of cyclone and floods. There are also 50 thousand coastal cyclone preparedness program and 20 thousand urban volunteers are engaged in front-line rescue and awareness activities with women participation for disaster mitigation. Built coastal embankments.

Bangladesh has made remarkable efforts in 'strategies and plans' to streamline regulatory and institutional settings as a pathway for adapting climate change impacts following the existing policies and acts. Bangladesh is the first example country for taking various initiatives for the adaptation. The adaptation is the key for survival, initiatives taken in different sectors of the government. One of the six pillars in the adaptation Strategy and Plan is Low Carbon development' that puts emphasis on energy efficiency, energy conservation and utilization of renewable energy as potential mitigation options (Bangladesh is less than 0.3 ton GHG emission per year). To adapt the climate impacts, Bangladesh developed Flood Action Plan (1988), the National Water Management Plan (2004), the Standing Orders on Disasters (2010), the 'National Adaptation Program of Action' (2005, revised in 2009) and the 'Bangladesh Climate Change Strategy and Action Plan' (2009) to take necessary preparedness.

The Strategy and Plan is to strengthen adaptive capacity of the local communities and to foster innovation in climate change related technologies which would reduce poverty, generate employment, ensure security of food, water, health, energy and socio-economic well being of all citizens of the country. Bangladesh has prepared a Road map towards formulating a comprehensive NAP with a view to reducing vulnerability to the impacts of climate change by building adaptive capacity and resilience, flood and cyclone shelters.

Bangladesh Meteorological Department developed better early warning system for cyclone and other hazards using satellite data. The Flood Forecasting and Warning Centre is engaged to alert the vulnerable people about flood risk. Introduced climate tolerance (saline, drought, flood, rain-adapted) crop production. Bangladesh has established two innovative funds: Climate Change Trust Fund from the Government's own budget with an initial capital of US$ 45 million, and Bangladesh Climate Change Resilient Fund (initial fund US$188 million) with the support of development partners. Recent disaster casualties and damages shows the successful reduction compare to previous events. Satellite images are most useful as first responses to disasters and post-disaster assessment. Satellite phones/mobiles/tv channels are useful for emergency warnings. The satellite technology creates new hope and inspirations for human lives.

P-3311-02

Forest management systems within rural communities of the north west region of cameroon, strong strategic approaches for climate change in sub-saharan africa.aw. awa (1)

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In a bid to tackle some of the questions raised by climate change, this paper will discuss Sustainable Forest Management Systems within Rural Communities of the North West Region of Cameroon, strong strategic approaches for climate change in sub-saharan Africa.

Human actions on forest, such as uncontrollable harvesting of medicinal plants, felling of trees, farming, bush fires and local bee farming practices like generating smoke to drive away bees from a hive by burning fresh leaves of plants, provide negative effects on climate. This paper presents an analysis of the scientific evidence, indicating that negative influence on forest is affecting the climate in Cameroon. Sea levels are rising; rainfall has decreased by 11%, early rains, increased temperatures and flooding. The paper identifies strategic approaches that are practiced in tackling forest management and climate change in Cameroon. Examples are: tree planting, renewable energy, solar powers, water powers, etc. It describes also, generated land use systems, forests conservation methods and farming techniques, which influence climate change and the health of forest positively.

The concept of indigenous ecosystem and forest management systems used in this paper refers to a series of practices based on agreed rules, carried out by the local people, aiming at the sustained availability of products and services from trees, crops and forest through Sustainable Development for climate change. Local populations surrounding these forests understand the education of community forestry, taking an active leading role in preserving and protecting the forests, in order to ensure long term benefits and stop the ill effects of climate change in the society.

The paper concludes that this project is building these capacities in collaboration with the various stakeholders in the localities for a healthy conservation of forest and monitoring of changes in the climatic conditions of the areas. Forest management and monitoring plans are carried out using participatory methods and are designed to meet the needs of the communities and their families, while at the same time maintaining Sustainable Biodiversity and Climate change functions.

P-3311-03

The political internalization process of climate issues in Brazil and China (1992-2012)

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In terms of climate change responses, it is argued that governments are important actors that play a key role in the development of norms, institutions and appropriate modes of governance to address these changes at different levels and scales. This paper analyzes the internalization process of the climate issue at the government level in Brazil and China. These two countries have been noted for their importance in the international arena and, above all, the importance of environmental issues at the core of their political processes. In terms of methodology, this analysis is based on three main points: i) Trajectory of greenhouse gases emissions in Brazil and China, in the period of 1992-2012; ii) Political and institutional structures mobilized to the climate issue, focusing on mitigation; iii) Political responses related to climate change, through a historical reconstruction of policies, plans, major programs and projects developed and implemented related to climate change mitigation. The starting point for this analysis is the year of 1992, more specifically the consequences of the United Nations Framework Convention on Climate Change, resulting from the United Nations Conference on Environment and Development, which marks the beginning of the involvement of both Brazil and China in international discussions and negotiations on climate change. The results of our analysis show that, in Brazil, emissions have fallen since 2008 and there has been a change in the profile of greenhouse gases emissions in the country. Land-use change and forestry sector has no longer been the most responsible for emissions since 2010. However, all other sectors have increased their emissions over the analyzed period. In the case of China, even with mitigation efforts undertaken, emissions have increased every year. However, the emission growth level has declined reflecting the country's efforts in the installation of low carbon power generation and improvements in energy intensity. In Brazil, there are robust and consolidated political and institutional structures to address the climate issue, involving other segments of society such as the private sector, civil society and research institutions, among others. Regarding political and scientific framework, there was a significant increase in the production and systematization of studies and reports, which can assist the design and implementation of policies related to the problem, and reduce the uncertainties related to climate change. China has also made some progress in this direction. The results show that, in Brazil, the climate issue internalization process is characterized by three phases: the first, marked by the establishment of political-institutional and scientific structures engaged with the issue. The second, stands out for greater understanding of this issue in the country. It is marked by the development of a political and scientific agenda around the theme and planning actions in the country. The construction of this agenda was fundamental in laying the foundations of the national policy on climate change. Finally, the third phase is marked by the development of climate policies and by strengthening the scientific agenda around the theme. The national policy agenda is focused on the implementation

of sectoral plans, to meet the voluntary mitigation targets established by the National Climate Change Policy. In the Chinese case, the internalization process of the climate issue has two phases: the first, has more focus on combating air pollution, whereas the climate issue stands as secondary focus of action and the second, more proactive regarding concrete commitments on climate change, with the establishment of the National Climate Change Program and the National Leadership Panel on Climate Change. Both Brazil and China still have challenges to be faced in relation to the set of problems that make up the environmental issue in a world characterized by global climate change. Environmental and climate concerns have difficulties to become political priorities in both countries. In any case, policy measures aimed at climate issue in these countries may lead to the reconfiguration of international negotiations about it.

P-3311-04

Agricultural biodiversity in climate change adaptation planning: An analysis of the National Adaptation Programmes of Action

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To guide climate adaptation policies and investments, the majority of least developed countries (LDCs) have developed National Adaptation Programmes of Action (NAPAs). This study analyzes the extent to which agricultural biological diversity is included as part of national adaptation planning in the 50 NAPAs developed by LDCs to date. Lessons learned from the NAPA development process are potentially valuable to countries that will be developing NAPs in the years to come. Agricultural biodiversity (at genetic, interspecific and ecosystem levels) can contribute to the resilience of the agricultural systems faced with increasing climatic variability, thereby reducing farmers' vulnerability. The paper presents a framework for analysis existing literature concerning climate change and adaptive capacity, agroecosystems' vulnerability and resilience and the use of biological/genetic diversity in agricultural production, plant breeding, research and development. The study identifies 48 activities included in the NAPAs that do (or at least could) increase biodiversity in agricultural production systems and/or in upstream research and development chains as part of strategies to adapt to climate change. These activities were clustered, first, by sectors (crops/forages, livestock, fisheries, forestry, agroforestry and natural resources) and then by biodiversity levels (genetic/intra-species, species and ecosystems). The analysis highlights that the exploitation and increase of agrobiodiversity is included in many of the NAPAs: 31% of all of the priority project proposals based on the NAPAs include some combination of the 48 agrobiodiversity-related activities. However, approaches taken to including agrobioversity varies considerably across the 50 NAPAs: 39% of the identified agrobiodiversity related activities are concentrated in 11 NAPAs; 20 NAPAs present the highest levels of inclusion of agrobiodiversity related activities; whereas 10 NAPAs were found to contain only between zero and 2 of the identified agrobiodiversity related activities. Eight of the identified 48 agrobiodiversity related activities accounted for the 56% of all the relevant activities mentioned overall, suggesting that relatively low range of actions were identified among the priority project proposals. The highest concentration of activities was found in the combined sector of crops/forages and at the ecosystem level; and the lowest in the fisheries sector and at the species and ecosystem levels. Only a small number of the NAPAs include a generally consistent spread of activities across the 3 levels of diversity. Interestingly, all 48 agrobiodiversity-related activities related to research, development, and production systems, and not to promotion of demand or consumption. The study concludes that a more comprehensive and organized approach to including agrobiodiversity in national adaptation planning will be important in future NAPA and NAP development. National planning teams will require capacity strengthening and tools to help them consider options and develop practical, scalable plans (there are few clearly established precedents/models for scaling up of agricultural biological diversification strategies at the national level). While it is beyond the principle scope of our analysis, the paper reflects on some of the factors that have contributed to the variable degrees to which agrobioversity has been included in some countries' NAPAs, including the influence of strong plant genetic resources for food and agriculture (PGRFA) national programs, high-profile agrobiodiversity projects, pre-existing national policies that underscore the importance of agrobiodiversity, etc. On the other hand, the paper notes that 11 countries that included highest levels of reliance on agrobiodiversity are spread across 3 continents and have very different agro-ecologies and climate-related farmer vulnerabilities.

P-3311-05

Analysis of low carbon policies in the building sector

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Building sector accounts for a large percentage of the GHG emission. It is critical to raise appropriate low carbon policies both in developing and developed countries in the building sector. This study focuses on low carbon policies in building sector by conducting a comparison study between Japan and China so that different policy implications can be recognized for countries in different development stages. Two research questions are discussed, including how effective current low carbon policies are and what obstacles exist. Both stakeholder interviews and literature reviews based on Scopus database were undertaken.

In order to address these two issues, related policies are categorized into four groups: control and regulatory instruments; economic/market-based instruments; fiscal instruments; information and voluntary actions. Policy effect analysis identifies that low carbon policies in the building sector have promoted energy saving in both Japan and China. Especially, the innovative Cap and Trade Program in Japan has greatly enhanced the GHG emission reduction. Obstacles comparison reveals that Japan and China shared many obstacles including high transaction costs and lack of applicable methodology. But certain differences also exist. For instance, the unstable political condition and the unexpected Fukushima accidents impede the Japanese government to initiate more innovative energy policies in Japan, while China is suffering from obstacles such as inefficient enforcement, and immature financial regulation system.

Based on the previous findings, common suggestions for overcoming these obstacles of low carbon policies in Japan and China are presented, such as the accurate methods of baseline identification and emission accountings, innovative incentives, and more capacity building activities. Finally more specific suggestions for both Japan and China are also added by considering their own situations so that both countries can further improve their BES policies.

P-3311-06

Rethinking Climate Change Research in Zimbabwe

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Climate change is arguably one of the most pressing challenges confronting Zimbabwe. As such, it has received considerable attention from a wide array of scholars. Certainly, very significant contributions have come from scholars who have deployed various models to establish trends in climate change as well as assess and predict its impacts particularly on agriculture. Paradoxically, even though climate change knowledge in the country continues to grow, questions on how climate change is framed, how impacts are derived using various quantitative methods and models and, even the language used in such studies have not been adequately analysed. These facets are critical particularly because how climate change is framed has important implications for adaptation in the country.

Following the above, this paper subjects various studies on climate change in Zimbabwe to rigorous critical analysis with the intention to demonstrate how climate change and its impacts have been framed and the utility and, pitfalls of such. The important question is, what and whose frames are being activated and hence strengthened and, what are the implications for adaptation? The paper argues that climate, climate knowledge and climate change need to be unpacked and reframed by deploying new and bold ontological and epistemological positions. This involves documenting and analyzing local narratives of climate change, for instance of local farmers, living on the frontiers of such changes. This also suggests that interpretive

methods fundamentally come to the fore, even so without laying claim to principled epistemological privilege.

Although this paper centers on climate change scholarship from a developing country, it draws insights from a number of scholars working in other contexts. For instance, Brace and Geoghegan (2010), brought together the themes on landscape, temporality and lay knowledge to propose new ways of understanding climate change and its impacts. Pettinger, (2007) alludes to the social construction of climate change and how power is used to impose a hegemonic discourse on climate change. Miller et. al., (2008) argue for epistemological pluralism when it comes to understanding complex systems that embrace the human and non-human worlds and climate change is one such system. Hoffman (2011) points out that climate change is not yet a 'social consensus', drawing attention to the various contestations and divergences surrounding the framing of climate change.

P-3311-07

Mainstreaming climate adaptation-mitigation measures at local level: rifling common institutional orbit in Nepal

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Integration of climate mitigation and adaptation has now been becoming more powerful concern in climate change policy architecture to achieve synergetic outcomes. It has become more relevant especially in least developed countries (LDCs) including Nepal considering unavoidable risk of climate change but their high vulnerability. Since recent past, Nepal has been planning and implementing both adaptation and mitigation projects. Despite sectoral seclusion on planning and implementation, both adaptation and mitigation projects have chosen resourceful and independent local forestry institutions mostly community forest users groups (CFUGs) as an entry point to dispense project input at the grass root level. This article scrutinizes the potentiality of local forestry institutions to contribute on and integrate climate adaptation and mitigation. It further reconnoiters implications of and lessons to achieve synchronized outcome from adaptation and mitigation measures from existing institutional arrangements in Nepal.

This paper is the outcome of two comparative case studies of CFUGs in Dolakha and Lamjung districts where mitigation and adaptation measures have been implementing through piloting the reducing emissions from deforestation and forests degradation (REDD+) and preparing community adaptation plan (CAPs) respectively, four focus group discussions in the case study sites, four key informant interviews, five policy level expert interviews, existing climate change policy documents review, and literature review.

The research found that CFUGs have been contributing on both mitigation and adaptation through their services since before any external funds. Nonetheless, both quantity and quality of services have increased after implementing climate mitigation and adaptation projects through both government and non-governmental agencies. CFUGs have been chosen as an institutional unit to implement different mitigation measures including sustainable forests management, afforestation, and installation of smokeless stoves. The same institution has been preferred to implement adaptation measures including conservation of water holes, riverbed conservation and management, and installation of early warning systems. The research further found the overlapping of activities such as installation of smokeless stove and afforestation to achieve both mitigation and adaptation objectives. CFUGs even have funded to implement both mitigation and adaptation measures. It signifies the functional aptitude of CFUGs to integrate mitigation and adaption in practice. However, sectoral divide exists specially at the national level since adaptation and mitigation projects are being designed and implemented separately by two different sectoral ministries. We found that the operative mismatch and ghettoized dealing of adaptation and mitigation at the community and central level mechanism has been encumbering the functional contribution of CFUGs. The contradictions between climate change policies have further been stimulating for the sectoral and segregated planning and implementation of adaptation and mitigation measures. Such contradictions have further affecting on mutual coordination at the policy level. Nepal is eluding an opportunity to utilize existing and voluntarily emerging forestry institution to integrate adaptation and mitigation due to such differential interferences at the central level. This paper suggests that Nepal has a unique opportunity to be a role model of and contribute to ongoing globate debate to integrate climate mitigation and adaptation in LDCs by employing collaborative planning and implementation process at the central level and by acknowledging the potential contribution of CFUGs at the local level. However, the existing mismatches and segregated planning and implementation approach has to be addressed at the policy level. Synergetic adjustments on existing climate policies would be one primary option to create sectoral collaborative milieu for integration of mitigation and adaptation. The central level policy institution such as national planning commission having directive authority to sectoral ministries should take lead role for overall designing and planning mitigation and adaptation projects to ensure bottom-up mainstreaming, overcome mismatch at policy level, and acknowledge functional potentiality of CFUGs at local level.

P-3311-08

Towards Adaptation : Advanced scientific knowledge to better prepare for climate change

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To prepare for and cope with a changing climate, the Québec government created, in 2002, a research consortium on regional climatology and adaptation to climate change named Ouranos. The organization publishes, approximately every 5 years, a state of knowledge review on impacts resulting from climate change for Québec. The latest edition, «Towards adaptation: synthesis of knowledge on climate change in Québec» is the most thorough and up-to-date portrayal of what can be expected in the upcoming decades in the province. The synthesis is divided into three major chapters including climatic analyses and scenarios of change; vulnerabilities and impacts; and implementation of adaptation. This document helps answer questions such as «What are the effects for Québec and what options exist to cope with the expected changes?» Elaborated through a collaborative process, it involved over 80 authors and advisers and covered an immense territory (over three times the area covered by France), exposing the reality of over 17 degrees of latitude and more than 22 degrees of longitude. Since this research covers a broad area of climate types and geographic regions, multiple results from this study could be applicable or transferable in other provinces of the country and even outside Canada.

The presentation submitted for this conference will explore a few highlights from this study including the following.

Since the 1950s, the average annual temperature in Québec increased by 1 to 3°C, depending on the region. It is anticipated that by mid-century the temperature could continue to rise by 2 to 4°C and, by the end of the century, by up to 4 to 7°C in the south and 5 to 10°C in the north. In addition, extreme weather events are expected to become more frequent and/or more intense with a warming climate. A sea level rise of 30 to 75 cm in the Gulf of St. Lawrence is also considered a major threat.

Some of these climate changes could generate business opportunities while others could generate significate risks for several sectors. For example, heat waves, aggravated by the urban heat island effect, will affect public health and could increase the cases of mortality and morbidity. Other effects, such as the lengthening of the pollen season and the intensification of atmospheric pollution caused by forest fires, could aggravate respiratory and cardiovascular problems. Likewise, the decrease in ice cover as well as the increase in precipitation could result in major impacts, including erosion of the coastline and flooding. Ecosystems and biodiversity could also be deeply disturbed by the arrival and expansion of harmful invasive species. Impacts from global changes are already noted on the life cycles and distribution of trees, plants, migratory birds, salmonids and the iconic migratory caribou. Water management will be a worldwide issue in a changing climate. Conflicts of use associated with issues of quality

and availability of water are likely to increase and could have negative impacts on aquatic ecosystems and fish habitat, production of potable water in municipalities and agriculture needs among others.

To reduce the vulnerabilities and diminish the costs and magnitude of the expected risks, it is critical to take all necessary measures to adapt. Adaptation measures not only need to help people adapt, but they must be chosen carefully so that they can facilitate sustainable development and more importantly not increase greenhouse gas emissions. To achieve great adaptation measures, all stakeholders within a given system need to be included in the process. This way the multidisciplinary and sometimes multicultural teams can identify issues and search for solutions together taking into account all vulnerabilities on a territory. It is therefore easier for them to implement these adaptation measures when they are directly involved in the identification process.

Québec possesses tools and expertise that could be put to use to reduce vulnerabilities, while leveraging possible opportunities arising from global warming. Revising laws and regulations, building and maintaining infrastructure according to improved design criteria and practices as well as early warning systems to reduce impacts on human health constitute tangible examples of adaptation options already implemented. The question now is not whether we need to adapt but rather how we can optimize the way we adapt to climate change.

P-3311-09

Tracking leading indicators to understand decarbonization trends and impacts of climate policies

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Over the last year, ClimateWorks Foundation with other collaborators created the Carbon Transparency Initiative (CTI) tool with the objective to provide a transparent, granular, and consistent reference scenario for greenhouse gas (GHG) emissions across regions and sectors based upon current policies, decarbonization trends, and expected investments. The CTI tool is an open-source, indicator-led methodology based upon fundamental analysis of a small number of underlying driver metrics that shape long-term emissions. It allows for comparing current regional emissions trajectories to other scenarios and government targets. It can also be used to track policy developments across nations at the sector level, and to some extent the ambition level of climate policies in different regions. Overall, it serves as a tool to evaluate the extent, pace, and efficiency of decarbonization. This presentation will review the main findings of the CTI for five focus regions, and compare scenario projections and decarbonization trends with other major modeling and tracking efforts and will evaluate the impact of specific climate policies on GHG emission reductions.

The CTI tool, as designed, provides transparency of emissions in China, the EU-28, India, Mexico, and the US, for which the methodology distinguishes between 11 sectors: power, transportation, oil and gas, buildings, steel, cement, chemicals, 'other industries', agriculture, forestry, and waste. The tool presents analysis on leading indicator statistics for each sector, and uses these metrics to both determine future emissions trajectories and benchmark current decarbonization trends. Approximately 10 additional countries are being added in 2015 in partnership with the Climate Action Tracker (CAT) group, though with less detail. All combined, the CTI will be able to evaluate decarbonization trends and impacts of climate policies in countries that account for 75% of global emissions.

Many of the highest-emitting countries are undergoing rapid changes. When extrapolating historic GHG numbers for these countries, forecasts and scenarios can fundamentally underestimate saturation and maturity effects, and cannot thoroughly capture the impacts of current and expected climate policies. CTI's methodology is uniquely designed to forecast emissions trends out to 2030, taking into account saturation points, macro and technology shifts in the economy, and climate policy implementation, and conducts fundamental analysis on a small number of key drivers of global emissions. The tool relies upon a number of trusted sources, including the International Council on Clean Transportation (ICCT), Bloomberg National Energy Finance (BNEF), International Energy Agency (IEA), and others. In addition, by providing a high level of granular visibility into its components and indicators, with all of its outputs broken by region, sector and covering the time period between 2010 to 2030, the CTI tool is designed for annual tracking of key driver metrics for the next few years that help understand and contextualize trends in decarbonization and implementation of climate policies.

P-3311-10

Greenhouse Gas Emissions and the Climate Policy Response from State and Local Governments in the United States: Comparative Analysis of California, Texas, New York, and Florida

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The purpose of the session is to assess the current state of climate policy and greenhouse gas (GHG) emission trends in the four most populated states in the United States (i.e., California, Texas, New York, and Florida). Together these states comprise one-third of the total United States population. Each state faces different challenges in addressing climate change and each has historically different approaches to climate policy. The session will be organized by the three research questions that guided the research: 1) What has been the policy response to the threat of climate change from each of the four states and its local governments; 2) What were the GHG emission trends from 2000 to 2010 in the four states and its local governments?; and, 3) What were the drivers of change of greenhouse gas emissions? Research was conducted to systematically catalogue climate policy within each state and specific actions taken at the local government level. Actions taken at the local government level included participation in one or more of eight climate networks and completion of a GHG inventory and/or climate action plan. A comprehensive GHG inventory was completed for each state (2000 through 2010) and for selected local governments (2000 and 2010). GHG emissions were summarized for total GHG emissions, per capita GHG emissions, and by sector (i.e., energy, transportation, industrial processes, agriculture, waste, carbon sequestration, and for miscellaneous other categories). Data availability at the state level is robust; however, readily-available data for all local governments continues to be problematic. The research also provides recommendations on data collection improvements at the local government level to better determine the efficacy of local government policies and to make comparisons among local governments. Policymakers need accurate data and a framework by which to measure progress towards reduction targets and mitigation strategies aimed at reducing GHG emissions.

P-3311-11

Localizing climate policy responses: Explaining local government responses to climate impacts in the United States

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In the context of American public policy, local and state governments have taken the lead in innovating and implementing climate change policies. This has occurred both in terms of mitigation and adaption efforts. This presentation reports results from a study of the actions of local governments in response to climate change in the United States. The study relies on a unique dataset of 1,277 public organizations at the city, county and sub-state levels engaged in climate change policymaking and implementation. The presentation focuses on climate adaptation efforts - defined for the purpose of this work as policy action taken that addresses a risk directly associated with climate impacts. The results examine the factors contributing to the likelihood that a local government organization has actively expended resources toward reducing climate vulnerability. It explores how

organizations collaborate and engage in collective action solutions that facilitate policy learning and innovative strategies to address climate risks. The variables examined include the type of policy action, exposure to real and perceived climate risks, levels of policy innovation associated with organizational collaborations, and the outcomes of these efforts. Additionally, it looks at the role of both informal and formal policy networks, sources of innovation, and the prevalence of horizontal and vertical collaboration. Findings contribute to the theoretical literature on institutional collective action, policy innovation and learning, and local public economies. The results present important lessons for local governments managing the challenges of climate change and a decentralized view of how climate policy can progress at the local level in spite of inaction at the national and international levels.

P-3311-12

Multilevel Governance and Institutional Capacity for Climate Change Responses in Latin American Cities

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Urban populations, economic activities and infrastructure are responsible for between 71 and 75% of global GHG emissions. However, often only a small fraction of emissions produced within a city is under the direct control of local governments. While cities are vulnerable to a suite of negative impacts that climate change is projected to aggravate, many adaptation options are also out of local reach. In these cases, other jurisdictions and actors, such as national governments or the private sector, may have control over regulations, investments and programs that drive and manage emissions and risk. Hence, in order to mitigate GHG emissions and adapt to the impacts of climate change a range of actors, across sectors and levels of government, will need to create multilevel and multisectoral coalitions for effective urban climate governance. Although mitigation and adaptation goals are, often of necessity, pursued in tandem by local governments, and urban climate policies are the product of multiscale influences, the relationship between multilevel governance and urban institutional capacity for mitigation and adaptation policies has only recently received attention, and studies focused on cities from Latin American countries are often missing altogether. We present work conducted through the ADAPTE project to explore some of the key factors or drivers shaping the institutional capacity to develop and implement mitigation and adaptation policies in the Latin American cities of Buenos Aires, Argentina, Mexico City, Mexico and Santiago, Chile. These cities have been molded by similar urbanization processes, neoliberal reforms, urban and environmental policies, and by the presence of scientific groups and multinational networks that have been instrumental in putting climate change on their policy agendas. We compare two late arrivals to the climate change policy arena (Buenos Aires and Santiago) with a frontrunner (Mexico City), and ask whether being a frontrunner is an indicator of greater institutional capacity to respond to climate change and whether barriers to creating institutional response capacity operate similarly across cities regardless of the status of their policy development.

P-3311-13

Economics of Global Climate Policies of Adaptation and Mitigation:A Review

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Climate change is uncertain all over the World. But its impact is visible everywhere.From the Arctic Ocean to the Tropics,climate is changing over the last several Decades. Greenhouse gas is the major cause of the Global climate challenges before the Mankind.It has been found that fossil fuel CO^2 is responsible for 78% of the total GHG gas emissions rise between 1970 and 2010.The concern about global warming was first raised in the UN Conference on Environment and Development(UNCED),which is also known as Earth Summit,held in Rio-De-Jenerio in 1992. Since then concerted work on climate challenges has been going on under United Nations initiatives.Conference of the Parties(COP) to the UN Framework Convention on Climate Change (UNFCCC) pledged that future Global warming should be restricted to below 2°C(3.6°F) in relation to the Pre-industrial level.This may be re-phased with a target of restricting global warming to below 1.5°C in relation to the pre-industrial level.Anthropogenic Greenhouse gases,a group of gases are responsible for golobal warming.All the Members of the United Nations are the Members of Conference of the Parties(COP). Conference of the Parties(COP) is being held at different locations of the World since 1995.The 21st COP will be held in Paris in December,2015.Now,the question is, how to adapt to the climate change and mitigate the severity of the climate change.This adaptation and mitigation policies will differ from one Country to another.However, the combined effect of the global warming has to be contained by the end of 2100 A.D.According to some others,it should be contained by 2070 A.D.Some adaptation policies are characterized as a private good as the benefit goes directly to the individuals,regions or countries that implement them.Mitigation Policies consist of switching to low-carbon energy sources for example renewable and low-carbon energy and to remove greater amounts of Carbon Dioxide from the atmosphere by enlarging forests and other «sinks».Improving insulation of the buildings may increase energy efficiency.Climate Engineering is another method of mitigation.With limitations, Economics provides mechanism for examining the merits or demerits of taking or not taking action on climate change mitigation or adaptation in obtaining competing societal goals.The Stern Review on the 'Economics of Climate Change' is a report by the Economist Nicholas Stern of the London School of Economics and the University of Leeds.The report indicates the effect of Global warming on the World economy. The Stern Review suggested fixing the accumulation of Greenhouse gas emissions in the atmosphere at a maximum of 550 CO^2e by 2050.According to the Review this amounts to cutting Greenhouse gas emissions to three quarters of 2007 levels.The costs of these cuts would be in between the range of -1 to +3.50% of World GDP(GWP) with an average estimate of approximately 1%.The revised figure by Stern is 2% of GWP.To make a comparison in 2010, the World Product(GWP) at purchasing power parity(PPP) was estimated at $74.5 trillion.Therefore, 2% of the amount is $ 1.5 trillion.The Review includes prescriptions consisting of environmental taxes to minimize the economic and social disruptions.The Stern Review's major concluding remark is that benefits of strong early action on climate change outweigh the costs of not acting.The Review points out the impacts of climate change on water, food,health and the environment.The Review says that without action the total costs of climate change will be equivalent to a loss of at least 5% GWP,each year now and forever.

3312 - Planning and assessing adaptation: Frameworks, methods and results

ORAL PRESENTATIONS

K-3312-01

Diversification: a safety net for Kenya's dryland farmers in the face of climate change

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Climate change threatens livelihoods of the predominantly pastoral communities in the arid and semi-arid lands of Kenya, making about 50% of households in these areas food insecure. This will worsen given the pressures from climate change, unless there are changes in food production. In adapting to climate change, agro-pastoralism is being embraced. While this shift represents an innovation, the households are exposed to new risks and challenges in securing their livelihoods. This risks include increased drought frequencies, pests and diseases, increased temperatures and erratic rainfall. The main challenges include dwindling land sizes and limited agricultural know-how. The IDRC-funded Agricultural Productivity and Climate Change in Arid and Semi-Arid Kenya project set out to identify suitable crops for local conditions that would be readily acceptable to farmers, and to investigate water efficient farming systems that would be more productive under projected climatic changes. Localised rainfall information for the region was used to indicate current and future rainfall scenarios, forecast the onset of the planting season and identify suitable areas for different adaptation strategies. Working with 240 households, over three years, the project established demonstration field plots and farmer field schools to introduce appropriate climate adaptation strategies. These included drought tolerant crops, cover crops, use of organic and inorganic fertilizer and new production systems. Through the farmer field schools, farmers evaluated crops and assessed their acceptability. Prior to the project, households had reported a reduction in crop yields over the previous ten years by between 10% and 50%. Project interventions saw households who had planted alternative, drought-tolerant and high yielding crop varieties obtain up to 40% increase in yields. Furthermore, households started to allocate about 10% more of their arable land to food crop production, improving their household food security by 18%. Having boosted crop production, 20% of the households started to supplement their animal feeds with crop residues, increasing their feed supplies by 8%. There was a decline in the size of their livestock herds as they adopted cropping practices, but increases in crop production compensated for the reduction in livestock-based earnings. Planting in zai pits reduced crop yield losses during extreme dry weather by up to 40%. Use of organic fertilizers, increased maize yields by 50% in a normal season, fertilizers reduced losses by up to 10% during severe drought and up to 30% during mild drought. By cultivating crops in former livestock pens, production was up to three times more than unfertilized fields, showing the importance of organic fertiliser, as a way to reduce the impacts of climate variability and change. Cost and benefit projections showed that crop diversification would yield over 40 times the investment cost within the first ten years, with the potential of further significant increases in subsequent years. All targeted households influenced 3-5 other households, significantly increasing the uptake of adaptation strategies and scale of impact. Households with the highest diversity of crops traded in the market more frequently than those with fewer crops. The linkages and support from the County government extension staff greatly promoted the success of the initiatives. The county government committed to invest in competent extension services, farmer field schools and demonstration centers for supporting households in building wealth, growing income and ensuring food and nutritional security.

K-3312-02

Picking mushrooms: how to gather adaptation science, theory and practice in order to assess progress

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By the 1990s, adaptation scientists had developed a rather sophisticated 'typology' of adaptation (see Smit, 1993; Smit et al, 2001), which reflected adaptation's elusive character. They showed that adaptation could exist in many different temporal and spatial scales and dimensions of consciousness. One of the most useful typologies to emerge from this work is the idea of 'planned' versus 'spontaneous' adaptation, also described as 'proactive' vs. 'reactive' adaptation. This distinction has in many ways been the core notion that has given policy makers and practitioners an entry into adaptation. Yet subsequent scholarship on adaptation has been unable to develop a robust theoretical basis necessary to further a common understanding. Rather than build on existing knowledge, initiatives, publications and theories have developed in a mushroom-like fashion. This creates a rift in the three domains of adaptation science-policy-practice. In this context, this paper asks how measuring adaptation - frameworks and indicators - can be applied when the conceptual underpinnings are debated and questioned.

O-3312-01

Adaptation tracking at global to regional scales

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Adaptation tracking seeks to characterize, monitor, and compare general trends in climate change adaptation over time and across nations. Recognized as essential for evaluating adaptation progress, there have been few attempts to develop systematic approaches for tracking adaptation, particularly at global to regional scales. This is reflected in polarized opinions, contradictory findings, and lack of understanding on the state of adaptation globally. This presentation will outline key methodological considerations necessary for adaptation tracking research to produce systematic, rigorous, comparable, and usable insights that can capture the current state of adaptation globally, provide the basis for characterizing and evaluating adaptations taking place, facilitate examination of what conditions explain differences in adaptation action across jurisdictions, and can underpin the monitoring of change in adaptation over time. We will use examples from our own work to illustrate approaches to adaptation tracking, including studies examining adaptation globally, in the EU, in the health sector, in urban areas with >1m people, and in 'hot spot' regions. The presentation will stress the importance of utilizing a consistent and operational conceptualization of adaptation, focusing on comparable units of analysis, using and developing comprehensive datasets on adaptation action, and being coherent with our understanding of what constitutes 'real' adaptation; collectively what we term the '4Cs of adaptation tracking.'

O-3312-02

Assessing the climate change adaptive capacity at the city level, a case study: the Concepción Metropolitan Area, Chile

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Despite the growing number of studies focusing on urban vulnerability to climate change, adaptive capacity, which is a key component of the IPCC definition of vulnerability, is rarely assessed quantitatively. This research examines the capacity of generic adaptation in the Concepción Metropolitan Area (CMA), Chile. A new approach is proposed to assess the urban adaptive capacity which is based on a set of indicators and fuzzy modelling techniques through Geographic Information System (GIS) technology. A general procedure is proposed which provides consistency while allowing the required flexibility for application to cities under conditions of varying urban context, such as: information availability, resources, time, and scale. The factors understood that facilitate or constrain the process of adaptation were identified to revealed the differences between the level of adaptive capacity over time among the municipalities of the CMA. This allowed monitoring of changes in the spatial distribution of the adaptive capacity over time. This is the first extensive quantitative analysis of urban adaptive capacity in Chile.

The model of the city's generic adaptive capacity was developed through fuzzy logic operations of ArcGIS software. This is based on seventeen indicators, derived from data available for all the urban areas in Chile, which are standardized and then aggregated through a stepwise approach into six determinants. These determinants are then aggregated into three components and finally combined to provide an overall generic adaptive capacity index, which was mapped for nine municipalities within the CMA. The set of urban indicators were selected based

on the literature and created using data available at the municipality scale. As the same indicators were recorded for 1992 and 2002, they can be compared to reveal changes in the indicators over a 10 year period. This allows to understand the past conditions and factors contributing most to positive changes in adaptive capacity over the period, as well as those factors that have changed least.

Over the studied decade, it can be seen that all the municipalities increased their level of adaptive capacity. However, the relative levels of adaptive capacity between the analyzed municipalities did not change significantly, this implied that the large differences observed between the municipalities were maintained over the studied period. The results also show that municipalities with lower level of adaptive capacity in 1992 presented the highest increases in level of adaptive capacity by 2002. In contrast, those municipalities with highest level of adaptive capacity in 1992 showed less improvement. One interpretation that can be drawn is that economic factors such as the increasing income inequality found particularly in the richest municipalities may actually be reducing the potential for further increasing adaptive capacity in these municipalities. These results suggest that efforts to improve the level adaptive capacity of the municipalities should focus not only on increasing the general adaptive capacity level, but also in reducing the wide disparities observed between municipalities.

The resulting indices enable monitoring of changes in the spatial distribution of the adaptive capacity and changes over time across the city. The resulting maps help identify areas where adaptive capacity is lacking or less developed. This can stimulate dialogue amongst policymakers and stakeholders regarding how to manage urban areas/ how to prioritise resources for urban development in ways that can also improve adaptive capacity. Such discussion can contribute to the climate policy in both city planning and national planning scale, e.g. the Chilean National Adaptation Plan (NAP). It highlights the benefits of modelling using fuzzy sets to future research in the field of vulnerability to climate change since allowed the straightforward standardization and consistent aggregation of indicators. The methodology developed for CMA can be readily applied for other cities in Chile and around the world.

O-3312-03

Impact of adaptation strategies on maize productivity under climate change: Empirical evidence from the Senegal River valley

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Climate change challenges require, at the microeconomic level, the adoption of effective strategies to ensure production performance for achieving food security. Adaptation strategies in the agricultural sector are essential to face issues related to climate change over the coming decades (IPCC 2007). In the literature, economists have mainly focused their interest on the impact of climate change on agriculture (Mendelsohn, Nordhaus, and Shaw, 1994; Deressa and Hassan, 2009; Deschênes and Greenstone, 2007) while the quantitative analysis of the role of adaptation remains marginally explored (Stern, 2006). In Senegal, food security depends on local agricultural capacity as agriculture, which determines the availability of food is the first element in the food safety chain (FAO, 2012). Maize (Zea mays L) is one of the major food crops in Senegal. This traditional crop has been part of Senegalese consumers' diet for centuries. However, maize cultivation is mainly rainfed. Approximately 40% of the maize growing areas are occasionally confronted with drought stress, with yield losses of 10 to 25% (Boone and al., 2008). To cope with irregular and insufficient rainfall, Senegalese farmers have adopted a range of strategies (NAPA, 2006). This paper's main concern is to identify the different types of adaptation implemented and quantify the impact of those adaptation strategies on maize productivity.

Materials and methods: This study was conducted in the Senegal River Valley which is one of the six agro-ecological zones of the country and where 8% of total arable lands are concentrated. The data used in this study was collected through surveys during the rainy season of 2013. The dataset encompasses 140 farms in the middle and upper Senegal River Valley. First, a frequency analysis is used to determine the adoption rate of coping strategies. Performing a student test, we identified strategies with a significant impact on maize productivity. Econometric estimates were then conducted for those strategies. Second, we used the endogenous switching regression model (Alene and Manyong, 2007, Di Falcao et al, 2010;. Di Falcao and Veronesi, 2011; Akpalu, 2011) to identify the determinants of the decision to adapt a given strategy. The advantage of this model is to allow for full interactions between the implementation of an adaptation strategy and the factors determining productivity. Finally, based on Sajaia and Lokshin (2004), we calculated the expected productivity in both factual and counter-factual groups to determine the impact of adaptation strategies identified on maize productivity.

Results and adaptation policy implications: The results show that 78% of farms in the middle and upper Senegal River Valley use at least one coping strategy. These strategies include the change of seeding date (implemented by 69% of farmers), the use of short cycle varieties (36%), the «cordons pierreux» (1%), the «zai» (3%), the use of trees or shrubs fertilizers (4%), the direct seeding (7%), the use of biomass (1%) and irrigation (2%). The Student test shows that the change of seeding date and the use of short cycle varieties have a positive and significant impact on maize yield. For these two strategies, the differences in yields observed between farmers who adopt a strategy and those who did not is not a hazard. Estimates of endogenous switching regression model highlight the main determinants of the decision to adapt. Farm households that use fertilizers with individual fields are found to be more likely to change the seeding date and use of short cycle varieties. Likewise, farmers who belong to a producer organization are more likely to adopt coping strategies. Therefore, dissemination of these coping strategies would be more efficient through producers' organizations than through extension services that have no impact on the decision to adopt a strategy. Results show also that in the Senegal River Valley, the change of seeding date is the best adaptation strategy to improve the maize productivity in the context of climate change. Indeed, the impact analysis shows that the change of seeding date increases the average productivity of maize by 506 kg/ha, while the use of short cycle varieties only increases it by 247 kg/ha. In terms of adaptation policy we propose the establishment of Climatic Information System which goal would be to provide information about climate to farms through a multi-stakeholder platform gathering both producer's organization and meteorological and extension services to better cope with climate change in Senegal rural area.

3312-POSTER PRESENTATIONS

P-3312-01

Formal and Informal Networks for Learning in Adaptive Risk Management in London, UK

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Since the 2003 European heatwave, risk management and early warning systems for extreme temperatures have been developed in many European cities. London, UK, a global frontrunner in urban climate change adaptation, introduced comprehensive risk planning arrangements in the context of the 2004 National Heatwave Plan. Its annual rounds of review and its application through local governments in London are the focus of the analysis in this presentation. They provide a unique opportunity to study, in a local government context, pathways and constraints for social learning as an aspect of urban resilience. Empirical evidence stems from 49 semi-structured expert interviews with risk planning officials from London local authorities, health and social care organisations. Findings suggest that the interaction of formal and informal institutions has limited social learning in heatwave planning to incremental changes that reinforced the status-quo. Informal networks and trust relationships between risk planners compensated for formal heatwave planning arrangements that were perceived as dysfunctional. This support from informal institutions to formal strategies undermined opportunities for paradigm shifts in risk planning. It suggests that social

learning can be associated with rigidity of established risk management strategies, rather than with their change. In the context of heatwave planning in London, missed opportunities for paradigm shifts concerned a consolidation of reactive risk management approaches that focused on the health implications of heat stress. This consolidation undermined the development of preventive risk management approaches that consider social, environmental and technical risk dimensions. The results of the analysis raise questions about the desirability of learning as an adaptive strategy in the context of climate change. The presentation suggests that learning is not necessarily beneficial for transformation if it is enacted through organisational systems that are inertial and resistant to change.

P-3312-02

Climate Smart Practices for Resilience and Sustainable Productivity: Sudan's NAPA Case Studies

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This study aimed at documenting climate smart practices implemented by NAPA at four States (River Nile, Gedarif, North Kordfan and Darfur) in Sudan. This documentation was done through reviewing the progress attained regarding the adaptive measures undertaken to enhance the resilience of the targeted communities. Climate smart practices identified include: Sand dunes fixation, forestry and rangelands rehabilitation, micro-fences in rangelands, improved rain water harvesting practices, groundwater harvesting for establishment of community managed horticulture gardens, energy substitutes, and livestock improvement activities. Areas rehabilitated on open sand dunes with range plants and tree seeds and seedlings were over 600 ha, clay soils areas covered with agroforestry, windbreaks and rangeland rehabilitation were 105.0, 21.0 and 84 ha, respectively. Rainwater harvesting structures were constructed to improve trees and rangelands rehabilitation. Shelterbelt was established covering an area of 300 ha. Range plants seeds were, also, broadcasted inside fenced areas. This was done through communities' participation, particularly women. Rainwater harvesting technologies enables farmers to break out of the cycle of poverty through increased crop yield, enhancing their adaptive capacity through improved food security and livelihoods. Improved water harvesting practice resulted in an increased sorghum yield over 477%. Earth bund water harvesting + chisel ploughing gave an increase in sorghum yield of over 177%. Cucumber, sorghum and okra, cultivated under the improved water harvesting technique accrued a profit of over $1000. The intervention of groundwater harvesting, which involved 199 women and using solar energy operated pumps, provided a good viable practice for enhancing community adaptation to climate change through food security and income generation. Over $2500 were stated to be the revenue from the different activities of the horticultural garden due to groundwater harvesting. Cylinders and stove units were distributed relieved pressure off the fragile natural resources through provision of alternatives to tree cutting for charcoal making and for firewood collection, hence reversing resource and land degradation. Sheep and goat improvement program activities, using local breeds conducted were good practices in increasing adaptive capacities of vulnerable communities' through income generation. Improving the nutritive value of Adar grasses and crop residues helped improving livestock feed balance in these areas in view of the deteriorated rangelands, particularly during the dry season. The study revealed several success stories and learning lessons.

P-3312-03

Climate change adaptation of community-based drinking water organizations: challenges and solutions

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Due to climate change and variability, drought events are expected to be more intense and prolonged in different areas of Latin American and the Caribbean (LAC), with significant impacts in the volume, timing, and quality of water provided by water suppliers (Kundzewicz et al. 2008). Community-based drinking water organizations (CBDWO) are the most important providers of water in rural areas of LAC and play a key role in decentralization and democratization processes in the region. The inherent capacities of CBDWO to adapt to expected impacts of droughts would be much conditioned by their capacities to initiate and catalyze collective processes in the communities they represent.

The rich background of actual and historical responses that CBDWO have given to drought phenomena is an essential starting point for understanding both processes and limitations to adapt to future adverse climatic events. The complex nature of collective adaptation processes involves the identification and analysis of relationships among different actors in the communities, the governance structure in which they interact, the physical and natural resource base on which they depend and the social, economic, demographic and political setting in which they reside.

Around 1500 CBDWO provide water to 60% of people in the driest rural areas of Nicaragua and Costa Rica. We randomly selected a sample of 130 CBDWO in these two countries to collect information, through interviews to CBDWO leaders and surveys to water customers, on governance and financial characteristics, performance indicators (e.g. hours of water service), technical features of the existing infrastructure as well as adaptation investments from these water providers, among other relevant indicators. This information helped us to identify empirically the factors that influence the performance of CBDWO in the context of droughts; enumerate the adaptation measures implemented by CBDWO to deal with these disturbances and acknowledge the specific challenges and facilitating conditions for the implementation of these measures and for building drought preparedness.

We found that CBDWO implement different hard (e.g infrastructure improvement), soft (e.g. rationing) and ecosystem based (e.g. protection of recharge areas) adaptation measures to deal with droughts and water scarcity in general. One of the main factors that facilitate capital intensive adaptation measures (e.g infrastructure measures such as water metering systems at home, storage capacity augmentation) is the ability of CBDWO to mobilize internal and external financial resources, which further depends on social capital (internal and external networks) and the governance structure. In particular, some conditions seem to be necessary for adapting to driest scenarios: water fees for recovering costs and incentivizing rational consumption; external mechanisms for financing water investments; legitimate, transparent and functional governance structures at the local level; and technical expertise complementing local knowledge.

Our results suggest that in most cases external support is critical for climate change adaptation of CBDWO. This has important implications for adaptation policy design and the role for development assistance in supporting adaptive capacity. In this regard we propose a long-term integral approach minimizing the incentives to perpetuate external dependency on limited governmental funds and international donors for maintenance, replacement and expansion of water infrastructure and investment in climate change preparedness. This approach should promote the long-term financial sustainability of CBDWO through improved mechanisms for cost-recovery, accessible financial options (e.g. through public-private banking partnerships) and conditioned subsidies under critical circumstances. These efforts should be accompanied by reachable opportunities for training in administrative and technical aspects of water management. Finally, the availability of more precise and updated information on how climate change would affect local water systems is an important pillar in this approach.

P-3312-04

The Mid- and Late Holocene Climate Changes in the Amuq Plain: The Adaptive Responses to Climate Change as Indicated by Archaeological Data

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Paleoenvironmental research has shown that significant climatic changes happened during the mid- and late Holocene yet it is hard to generalize changes in crucial climatic variables across the Near East. The Amuq Plain is located at the northern terminus of the Jordan Rift Valley. The region has been recognized as a hot spot for biodiversity in the modern era (ancient Antioch, the Turkish city of Hatay). The Plain has been densely settled and its resources have been used intensively in the last 10.000 years, which has become a hub for social interactions. Consequently, the Amuq Plain has a lot to offer in studying the dynamic and multifaceted history of human-environment relationships, especially the adaptive responses to climatic changes in the Holocene. Although untangling such relationships in time is essential, given the complexity of the geology of the Plain (i.e., tectonics, fluvial, and colluvial processes), spatial dimension becomes equally important. Contextualizing the range of human adaptive behavior in the Plain, across space and time, requires analyzing diverse sets of data. In addition to archaeological, economic, social, historical, and political data, environmental data are also needed to have a more accurate and complete reconstruction of adaptive patterns.

My talk will focus on correlating the results of the Macrophysical Climate Model with the long-term archaeological settlement systems on the Plain, which have been documented through traditional survey methods as well as remote sensing, geoarchaeology, and paleoenvironmental research. Macrophysical Climate Model (MCM) is one of few paleoclimatic-modeling tools that have been available to researchers. In comparison to other paleoclimate models, MCM has higher spatial resolution and the results are synoptic (i.e., local). Research in different parts of the Near East suggests that the results of MCM agree well with the results from multi-proxy based paleoenvironmental reconstructions. The model output provides quantifiable figures at centennial resolution.

In my talk, first, I will present the output from MCM that provides average annual precipitation and temperature between 12,000 and 2,000 cal. BP (ca. 10,000 B.C. - 0). Calculating annual averages at centennial resolution, changes in precipitation and temperature will be plotted. Then, I will interpret the possible impacts of climate change on the settlement systems of the Amuq Plain at spatial and temporal scales. In this comparison, the size, function, preference of land formation, and distance to the nearest water source will be analyzed using geographical information systems (GIS).

P-3312-05

Climate Change Adaptation and Household Resilience to Shocks in Ethiopia

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Rural households in Ethiopia that depend on agriculture for their livelihood are highly susceptible to climate variability and change. A number of adaptation strategies have been identified as having great potential to reduce vulnerability to climate variability and change and many of these practices have already been adopted by agricultural households. However, few studies have assessed the extent to which particular practices actually increase resilience to climate shocks, which are becoming more frequent with climate change. This paper assesses the effectiveness of key adaptation strategies in the Nile Basin of Ethiopia by examining the extent to which adoption of these practices protects household assets following a climate shock, drawing on data collected through two rounds of a survey of 1,000 agricultural households in the Nile Basin of Ethiopia.

P-3312-06

Assessing adaptation on the ground: a proposed framework to measure adaptive capacity

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Methods for evaluating adaptation projects are a growing concern, in both the applied and academic spheres of climate change adaptation (CCA). Internationally, there is increased funding for supporting adaptation projects, yet limited exploration of how this international funding is landing on the ground and impacting on adaptation. The key objective of our research is to highlight evidence of how external funding in developing countries is contributing to building adaptive capacity and implementing CCA. The core research question that guides the study is: what is the role of international funding in building adaptive capacities across scales and, especially, on the ground? This question will be addressed with a specific focus on how international funding enables or undermines adaptive capacities among local institutions (both governmental and non-governmental).

The initial phase of the study is based on a review of existing literature exploring to role of international development funding on building generic and specific adaptive capacity. The review will also serve to capture methods and approaches to measuring adaptive capacities on the ground. The literature review will inform a framework to track adaptive capacities at the local level, during the implementation of CCA programmes funded by international organisations. This first phase will be followed by the second phase that will evaluate the programme: "Taking Adaptation to the Ground: A Small Grants Facility (SGF) for Enabling Local Level Responses to Climate Change», funded by the Adaptation Fund and implemented in the Northern Cape and the Limpopo Basin, South Africa. The SGF programme's main objective is to empower local organisations so that their capacities to access external funding for CCA and to implement contextually-relevant adaptation programme are significantly enhanced.

Due to the early stage of this research, the presentation will focus on the result of its initial phase. More specifically, we will present a framework to assess adaptive capacities on the ground, among local institutions. This framework is based on a review of existing literature and on an in-depth assessment of institutional configurations within the studied area (Namakwa District in Northern Cape, South Africa). This type of research is critical to help provide an increased understanding of what constitutes an effective institutional configuration that supports the implementation of successful internationally-funded CCA strategies in developing regions. This work is important for informing future scaling up and replication of small grant-financing approaches.

P-3312-07

Climate Change Adaptation of Watershed Key Stakeholders in Talomo-Lipadas Watersheds, Davao City, Philippines

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Talomo-Lipadas Watershed, Davao City, Philippines is the main groundwater source for drinking water of 99% of the urban population in Davao City, Philippines (Hearne, 2011). Yet, these watersheds are in surmountable threats because of continuous land conversion, unavoidable development, unregulated water extraction, among others. Threats are exacerbated because of potential impacts of Climate Change.

The study aims to determine Station-scale climate projections using Statistical Downscaling; groundwater recharge determination using Brook 90 hydrological model; projection of water demand using per capita method and lastly, identification of Climate Change Adaptation Strategies of three key stakeholders groups.

Results revealed that months of March and April are likely to experience intense temperature along with a low flow recharge to groundwater, and this pattern will likely sustain until the next two slice period of 2050 and 2080. Moreover, the projected water demand is increasing from 101.26%, 228.18%, and 355.10% for the slice period of 2020, 2050, and 2080; respectively. With the potential Climate Change impact to watersheds, water deficit of -31.22 and 91.52 MCM (million cubic meters) is projected for time slice period of 2050 and 2080, respectively.

Stakeholders have fragmented priorities in their adaptation strategies. Domestic water users' planned adaptations are mainly for demand-side adaptation rather than supply-side adaptation. Watershed Managers' planned adaptation is to tap surface water and tree planting. Policy makers aim to fully implement City Ordinances pertaining to Watersheds.

P-3312-08

Socio-economic aspects in the spatial differentiation of vulnerability to climate change in river basins

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The measurement of vulnerability to climate change is a central moment in adaptation activity to mitigate adverse climatic impacts. Both natural and social scientists try to measure and assess such vulnerability, whether from the perspective of regions, socio-ecological systems, or individuals. Different approaches to this issue have penetrated into climate change research, and with rapid growth of attention to vulnerability, the concept itself has been re-defined, and new interpretations and approaches were developed.

Climate change represents a classic global problem characterized by infinitely diverse actors and multiple stressors at multiple scales. As a result, research on vulnerability to this phenomenon have to address at least three important challenges: (1) to improve approaches for comparing and aggregating impacts across diverse sectors and populations, (2) to model socioeconomic transformation in assessing the significance of these impacts, and (3) to account for multiple dimensions. Different challenges result in their different 'diagnoses' and different kinds of 'cures'.

Initially, the assessment of vulnerability to climate change was approached from the impacts point of view where it was defined as the degree to which a system is susceptible to and unable to cope with adverse climatic effects. However, recently the emphasis in these efforts has moved from better defining exposure and potential impacts to a better understanding of factors that affect sensitivity of societies to these impacts and their capacity to adapt. There is an increasing recognition of the importance to consider the social component of vulnerability equally with the biophysical one, thus presenting vulnerability as a function both of physical characteristics of climate change and of social systems' inherent sensitivity and adaptive capacity. Various researches try to bridge the gap between social, natural, and physical sciences' contributions to new methodologies that confront this challenge, primary under the umbrella of sustainability and resilience. On the other hand, a system of vulnerability 'measurement' should allow comparisons between different places, social groups and sectors in terms of their susceptibility to climate change risks and capacities to deal with them. Climate change consequences first of all are experienced at regional and local levels, varying between communities, social groups in a community and even between individual households.

Based on evidences that surface waters are especially sensitive to changes in climate, the main goal of this contribution is to present the pioneer assessment of socio-economic vulnerability to climate change of the Dniester River basin at its local level, namely – at the level of Moldova's administrative-territorial units (ATU). To address this task there was proposed and practically realized a relevant methodology that included development of a set of specific indicators and proxies describing the natural and socioeconomic systems sensitivity to climate change impacts and adaptive capacity to confront them. Through a ranking approach, the relative vulnerability of each ATU was calculated by summing its sensitivity and adaptive capacity ranks, arranged respectively in an increasing or decreasing order; the latter were obtained as combinations of their primary indicator ranks. To better understand the drivers of vulnerability and to compare ATUs in terms of risks, which they can face from climate change impacts, as well as their capacity to deal with their adverse consequences, the spatial models of local vulnerability and its components distribution were carried out. Corresponding mapping revealed areas that are the most vulnerable and are needed in special attention in climate change adaptation. In a final stage, the Dniester basin's "hotspots" were discussed with wide public participation.

The proposed integrated approach to local vulnerabilities assessment facilitates allocation of limited resources equitably and efficiently among different entities – regions, administrative groups or different proponents of adaptation that is especially important for transition economies, to which Moldova is attributed.

P-3312-09

Bottom-up initiatives for flood risk management in Europe: How can we evaluate governance processes and spatial outcomes? (TRANS-ADAPT research project, JPI-Climate)

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The aim of the proposal is to present the Trans-Adapt research project and its assessment framework that will be applied to community-led bottom-up climate change adaptation strategies. Trans-Adapt (awarded by the European Joint Programming Initiative-Climate) focuses on bottom-up initiatives to flood risk management. In the context of climate change that triggers more extreme meteorological events, including severe floods, strategies are developed by local authorities, sometimes with the collaboration of civil society. These initiatives intend to make land allocations to flood risk management more efficient and socially beneficial. Trans-Adapt project assumes that these initiatives are different from mainstream flood risk management measures, dominated by one type of use (flood protection). Our hypothesis is that bottom-up initiatives pursued by local stakeholders lead to multi-functional use of land and represent a solution of adaptation to climate change. 12 case studies are studied in four European countries: Austria, France, Ireland and the Netherlands.

The overall aim of the project is to analyse, explain and evaluate similarities and differences between the selected regions in terms of climate change adaptation performance, with a particular focus at the local-individual household level, burden-sharing and equity issues. The purpose is to understand the challenges and limitations in the on-going policy and institutional arrangements, such as benefits and costs of adaptation measures at different levels.

The proposal will present Trans-Adapt research questions and the conceptual framework for assessment and evaluation of our case studies, which will give insights to the parallel session 'Assessing adaptation' in Day 3. Preliminary results from one French case study will be used as illustration of the assessment framework application.

In order to identify the barriers and limitations of the current governance and management structures in flood risk management, the project develops an analytical and evaluation framework that focuses on efficiency, effectiveness, legitimacy, accountability, social justice and social capacity, as classical policy analysis criteria. Moreover, we carry on a reflection on feasibility and vulnerability of the risk management processes and outcomes, in a policy design concern.

The assessment framework will adapt the chosen criteria to the specific topic of flood risk management, providing operational indicators that will be used to evaluate the 12 case studies.

The final objectives of the project will be to explore the possibilities for up-scaling and replicating local initiatives in other countries and outlining the institutional change required to facilitate local initiatives, by providing a means of guiding the decision-making process at different levels of authority.

P-3312-10

Prioritizing Climate Impact Risks at the Neighborhood-level: Applying a Hazard Vulnerability Analysis for Los Angeles County

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Los Angeles presents a unique challenge in assessing local climate impacts on human health due to the county's diverse neighborhood demographics, numerous jurisdictions, and varying geography and microclimates. High-resolution climate modeling for Los Angeles County has allowed for climate impact assessments at the neighborhood-level. In order to address these impacts, it is necessary to develop a regional Climate Adaptation Plan to prioritize activities and build resiliency to climate impacts for Los Angeles County. Unfortunately, few health impact tools allow for the ability to compare the risk for a range of climate impacts at the neighborhood-level. As a case study, UCLA researchers have adapted a Hazard Vulnerability Analysis tool to compare eight different areas by which climate change impacts health (extreme heat events, sea level rise, air quality, wildfires, vector-borne diseases, water availability and quality, food security, and health systems). We applied this tool to four different neighborhoods that represent the geographic and demographic diversity of Los Angeles and observed large differences in the overall and relative risk to climate change impacts for each neighborhood. This study provides strong evidence for the need to develop priorities and implementation plans at the neighborhood-level in large, complex regions like Los Angeles, and highlights a useful tool for ensuring that this planning process is evidence-based.

P-3312-11

Stepping on agricultural biodiversity to build resilient small-holder farming systems in West African Sahel

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There is evidence that the impact of climate change on agriculture will increase, under the status quo scenario. It is also advocated that agricultural biodiversity (ABD) is part of the solution to minimize the negative effects of climate change and variability on livelihoods and food security. In this paper we investigated the best adapted crop varieties to the prevailing biotic and abiotic conditions of West African Sahel. The study aimed to assess and test the adaptation potential of local genetic diversity to critical environmental conditions in the region. The field experiments were carried out using the Diversity Field Fora (DFF) participatory research approach in Mali, Niger and Burkina Faso. Each DFF consisted in a group of 25 farmers, gender mixed, which received a diversity kit (a collection of local cultivars and improved varieties grown in the contrasting environmental conditions of each country), and worked together to select preferred and adapted crop varieties to local conditions. A total of nine communities (225 farmers) participated in the DFF participatory research in the three countries. Each DFF received a minimum of six varieties or cultivars of each crop. After two cropping cycles, each community selected the three top performing crop varieties or cultivars that are best adapted to their environmental but also social and cultural contexts. This selection followed a south-north climatic gradient, dividing the study area into i) dry zones (<600 mm rainfall per year), ii) semi-arid zone (600-800 mm rainfall per year) and iii) relatively humid zones (>800 mm rainfall per year). Farmers' criteria for selecting adapted crop varieties included time to maturity, resistance to drought, resistance to diseases, yield, and food quality attributes (taste, flavour, colour, etc.). Through the DFF trained farmers selected and multiplied adapted cowpea, fonio, sorghum and millet varieties. Thanks to the capacity building activities, seeds of the farmer selected local varieties were multiplied and certified as commercial seeds in Mali and similar efforts are on-going in Burkina Faso and Niger. We concluded that cultivating adapted local and improved varieties would increase resilience of the farming systems in the region for resilient food systems.

P-3312-12

Indicaters of Vulnerabilities, Adaptations and Mitigation Strategies to Climate Change and Sustainability in Uttar Pradesh the Northern State of India

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Climate Change poses an unprecedented impact to the life on earth. In addition, predictions about the scale and enormity of it are continually being revised upwards so what was already a serious situation continues to look even more alarming. The atmospheric greenhouse gases and their levels too are increasing and are creating warmer temperatures, receding glaciers, sea level rise and an unpredictable climate with a range of extremely serious and hard to predict consequences.

The impacts of climate change in Indian subcontinent are important in many ways due to diverse topography, seasons etc. India in fact is considered to be highly vulnerable not only because of large physical exposure to climate related disasters 65% of India is drought prone, 12% Flood prone and 8% susceptible to cyclones are just indicative. It is a giant rain fed ecosystem and also because of its dependency for economic growth and majority of its populace on natural resources viz Water resources, agriculture, forests animal husbandry, fisheries etc. With a large land area and diversity of agroclimatic and ecological regions makes it a more vulnerable to the impending threat of climate change that threatens livelihood security of large rural masses of the country.India has been aggressively pursuing the agenda of combating climate change on two fronts namely adaptation and mitigation and to ensure coherence between the Climate change strategies on National and State levels, National and State plans have been envisaged. This is over and above the National Missions including one on climate change as a policy measure.

State of Uttar Pradesh possesses socio-cultural and geographic diversity with its eastern parts touches the foothills of Himalaya. It is one of the most populous states of the country with 16.49 % of country's total population of 1.21 billion with 7.87% of country's geographical area. The states has been divided into four zones or regions viz, Western Region, Central region, Eastern Region and Bundelkhand Region and 17 administrative divisions and almost 79% populations is residing in rural areas of 97942 inhabited villages and 114 forest villages.

Studies carried out on the indicators of Rainfall/preciptaion of five successive years of last decade particularly between 2006-2010 indicates that Bundelkhand region of the state is predominantly drought prone while some part of Eastern and Western suffers from a flood which is one of the important drivers of forced migration of workforce to other regions of country. The estimated percentage of migration of workforce who have small and marginal land holding ranges from 10 to 35% and upto 40% in the landless labourers. The nature of migration also varies in both the post and preharvest season known as rabbi and kharip. One of the observation indicated that incessant flood preceeded by long dry spell is also negetively influencing the agricuture productivity of the region. These are the areas that reflect more as negative indicators of productivity due to variety of reasons. Further climate of the region also varies from moderately temperate in the Himalayan reagion to tropical monsoon in the Ccentral plains and southern upland regions

Our analysis to assess the flood/drought dizaster risk by Latin Square Design (LSD) using statistical software SPSS reveals direct relationship of degraded ecosystems and sustainable livelihoods of the dependent population who are peasants with small land holding and agriculture labors primarily. Interestingly some measures adopted by the farmers and the state policies to resolve the ecological crisis are indicative of strategies to combat the threat. One of the means of weather based crop insurance is also felt imporatant as untimely weather fluctuations are compounding the losses to the small and marginal farmers and many have succumed over the last decade. This paper attempts to highlight impending issues in the context of Uttar Pradesh a Northern State of India focusing on issues of sustainability which is pivotal.

P-3312-13

The effects of ecosystem-based adaptation on vulnerability to climate change: evidence from semi-arid Brazil

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Assessing the effectiveness of adaptation strategies in rural parts of developing countries is an important, but relatively understudied topic. One important question is the effect of social interventions and anti-poverty programs on vulnerability and influence the possibility of social transformation (Lemos et al. 2013, Eakin et al. 2014). While there is growing evidence that poverty is a robust predictor of vulnerability, there is also growing attention to the ways they do not overlap and/or the different ways they do overlap (Olson et al. 2014, Nelson et al. in review, Patt 2012). In this context, so-called ecosystem-based adaptation (EbA) strategies - i.e. options that combine community management of natural resources with specific agro-ecological technical assistance and production methods - have gained wider attention specifically in Latin America as means for reducing vulnerability to climatic extremes while simultaneously contributing to local sustainable development (Magrin et al., 2014). But while the role of sustainable use of biodiversity for climate adaptation is relatively unquestioned, there is little evidence on the effects on reducing social vulnerability, particularly when assessed in the context of ongoing anti-poverty programs.

This study assesses the effects of ecosystem-based sustainability projects on smallholder farmers. We focus our research on drought-vulnerable communities in Northeast Brazil where we have already carried out research and collected longitudinal data at the household (in 1998, 2012, 2013 and 2014) and municipal (in 1998 and 2012) levels at the intersection of livelihoods, technological innovation, environmental sustainability and vulnerability to drought (Lemos et al., 2002; Obermaier, 2013; Obermaier et al., 2014; Simões et al., 2010; Tompkins et al., 2008). Climate projections for NE Brazil indicate a strong likelihood of decreased precipitation, resulting in more aridization and drought (Magrin et al., 2014), which will further exacerbate social vulnerability to currently sensitive populations in the region.

Our motivation for carrying out the research in Brazil is the ability to locate the analysis in the context of a much larger social experiment in poverty elimination implemented by the Brazilian government since the late 1990s called Programa Bolsa Família. The program provides a conditional cash allowance to all households with school age children and whose income is below a minimum amount established by the government. In order to qualify for the allowance families have to enroll and keep their children in school and provide basic health care (e.g. vaccination). One hypothesis behind the Bolsa Familia program is that it will slowly eliminate severe poverty in Brazil and potentially transform the livelihoods of the segments of the population that currently live below the poverty line (below 2 dollars a day).

First evidence by our research supports the hypothesis that although Bolsa Família is necessary for families it is also insufficient to reduce vulnerability to drought. On the other hand, ecosystem-based strategies carried out through regional Conservation and Sustainable Use of Biodiversity Programs in NE Brazil seem to enable rural farmers to maintain their food security (including access and nutrition values) at higher levels as well as to contribute to income generation.

Empirical findings from this research will critically contribute to both scholarship and policymaking. Currently, there is debate among academics and practitioners alike regarding the best types of actions to reduce the risk of experiencing harm derived from extreme events particularly within the developing world where losses are expected to be significant. In order to support household adaptation, policy makers must decide whether it is more effective to invest in measures that will reduce vulnerability to a broad range of both climatic and non-climatic stressors, or whether it is best to focus on enhancing specific capacities to manage particular hazards. In terms of the livelihood framework, policy-makers must decide which types of livelihood assets should be strengthened through public investment and support. This research will contribute to this debate by providing empirical evidence of the role of anti-poverty programs in building vulnerable households' and individuals' adaptive capacity to climate impact.

P-3312-14

Water security indicators for a climate variability and climate change adaptation process in the Maipo River basin in Central Chile

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Observed climate change effects are challenging government and societies to start thinking how to adapt to an even more extreme range of potential future changes that will impact many aspects of our lives. As this need for adaptation arises so does the practical details about how to successfully implement this adaptation process, given the socio-ecological complexity of systems involved. The Maipo river basin in the semi-arid Central Chile is an example of such systems that most likely will need to adapt in the future due to climate change. The Maipo river provides water for over six million people and to more than 200.000 hectares of agricultural land and many other productive (e.g. mining, hydropower) and not productive activities in the Santiago Metropolitan Region. Previous studies have shown that future temperature and precipitation changes will result in more stress to the already water scarce basin, but could also result in more extreme flood events due to a rising zero degree isotherm.

To face the multiple demands in an uncertain future with climate change and population increase, the public and private sectors as well as the civil society will require information and tools to concentrate efforts in the most relevant aspects of life that will need to be adapted. To respond to this need, a three-year project (2012-2015) entitled MAPA (Maipo Adaptation Plan for its initials in Spanish) is being implemented in collaboration with a multi-stakeholder platform of around 30 public, private and civil society organizations, both at the local and regional level. The objective of the project is to both identify vulnerabilities and adaptation options to potential future scenarios in the basin. To facilitate the work the scientific team and the stakeholders were grouped in three working groups (i.e. mountain/natural systems, rural sector and urban sub-sector). This project is guided by the Robust Decision Making framework that incorporates both stakeholders expertise and computational capabilities in a mutual feedback process to identify future scenarios, appropriate tools and models, adaptation measures and Performance Indicators, which are a key outcome. These indicators allow both the identification of base line vulnerability levels and the understanding of the benefits of implementing adaptation measures given uncertain scenarios.

Since water is the common link between the diversity of threats and demands at different scales in a basin, we used the Water Security definition by the U.N. to frame a participatory process to identify locally-based, multi-scale Performance Indicators, and measure climate change impacts in a way that could trigger the implementation of adaptation measures. In order to operationalize the definition into the adaptation process, we disaggregated water security into its five main sub-components (i.e. economic development, livelihoods, ecosystems conservation, protection against hazards and protection against water-borne pollution). The concept and its sub-components were intensively discussed with the working groups. A set of factors, demands and aspirations denoting water security in different spatial and temporal scales were identified by each working group (e.g. flow of water for rafting, volume of minerals extracted or turbidity in water). The indicators, relationships and casual links among them were analyzed and consolidated in order to generate a conceptual model to characterize water security

in the Maipo basin.

The guided but still highly participatory process implemented in this study identified causal links and scales of indicators, which in turns will allow defining metrics and optimum levels to be used as early signs in this adaptation plan in process. The water security conceptual model goes beyond capturing water physical manifestations, as it attempts to make visible hidden connections to ecosystem goods and services and human aspirations that represent human well-being, which could be finally impacted by climate change.

The approach has also the potential to capture the general aspirations of the different users in a basin related with economic development, ecosystem conservation, basic human needs, pollution and hazard allowing in this way not only the design of adaptation measures that have a physical water representation but also measures that are closely related to the final objectives that water security tries to achieve: human well-being.

P-3312-15

Emerging Response to climate change and Variability in Semi-Arid Areas of East Africa

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Arid and semi-arid regions are characterized by insufficient rainfall to sustain agricultural production. The rains are erratic and often come in a few heavy storms of short duration resulting in high run-off, instead of replenishing the ground water. Protective vegetation cover is sparse and there is very little moisture for the most parts of the year. Communities in these regions are particularly vulnerable to climate change not only because of their dependence on climate sensitive sectors but also due to limited capacities to anticipate and effectively respond to climate change. The main objective of this study was to determine the emerging coping and adaptation strategies of the local communities in Semi-arid Regions of East Africa with a view of enhancing their resilience and reducing vulnerability to climate change and variability. The paper is based on the synthesis and comparative analysis of coping and adaptation strategies employed by different countries in East Africa. The study found out that the communities and local governments are investing on several adaptation activities to address impacts of climate change in semi-arid areas. These include rain water harvesting for domestic, livestock and agricultural production needs. The availability of this water resource significantly reduces community vulnerability to food insecurity. The establishment of water pans and water conservation structures provide opportunities for the local community to diversify their economic activities through the cultivation of high value horticultural crops under drip irrigation systems. The pastures and improved fodder grasses planted under furrow water conservation structures provides the opportunity for the local community to produce pastures/fodders during the dry periods. The proactive responses and investment in conservation structures in ASALs is crucial towards enhancing resilience and adaption of the local communities from the adverse vagaries of climate change. Other projects such as cropping and agronomic adaptation options that promote already existing best management practices should be implemented. There is also a need for the integration of local knowledge in government climate policies to improve adaptation and enhance local adaptation strategies.

P-3312-16

Climate Change Adaptation and Vulnerability Assessment: A case Study of Lesser Himalaya

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Climate change and land use degradation are accelerating water induced hazards such as cloudburst, flash floods, riverine floods, surface erosion and landslides in Himalayan geosystem. Himalayas, due to their complex geological structure, dynamic geomorphology, and seasonal hydro-meteorological conditions experience very frequent natural disasters, especially water induced hazards. Natural hazards have had significant impacts on life and property in areas with high population densities and land use intensity. The escalation of risks and vulnerability has come about through population growth and land use intensification in the areas, both of which have encroached upon hazard zones and in some case, such as road construction on slopes, have exacerbated the hazard of slope failure. The association of deforestation, rainfall and steep topography was augmentative.

Climate Vulnerability Index (CVI) is being proposed to assess climate change vulnerability of communities with a case study in high mountain areas in the Beas River valley of lesser Himalaya. The index consists of household parameters of all the three dimensions of vulnerability such as Exposure, Sensitivity and Adaptive Capability. Exposure is defined by Natural disaster and Climate variability, however Sensitivity by Health, Food, and Water and Adaptive Capability by Socio demographic profile, Livelihood strategies, and Social networks.

P-3312-17

Smallholder farmers in the Great Ruaha River sub-Basin of Tanzania: coping or adapting to climate stresses?

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Climate change and variability are pervasive contemporary realities in Africa. In this paper, we investigate the changes that have occurred in the Great Ruaha River sub-Basin (GRRB), Tanzania. By making use of a mixed-methods approach, including both quantitative and qualitative data collection methods, we demonstrate that climatic stresses have increased since the 1990s, as have limiting factors constraining effective and sustainable response options. By interrogating data from smallholder farmers focus group discussions, household questionnaire surveys and records in government institutions we show that sustainable livelihoods in this area are compromised by non-climatic stresses such as a lack of coordinated crop markets and poor access to loans, weather forecast information, and to irrigation infrastructure. Smallholder farmer responses to climatic stresses (i.e. resources utilisation, farming methods diversification) have changed over time, with corresponding changes in coping strategies that are adopted in response to specific stresses. Barriers to adaptation include limited access to irrigation water, crop markets and loans. Consequently, smallholder farmers are resorting to shorter-term coping strategies more frequently than longer-term adaptation to impacts of climatic stresses, and are thus still heavily reliant on social, economic and policy support to improve their adaptive capacity.

P-3312-18

Generating Knowledge and Capacity for Climate Change Impacts and Adaptation for Water Security

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This research seeks to narrow the existing gap between scientific knowledge on climate change impacts on water resources and efforts made by national and local water management institutions in Central America and the Caribbean. Hence, from the start, these institutions were involved, in two prioritized countries, to assess climate change impacts and adaptation measures on water resources in this region. Regional, national and municipal

scales of analysis were used in a pilot basin in each of the two countries under study: the Dominican Republic and Guatemala. Research was done together with universities, ministries of environment and other stakeholders from two municipalities per basin, making it one of the key aspects that contribute to achieving the objective. This approach of incorporating decision makers, water resource managers and other stakeholders, aims to promote the application of the findings and the use of research results and to strengthen learning and management skills for beneficiaries and the organization leading the research.

For the climate change models for the region published in the IPCC Fourth and Fifth Assessment Reports (AR4, AR5), we performed a comparative analysis, in terms of future water availability. It is among the main results of the project, to date. Based on technical criteria, we chose four of the 19 General Circulation Models (GCMs) published in the last IPCC report, the new Representative Concentration Pathways scenarios (RCPs). These models were inputs to determine the impacts of future climate change on water quantity, compared to current conditions. Distinct models produced different results, especially for rainfall. Regarding erosion, the most vulnerable basins were mostly located in Haiti and Guatemala. Hydrologic and climate modeling with a Soil and Water Assessment Tool (SWAT) provided a more detailed analysis on the two basins. Results will be available in a public website, for consultation by the 22 countries in this region and can be used in their next Climate Change National Communications. Project-sponsored universities, national researchers, and students collectively performed vulnerability analyses in the pilot basins. Thru the project, a regional study was done in the countries with information available, to understand how the countries invest on climate and water resources. It showed that more than 60% of investment funding comes from external sources. From this 60%, three quarters go to the implementation of programs and costs of operation and maintenance of infrastructure. One quarter goes to actual infrastructure or hard investments. In general, countries set priorities depending on the pressure over water resources from different sectors, especially agriculture, energy generation and industry.

In the policy framework, the Roman law system prevails for Central America and in the Caribbean, the so-called common law applies. Differences in motivation are evident in the regulatory frameworks among the Caribbean Community (CARICOM) member countries and the Central American Integration System (SICA) countries. Both policy and investment studies were specific to both pilot countries. The studies were complemented by a thorough analysis of water resources management, conducted by relevant stakeholders from the pilot municipalities. It found that conflicts and gaps existed in the institutional responsibilities, policies, regulations and investments to the sectors. It identified the different local strategies that allow people to move forward in terms of water security. The municipal government scale is where findings will integrate at the end. The biophysical, economic, management and political research done will be the basis to develop Municipal Adaptation Plans. Research results plus lessons learned, will be used to prepare the guides to optimize public investment in climate change adaptation on water resources. Local stakeholders have already integrated into a «Participation Focus Group (GFP)» in each country basin in a process that promotes learning, communication and empowerment of results. They have participated in the whole process; strengthened their knowledge and perspectives; validated methodologies and monitored research outcomes, and provided recommendations. A public resource-sharing platform will complement the advances in guiding adaptation policy through knowledge built together. It will provide results and products already obtained, and the new ones we expect to obtain. This platform aims to engage and share with the rest of the regional community as a means to promote sustainability, scaling and dissemination of results.

P-3312-19

Prepared for climate change? A method for the ex ante assessment of the completeness, transparency, legitimacy, and expected effectiveness of responsibilities for climate adaptation

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Climate change related risks encompass an intensification of extreme weather events, such as fluvial and pluvial flooding, droughts, and heat stress. A transparent and comprehensive division of responsibilities is a necessary - but not the only - precondition for being prepared for climate change. In this paper we present, and preliminarily test, a method for the ex ante assessment of the division of public and private responsibilities for climate adaptation. This method proofs particularly suited for the assessment of adaptation responsibilities in combination with a sectoral approach. It helps identifying a number of shortcomings in divisions of responsibilities for climate adaptation. We conclude that this method is useful for identifying the expected climate change preparedness level, and recommend to combine this with ex post analyses of real-life cases of extreme events in order to assess the actual preparedness for climate change. With this method, we intend to assist policy-makers in developing and implementing adaptation plans at various levels.

Keywords: adaptation; climate change; responsibilities; ex ante assessment method; the Netherlands.

P-3312-20

A comparative sustainability analysis of conservation agriculture in the Mediterranean: The ACLIMAS project

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The sustainability analysis of selected combinations of genotypes and water management practices (including water harvesting and conservation tillage) is here interpreted as an analytical approach towards the long-term perspectives. The selected combinations, specifically chosen as potential alternatives to current farming practices, should help farmers to cope with more frequent droughts induced by climate change, as well as being able to sustain their farms' activity over time. We present herein the sustainability assessment of three different Mediterranean case studies, by analysing trade-offs among environmental, economic, and social performances of farms from the Chaouia Region in Morocco, Bekaa Valley in Lebanon and in Irbid Governorate in Jordan growing mainly cereals and legumes improved varieties tolerant to water, heat and salinity stresses. Several combinations of different genotypes, fertilizers practices, tillage systems and water management options were tested and evaluated. The sustainability assessment, carried out within the activities of the project Adaptation to Climate Change of the Mediterranean Agricultural Systems (ACLIMAS, EuropeAid ENPI/2011/269-668), adopts a participatory multicriteria decision support system framework including several steps: (1) description of farming systems: identification of farmers' problems and priorities to be considered in the evaluation; (2) design of the knowledge base: identification of evaluation criteria (indicators) for the three pillars of sustainability (environment, economy, and society) in accordance to the local specificities; (3) collection of quantitative data for the selected indicators and (4) multicriteria sustainability analysis of different combinations proposed by ACLIMAS. Results demonstrate that "ACLIMAS practices" increase the three dimensions of a sustainable development and have a high rate of acceptability and a big potential of adoption.

P-3312-21

Climate Change and Adaptation Capacities in Ethiopia: Constraints and Opportunities

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Assessment carried out under Ethiopian National Adaptation Program of Action (NAPA) indicates that; agricultural, water and human health are the most vulnerable sectors to climate change in Ethiopia. The present paper focus on the agriculture sector, as agriculture production complemented with pastoralist production, provide livelihood to about 80 percent of Ethiopia's population. Both of these activities are very sensitive to the changes in the climate conditions. Further, available data indicate that, in Ethiopia climate change impacts may be severe and the existing adaptation capacities are not sufficient to deal with these severe problems. Therefore, this study was designed to assess the impacts of climate change and constraints and opportunities pertaining to adaptation capacities in Ethiopia. Due to the financial limitations, the assessment was limited to two woreadas (districts) of the country-Gudura, Oromia region (predominately agricultural) and Mieso, Somali region (predominately pastoral). To achieve the objectives of the study both primary and secondary data was collected. Primary data was collected through a questionnaire survey of 100 farmers in Gudura woreda and 50 pastoralists in Mieso woreda. Further, interview was also conducted with 8 expert from federal agricultural and environmental ministries, federal and concerned regional Environmental Protection Agency (EPA), respective woreda agricultural office heads and expert of CSO named Forum of Environment, Addis Ababa. In case of farmers, for the questionnaire survey, sample respondents were selected by simple random method and experts were chosen through purposive sampling technique. Secondary data were also used to identify the types and nature of climate change impacts. To analyze the data, descriptive statistics, narration and document analyze technique was utilized. Both instrumental and proxy record have shown substantial variation in the spatial and temporal patterns of climate in the country, the UNDP climate change profile for Ethiopia shows that the mean annual temperature increased by 1.3°C between 1960 and 2006, at an average rate of 0.28°C per decade, further the results of the IPCC"s mid-range emission scenario show that compared to the 1961-1990 annual precipitation show a change of between 0.6 and 4.9% and 1.1 to 18.2% for 2030 and 2050, respectively. The percentage change in seasonal rainfall is expected to be up to about 12% over most parts of the country including the study areas. Environmental extremes are decreasing the land's productive capacity leading to a decrease in subsistence agriculture, income, assets, and a rapid decline in the health and nutritional status of the rural population and ultimately force rural people to migrate to urban centers. Latter the results of the study enable to conclude that an adaptation capacity both at household and institutional levels are very low and indicates that climate change governance framework is not properly operational. Poverty, limited resources (such as land and livestock), lack of access to credits and finance, alternative sources of income, as well as technology, knowledge and expertise, lack of integrated public policies and effective program enforcement, increase the vulnerability and adversely affect the capacity to cope with the problems. However, one can also visualize certain opportunities in the form of CRGE (Climate Resilient Green Economy) strategy, Energy Policy and Bio-fuel strategy, public sector capacity building project, southern voices capacity building program, international and Civil Society Organizations (CSOs) about 60 CSOs/NGOs formed a network-the ECSNCC (the Ethiopian Civil Society Network on Climate change), which proactively engaged in international negotiations (as observers), the generation of research based knowledge, raising of public awareness, building of local capacity and supporting adaptation efforts by vulnerable communities and regional and national government bodies. The promotion of micro finance by federal government and education, training and consultancy services available at Ethiopian Universities which may be utilized to enhance the adaptation capacity to cope with the climate change impacts. To improve the situation it is recommended to invest in climate change research and livelihood opportunities and strengthening the capacity of policymakers and institutions to enforce policies and programs.

P-3312-22

Assessing adaptation in evolving populations

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The current theoretical framework for the management of populations which are responding to global change lacks a systematic integration of the biological concept of adaptation. In evolutionary biology, «adaptation» describes the evolutionary process where organisms become fitted to their environments. The same term is used to denote the results of such adaptive processes: suites of evolved characteristics which are optimal in a specific sense. By using adaptive dynamics modelling, it has become possible to investigate adaptation to complex and variable environments, with interactions between individuals of the same and of different species. There is one difficulty, however, when this type of modelling is applied in the context of climate change adaptation: it assumes environments which are stationary and which are not changing with a trend.

By means of a textbook model of bet-hedging evolution, namely for plants with a seed bank and an evolving germination probability, I illustrate how concepts from adaptive dynamics modelling can still assist in predicting how natural populations would respond adaptively to climate change and in assessing adaptation. I will show that during gradual environmental change, populations will often lag behind the most adaptive response. Surprisingly, there are conditions where the adaptive state does not show a unidirectional trend. Its changes can reverse direction. The consequence is that populations which lag behind, can suddenly find themselves lagging ahead.

This model is extended with evolving phenotypic plasticity, and an exploration of evolutionary scenarios where the environmental change has a tipping point.

P-3312-23

Analysis of Spatio-temporal Climate Variability and Resulting Challenges for Household Adaptation in Lake Victoria Basin of Kenya

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Climate variation is one of the most challenging and intricate problem facing the world today. The resulting effects of changing climates have been of great concern to almost all sectors of the economy in Africa. This study sought to analyze spatial and temporal climate variability and the resulting challenges for household adaptation in Lake Victoria basin of Kenya. Most households in rural areas of Kenya have adaptation capability is low and this probably could result in serious challenges in as far as their livelihoods in concerned. The objectives of this study were to determine rainfall and temperature as indicators of climate variability experienced in Lake Victoria basin of Kenya. It sought to establish local awareness of climate variability, perceptions about vulnerability and observed adaptations with view to recommend effective adaptation measures.

The study presumed that rainfall and temperatures have not changed over Lake Victoria Basin of Kenya between 1973 and 2014, there was no sufficient effect of climate variability on households of Lake Victoria Basin, the residents of Lake Victoria Basin lacked sufficient knowledge on the effects of climate variations and that there are no observable adaption measures put in place in Lake Victoria Basin.

To achieve the objectives of this study, an empirical research design was employed. Climate variability was determined using rainfall and temperature data from observations and climate models over a period of 40 years, future projection were also be done for period of until 2100 in order to establish future climatic pathways. Both primary and secondary data were used in this study. The primary data was used to assess the implications of

climate variability on rural livelihood. The respondents from the study area were interviewed using a standardized interview schedule or depending on their literacy level and availability, they were supplied with a questionnaire. Focus Group Discussions were set up to explore important issues regarding livelihoods in the community.

In data analysis basic statistics of mean, standard deviation, Skewness, Kurtosis and trend were used to show the central tendency of climate. The optimal fingerprinting (Paeth and Mannig 2012) was applied in order to quantify climate change signals in the light of internal climate variability

Africa's development efforts in the continent over depend on natural resources which are vulnerable to climate change and variability. This study used multinomial logit models to analyze the effect of spatial and temporal climate variability and change on household adaptation. The Heckman model was used to assess whether households perceive climate variability and assess thier decision making process to adapt or not. The data was collected from a survey of about 400 households using semi structured questionnaires. The climatic data were obtained from Kenya Meteorological Headquarters at Dagoreti as well as from gridded observational and regional climate model data sets. This study used the newest CMIP5 and CORDEX model data sets for the assessment of climate variability and change over eastern Africa. The study was designed to have an in-depth understanding of climate variability and change at small area within on regional scale. The results of this study have been helpful in influencing the policy markers' decision making process in the face of climate variability adaptation measures at both national levels.

Households in both rural and urban settings experienced huge burden to adapt to persistent climate variations. The variations were hardly predictable within space and time and frequently they induce disasters such; as prolonged droughts or floods which have heavy burden to human livelihoods. The study established that traditionally, people used the indigenous knowledge to predict certain climate change; they also managed to cope with changing climates through applying certain adaptation measures such as planting different crop varieties, improving water conservation techniques and keeping livestock as a buffer to crop failure. Today the paradox is that people are not aware of changes in climate and the indigenous knowledge which was significant is now scanty in the face of scientific knowledge.

P-3312-24

Key climate change adaptation deficits in Indonesia: Sectoral coordination and local capacity building

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The commitment to mainstream responses to climate change in Indonesia's development agenda has been acknowledged in several government regulations. Many obstacles hinder such efforts, especially the lack of clarity over the functions of central and local governments and lack of capacity within the governments to administer new functions due to decentralization. To encourage Indonesia's participation in this global issue, there is an urgent need to identify ways to develop national capacity, including local government due to their significant roles to mainstream climate change adaptation into development agenda. This paper outlines the findings of a field trip to central and several local governments in Indonesia to seek the views of policy-makers, researchers, community representatives and other key actors related to climate change adaptation. Emphasised areas for enhanced adaptation policy development were, first, institutional strengthening through the enhancement of sectoral coordination and capacity building to ensure the adequate institutional setting and capacity. Second, for effective sectoral coordination among government agencies there needs to be elevated synchronisation of crosscutting issues, and the development of appropriate coordinating agencies and appropriate guidelines for the local level mainstreaming of climate change adaptation into development. In turn, for enhancement of capacity building there needs to be elevated local governmental and civic awareness raising; promotion of government and non-governmental partnerships; and greater availability of scientific assessment and incentives as well as inclusion of local social and traditional knowledge

P-3312-25

Assessment of Socioeconomic Vulnerability to Floods at Small Area Level in Malawi

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Vulnerability assessments involve indicators and measurement methodologies to assess the vulnerability of socio-ecological systems, for example to natural disasters such as floods. Flood events directly and indirectly threaten people's health, livelihoods, food security, and deepen poverty. Flood is expected to worsen with climate change, and has disproportionate impacts on different segments of the population. Poor people, women, youths, adolescents, people with disability, and migrants are more generally more vulnerable to the impacts of floods. In many urban areas, inequities will become more apparent with higher concentration of vulnerable people in less desired but higher-risk locations. There is urgent need for incorporating socioeconomic vulnerability and equity factors into climate change adaptation planning and development policies. In this paper, we examine the vulnerability to flooding in Malawi at small area levels, integrating a number of datasets.

In Malawi, we will integrate socio-demographic data with hazard data and examine vulnerability at the small-area level. We employ census data for demographic, housing quality, and service data, World Bank estimates for poverty data, and Demographic and Health Survey (DHS) data for education and nutrition data. This socio-demographic data will be merged with spatial hazard data on flood risk in Malawi, from two global hydrological models (GLOFRIS and SSBN). As socio-demographic data is at the 2nd and 3rd administrative boundary level, and hazard data is at high-resolution, the vulnerability analysis will be done at small area level, based on the level at which decision-making processes are made. The joint paper will identify a suite of indicators to develop a vulnerability index, and examine where high vulnerability coincides with high risk from flood, through spatial and statistical analysis.

The project will pilot the vulnerability index and assessment in Malawi, a country with increased pressures from population dynamics, poverty and natural disasters, where the climate data and information are sorely lacking. In addition to examining socioeconomic vulnerability, the index can be disaggregated to provide information on each dimension (demography, health, economic and flood). By disaggregating vulnerability at small geographic level over four dimensions, the project aims to better understand the socio-demographic vulnerability to floods, in a context of climate change. It is also in line with the post-2015 Sustainable Development Goals and targets by contributing to strengthening resilience and adaptive capacity to climate-related hazards and adaption, as well as providing evidenced data by small geographic location. The data, index and methodology applied in this project may also be scaled-up to more countries.

ORAL PRESENTATIONS

K-3313-01

Coordinated adaptation to future climate change, Concept and case studies in China

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Human societies have continuously adjusted themselves to meet the dynamics of climate since ancient time, long before global climate change is considered as threaten issue. Traditional approaches for climate change adaptation are often based on certain sector or administrative unit, and lack of coordination or integration across those boundaries. Such barriers among sectors and administrative units often cause conflict interests and compromised overall effects of those efforts. In some extreme cases, the adaptation strategies developed by one sector or area could even lead negative impacts on other sectors or areas. Therefore, different sectors and subregions are encouraged to work together to develop coordinated and integrated adaptation strategies at regional and global scales, in order to achieve optimal effects for sustainable development. Here we propose and discuss the possible pathways, i.e., coordinated adaptation strategies, towards integrated approaches for climate change adaptation across sectorial and administrative boundaries. Such pathways ask policy and planning at the scale of an entire region or subregion and cutting across sectorial boundaries. The proactive and coordinated adaptation planning potentially affects all sectors and all parts of a region. Cross-sectorial and cross subregion policy coordination mechanisms will also be discussed, with several case studies related to regional urban clusters and dryland watershed management in China in response to climate change.

K-3313-02

UNEP's global adaptation strategy: from global governance to community based solutions

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Recognizing the need for integration across scales and sector's UNEP's adaptation portfolio includes actions on many different levels of governance (global, regional, national, sub-national, local) alongside coordinated engagement across different sectors of government, economy and society.

The presentation will first introduce UNEP's global adaptation efforts; including the 2014 United Nations Environmental Assembly Resolution on Ecosystem based Adaptation, the Global Adaptation Network, our global support programs for NAPs and access to climate finance and publications oriented towards informing global climate negotiations such as the Emissions and Adaptation Gap Reports.

The presentation will then highlight UNEP adaptation actions at the regional level including management of transboundary resources in the context of climate change and regional knowledge sharing on adaptation under the "Lima Adaptation Knowledge Initiative" pledge the Nairobi Workprogram of the UNFCCC.

Finally, the presentation will provided an overview of UNEP's portfolio of national and local projects under implementation, helping communities around the world harness ecosystems to build resilience as part of their adaptation plans and actions.

The presentation will conclude with an overview of UNEP's program of actions supporting countries in the leadup to the Paris COP.

K-3313-03

EU climate adaptation policy integration between mainstreaming and marginalisation

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Policies on climate change adaptation aim to contribute to a more climate-resilient society. In the European Union, this is pursued by ensuring that adaptation considerations are addressed in all relevant EU policies. It also promotes greater coordination and information-sharing among Member States. Such coordination of climate change adaptation measures require the vertical integration of different levels of governance (European, national, regional, local) as well as horizontal integration between different sectors of the economy and society. This 'mainstreaming' will also offer potential for synergies if adaptation policies are successfully coordinated.

Horizontal and vertical policy integration is to be seen as means to achieve policy coherence for climate adaptation. The rationale for such an approach is that cross-cutting priorities can all too often fall into the gaps that exist between narrowly specified sector objectives or lead to inconsistent or conflicting policy objectives within sectors. Integration is particularly vital for climate adaptation as climate change impacts have implications for many sectors and actors. However, adaptation concerns may get side-lined as they can be obstructed by sectoral objectives that are of more immediate concern or that appear to compete with adaptation. So while the rationale to integrate seems straightforward and desirable, implementation at sector levels is rather complex and is a potentially conflict prone process, where conflicts may arise between objectives within a sector or between sectors and broad societal objectives.

This paper explores how action on climate adaptation can be taken forward in complex policy environments such as that of the European Union. It explores the conditions for successful policy integration and coherence, which are considered to be crucially important for progressing with climate adaptation.

O-3313-01

Integrated Trans-boundary Headwater Governance in Hindu Kush Himalaya Under Climate Change: A Coordinated Adaptation Framework for Water, Food and Energy Security in South Asia

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Hindu Kush Himalaya constitutes headwaters of some of the largest trans-boundary basins of planet. The ecosystem services, particularly the freshwater flowing down from the Himalayan headwaters sustain one-fourth global population dependent primarily on subsistence agriculture in Pakistan, India, Nepal, Bhutan and Bangladesh. Climate change has stressed hydrological regimes of Himalayan headwaters through higher mean annual temperatures, fast melting of glaciers and snow, altered precipitation patterns and increased incidences and intensity of extreme weather events causing substantial decrease in water availability and increasing frequency and severity of hydrological hazards. This may increase proportion of water, food, health and livelihood insecure population in entire South Asia which represents one of the most water stressed, food insecure and energy deficit regions, and inhabited by some of the poorest people of the world with access to less than 5% of planet's freshwater resources. This will have enormous regional implications for fundamental human endeavors ranging from poverty alleviation to environmental sustainability and climate change adaptation, and even to human security and peace in the region. A coordinated regional adaptation framework

is therefore highly imperative not only for responding to long-term impacts of climate change and achieving water, food and energy security, but also for attaining post 2015 Sustainable Developments Goals (SDGs) to provide social and economic sustainability to more than 40% global population living in the region.

The main objective of the study is to evolve a coordinated regional trans-boundary headwater management framework underlining the role and critical significance of Hindu Kush Himalayan (HKH) ecosystem services in sustaining food, water, and energy security in South Asia under climate change. In order to attain this the study: (i) appraised the mutual environmental and economic benefits of integrated trans-boundary headwater management; (ii) investigated reasons and rationale for missing regional cooperation among riparian countries; (iii) explored geo-political constraints in initiating effective regional cooperation dialogue; (iv) evolved an institutional framework for effective trans-boundary headwater governance in Hindu Kush Himalaya through the analysis of secondary data collected from varied sources. Besides, comprehensive study of available literature and media reports, interpretation of people responses obtained through interviews, interaction with political leadership and policy planners across Hindu Kush Himalayan countries formed the basis of this study. Study revealed that despite geographical and cultural contiguity South Asia is one of the geo-political hotspots as it is one of the most disintegrated regions of the world characterized by political tensions, armed conflict, and extreme political instability and economic imbalances. It was observed that political transition, threats of internal and external security, weak leadership, and long standing conflictual inter-state dynamics are important reasons for missing regional cooperation in trans-boundary water management and for freezing hydro-diplomacy in the region. Further, the results clearly indicated that the issues and challenges in the food, water, and energy sectors are interlinked in several complex ways and cannot be managed effectively without cross-sectoral integration and regional cooperation. The study also identified a range of important potential benefits of regional cooperation in integrated water resources which include: (a) sharing information for developing integrated flood forecasting and early warning system for different basins , (b) storing water in upstream river basins for flood moderation, (c) storing water resources for increasing flow in dry seasons, (d) accumulating water for inland water transport, (e) harnessing water resources to generate hydroelectricity, and (f) managing watersheds to help increase the quality and quantity of water available, irrigation, industries, drinking and sanitation by downstream users. A number of regional and local institutions, particularly International Centre for Integrated Mountain Development (ICIMOD) and South Asia Association for Regional Cooperation (SAARC) are interested to play effective role in initiating regional water cooperation in South Asia.

O-3313-02

Coordinated Regional Adaptation to Sea Level Rise -- A Case Study of Land Use and Transportation System

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In recent years, many research efforts have been made to study the impact of climate change, especially sea level rise, on transportation system at the local level. While these studies provide many useful insights for the vulnerability of transportation system to sea level rise, few analyzed the impacts of adaptation strategies (i.e. protection, accommodation, planned retreat) on transportation system. Furthermore, the diversity of study contexts, the variety of methods utilized, and the lack of standard evaluation metrics make it difficult to compare the results of different studies. Therefore, the interaction between adaptation strategies, corresponding long term land use change, and transportation system performance are not thoroughly studied. To bridge this research gap, three adaptation scenarios with different network disruption levels and land use schemes are analyzed using Tampa, Florida as a case study. Transportation system vulnerabilities to sea level rise under three scenarios are compared using multiple performance measures. Vehicle hours travelled (VHT) shows to be the most sensitive performance measure to transportation vulnerability change. Without any adaptation strategies, the regional transportation system could have 40% VHT increase under 2ft sea level rise. Protecting up to 108 miles of freeway/bridges could prevent about 18% of VHT increase, while large scale traffic analysis zone internal capacity protection or development retreat have less than 2% contributions. Supposing the average value of travel time savings in Florida is $32 per hour, protecting up to 108 miles of freeway or bridges would generate a saving of more than $30 million per day. If the cost to elevate road is $2 million/mile, it takes about a week for the benefit to recover the cost. Consequently, even with neighborhood flood prevention and planned retreat strategies, protecting coastal freeways and important bridges would be necessary and cost-effective to adapt to sea level rise for the case study area. The results of the case study illustrate that communities outside the inundation zones or lowlying areas are also vulnerable to sea level rise because their activities are supported by critical infrastructures (i.e. transportation in this case study) within the inundation zones. Without long-term coordinated regional land use and transportation planning, adaptation strategies focus only on accommodating or relocating local vulnerable communities might not be effective at the regional level.

O-3313-03

Making adaptation policy integration work in local government: Lessons from Australia

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Considering and planning for the impacts of climate change has entered the mainstream of local government policy level, yet much experimenting is still taking place about how adaptation can meaningfully and effectively be tied in with existing policy agendas and integrated into policy making, across departmental boundaries and organisational hierarchies. Over the past decade, there has been slow recognition that, from an organisational perspective, climate change adaptation needs to be broadly anchored in an organisation; for adaptation to be effective and comprehensive, it cannot be simply be another task of environment departments or sustainability officers.

While many adaptation policy frameworks point to the need for such systematic and deep integration and recommend high-level actions, not many empirical studies exist that document the strategies that complex organisations pursue to embed adaptation, nor is there much empirical evidence assessing the success of specific strategies. While key barriers to integration are knows, many organisations still struggle to make much progress with embedding adaptation across divisions, departments or operational units.

This paper presents, for the first time, empirical findings from two research projects concerned with embedding adaptation in the local government sector in Australia. The focus of the analysis is on intra-organisational processes for embedding adaptation across an organisation, although some inter-organisational strategies will also be highlighted. The local governments that participated in these research projects are highly exposed to multiple climatic stressors and their impacts, including sea-level rise, bushfire, flooding and heatwaves. They provide interesting case studies for adaptation policy development and implementation at the local government scale, adding to our understanding of the role of institutions in climate change adaptation.

3313-POSTER PRESENTATIONS

P-3313-01

Regional climate change adaptation and mitigation in the North German Plain - a cross-sectoral analysis of land use experts' perception

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Climate change is beyond dispute and a crucial challenge for mankind on the global scale as well as on the regional scale. In order to successfully implement adaptation and mitigation measures towards climate change on the regional scale, the involvement of regional land use experts is very important. Moreover, cross-sectoral interdependencies of adaptation and mitigation measures on the regional scale – both synergies and conflicts – have to be taken into consideration. One crucial requirement of a successful adaptation and mitigation concept is the analysis of those measures already implemented on a regional scale, including the appropriate spatial scale for measures taken. Furthermore, coping with climate change is a multi-level policy concern. Therefore, the appropriate level of political regulation, as assessed by regional land use experts, is an important element of the analysis of adaptation and mitigation measures.

In our study we applied a qualitative, cross-sectoral approach, primarily analysing which adaptation and mitigation measures are implemented or demanded on the regional scale in the land use sectors agriculture, forestry and water resource management. The results are derived from 60 semi-structured expert interviews conducted in four case study regions in the North German Plain as well as from a subsequent survey (n=37) amongst regional land use experts. Experts involved cover a wide range of land use experts, including farm managers, forestry experts and their respective interest groups, flood protection and water body maintenance specialists as well as representatives of regional administrative bodies.

Our results show that: (1) Even if Germany may not be as affected by climate change as other countries, a number of climate change induced adaptation measures are nevertheless already implemented, (2) further measures are taken into recognition or are demanded by regional land use experts, (3) adaptation measures play an important role on the regional scale whereas mitigation measures are almost negligible, (4) water-related issues, respectively water management approaches and related measures are the linking elements between the analysed land use sectors in all case study regions and (5) in general, there is no particular spatial level favoured for the implementation of adaptation or mitigation measures. However, with regard to policy-makers' ability to exert influence on climate change related measures, the national scale is seen as the most effective level.

Our results implicate that the implementation of adaptation measures can be focussed on the regional scale, whereas efforts to mitigate climate change should be coordinated and implemented on the national or even global scale. Furthermore, cross-sectoral interdependencies between the analysed land use sectors can be shown. Therefore, an integrated, cross-sectoral approach should be further pursued, to combine the sectoral efforts to adapt to climate change, to generate synergies and to minimise conflicts.

In our study we also identified needs for further research. Whereas further analyses of interdependencies between different adaptation measures on the regional level seem to be fruitful, the analysis of regional mitigation measures is not sufficient at this point. There is further need for research on why the regional scale lacks mitigation measures and how to integrate those at the regional level. While the study's focus lies on those adaptation and mitigation measures clearly depicted as climate change related, other regional measures may also be linked to climate change. Though those were not included in our study, they should be considered in future analyses for a coherent approach. Also, further analyses on how to integrate sector-focused measures into a more comprehensive, cross-sectoral approach should be conducted.

The study was carried out within the research project „NaLaMa-nT- Nachhaltiges Landmanagement im Norddeutschen Tiefland" (Sustainable Land Management in the North German Plain) within the frame of the FONA program initiative funded by the German Federal Ministry of Education and Research (BMBF).

P-3313-02

Adaptation to climate change in Tampere Region, Finland

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Adaptation to climate change will be one of the most important issues in the different regions of Europe. Adaptation plans cannot be made only internationally or nationally but local and regional authorities must have the main be responsibility for adaptation planning. One of the four main themes of the Climate and Energy Strategy of Tampere Region is adaptation to climate change. The purpose of this presentation is to deal with the aims and the proposed actions of adaptation in Tampere Region.

In the strategy, the main general aim of adaptation is that people and different organizations of the region are reserved to governance of climate change phenomena. The aim is that Impacts of climate change have been studied, their importance has been assessed and the most important actions of adaptation have been carried out in a cost-effective way, taking into account the aims of mitigation of climate change. Another aim is that awareness of the impacts of climate change and the need of adaptation has increased. It is important that people realize that the change is permanent and the threats and also the possibilities of the changes are taken into account. For achieving the general aims, six main actions have been acknowledged:

- Research is utilized and comprehensive assessment of the impacts of climate change is made, as well as risk analyses and considerations of vulnerability.
- Skills of ordinary people in adaptation and reservation to the impacts of climate change are improved.
- Proactive and cost-effective actions of adaptation are carried out in practice.
- Adaptation to climate change is taken into account in the Biodiversity Programme of Tampere Region.
- The Centre for Economic Development, Transport and the Environment for Pirkanmaa (CETEP) is coordinating the cooperation in adaptation to climate change.
- In adaptation, the cooperation over the borders of the regions is considered.

More detailed aims have been presented for increased precipitation and humidity, increased temperature and extreme events. One of the main aims is that the risks of increased precipitation and humidity have been assessed and the most necessary actions have been carried out. Attention must be paid to the following issues for example: the amount of storm water and the capacity of sewerage systems, the condition of roads and streets, the increase of nutrient leaching from agricultural areas, regulation of lakes and rivers, and the impacts of increased humidity on houses and other constructions.

The main aims connected with increased temperature are that new animal and plant species (including cultivated plants and trees) can be utilized, harmful alien species are recognized and their distributions are monitored and restricted, and cooling of houses is carried out taking into account requirements of energy efficiency. Attention will also be paid the impacts of increased temperature on human health.

When extreme events are concerned, one of the main aims is that adaptation planning in the different sectors (local communes, industry, service, households) is sufficient. The other two main aims are that forecasts and informing about extreme events has improved and that the basic functions of society have been secured during more drastic and more often occurring extreme conditions.

For monitoring the proposed actions of the Climate and Energy Strategy of Tampere Region, a working group has been founded. The group is coordinated by CETEP and particular attention is paid to adaptation to climate change. The first report will be published in 2016.

P-3313-03

Flooding in the Urban Space: the Contribution and impact of law in relation to resilient Flood Risk Governance in the EU

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This presentation will take an overview of one of the most important environmental issues affecting more than half of the world's population. How should environmental risk governance respond to climate change which is likely to have caused increasing problems of flooding in recent years and the increasing threat of flooding in the cities and urban spaces of the future? An important aspect of such governance arrangements is the impact and importance of a number of legal issues.

This paper will examine some of the law's response to the problems of the governance of flooding in England and make some comparisons with other EU Countries. This will include reference to the preliminary findings from the large 6 Million Euro EC funded STARFLOOD Research project on Flood Risk Management, with which the author and other colleagues are involved, together with 5 other European Universities.

P-3313-04

Promoting the consideration of the effects of climate change on Agriculture in Morocco

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The effort of adaptation to climate change must be involved in the fields of resource management and governance, by the research on the possible correlations between Climate change / Management of resources / efficiency of institutions responsible for these resources, in order to better respond to the questions posed and propose ways of adaptation capable to mitigate the negative effects of the current trends.

On the political level, because of the strong interactions of the three domains, climate water and environment, it is advantageous to opt for integrated actions, winning on several plans: reduce the vulnerability, conservation of resources, development of agriculture and guaranty of water volume and quality.

Therefore propose measures with tangible effects, reform the decision-making process and place it on top of sector structures.

We can't overemphasize the importance of anticipation, ie, possess an elaborate knowledge, the result of advanced research, based on sufficient measures and studies. Careful planning is to be prepared, on the basis of a prospective based on reliable indicators. Finally, we must adopt policy choices and courageous management, by challenging truths that seemed established and proved, but recent studies seem to contradict.

Non integrated solutions with only a technical content can affect the consistency and efficiency of decisions and policies. It is necessary to collect sufficient data to validly base on the decisions and thus strengthen the links between scientific research and decision making. A sufficiently broad debate should take place, to compare the values, perceptions and views, to allow the decisions ownership by everybody. We must provide relevant and reliable scientific data and the results must be communicated to the general public and organizations, to ensure a sufficient level of awareness and commitment.

Adaptation is not exclusive to the most vulnerable farmers and most fragile lands. The rainfed land of the Atlantic plains of Morocco, considered as favorable, covered by large farms, in which aggregation of means permits to promote agriculture, and which are directed by conscious farmers, in principle, of the possible impacts of Climate change on the process of degradation, can suffer serious threats, especially because of the unexpected occurrence of large magnitude events. Irrigated land, either, are not immune to environmental crises, especially in case of water stress. So we must be prepared for any eventuality and therefore adopt a crisis management policy in the event of occurrence of major risks.

An effective integration of climate change on agriculture, as in other sectors, implies the need for a clear commitment at the highest level of the state apparatus and ensures the contribution of the private and civil society to establish the conditions for the establishment and implementation of a structured and effective strategy.

P-3313-05

Climate change and necessary actions for Sahelian rural world. What choice and what measures for responsible authorities?

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In the Sahel, rural populations are increasingly faced with a decline in agricultural production due to various inappropriate methods of production but also and especially to the influence of climate change is manifested in the form of recurring hazards: droughts, floods, dry spells, the greater wind speed, etc. However, to ensure food security, more than 80% of rural depend on a hypothetical rainy winter, very disturbed in the course of its cycle. It follows strong pressure exerted on natural resources (Sivakumar, 1993; Servat et al 1997; Etc.).

These climatic disturbances that last for almost half century affected the bio-productive system and induces degradation. It appeared everywhere, the most degraded landscapes are those affected by overgrazing, agricultural pressure, where poor farming practices; the disappearance of fallow and lack of fertilizer supply has exacerbated the phenomenon (Preliminary Report of the FAO project «Land Degradation Assessment,» FAO-CSE, April 2003), etc.

Thus, disturbances occurred on climatic factors, will have notable effects on the lifestyles of the population and socio-economic activities. They are facing, at the same time, to constantly risk situations and high vulnerability due to the lack of resources available to them to face the multiple pressures.

A diagnosis based on a field visit in 2014, with a project from F.A.O. (collection of basic information: individual interviews and focus group interviews with facilitators and leaders of structures, etc.) in Senegal, Gambia, Burkina Faso and Mali , has identified and assess the adaptive capacity of farmers to climate change in relation to their livelihoods, to identify their roles and responsibilities but also those of the various technical and administrative services that support them in their fight against the effects of the phenomenon.

It appeared at the end of our research that, the main policy advice is that both addressing food and nutrition security and building resilience in vulnerable nations and communities require an integrated approach of investing in long term production enhancement interventions, but also short term price and climate risk management strategies. Investing in responsive and sustainable safety nets that will enhance food and nutrition security can thus reduce the impact of short term risk factors. Once risk and vulnerability are not factored, hazards may reverse progress made over some years in most fragile and vulnerable countries and communities.

It appeared too, that the active participation of all stakeholders, enabling the development of the strengths and potential of rural areas and thus the assertion of economic identity, social, historical and cultural populations could assure them the well-being so aspired. Furthermore, the challenges of climate change in the context of globalization, there were proven everywhere (Smart Village, Eco-villages, etc.) that local development, will, in the future, more than in the past, a role key to play in ensuring a confirmed transformation of territories?

Ultimately, it will be discussed in the context of this paper, to succinctly analyze climate trends indispensable for socio-economic projections, to study the factors (internal and external) that exacerbate the vulnerability of farmers and finally to assess the relevance of options / more effective coping strategies in this sense the emergence of a local socio-economic consciousness and collective responsibility to build a regional project through an agreed methodology.

P-3313-06

Rethinking Coastal Design and Planning: Integrated SLR Vulnerability Assessments, Case of Mombasa and Lamu Islands

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The world coastlines are increasing in population due to their natural beauty, tourist attraction of the luxurious coastal cities leading to ever larger populations, and a vast interest in developing infrastructure at coastal areas. Sea level rise (SLR) is threatening the sustainability of coastal residents as well as the related infrastructure, The Low Elevation Coastal Zone (LECZ) defined here as the contiguous area along the coast that is less than 10 metres above sea level covers 2 per cent of the world's land area but contains 10 per cent of the world's population and 13 per cent of the world's urban population. The least developed countries have 14 per cent of their populations living in the LECZ compared with 10 per cent for the developed countries with the disparities widening in coastal urban areas at 21% and 11% respectively. Literature suggests that coastal cities in the developing world are ill prepared for the impacts arising from sea level changes and related storm surges. The Southern and Eastern African coastline (comprising the coasts of South Africa, Mozambique, Tanzania and Kenya), will regularly be affected by changes in cyclonic and other significant weather events that pose risks related to the development and infrastructure in these countries. The East African coastal Islands of Mombasa and Lamu being relatively low elevated will become increasingly vulnerable to the associated risks of increasing SLR. Urban infrastructure development, use planning and design is most likely going to be impacted by the sea level rise on the coastal built environment, these factors along the coastline will require a rethinking of coastal design and planning especially with regards to Sea level rise (SLR). The main purpose of the integrated and participatory vulnerability assessment was to identify adaptation strategies that are feasible and practical in both the local government and communities. The distinctive features of perception and adaptation analyses with this purpose are outlined, and common elements of this approach are described. The specific objectives was to assess initial SLR vulnerability levels for the coastal strip of Kenya in terms of the zones, assets, infrastructure, public services, people and activities, Use GIS-based tools and techniques to determine and map out the extent of inundation risk for Kenya's coastal strip based on localized modelling from global inundation scenarios of 1m, 3m, and 5m assessment, Appraise baseline sea level vulnerability awareness and perceptions through focus group discussions in order to understand the prevailing mitigation/adaptation practices and coping strategies now in place, co-creatively evolve intervention or mitigation policy options for subsequent action and implementation. In this case meaningful and Practical adaptations initiatives tend are enhanced when, climate is considered together with other environmental and social stresses. The important input was maily the participation of the affected communities through the mini charette on the concept of sea level rise, climate change and coastal adaptation and mitigation, especially in the context of the developing countries. The participation of the communities gave a great insight in the enhancement of the adaptation and mitigation strategies, and the absorption of climate change related mitigation and policy strategies for the two islands.

P-3313-07

Adapting to climate change through local planning: The Bolivian Andes

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The manifestations of climate change contribute to increasing threats to national development strategies. Every year more intense extreme weather impact on natural and human systems; impacting on the social and economic development in the Bolivian Altiplano. Studies by the National Climate Change Program in Bolivia (1997) and SENAMHI (1998), predict future climate scenarios in Central Altiplano of Bolivia, where variations in the cycle of rainfall and temperature increases with consequences of aridity.

Faced with this problem, there is an urgent need to build a solid foundation of scientific information, develop skills and knowledge management under which it will explore and identify the best options and tools for effective response to the impacts of change and climate variability using appropriate instruments as the rescue of knowledge, mathematical modeling, mapping rights, spatial tools, etc. To achieve this solid base of information, provide information to decision makers on the most effective use and the most appropriate destination of public investment funds and strengthen the governance structure to adapt to climate change.

An adaptation plan should address policy guidelines and adaptation to climate change in order to reduce the vulnerability of communities. In general, the policies relate to the objectives and the means of implementation, while the measures focus on actions to specific topics.

The construction of such a plan is based on social learning processes, methods and developed, adapted and tested for Sustainable Water tools, where both men and women in the communities participating in activities from the accompanying research, information gathering and building community action adaptation action plan and regional adaptation and analysis of lessons learned and planning.

Through the processes described, a methodological approach based on a sequential flow and simultaneous integrated actions in three fundamental axes parallel builds, which feed off each other 1) research, 2) Spaces of public social deliberation and advocacy and 3) Planning and investments for adaptation.

The applied, collaborative and participatory work of local actors is the key in vulnerability analysis locally and expanding to a regional analysis as well as in identifying adaptation options to climate change, some of which are re-evalued as traditional or ancestral forms of water management and some as new initiatives that are found from the research.

On the other hand, the second axis are social spaces of public deliberation. It is under this axis where the dissemination of knowledge for capacity building and strengthening works by promoting a roundtable of the basin where the actors are the same, both civilian and public. Finally, the focus of investment planning for adaptation is at the base of solutions to address climate variability and change tools built from the negotiating Regional Plan for Adaptation to Climate Change.

To meet future challenges involving climate variability and change, it is necessary a permanent improvement of the planning system (plans, programs, projects) to which this proposal raises contribute to the development of their own capabilities of the governors on the issue of adaptation. The principles of good governance imply that adaptation schemes are aimed at consensus, joint planning, effective, efficient, accountable, transparent, flexible, equitable, inclusive and law-abiding. These are basic principles to be considered to achieve reliable processes and establish legitimate institutions that lead to effective adaptation measures.

- Adaptation planning does not need to be separated aside the already known planning development actions at local levels.
- Adaptation capacities of the municipalities can be improved by better allocating the funds for adaptation actions argued by the big losses after no adaptation

Municipalities can plan adaptation actions and level up those to the Programs for development at the Regional and National level.

P-3313-08

Dynamic coherence of risk management and adaptation strategies in cities

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Decision¬making in cities has a specific temporal character. It ranges from mainstreaming existing urban infrastructures and planning and more immediate measures to increasing theadaptive capacity of cities, to long¬term transformations of urban living and design. Scaling urban challenges of CCA in time strongly relates to the analysis of risk management andadaptation needs, measures and actions. Much knowledge is already available on the impacts of climate change and natural hazards on different sectors in cities and on associated existing vulnerabilities and risks, and many sector ¬specific CCA and DRM options are available. However, the existing methods and tools have not been studied for dynamic coherence. This paper displays the structure of risk management and adaptation need in short term direct and indirect cross¬sectoral impacts, vulnerabilities and risks of climate change, mid term levels of preparedness of cities (adaptive capacity) for these impacts, and robust long¬ term urban sustainability transformations for challenges going beyond existing adaptive capacities. It also covers the role of the private sector in short and long¬term urban resilience programmes,with a special focus on municipal climate and resilience finance.

3314 - Innovate for addressing climate change challenges: examples from different industries

ORAL PRESENTATIONS

K-3314-01

Pioneers into Practice: initiatives for entrepreneurs

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Abstract not communicated

O-3314-01

Producing pulp and paper in 2050: from incremental improvements to breakthrough technologies

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When the European Commission announced in 2011 its ambition to reduce the EU carbon emissions by 80% by 2050, the European pulp and paper sector, represented by the Confederation of European Paper Industries (CEPI), decided on its way to achieve that ambition. After the publication of its own roadmap, specifying the ways and conditions for the paper sector to reduce its own emissions by 80% and complementing it with an ambition to increase the creation of value in the sector by 50%, CEPI launched an open-innovation process to identify concrete technologies to reduce the carbon impact of the industry. The process was called "the Two Team Project".

In November 2012, 2 teams composed of paper company representatives, experts from suppliers to the paper industry, scientists and researchers, free thinkers started to compete in identifying disruptive technologies to make pulp and paper differently and with much less energy and carbon emissions. Since the project was a competition, a pre-jury, followed by a jury had to choose a winning concept out to the eight that have been submitted by the teams. They assessed the concepts on the basis of 5 objective criteria, primarily on the contribution to the carbon emissions' reduction, but also on the contribution to value creation, the feasibility of the idea, the conditions for success, as well as the overall innovativeness of the idea.

In November 2013, a winning concept was unveiled by Connie Hedegaard, at the time European Commissioner for climate action. Since then, consortia to further develop the concepts and carry out the needed research have been established.

Among the 8 concepts for breakthrough technologies in pulp and paper making identified by the teams, 5 are listed below.

1° Deep Eutectic Solvent for pulp making - the winning concept - is an adaptation of a natural phenomenon known from plant metabolism. Glucose-based DES can dissolve wood and extract in a selective manner cellulose, lignin and hemicellulose, hence allowing their use to produce different products. The dissolving process takes place at low temperature and atmospheric pressure. By using DES, the European industry can secure a low-carbon (-20%) and low-energy (-40%) production of pulp and use the other components in bio-based products or sell them to other industries.

2° Making paper with less water and no longer using the current energy-intensive drying techniques is feasible. The concept builds on the blowing of dry fibre into highly turbulent steam and the sheet formation by flash condensation combined with steam expansion, hence requiring a thousandth of the usual water consumption. The industry can reduce its energy needs by 20% and its CO2 emissions by 50%.

3° The current paper drying technique via heated cylinders leads to evaporating water by using air as a heat carrier. Increasing temperature and humidity towards "pure vapour" allows using this "superheated steam" instead of air as heat carrier. With this, large amounts of heat can be recovered and recycled. Using superheated steam for drying would deliver 25% energy reduction and up to 50% CO2 emissions reduction.

4° The use of a very highly consistent fibre input in the headbox requires the fibre to be placed into a very viscous environment to avoid flocculation, while protecting it from shear. The sheet formation is then achieved by pressing the dry pulp components, which takes away 80% of the viscous component, and is followed by a curing technique to obtain a dry sheet. Energy demand is here reduced by 25% and CO2 emissions by 55%.

5°"Supercritical" is a stage where CO2 is neither a liquid nor a gas reached by combining a certain pressure and a certain temperature. Supercritical CO2 would allow drying paper in an autoclave with much less energy and therefore CO2 emissions. It provides the additional benefit of extracting contaminants in the recycling process. Ideally, the mill CO2 emissions could be the needed resource to run the autoclaves (carbon capture and use). The energy demand is expected to decrease by 25% and the CO2 emission by 45%.

The CEPI Two Team process has shown to be successful in showing that an open-innovation process can deliver realistic and disruptive concepts, provided the enabling conditions have been put in place.

O-3314-02

(Con)Fusing Durability Performance of Reinforced Concrete Structures with Environmental Sustainability

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INTRODUCTION
Concrete is one of the most extensively consumed human-made material. The annual global consumption of concrete in 2013 was estimated at 25 billion tons per year, which implied a 900 % increase in concrete consumption in comparison with that of 1950. The reasons for concrete's significant use may be attributed to its numerous benefits which include its versatility, affordability and its ability to be engineered to suit desired performance. The consumption of concrete continues to increase with increasing world population and rate of urbanization. The world population is estimated to be about 7 billion, which is a 40 % increase from the 1990 population statistic and it is projected to rise to 9 billion by the year 2050. Furthermore, with future projections of urbanization to reach 67 % in 2050 from 36

% in 1950, it is expected that there will be a consequent rise in concrete demand for infrastructure development.

However, the continued use of concrete in massive quantities has significant effects on the sustainability of the environment. Firstly, the production of cement, one of the main constituents of concrete, is responsible for 7 % of anthropogenic carbon dioxide (CO2) emissions. Secondly, the annual aggregate and water consumption for concrete production are estimated to be at about 9 billion and 1 billion tons respectively. The massive use of natural resources by the concrete construction industry is environmentally unsustainable.

Concrete is usually used as a composite material with embedded steel reinforcements because of its limited tensile force resistance. The total amount of concrete produced annually goes towards the construction of reinforced concrete (RC) structures. RC structures are prone to inevitable, time dependent ageing after construction. Hence, during their service-life repair or rehabilitation become imminent. Repair and maintenance of such structures may involve concrete patching, or in the cases of failure, reconstruction resulting in further consumption of raw materials. Statistical data on the quantity of additional raw materials consumed during infrastructure repair may not exist, however, about R 11.8 billion (US$ 1.1 billion) is required annually in South Africa for the repair and maintenance of 8,246 bridges and culverts.

MAKING CONCRETE SUSTAINABLE & DURABLE

- Zero percent cement concrete production

The removal of PC use in concrete production is also currently been advocated for by sustainability researchers. 0 % cement concrete is also referred to as geopolymer concrete and contains no PC in its production as the name implies. The concept 'geopolymer' has been in use since the 1950s but it was used to refer to alkali-activated clay-based binders in the 1970s. Geopolymers are used as an alternative to PC because of low CO2 component compared with PC production.

- Use of supplementary cementitious materials

The use of SCMs to partially replace plain PC is common because of the associated benefits with their use, which generally relates to improved economic, durability performance and sustainability properties. Binders that have chloride binding content such as fly ash (FA), ground granulated blast-furnace slag (GGBS) and condensed silica fume reduce the permeability of concrete.

CONCLUSION

The design of durable concrete for a sustainable environment must encompass the use of recycled and by-product materials, low energy requirement for cement production, low CO2 emissions from concrete production and ensure low incurred costs from maintenance. This is possible through the removal or substitution of PC in concrete production and by understanding and adequately designing for the RC structures the service environment.

O-3314-03

Dealing with the Aviation Challenge

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Aviation is a growing source of carbon dioxide emissions and an enabler of the global economy leading to a polarised debate about the economic benefits versus the environmental impact. This makes the sector a barometer of the world's willingness to change economic models to deliver climate change mitigation. Currently aviation is outside the UNFCCC framework, with work on developing a way forward delegated to the International Civil Aviation Organization (ICAO). Aspirational targets have been proposed by the ICAO to limit net emissions based on a combination of shifting to bio fuel and market-based measures. However there are no plans to limit gross emissions which are expected to more than double by 2050. The research reported in this presentation has identified a way forward which requires moving away from fast-jet technology, except for an expensive First and Business Class service. Affordable flying will be on a new design of efficient and relatively slow air vehicle. Interviews with stakeholders found that passengers were generally content with the proposed changes and environmentalists were enthusiastic to shift from opposing flying to supporting the low-carbon model. Industry outside aviation was also willing to embrace the new model and focus on thinking through how they would adjust operations to suite. However, resistance was encountered from the two prime players, the aviation industry and government. The aviation industry was concerned at the impact on their business; concurring with the research which indicated that parts of the industry are likely to be bankrupted. Governmental actors did not foresee aviation coming high enough up policy priorities for them to expend political capital on taking action. In conclusion, there is a bright future for low-carbon aviation but the demand for change will have to come from society to bring the future of aviation onto the political radar so that politicians agree the policy changes required to force a reluctant industry to respond.

3315 - Energy Innovation for Climate Change: systems approaches and societal responses

ORAL PRESENTATIONS

K-3315-01

The need for energy innovation: chair's introduction

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Current energy technologies available to the market at scale are not capable of reducing CO2 emissions to levels compatible with achieving the UNFCCC goal of limiting global warming to 2°C. The last decade has seen a significant scaling up of both public and private sector energy RD&D efforts, but these have yet to reach the levels required to achieve climate policy goals. Indeed, much of the private sector effort will have the effect of extending the potential fossil fuel resource base leading to potential policy dilemmas.

Against this background, the objectives of the chair's introduction are to: identify the needs for investment in energy RD&D; identify patterns of investemtn in R&D in both the public and private sectors; identify investment priorities and methods for establishing them; and consider what institutional frameworks and policy instruments will be most conducive to innovation that will help the achievement of a low-carbon transition. Energy innovation systems now transcend national boundaries due to international co-operation, the mobility of human capital and the activities of multinational companies. These factors will be sketched to help frame the session Energy Innovation for Climate Change: systems approaches and societal responses.

K-3315-02

A Systemic Approach to Assess Energy Technology Innovation

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A systemic framework to assess energy technology innovation efforts, the Energy Technology Innovation Systems (ETIS), is outlined. ETIS describes innovation activities within both a systems perspective of all phases of a technology's life cycle (R&D to maturity/

obsolescence) as well as all components of energy systems from supply to end-use. Within these two system boundaries innovation activities are assessed across four dimensions that represent critical inputs as well as outputs of innovation activities: knowledge generation, resource mobilization, and actor/institutional network build-up as innovation inputs, as well as improvements in technology characteristics (feasibility, performance, costs) as innovation outputs.

The ETIS framework is used to assess current global innovation efforts for climate mitigation concluding that current innovation portfolios are highly biased, resource allocation and policy focus are misaligned, as well as actor and institutional mobilization insufficiently globalized to provide for an effective innovation system that can generate and diffuse required innovations in improved resource efficiency and low-carbon technologies. Selected quantitative examples underpin the assessment presented that emerged out of work conducted within the framework of the Global Energy Assessment (GEA).

K-3315-03

Stakeholder engagement in innovation and deployment

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Low carbon energy systems will require significant infrastructural transformation, involving both novel technologies and new configurations of existing technologies. However, stakeholder 'opposition' is a frequently cited barrier to such change. Framing our research with a brief rejection of the usefulness and veracity of the dominant concept of Not In My Back Yard (NIMBY) in understanding different stakeholder positions, we draw on numerous research projects on low carbon energy siting controversy that have been undertaken at in the Tyndall Centre Manchester, UK. This body of research, undertaken over a decade, examines the local enactment of national policies, demonstrating that it is in this local deployment of technologies that the particular constellations of normative goals and power relationships come in to sharp focus. Such deployment can act as catalyst for local stakeholders to engage with, and challenge, the desirability of the dominant energy system or novel technologies for the first time. This presentation will emphasise the socio-technical nature of energy infrastructure and services, and will explore societal responses to, and engagement with, such significant changes. Issues identified and discussed by stakeholders have included: what social goals are driving policy and are these appropriate? Who are the winners and losers and what power do they have? Whose interests are protected within official impact assessments and whose are not? What kind of society does a particular energy system support or challenge?

We use case study material to explore a range of themes at the deployment stage of energy technologies and set the scene for other panel contributions which focus more on the role (and potential role) of stakeholders in determining the overarching shape of the energy system. We draw together insights from a range of disciplines addressing common themes in low carbon energy controversies such as: different interpretations of impacts and benefits; governance, consultation and engagement activities; the role of governments and businesses. In particular we draw on recent and current projects on smart grids and future energy system resilience. Exploring, for example, the impact on deployment of tensions between the visions of 'ideal' consumers used by designers and engineers to shape technology and the more messy reality of everyday energy consumption. A case study of siting a CO2 pipeline is used to examine how to engage local stakeholders, and in particular how to reconcile expressed desire for communication and engagement with a lack participation in the activities offered. Here, we find that different types and levels of engagement will be suitable for different individuals, information materials need to be tailored to different audiences and opportunities to engage should be provided through a variety of channels and methods.

We argue that there is a need to more closely examine the social assumptions within both positive and negative accounts of low carbon energy technologies and systems, as this allows for the source of controversy to be more fully understood and a wider range of ways of developing support for particular transitions to be developed. Finally, to close the presentation and frame the following panel discussion, we will reflect on the implications of our findings for those trying to deliver transitions in the energy system, particularly in the context of calls for these transitions to be achieved more rapidly.

O-3315-01

Fuel du Jour: Cutting through alternative fuel hype to decarbonize transportation

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Achieving global climate mitigation objectives requires a substantial shift to alternative fuels such as electricity, hydrogen or biofuels for road transport. Over the past three decades, government, industry and others have repeatedly been swept up with the «fuel du jour» phenomon, believing that a particular alternative fuel vehicle (AFV) technology will succeed in replacing conventional gasoline powered vehicles. However, despite numerous periods of hype AFVs are not yet being adopted at rates sufficient to achieve deep decarbonization. The dynamics of hype and disappointment are exemplified by the ambitious statements of US presidents. For example, in 1989 President George H.W. Bush announced an Executive Order requiring 500,000 methanol vehicles to be produced by 1996. Over a decade later, President George W. Bush declared a goal of making cellulosic ethanol «practical and competitive within six years.» And in 2011, President Barak Obama made a goal of having one million electric vehicles on the road by 2015. Despite each period of hype being associated with an upswing of attention, expectations and innovation, none of these goals have been met.

Our study builds on existing science, technology and innovation research to improve awareness about the extent of hype and disappointment cycles for AFV technologies. This research has implications for all sectors where emerging technologies are important for mitigating climate change. The specific objectives of our research are to: 1) identify periods of AFV hype and disappointment by examining trends in societal attention and innovation, 2) explore the ways in which governments participate in and/or contribute to hype by examining funding, policy and political announcements, and 3) identify options for minimizing the negative effects of hype on the decarbonization of road transport. To accomplish these objectives, we analyze mass media, prototype and funding data between 1980 and 2013 for all major AFV technologies.

Hype begins with a technology breakthrough (e.g. the discovery of a new fuel cell manufacturing process) or a policy trigger (e.g. an increase in funding for fuel cell research) that attracts interest in that technology. Innovation actors such as scientists, industry and governments then communicate technological promises in order to attract attention and resources. Hype can play an important role in supporting successful innovation activities, but excessive hype increases the chance of failure. Unfulfilled promises and expectations undermine the reputation of new technologies and their developers, hamper resource mobilization and may lead to the abandonment of innovation activities.

Our research identifies and describes numerous cycles of AFV hype and disappointment, starting with methanol and natural gas in the late 1980s, moving through plug-in electric vehicles in the mid 1990s, and then turning to hybrid-electric, hydrogen and biofuels in the early 2000s. Presently, expectations about plug-in electric vehicles are particularly high (although not for the first time). We show how automotive firms, policy makers and politicians have touted the benefits of each of these AFV technologies at different times, only to lose interest and turn attention to the next technology when initial expectations fail to be met.

While some degree of hype is desirable for stimulating interest and investment in new technologies, the extreme and typically unrealistic promises related to AFVs are contrary to an efficient transition to low-carbon transportation. For policymakers seeking to induce such a transition, it therefore seems prudent to take steps to mitigate the negative impacts of hype and implement

effective policy that is relatively immune to disappointment cycles. To accelerate the adoption of low carbon technologies, we suggest that policymakers: 1) set realistic goals for AFV market penetration, 2) implement strong and consistent policies to achieve desired penetration (i.e., technology agnostic policy focused on environmental damages), and 3) establish institutional capacity to inform expectations via technology assessment. These recommendations are likely applicable to other sectors where emerging low carbon technologies is important for achieving climate mitigation objectives.

O-3315-02

What role for climate negotiations on technology transfer?

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Technology has been an important topic of international climate change negotiations since the adoption of the United Framework Convention on Climate Change in 1992, in which the parties committed themselves to "promote and cooperate in the development, application and diffusion, including transfer, of technologies". North-to-South technology transfer has been given a particularly high importance since technologies have so far been mostly developed in industrialized countries, but are urgently required to mitigate greenhouse gas (GHG) emissions in emerging economies where the bulk of future emission increases are expected.

Little progress has been made, however, in the climate negotiations on these issues. The only significant result to date is the establishment of a Technology Mechanism in 2010 in Cancun. It consists in two coordination bodies – the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTC&N) – the role of which is to elaborate and implement practical solutions to boost technology transfer and technology diffusion towards developing countries.

In this paper, we argue that this apparent lack of success has had little negative consequences on international technology diffusion until now. We even offer the perhaps controversial view that climate negotiations should continue to neglect technology issues.

We provide evidence that, despite the absence of progress on these issues, North – South technology transfer of climate change mitigation technologies has dramatically increased in the last twenty years. This has mostly concerned emerging economies which are now reasonably well connected to international technology flows. This is good news as these are the countries where most of emission increases are expected to occur in the near future. In contrast, least developed countries appear to have remained excluded from international technology flows. This evidence is based on an up-to-date analysis of the climate-related technology transfer landscape, based on a combination of patent data, bilateral trade data and foreign investment data. To the authors' knowledge, this is the first time that such a comprehensive database on climate-related technology transfer has been assembled. Existing studies essentially rely on patent data (e.g., Dechezleprêtre et al. 2011). This evolution has mainly been driven by the growing integration of emerging economies to the global economy, as technological knowledge mostly crosses borders though the international trade of capital goods and Foreign Direct Investments. Similarly, the fact that least-developed countries remain outside is explained by their little participation in the recent economic globalization.

What, then, should be the priority for international coordination on technology diffusion in the future? In the case of emerging economies, there is no reason to think that they will not continue to effectively absorb foreign technologies. In this group, certain laggards – South Asia and India in particular – will benefit from a growing participation in economic globalization. This suggests a limited role for the Technology Mechanism which should essentially provide local private and public actors with information to facilitate coordination (e.g. through technology needs assessment). In parallel, there is no reason to transfer the international regulation of market mechanisms – in particular, trade rules and Intellectual Property – from the World Trade Organization to the UNFCCC.

The situation of least-developed countries is paradoxical. On the one hand, it is more critical as they do not import green technologies; on the other hand, there is less urgency to deal with the problem as their contribution to global emissions will remain limited in the near future. In these countries, the priority is then to build technological capacities and to promote their integration into the global economy. In fact, the problem to be solved is very general: the economic under-development of certain countries and regions, in particular in Africa. We believe that the UNFCCC might not be the adequate forum to deal with what, essentially, appears as a development issue rather than a climate change-related problem.

O-3315-03

Engaging stakeholders towards low carbon energy technology deployment

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No. 3315 Innovation, Technology Deployment and Policies FOR TYNDALL CENTRE SESSION

Like many technologies, deployment of low carbon energy technologies is a contested topic that often divides communities that previously may have coexisted harmoniously. As a result, community engagement and citizen participation have become important, if not essential components of the climate change – low carbon energy landscape. With the overriding aim of community engagement being to involve community members in decisions or policy making that is likely to affect them now or in the future (Keeney 1998), there has been a move away from the traditional one-way, top down approach to one that is far more inclusive. At the same time there has been an increase in the research literature – theoretical frameworks and models – that relate to this topic as governments and industry internationally are being held to account for their actions by their constituents and impacted communities. For example, much has been written about participatory technology assessment (pTA). Huijts, Molin and Steg (2012) proposed a framework for technology assessment with a focus on carbon capture and storage (CCS). The framework emerged from both the pTA literature and psychological theories. They have subsequently tested and refined the framework using hydrogen refuelling as their example. Key elements of their framework that influence decisions to support a technology include attitudes social norms, perceived behavioural control and personal norm. Other components include procedural and distributive fairness, perceived risks and benefits and trust. Similarly, Hall, Ashworth and Devine-Wright (2013) examined key themes that arose from an examination of seven case studies of wind farm deployment. From the qualitative interviews four common themes emerged which included trust, distributional and procedural justice and place attachment. The researchers argued that with out addressing these factors into policy development and engagement approaches wind energy is likely to be deployed for meeting new renewable energy targets. There are similar results reported for the range of low carbon energy technologies such as nuclear, geothermal, CCS and so on. Despite the similarities and overlaps across the frameworks, models and case studies successful deployment of low carbon energy technologies is still challenging and in some cases out of reach. This panel discussion will examine how the requirements for ensuring procedural and distributive justice, trust and place attachment can be met. It will also discuss responses to questions such as? Who should be included in engagement activities? What process will be used to engage? How do you ensure the process is fair? What are the components of trust? How do you evaluate success?

O-3315-04

The role of public-private partnerships in in energy innovation and technology development

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In order to transition to a low carbon, sustainable, energy system globally and avoid potentially dramatic effects from climate change, the work needs to reduce greenhouse gas emissions by roughly an order of magnitude.

Existing technologies and strategies, such as using energy more efficiently, scaling up of renewables, the use of nuclear and a short-term transition to natural (ensuring low leakage rates), and deployment of carbon capture and sequestration will be necessary to help with such transition.

However, there is a continuous need for innovation to help achieve these goals at lower costs. This brings us to a conundrum: the returns on public and private R&D investments and other policies (such as a carbon price or tax, production tax credits, feed-in tariffs, among others) that may lead to energy innovations and help curb the costs of climate mitigation strategies are multifaceted uncertain problems. Namely, uncertainty arises regarding 1) what will be the outcomes in terms of technology breakthroughs or improvements associated with R&D investments or other policy mechanisms that are implemented to promote innovation? 2) when will these technology breakthroughs or improvements occur and how to deal with the uncertainty regarding the timeline of such improvements? 3) if these breakthroughs or improvements occur, how fast or slow will the diffusion process be across different regions?

To address this issues requires both retrospective assessments of what outcomes have different policies and R&D investments delivered so far, as well as a forward looking perspective to enable us to make decisions for climate and energy decision under deep uncertainty.

In this talk, I will start with a retrospective analysis with the evidence from the literature regarding the outcomes of R&D investments and other policies on technology innovation and deployment in several regions of the work. In particular, I will provide examples regarding the Advanced Research Projects Agency-Energy (ARPA-E) program, the production tax credits and the renewable portfolio standard in the United States, and regarding the feed-in tariffs (and other similar policies) in many of the European Union countries, and finally assessing also the outcomes of incentives provided to wind and solar innovators in China.

While understanding the outcomes of previous policies on innovation is already a challenging task, a forward looking assessment is an even more daunting and humbling exercise: forecasts of how the energy system is likely to be shaped in the future has been proven to be quite poor, and any decision framework will be plagued by deep uncertainty. I will outline a methods that provides insight on the quality of forecasts for energy quantities and prices, and suggest a framework on how this information could be used to help identify the needs for investment in energy RD&D and to avoid "dead ends"; identify investment priorities and methods for establishing them; and consider what institutional frameworks and policy instruments will be most conducive to innovation that will help the achievement of a low-carbon transition.

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3315-POSTER PRESENTATIONS

P-3315-01

Modelling Malaysia's Potential for Deployment of Biomass for Bioenergy in the Power Sector

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Biomass is a primary source of renewable energy and accounted for about 10% of the total global primary energy supply in 2008. The Special Report of the IPCC on Renewable Energy Sources and Climate Change Mitigation (SRREN) suggested that the potential bioenergy deployment levels of biomass for bioenergy by 2050 could be in the range of 100-300 EJ; a substantial potential that could contribute to the global total primary energy supply. In the context of developing countries, this work is aimed to assess the future role of bioenergy in the power sector in Malaysia, focusing on power generation capacity and its utilisation under the scope of energy system framework analysis using TIMES (The Integrated MARKAL EFOM System) Model. The model is used to simulate scenarios based on bioenergy implementation under a number of national policies and action plans against a reference base case scenario. The biomass-based electricity promotion policies are contained in its National Renewable Energy Policy and Action Plan (2012-2050) and the National Key Economic Area (NKEA) for Palm Oil Sector under the Economic Transformation Programme. Simulations conducted include increasing biomass-based electricity production from palm oil mills under the NKEA Programme and other agricultural residue use in electricity generation. The results indicate that implementation of the NKEA programme is the most critical factor to achieve the bioenergy and environmental targets; both in terms of electricity generation capacity and in CO2 avoidance.

P-3315-02

Grey water treatment by slanted soil system under real conditions in rural area

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The Performance of the slanted soil for grey water was evaluated in light of required water quality of irrigation reuse. This study aimed to assess the treatment performance of grey water system by slanted soil and check the possibility of reuse this water treated in irrigation. The greywater was collected every week in two pilot families in "Kologondiéssé" village. The levy was made at the input and output of grey water in the treatment system and the storage tank points. Samples were submitted to physicochemical and microbiological analysis. Following changes to the treatment system, it is expected a strong improvement of purifying performance of this system. The results of this survey showed a very good purification performance of organic matters up to 89.78% for suspended solids (SS), 86.75% for chemical oxygen demand (COD) and 87% for biochemical oxygen demand (BOD). Regarding the reduction of bacterial pollution, the obtained results are greater to those of previous studies with 2.48 µlog, 3.33 µlog and 1.99 µlog respectively for E. coli, coliforms and enterococci. These results are slightly higher than the standards of reuse in irrigation.

P-3315-03

Community Investment in Wind Farms: Funding Structure Effects in Wind Energy Infrastructure Development

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Wind energy development is an increasingly popular form of renewable energy infrastructure in rural areas.

Communities generally perceive socioeconomic benefits accrue and that community funding structures are preferable to corporate structures, yet lack supporting quantitative data to inform energy policy. This study uses the Everpower wind development, to be located in Midwestern Ohio, as a hypothetical modeling environment to identify and examine socioeconomic impact trends arising from corporate, community and diversified funding structures. Analysis of five National Renewable Energy Laboratory Jobs and Economic Development Impact models incorporating local economic data and review of relevant literature were conducted. The findings suggest that community and diversified funding structures exhibit 40 to 100 percent higher socioeconomic impact levels than corporate structures. Prioritization of funding sources and retention of federal tax incentives were identified as key elements. The incorporation of local shares was found to mitigate the negative effects of foreign private equity, local debt financing increased economic output and opportunities for private equity investment were identified. The results provide the groundwork for energy policies focused to maximize socioeconomic impacts, while creating opportunities for inclusive economic participation and improved social acceptance levels fundamental to the deployment of renewable energy technology.

P-3315-04

Dew collection for water supply in Valparaíso, Chile

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The availability of fresh water has become a serious problem in arid and semiarid areas of the world. There are large areas in the world, mainly in arid or semi-arid climate, with chronic shortages of fresh water, which has been aggravated consequence of climate change, population growth and, agricultural and industrial activities. As the demand for fresh water is constantly growing, vast areas that historically had no problems with availability of fresh water, have become areas with intermittent water shortages or even permanent. The problem of water shortage has been acute in Chile, particularly in the north and increasingly in the central area, affected by the intensive use of water in agriculture mainly. As a consequence of the problem of water scarcity, various technologies have been developed in order to capture not only fresh water from conventional sources such as rivers or groundwater, but also unconventional sources such as seawater treatment through processes such as distillation, reverse osmosis, nano-filtration and electro-dialysis, and from the atmosphere as is the case of fog precipitation and dew collection based on radiative cooling.

Dew formation by radiative cooling occurs when a solid surface radiates heat into sky causing its temperature becomes lower than the dew point of the water vapor contained in the surrounding air, causing condensation (liquid water). This condition usually occurs during cool nights with high relative humidity, low cloud cover and moderate or low wind speed. Once the condensation process occurs, the liquid water may be collected by natural drainage on an inclined surface (by gravity) and then stored in tanks. The water produced by the system may have uses such as irrigation or human consumption (pre purification treatment if necessary).

This work aims to assess experimentally the dew water collection based on radiative cooling using galvanized steel sheets as radiative surface. Experimental tests were carried out in the city of Valparaíso, which is located in the central coast of Chile. The amount of dew water produced was experimentally quantified, and the quality of dew water produced in the test location was analysed. The testing location included five experimental units (modules), each of which consist of galvanized steel sheets with zinc-aluminum, supported by a steel frame. Each sheet was thermally insulated on its back by Styrofoam. The sheets were coated with a paint containing an additive infra-red emitting minerals (TiO2 and BaSO4) in the atmospheric window, and a non-soluble surfactant that render the surface more hydrophilic (manufactured by OPUR, France). An experimental campaign with a total duration of 30 days was carried out.

The results indicated the following: the collectors produced amounts of dew between 0 and 89 ml/m2 per night and the analysis of dew water showed alkaline pH for all samples which may be due to the proximity of the ocean. Weather station measurements indicated significant changes in several atmospheric parameters on daily as well as hourly basis, including humidity and wind speed which could explain the variability of the amount of dew obtained. The next steps in this project include; chemical and biological analysis to determine whether dew water is potable in the study area, analysis of spatial gradient of temperature in the collectors and a test campaign of one year to determine the seasonal variability of dew yield in the study area

Acknowledgments

This work was supported by FONDECYT N° 11140863 project from CONICYT (Chile) and DI 37.0/2014 project from the Universidad Católica de Valparaíso (Chile).

P-3315-05

Interrogating the transformative power of renewable energy support instruments: the example of feed-in tariffs on photovoltaics

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The deployment of renewable energy is considered to be a crucial part of mitigation strategies, and its promotion on the policy agenda has been largely driven by concerns related to climate change. This is particularly true of the European Union, where renewable energy policy and climate policy now go hand in hand. Besides being coupled, these two EU policy have in common their reliance on market mechanisms as means to trigger change in socio-technical systems by triggering innovation and redirecting investments towards mitigation solutions. As far as renewable energy is concerned, feed-in tariffs (FITs) have been one of the main instrument of transformation, and they have indeed proved effective in attracting investment towards renewable energy technologies, especially wind power and photovoltaics.

However, the transformations triggered by such instruments do not exactly conform to expectations: feed-in tariffs have driven the deployment of markets for electricity from renewable energy sources and the increase in renewable energy installed capacity, but they have also had many unintended effects and consequences that had to be addressed "on the go". The difficulties in managing the dynamics triggered by such mechanisms are especially striking in the case of photovoltaics, which have developed at a dramatic pace and led to political reforms and crises of varying intensities in several countries (e.g. France, Germany, Spain, UK...). Feed-in tariffs, it turns out, transform not only markets and technologies, but society and politics as well. This contribution will attempt to conceptualise the transformative power of such instruments and the issues related to its management by suggesting an alternative account of the functioning and effects of feed-in tariffs for photovoltaics.

To this end, it will rely on actor-network theory research on market-making and politicisation and on studies on governmentality. From this theoretical perspective, it will explore FIT-driven photovoltaics development in three sites, each of which sheds light on specific aspects and tensions of feed-in tariffs for photovoltaic electricity understood as political prices: the emergence and sophistication of feed-in tariffs for photovoltaics in the context of European renewable energy policy; the overflowing of the photovoltaic market that they provoked and the political crisis that ensued in France between 2009 and 2012; and the way in which they can be seized as instruments for territorial development and translated into economic and political resources. The contribution will show that feed-in tariffs for photovoltaic electricity can be described as political market agencements meant to trigger the deployment of electricity generation capacities as much as to foster innovation and experimentation around photovoltaic technologies. The articulation of this dual aim is delicate, especially since the modularity of photovoltaic technologies enables them to proliferate and spread rapidly, making their deployment hard to steer. This re-interpretation of feed-in tariffs will thus suggest ways to account for and analyse the difficulties in regulating current emerging renewable energy markets. It

will also contribute to the analysis of the implications and challenges of driving transformations through the creation and engineering of new markets that seems to characterise many climate policies.

P-3315-06

The role of public-private partnerships in energy innovation and technology development

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Innovation is key to delivering an affordable and secure low carbon energy system. There is no time to invent and deploy a set of novel breakthrough technologies and the cost of adaptation will inevitably be higher than the cost of mitigation. So, whilst breakthrough technologies will always be welcome we cannot wait on them and neither do we need to. A transition to low carbon can be achieved by developing, commercialising and integrating known but currently underdeveloped solutions.

This means that the emphasis of technology innovation shifts from basic research and development towards scaling up, demonstration, early deployment and systems integration to prove and improve performance, drive down cost and build developer and investor confidence.

This scaling up of known but underdeveloped technologies implies different challenges and risks to earlier stage R&D and requires different skills to deliver it as well as an increase in funding levels. In a world with a functioning carbon market providing clear market signals public sector investment in early stage R&D should leverage investment from the private sector to further develop and deploy the most promising technologies. However, given the long lead times and high capital costs for many energy technologies, even with a functioning market, there is potentially a significant valley of death in which the risk/reward balance remains insufficient to attract the levels of finance needed for demonstration and early scale deployment.

Current market structures and carbon pricing appear unlikely to provide a sufficient market signal to incentive the private sector alone to deliver the level of change needed in the timeframe required. In fact the lack of a carbon price in many ways reinforces the somewhat pessimistic view from many of the larger companies in the energy sector that there is insufficient political will and co-ordination to contain global warming to 2degC, even though it is technically feasible and affordable to do so. Current policies, economic drivers and the rise of renewables, do encourage continued substantial private sector investment in improving the efficiency and performance of incumbent technologies but this alone is insufficient to deliver the scale of transition needed. An alternative is increased government-led support with penalties and incentives tailored to each sector, such as the Contracts for Difference introduced in the UK's Electricity Market Reform, to deliver a 'policy pull' until a carbon market is established. This approach is not without its challenges; not least the need to award Contracts through a transparent and competitive process in a particular sector, whilst also evaluating the value of proposals in terms of their long term contribution to decarbonising the energy system. Given the short term nature of the policy mechanism it also doesn't adequately address the valley of death for some of the large scale technology and infrastructure developments that are potentially key to an affordable transition. Moreover, private sector organisations tend to be focussed on a particular sector (or component of a sector) of the energy landscape whilst the public sector needs to integrate and assess priorities across and between sectors.

A successful transition requires the free markets efficient allocation of resources, innovation and deep technical skills to be combined with the governments ability to prioritise between sectors, its access to low cost of capital, democratic legitimacy and protection of consumers role. Without a functioning carbon market (and probably even with it) the public sector plays an essential role in providing long term funding and taking much of the risk in demonstration and early deployment of key technologies. However to be successful this must leverage financing and draw on the skills of the private sector. The UK's experience suggests that working in partnerships is a way to combine these elements that the public and private sectors need to bring to a successful transition.

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P-3315-07

LIFE programme and Climate Change

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The LIFE programme was established in 1992 and is the EU's funding instrument for the environment. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with added value.

With 4171 initiatives supported to date, LIFE has improved the environmental performance of a wide range of sectors and fields across Europe. Pressure on water resources is being exacerbated by climate change. LIFE projects have focused on tackling water scarcity and natural water hazards, both in urban and rural contexts. Optimisation of water use through innovative water management infrastructure, water resource planning and allocation modelling, techniques for groundwater storage improvement, cost analysis and water pricing services are amongst the practices developed and tested when addressing the impact of climate change on floods, as well as on supply and availability of water.

Below you can find some examples of LIFE projects on specific themes:

Europe, flood risk management

Floodscan: The project aimed to limit flood risk by testing an innovative and cost-efficient method of mapping flood hazard areas. A web mapping service was developed to provide reliable and accurate information about flood risk not only for the general public and businesses but also for local and regional authorities, enabling them to take more effective planning decisions (e.g. to ban building in certain areas).

HydroClimateStrategyRiga: The project aimed to create a flood risk management plan for the city of Riga in order to create the means necessary to ensure that hydrological processes intensified by climate change phenomena are adequately investigated and incorporated into the city's planning system. Methodological guidelines were developed, based on existing and future flooding trends in Riga and reinforced by best practices in the identification, planning and management of flood risk zones as adopted in Rotterdam, Antwerp and Hamburg.

Mediterranean Basin / Innovation, Technology deployment & policies

Water Agenda: The main objective was to apply the Water Framework Directive principles and guidelines in order to reverse water degradation trends at a local level in the Anthemountas river basin, in Greece. A sustainable water resource management policy was developed and agreed amongst locals, demonstrating adequate social, technical, administrative and economic techniques and tools (e.g. allocation of water, real-time cost/benefit data, water pricing), mainly focusing on how to address water quantity/quality problems according to the region's development trends, natural and social characteristics.

WIZ: Developed and demonstrated an innovative online platform that includes two informative services (WIZ4All & WIZ4Planners), able to incorporate the protection and sustainable management of water in urban planning processes and local policy areas. An analysis of long-term management of drinking water integrated into land use planning was conducted, enabling water authorities to prepare investment plans and harmonize data characterising the water demands of an area. Information on water resources availability based on the effects of

climate change or active reporting on the quality of drinking water are amongst the activities making an optimum 'participatory management approach' possible.

P-3315-08

Lost at sea? Charting wave energy's difficult journey towards commercialisation since a resurgence in UK government support

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Large-scale support for wave energy innovation in the UK can be traced back to the early 1970s, a movement triggered by a sharp rise in fossil fuels following the oil crisis (Mukora et al. 2008). During this time wave energy became the principal focus for public research, development and deployment (RD&D) funding for renewable energies. However, as oil prices fell and the UK became a net exporter of oil during the 1980s and 90s funding began to decline rapidly. This shift is embodied by the termination of the UK's Wave Energy Programme in 1982, which was discontinued on the basis that official government cost estimates projected that wave energy would be more expensive in the long run compared to other promising (e.g. wind, nuclear) and established (e.g. coal) sources of energy (Ross 1996).

It wasn't until the late 1990s and early 2000s that ocean energy enjoyed a renaissance on the basis that UK government believed it could play a central role in meeting its carbon emissions reduction targets, whilst at the same time stimulating economic growth (LCICG 2012; Jeffrey et al. 2013; RCEP 2014). Subsequently, $120 million of UK public funds have been committed to ocean energy RD&D since 2000. However, despite this resurgence in support there are still no commercial wave energy devices operating in UK waters today, with no major roll-out of devices expected until at least the 2020s (LCICG 2012).

In this context the presentation explores why wave energy technology has failed to reach commercialisation in the UK despite a rich history of wave energy RD&D and a recent resurgence in public RD&D support since the turn of the millennium. It takes a detailed look at what have been the subsequent successes and failures during this period and which factors have been responsible. To answer these questions the presentation draws upon a combination of qualitative (i.e. interviews, documentary analysis) and quantitative (i.e. IEA RD&D repository) analysis to provide underpinning evidence. To conclude, some recommendations are presented to inform the design of the UK government's energy and innovation policy, with a view to accelerate the development and deployment of low-carbon technologies and help it meet its carbon emissions targets.

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P-3315-09

Device of dew and rain collectors in Guéné, Northern Benin

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Dew phenomenon is a process where water vapor condenses on various types of surfaces, such as grass, crops, roofs or vehicles, which are daily experience. Dew occurs at night or early in the morning, when nocturnal radiative cooling leads to surface temperature decrease, and humid air nearby the surface condenses as its temperature falls down below the dew point temperature of the surrounding atmosphere. Dew is important in several domains and has been the focal point of various scientific researches during many years. Its ecological and social importance has been shown in arid and semiarid areas or Islands. A condenser is a surface on which dew can condense on. Three main geometrical shapes of condensers are generally presented: flat condensers, conical condensers and truncated condensers. Guéné is a semiarid village in northern Bénin with hard scarce drought conditions. The objective of this work is to present the different phases of making a truncated dew condenser, using local materials in order to pull better profit from dew water as an alternative source of water to adapt to climate severe conditions in Guéné. A device of rain water collector combined with the truncated condenser increase the amount of water that can be mobilized. During 62 days of measurements, 44 dew events and 5 rain events were observed. The results show that: (i) the truncated condenser can collect about 166 Liters, which represent about 2.7L per night, or 3.77L per dew night (ii) until 10 m3 of rain water can be stocked during the rainy season, (iii) dew amount represents about 36% of the total rain amount during dew measurement period. The collected dew and rain water represent the only source of water used in Guéné primary School for daily academic activities.

P-3315-10

The role of innovation and deployment policy mixes for innovation in renewable power generation technologies: a survey analysis of German technology providers

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The decarbonization of energy systems constitutes one of this century's key challenges for human society in the fight against climate change (van Vuuren et al 2013). In such a transition so-called policy mixes play a crucial role in redirecting and accelerating technological change towards low-carbon solutions (Rogge and Reichardt 2013). Yet precisely how policy mixes affect technological innovation remains poorly understood. Rather, studies so far have focused on the impact of single policy instruments on environmental innovations, and also on their stringency as one of their design features (Kemp and Pontoglio 2011). However, in reality complex policy mixes are at play, implying that studies should focus on the interaction of policy instruments (Flanagan et al. 2011) and on overarching characteristics of such policy mixes, such as their consistency (Rogge and Reichardt 2013).

We address this gap in the literature by studying the case of the German Energiewende. More precisely, we analyze the role of the policy mix for firm-level innovation activities in renewable power generation technologies within the German power sector. Since this sector is supplier-driven (Pavitt 1984) we focus on German technology providers, and extend existing qualitative work in the sector (Rogge et al. 2011, Hoppmann et al. 2013) by conducting a suryey of companies' innovation activities. The questionnaire for this survey was designed in line with the Community Innovation Survey, but was adjusted to the context of renewable power generation technologies and extended by a questions on companies' perceptions of the policy mix. The survey was conducted by telephone from April 9 until June 22, 2014, with interviews lasting around 30 minutes. In this time period we contacted all German renewable power generation manufacturers and suppliers and achieved a response rate of approximately 36% (n=390).

In our econometric approach we employed a bivariate Tobit model to estimate R&D expenditure equations for the years 2014 and 2015, where the error terms captured possible

correlations between R&D expenditures in different years. In this case, the use of univariate Tobit probit models can lead to biased and inconsistent parameter estimations (e.g. Greene, 2012). The simulated maximum likelihood estimations were carried out with STATA 13, relying on Barslund (2009).

Findings of our econometric analysis suggest that R&D expenditures in both years are larger for companies with higher current and expected future turnovers (including export) in the respective renewable power generation technology, which is in line with other studies on the key relevance of domestic and foreign demand pull instruments (Peters et al. 2013). Likewise, higher R&D expenditures are positively related to the amount of subsidies received for R&D from German or EU public funding bodies, thereby confirming the importance of technology push instruments for innovation. Further, future R&D spendings are larger if respondents perceive the current instrument mix to be consistent in its support of renewable energy, and if they perceive a high credibility of the overarching policy mix, as measured by the uniform cross-party support for the expansion of renewables within the German Energiewende. This confirms and extends qualitative findings for offshore wind in Germany pointing to the importance of policy mix consistency and credibility for R&D and adoption activities of emerging renewable power generation technologies (Reichardt and Rogge 2014). Finally, the time a company has been on the market for the respective renewable power technology considered is positively related to the magnitude of innovation expenditures, i.e. more experienced firms invest more in innovation.

Based on our findings we derive recommendations for policy makers on how to tailor policy mixes to support innovation in low-carbon technologies. These policy implications are not only relevant in the context of the German Energiewende but for any country aiming to promote innovation activities of domestic manufacturers in renewable power generation technologies. Such support enables the build-up and strengthening of low-carbon industries and the global deployment of innovative low-carbon technologies, thereby contributing to mitigating global climate change.

P-3315-11

The role of micro-grid on decoupling sharp fluctuations of electricity demand

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Among the many human activities that produce greenhouse gases, the use of energy represents by far the largest source of emissions (IEA, 2014). This paper presents the relationships that sharp electricity demand fluctuations have with CO2 emission and describe how the shape of fluctuations interact with power dispatch, contributing to increase greenhouse gases that influence climate change. The impact on peak loading is particularly important, since occasions of extreme temperatures are likely to stress electricity systems in meeting demand (Parkpoom & Harrison, 2008). The Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) is used to simulate different daily load profile and thus power output can be evaluated for both centralized generation and distributed generation.

Peak demand fluctuations may occur on daily, weekly, monthly, seasonal and yearly cycles. Different power system or different categories of consumers (Residential, Industrial and Commercial) can have similar or distinct daily demand curves. Daily load profile shape has a significant influence on power dispatch and thus, during the peak hours most of power plants need to run on their maximum output. Since peak power plants are in most case fossil fuel power plants due to their operation costs, it can be assumed that the need of covering peak demand contribute to aggravate CO2 emission. The shape of the daily load curve is associated with plant capacity factor. High plant capacity factor leads to increase of power production.

Plant capacity factor = (Average annual Output/Plant capacity*8760)

In order to avoid peak demand, different measures can be implemented (energy efficiency, micro-grid system, renewable technologies etc.). According to IEA (2007), micro grid systems show strong potential to optimize asset utilization by shifting peak load to off-peak times, thereby decoupling electricity growth from peak load growth. Apart from this advantage, micro grid systems improve power quality and reliability due to decentralization of supply and better match of supply and demand. Economic operation of micro grid systems should be ensured through generation scheduling, economic load dispatch and optimal power flow operations (Chowdhury & Crossley, 2009). MESSAGE is a powerful tool for assessment of economic load dispatch and optimal power flow operations. For example, considering that renewable technologies such as solar PV and wind power plants are no dispatchable, connecting them off-grid can make those technologies competitive with other dispatchable technologies such as gas and coal power plants.

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P-3315-12

Resource-Policy-Innovation Nexus for Entrepreneurial Roles across Scales and Sectors of Low Carbon Pathway in Climate Governance

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In the next 25 years, the world needs to invest 40 trillion dollars in infrastructure modernization. It is important to ensure that these financial resources are invested in low-carbon technology instead of conventional carbon-dependent systems. For developed economies where investments will mainly involve replacing out-of-date technology, the transition to a climate-friendly society will involve replacing existing fossil intensive systems. For developing economies, the transition to a larger extent concerns changing the course for implementing new entire systems. This brings opportunities and challenges for sustainability entrepreneurs. Nations not yet subject to fossil technology and institutional lock-in could potentially skip certain development stages (such as the fossil era), thus "leap-frogging" into the new low-carbon economy. Indeed, fast-growing economies will have to leapfrog past much fossil technology, or we will not be able to meet the climate challenge.

The study outlines the essential role of entrepreneurs to operate within resources unaccounted for effects, within which they find opportunities to create value. These efforts are easier when property rights and legal rules are clearer. Challenges to environmental entrepreneurs include environmental problems that cross international boundaries--the transaction costs and financial resource institution of dealing in different legal structures and

property rights systems are huge. As this space for environmental entrepreneurship based on property rights and win-win outcomes shrinks, the space for political entrepreneurship expands. One form of political entrepreneurship is alertness to previously unnoticed rent-seeking opportunities. Cross-boundary environmental issues are characterized by more than usual actions by political entrepreneurs. An example is the potential for climate change caused by humans producing greenhouse gasses, effects of which are globalized. This calls for consideration of effects on global emissions including from import and export.

The research utilizes the policy umbrella under which shifting from product focus to service focus will be central in establishing demand-side incentives for innovation through public procurement policies, which can play an important role as an early test market for climate technology while pushing down costs for new technology and provide low-carbon innovations in different types of businesses. Using the theoretical lenses of multi-level governance, socio-technical transitions, and corporate sustainability and sustainability entrepreneurship the paper highlights the achievement of low-carbon future through economic policy by particularly examining the climate policy within the major themes of globalization as climate objectives have more weight in economic policy than environmental policy. The climate goals manifested in economic policy for decarbonizing economies have potential clear short-term benefits, with short-term costs, and coincide with people's economic goals for greater acceptance and appreciation and in turn fostering involvement.

The study meets the challenges of institutional path dependency as existing institutions and interested parties are typically tied to existing technologies and systems, which hinder transition to the low-carbon economy by the fact that carbon emitting technology does not carry its full climate cost, or that innovations typically require higher upfront investment than fossil intensive systems—while subsequent costs for operations are lower, and due to which short-sighted financial analyses favour fossil intensive systems. In this context, the research allows for collective entrepreneurial effectiveness to be higher than the sum of individual roles in administering linear resource flows with input, process, and waste that will be replaced by cyclical flows. The outcomes favour entrepreneurial roles in dynamic interplay between nonstate, or subnational, actors (such as municipalities, state and provincial authorities, nongovernmental organizations, and civil society groups), international knowledge networks and organisations.

P-3315-13

The impact of policy and uncertainty on innovation in the wind industry: evidence from European countries

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The 2010 moratorium on the level of feed-in-tariffs in the French solar photovoltaic industry offers one of the best illustrations of how impactful an abrupt policy change can be. Fearing the development of a "green bubble", the French government suspended the grid connection permissions for solar PV installations over 3 kilowatts peak for a period of 3 months. Since then, the French solar industry has repeatedly been described as "plunged in an induced coma" with dramatic social and economic consequences. Projects backlog reached ~3.6GW at the end of December 2010 fell by 58% as of June 2012, employment in the French photovoltaic sector declined from 32,500 in 2010 to 18,000 in 2012.

This is one of many examples highlighting the negative impact of policy uncertainty, namely of uncertainty arising from policy change and complexity. Similar anecdotal evidence and case studies can be found in the academic literature for other renewable energy technologies. For instance, Barradale (2010) describes how chronic uncertainty over the renewal of the production tax credit in the U.S. has been driving investment volatility. Meyer and Koefoed (2003) investigate how changes in the policy regime in Denmark has generated uncertainty for investors. Agnolucci (2006) shows how the introduction of a biennial revision of feed-in-tariffs in Germany through a modification of the Renewable Energy Act (EEG) may cause significant uncertainty. While praising the results achieved by the German renewable energy policy, he demonstrates that political uncertainty was behind the decrease in additional capacity in 1997-1998, 2000 and 2003.

The uncertainty surrounding policy may be a strong determinant of the development of renewable energy sources. However, a brief overview of the economic literature on climate change and energy policy shows that less attention has traditionally been devoted to its impacts than to those of economic or technological uncertainty. Moreover, most of the discussion in this respect has remained theoretical. This is a major shortcoming, as policy making and design should be informed about the negative impact on private investors decisions of changing rules, conditions, and more in general of not being able to provide a sufficiently stable policy environment.

This paper attempts to bridge a gap in the empirical literature and provide policy-relevant insight on the impact of uncertainty on wind innovation in 18 European countries over the years 1995-2009. We go a great length towards constructing sound empirical proxies for environmental policy strigenty and policy uncertainty. Inspired by the real option theory, we propose two novel proxies, one for environmental policy stringency and one for the uncertainty that charachterizes such policy. Unlike those used in previous studies on renewable energy technologies, our proxies for policy stringency and policy volatility are robust to three major concerns. First, we net out the effects of those non-policy factors which might drive capacity addition on top of government policies. Second, our proxies account for the fact that rational investors refer to expected policy and policy changes, namely future capacity additions rather than current ones, to make their decisions. Finally, and more fundamentally, we clean our proxies from the issue of potential reverse causality between installed capacity (and its volatility) and innovation. More specifically, we control for the fact that innovation may stimulate capacity additions through technology improvements resulting in greater efficiency and/or lower costs.

We confirm the positive inducement effect of environmental policy on innovation and most importantly show that indeed policy uncertainty counters such positive effect. We find that if both policy and uncertainty increase by one standard deviation in the sample, the benefits to innovation due to the increased stringency level are wiped away due to the negative effect of policy uncertainty.

P-3315-14

Scaling up technology transfer through the UNFCCC Technology Mechanism

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This paper contributes to debates about technology transfer through the UNFCCC Technology Mechanism for climate change mitigation and adaptation. The purpose of this study is to understand the challenges that the current UNFCCC approach faces and to make policy recommendations on how the UN process can be brought closer to the actual need of technology to address climate change. This analysis is relevant to international negotiation in the post 2020 climate regime.

The mechanism has played a limited role in technology transfer so far, failing to materialize in actual technology deployment. Technologies can be transferred through various channels, ranging from official development assistance (ODA) to private economic activities, such as foreign direct investment (FDI). The UNFCCC, however, deals with technology transfer, as a government-to-government process and disvalues the role of private sector. This narrow focus cannot deliver a significant level of low-carbon technology required to curb GHG emissions in developing countries.

There are number of reasons why the UNFCCC needs to structuralize business activities, rather than governmental support, as a basis of technology transfer. First of all, the private sector owns most of the low carbon technologies. Without their engagement and innovative capability, the existing UNFCCC process will not deliver the scale of change that is necessary to achieve climate goal. Thus far, carbon credits via the CDM have facilitated private sector

participation, but future flexible mechanism is under uncertainty, which lacks the necessary signals to stimulate investment in low-carbon technologies. Furthermore, financial resources to support technology transfer, such as the Global Environment Facility (GEF) and Green Climate Fund (GCF), have limited availability and the eligibility criteria for the Technology Mechanism is still unclear. Lastly, but not least, about 30 developing countries with a total population of 2 billion are projected to exceed the income threshold for ODA eligibility over the period until 2030 due to their substantial economic growth, according to the OECD projection. These imply further efforts to involve private sector both in developed and developing economies are crucial.

The Technology Mechanism established in 2010 can be a potential platform to bring the UNFCCC process closer to the enabling frameworks that facilitate private sector investment. The Technology Executive Committee (TEC), together with the Climate Technology Centre and Network (CTCN), is mandated to facilitate the effective implementation of technology transfer. The CTCN strives to stimulate technology cooperation and to enhance climate technology development and transfer. CTCN operations are supposed to be conducted via partner institutions with expertise in climate technologies with an international network of academic, finance, NGO, private and public sector institutions. National Designated Entities (NDEs) are also nominated as national CTCN focal points to coordinate and submit technical assistance requests to the CTCN.

Technology has rarely been transferred explicitly yet through this premature mechanism. Hence, I would propose three specific ideas to enhance the mechanism. First, the CTCN, whose current network members are mostly public sector institutions, needs to involve more private firms that have technology solutions and financial sector, such as regional development bank, to harnesses more private sector investment. Secondly, the function of NDEs in developing countries needs to be expanded. The present role of NDEs is limited to a focal point to their technology needs to the CTCN, but it can be strengthened as a liaison between local technology needs and businesses opportunities by helping the national enabling environments that facilitate private investment. Finally, linkages between the Technology Mechanism and the Financial Mechanism of the Convention is necessary to provide grants to developing countries for the support of capacity building or adaptation technology, which are usually not covered by business activities. This item was negotiated in COP20 but the parties were unable to reach agreement, and discussed again in COP 21. The link between the two mechanisms and enhancement of the private sector involvement would be drivers of scaling up technology transfer.

P-3315-15

University-Industry-Government Collaboration for Innovation to Tackle Sustainability Challenges: Functions and Mechanisms of Stakeholder Platforms on Smart Cities

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Many countries have introduced policies to encourage innovation through technology transfer academia to the private sector, often with exclusive agreements on intellectual property rights. While some successful cases have been reported in transforming knowledge created by university researchers into industrial products, the existing models of university-industry-government collaboration tend to focus on narrowly-defined technical issues, mainly targeted to commercial applications. For tackling sustainability challenges, a new approach would be required to promote innovation, involving a wider variety of stakeholders with more diverse knowledge and expertise in scientific and technological fields. Smart cities and communities are particularly considered to be one of the key areas in which a variety of science and technological knowledge need to be integrated effectively through collaboration among multiple actors. A smart city would involve an advanced technological system for efficient electricity supply and applications, incorporating all the behavior of the actors involved, including generators, distributors, technology developers, and consumers, through an intelligent information network. As a smart city integrates a diverse mixture of hardware as well as software in a complex way, different approaches would be possible to introducing and implementing the concept of smart cities in practice, depending on the economic, social, and environmental conditions and purposes, such as energy efficiency, operating cost, environmental impact, resilience to external shocks and disturbances, and accessibility and inclusiveness to end users.Recently, leading research universities around the world have started to apply their expertise and sources of innovation to the goal of building smart cities and communities. In this paper, we examine approximately 80 cases of the leading initiatives led by universities through stakeholder platforms in Japan, Europe, and the United States. A particular focus is placed on smart cities and communities, involving relevant stakeholders in academia, industry, and the public sector. A close examination of the leading initiatives reveals the important functions of university-driven stakeholder platforms in implementing innovation to address societal challenges. These include the creation of future visions based on science, setting of concrete and practical goals and targets, joint scenario making with stakeholders, securing active participation and serious engagement of stakeholders, collection and analysis of data on societal needs and demands, development of new technologies and systems through social experimentation at universities as living laboratories, assessment of impacts with transparency, objectivity, neutrality, legitimation of innovation in society, provision of effective feedback to decision makers, incorporation into institutional design, and contribution to agenda setting at regional, national, and global levels. On the other hand, difference are also found with regard to the direction and process of technological development on smart cities and communities between Japan, Europe, and the United States. The Japanese approach is characterized by a strong focus on sophistication of application technologies for extensive use of home appliances and electric vehicles. In Europe an emphasis is placed on establishing a basic infrastructure in which information about the behavior of all the stakeholders is collected and distributed among the stakeholders appropriately so that the various objectives of the electricity grid are achieved in a more equitable way. In the United States a strong interest can be observed in creating and maintaining security through improvement in resilience against physical as well as virtual threats. These asymmetries in conceptualizing and implementing smart cities reflect the differences in how knowledge development, stakeholder networks, and institutional environment interact in dynamic and systemic manners. The cases highlighted in this paper provide valuable insights into potential ways forward for collaboratively designing and creating knowledge and implementing innovation to tackle sustainability challenges. For follow-up efforts and new projects in the future, however, we still need deal with remaining challenges, including how to navigate differing motivations and incentives for serious engagement and fruitful collaboration among stakeholders, to promote joint initiatives and networking that contribute to achieving desirable goals and targets and developing complementary skills and capacities, and to identify the factors and conditions required to promote their successful implementation.

P-3315-16

Re-engeneering a Flood Control in Jakarta as a capital city of Indonesia

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Background: Without an integrated system and good infrastructure as well as lacks of feeling "sense of quality", these implies inconsistent in various aspects. The aversion of the goverment and company to invite along experts from Universities to optimize the system of flood control in Jakarta as capital city of Indonesia is also become an obstacle. However the need of research to solve these problems is urgently necessity, because now Jakarta attracts more investors from abroad and domestic where Jakarta is the center of all interests and decisions. Therefore a good infrastructure that guarantee safety, comfort and health can boost the condition by giving the effectivity, efficiency and also its quality.

Project: The paper is done by following the estimation of design flood and the control for 3 months by observing several values for flood routing, flood mitigation, flood forecasting, drainage system, infrastructure, maintenance

of the assets, zoning by direct observation and some interviews with officials of reservoir. The problem that occurred is always every year and mostly in the same place. Also the information that we get from the website is non-interactive.

Problem and solution:

1. Rainwater that fell and the overflow of rainwater from the higher regions provinces can not be managed properly. For instance, it rained only 5 hours it could cause flooding in several locations. It needs urgently to designing flood protection measures, Hydrology of the catchment area, it meanshow to build up a design flood based on the knowledge of hydrology of the catchment area.

2. Storage reservoirs currently not functioning optimally and manually operated. Thereafter, this required to plan re-engineering structures, its schedule of operations, so that the flood cannot cause serious damage downstream.

3. Today flooding could come suddenly without early notification to residents and may causing loss of material and human life. Further as the floodwave passes through a stream it is necessary to know how the stage varies with respect to time and distance for the design of river engineering works as well as for issuance of flood warning by the civil authorities.

4. Current water pump system is not well integrated, electricity is not equipped with backup power, so if the power fails then the pump is can not use. It is need an installing pumping facilities which comes under drainage engineering and with integration system.

Conclusion:

With this current state, it is no wonder if Jakarta famous with the flood in every year. This must be repaired and done some innovations by cooperating with universities to conduct research and continuous improvement for a greater goal. Ensure operation and maintenance personnel are part of project planning and development process including developing criteria for the initial commissioning of the project and wherever possible, choose an easily maintained system. Knowledge is considered today to be one of the main assets of a company. Together company and university can try to develop new approaches and find answers to those challenges.

3316 - Towards solutions that transcend technology and markets: The role of choices and behaviour change

ORAL PRESENTATIONS

O-3316-01

Demand-side solutions to mitigate climate change

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The main emphasis in assessments on climate change solutions has been on technologies and options subjected to cost-benefit analysis. However, many proposed mitigation solutions can hardly be squeezed into such categories or assessed through such analytical frameworks. Because of this mismatch such mitigation options are systematically underrepresented in integrated climate change mitigation analyses and assessments. To counteract this bias, the paper emphasizes the importance of these underreported mitigation options. First, the paper reviews the literature and taxonomies on the options available in the "mitigation space" and maps the diversity of mitigation options. Then, it reviews the key analytical frameworks that integrate mitigation options to prepare climate-related decision-making, including their strengths and shortcomings. The paper thene synthesizes examples of the underrepresented mitigation options from different sectors mostly drawing on results from the IPCC's AR5. The paper then reviews selected examples of the underrepresented mitigation options from several demand-side sectors. it calls for the need ofcomplementary analytical frameworks to cost-benefit analysis, and suggests one based on evaluating political feasibility and desirability of demand-side and infrastructure solutions that interact with endogenous preference formation. It observes that both 'hard' infrastructures, such as the built environment, and 'soft' infrastructures, such as social expectations, share behavior, and, in turn, offer significant potential for mitigating overall energy demand. The overall order of magnitude of mitigation potential of these underrepresented options can be equal to those of technologies. In contrast to the technological options, their potential depends less on economic factors but more on political will and social transformations.

O-3316-02

Show me the money (and the information)! Durability driven uptake of efficient lighting in a context of informality

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Consumer-driven uptake of energy efficient lighting can make meaningful bottom-up and behaviour change driven contributions to address climate change challenges. The International Energy Agency (IEA) estimated that in 2005 lighting accounted for 2,650 TWh, equivalent to 19% of annual global electricity demand. This is equivalent to the power generated by all gas-fired power plants worldwide and results in annual emissions equal to 70% of world passenger vehicle emissions (IEA 2006; UNEP 2012).

Particularly among poor communities in developing countries where a light bulb is by far the most common household appliance, progress is needed to realise end-user uptake. Although light-emitting diodes (LEDs) may not always be available or affordable for these communities, compact fluorescent lamps (CFLs) offer a cost competitive means of energy efficiency uptake. CFLs use up to 80% less power and offer co-benefits such as a longer lifespan and grid load reduction which can contribute to economic welfare and development pursuits. Yet despite these potential benefits, the uptake of CFL bulbs lags. Among 800 survey respondents with an existing electricity connection in Kibera, an informal settlement in Nairobi, Kenya, only 20% have CFLs. What prevents the apparently economically rational purchase of CFLs and how might behaviour change contribute to increased uptake?

Field research in Kibera identified burdens and benefits of CFL adoption. This revealed that when power surges occur on the electrical grid serving Kibera, a majority of residents report that incandescent bulbs burst while CFLs withstand power surges. The relatively high number of power surges occurring on the grid translates to a payback period averaging six weeks, even in a context of non- or flat-rate electricity payment, common arrangements in informal settlements. However, behaviours such as a present-bias or limited self control along with quality assurance concerns such as the high presence of apparently poor performing counterfeit bulbs has reduced confidence and resulting market share for CFLs.

We employ a laboratory-in-the-field experiment (N=651) in Kibera to identify barriers and potential drivers of CFL purchase. Four elements form our research framework: a laboratory protocol testing psychological attributes; a household baseline survey evaluating demographics

and energy use; the application of a randomised control trial testing three potential drivers of CFL uptake, and household endline observation.

The treatments seek to test three hypothesised barriers to the uptake of CFL light bulbs: Awareness, liquidity, and commitment, by providing treatments anticipated to address each barrier. The awareness treatment seeks to "nudge" (Thaler / Sunstein 2008) consumers toward CFL purchase by providing information to address a perceived bias towards incandescent light bulbs. The liquidity treatment provides a subsidy to reduce the price of a CFL bulb to that of an incandescent. The commitment treatment provides a financial reward for committing to purchase a CFL and seeks to address potential barriers related to self-control by regulating this through a prior commitment. We employ a field purchase experiment that more realistically replicates the actual shopping environment that would be encountered.

The findings show that while the provision of liquidity for CFL purchase can positively impact uptake, this is more than tripled by the additional provision of salient information demonstrating the durability of CFL bulbs in comparison to incandescent bulbs. This finding is relevant for the design of behaviour-informed energy efficiency initiatives in developing countries. It demonstrates the potential "pull" of non-monetary and behavioural instruments in energy efficient lighting uptake in a context of poverty, extending the traditional focus of behaviour and energy efficiency beyond developed countries.

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O-3316-03

Perceived climate variability and water scarcity: stress experiences and survivalist responses in water resources management in Cameroon

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Despite the interplay of many factors, climate variability has been recognised for degrading fresh water resources, destabilising human behaviours and activities; drawing in behavioural intervention as an indispensable dimension of integrated water resources management. Positioning water at the centre of human life and activities the paper regrets that human behaviour appears the least understood dimension of global change, climate variability and accompanying risks such as water related stress, thereby undermining human factors in management options and survivalist behaviours of local people. It asserts that emerging strategies in natural resources management drawn from climate variability have embraced people-centre models as core strategic values in sustainable water resources management with increased role of human factors in understanding the psychology of people as facilitators and inhibitors of effective outcomes in physical water systems. In context, increased recognition and focus on the human factor in climate variability, water crisis, stress experiences and response measures are evidenced by the critical role of human behaviours. While crisis relating to water resources management has been generally approached from physical science perspectives, the paper upholds that water management is a psychological problem, and human behaviour can provide significant insights into the antecedents and consequences of water crisis. Also, it submits that the inclusion of behavioral sciences is a prerequisite to linking the physical sciences to the broader social context while promoting water conservation behaviours capable of stress aversion. The present study investigated perceived climate variability, water scarcity and adaptive strategies of local people. A sample of 254 participants (52.4%) males, average age 28.39, (SD, 9.08), were drawn from Bangagnte, Cameroon. A self-report questionnaire with significant internal consistency was used to collect data, and descriptive and inferential statistics used for analysis. Results revealed significant relationships among study variables, except for perceived water scarcity and stress experiences, suggesting the relevance of a behavioral framework in the analysis of climate variability and sustainable use and management of water resources. Also, the relationship between perceived climate variability and water scarcity was significant, while perceived water scarcity and stress experiences were insignificant. Regression analysis confirmed perceived climate variability, water shortage and stress as significant predictors of adaptive responses and mitigation behaviors. Apart from perception of water crisis, t-test analysis showed no significant gender differences for stress level, adaptive and mitigating behaviors. From analysis, the human-centre model constitutes a pathway toward sustainable water management capable of promoting adaptive competences, strategies and actions. While the study has implications for policy, research and practice, it strongly advocates the integration of behavioral science mechanisms in addressing climate variability and natural resources management dominated by physical sciences in an anxiety-provoking era of global change.

O-3316-04

Motivation to engage in sustainable behaviour

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Contribution to session no. 3316 (convened by Dr. Sabine Pahl)

Sustainable development implies a future in which both environmental quality and human well-being are secured. Yet, sustainable behaviour is often believed to be less attractive (e.g., more expensive, time consuming, effortful), which may inhibit sustainable choices as this may threaten individual well-being. Despite this, many people do engage in sustainable actions. Why are they willing to do so? I will argue that values are a key motivating factor in this respect. I will elaborate on which values are likely to promote or inhibit sustainable actions. Notably, hedonic values that make people focus on what makes them feel good, and egoistic values that make them focus on how to increase their resources often inhibit sustainable behaviour, particularly if such behaviour is costly or effortful. Both reflect self-enhancement values. In contrast, altruistic values that make people focus on ways to benefit others, and biospheric values that make people focus on benefiting nature and the environment generally promote sustainable behaviour; both reflect self-transcendence values. Next, I indicate via which processes values affect sustainable behaviour. More specifically, I will illustrate that values affect which behaviour consequences people find important, and how they evaluate behavioural consequences given the implications of the relevant behaviour for their important values. Moreover, values affect the activation of personal norms, that is, feelings of moral obligation to engage in sustainable behaviour, that in turn affect the likelihood of such behaviour. Also, engaging in sustainable actions make people good, and people may anticipate such positive feelings elicited by doing the right thing, which may promote sustainable actions. Finally, I will discuss factors that may activate or deactivate values, thereby affecting the likelihood that the relevant values steer sustainable choices in a given situation. Values can be activated by value-related cues, costs of sustainable behaviour, and situational cues that reflect that other people respected or disrespected norms, and acted upon their self-enhancement rather than their self-transcendence values.

O-3316-05

Behaviour change or lifestyle change? Evidence and prospects for behavioural 'spillover'

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Contribution to session no. 3316 (convened by Dr Sabine Pahl)

There is increasing acknowledgement that profound changes to individual behaviour are required in order to tackle climate change, and yet policies to achieve these changes have so far met with limited success. Most people are willing to make only very small changes to their lifestyle – so new ways of encouraging green behaviour which can match the scale of the climate change challenge are needed. The UK government and several psychologists have suggested behavioural 'spillover' might be a way to achieve this. Spillover is the notion that taking up one green behaviour (e.g., recycling) can lead on to other green behaviours (e.g., taking your own bags shopping). Ultimately, this might hold the key to moving beyond piecemeal behaviour change to achieving more ambitious, holistic lifestyle change. This talk will present initial work to explore when spillover does, does not, and could, occur using correlational and experimental data. First, factor analysis of UK survey data (N=551) will be presented exposing clusters of pro-environmental behaviours that co-occur, potentially indicating spillover between actions similar in difficulty and/or location. This study exposes how consistent individuals are in their behaviour and which factors (e.g., identity) might underlie spillover; it also provides some insight into which behaviours might act as 'catalyst' behaviours to trigger spillover to similar actions. Next two studies are presented which focus on the potential for specific behaviours – installing insulation and carrier bag reuse – to trigger behavioural spillover. Analysis of survey data (N=736) of Welsh homeowners' adoption of energy efficiency measures shows that those who adopt home insulation are significantly more likely to undertake other energy saving measures (e.g., turning down thermostats) in the home. This relationship holds when controlling for environmental values, suggesting behavioural spillover may be occurring in this context. Finally, a field experiment of the Welsh carrier bag change, will be presented that finds carrier bag reuse does not lead to behavioural spillover to similar (waste-related) pro-environmental behaviours. These divergent findings highlight the importance of contextual factors in facilitating pro-environmental behaviour and behavioural spillover, and a need to understand the mechanism underlying spillover. Ongoing lab experiments to induce behavioural spillover and thereby expose this underlying mechanism will briefly be discussed, along with implications for policy and practice.

O-3316-06

Global middle classes and their carbon footprints

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While many climate change scholars from the social sciences (including economics) have paid attention to the GHG emissions contribution of different countries (including average per capita incomes and per capita emissions), we do know much less on emissions by individuals worldwide (regardless of country). But the development of the former (e.g. measured in average GDP) and the latter are linked: the richer countries get on average, the higher the income inequality, and the larger the portion of people that move from the national poor to the national middle classes. Currently, this is particularly the case in rapdily developing countries such as India and China.

We will present estimates of indivdual income by class, and of the respective carbon footprints by class. Our main reference points are Germany, the US, and India. Our basis with respect to income distribution worldwide will be the work of Xavier Sala-i-Martin and Thomas Piketty on the one hand, and national statistics on the other. The assessment of class-specific individual footprints will be based by nation-specific carbon footprint assessments and calculators.

Our results will show that while individuals from the developing world are still responsible for the vast majority of GHG emissions, upper and upper middle classes in some rapidly developing countries have now entered the global 'responsibility space', i.e. emit above per capita world average. We will discuss the implications of these findings both for national and for international climate policies.

3316-POSTER PRESENTATIONS

P-3316-01

Stimulating climate aware behavior among young people in Austria

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Given the latest scientific observations regarding global warming, there is an urgent need to enhance the outreach of climate change communication efforts in order to mainstream low carbon lifestyles (APCC 2014). This is specifically relevant for young people, as their future is most affected by the consequences of global warming. It is evident that the predominantly negative communication of climate change – including catastrophic imagery – simply does not positively engage (young) people in low carbon behavior (O'Neill & Nicholson-Cole 2009, Hibberd & Nguyen 2013). The ongoing research project AUTreach (funded by the Austrian Climate and Energy Fund) aims to enhance the outreach of climate communication in Austria towards young people by shifting the focus of climate communication towards environmental, personal and social benefits of climate-aware behavior, as well as towards desirable solutions for young people's daily lives. It focusses on whether and how such alternative ways of communicating climate change issues – e.g. positive framing of messages and choosing communication formats relevant to the young's needs and habits – can catalyse low carbon behavior among young people.

The project is coordinated in a transdisciplinary manner, actively involving young people and climate change communicators e.g. scientists, NGO's, lecturers, teachers, policy makers. As a first step, an extensive literature review and a quantitative online survey among young Austrians were conducted to evaluate young people's level of awareness, knowledge and engagement regarding climate change and low carbon behavior. Secondly, several workshops with young people were carried out to test possible stimulating effects of different communication formats. In these workshops also good-practice formats, which have been nominated by stakeholders before, were tested. Thirdly, three events that aimed to trigger climate engagement among this audience ("Encourage sustainability"/ lecture, "Earthtalks"/ annual evening event, "UN climate reporter"/social simulation) were evaluated in a qualitative ex-post analysis, interviewing young participants one month after the events.

In light of the conclusions of the literature review (Corner et al., submitted), and the findings of the online survey, a list of youth-specific success factors for climate communication has been derived. These success factors were further revised and supplemented by the results of the workshops and the (ongoing) ex-post evaluation. The following criteria have been identified as key in fostering behavioural change among young people through climate communication:

- frame message-content based on the values most relevant to young people
- phrase clear messages using the target group's language
- stress & strengthen perceived self-efficacy of young people
- provide concrete solutions applicable & relevant to young people's daily lives
- use formats that include social interaction & fun
- consider visual design & possible incentives

The wide spectrum of project results will be summarized concisely for stakeholders by creating an online toolbox to support them in developing youth-oriented climate communication formats. The toolbox will be co-created with young people in a one day workshop towards the end of the project and be presented in a final stakeholder workshop facilitated by young people.

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P-3316-02

Addressing the behavioural gap in energy/economy models: Outcomes of the BE4 Workshop and outlook for the state-of-the-art

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Energy system optimisation models (ESOMs) simulate long-term least-cost energy system trajectories with high technology resolution, and are frequently used to better understand the trade-offs of sustainable technology transition possibilities for the future energy system. ESOMs are commonly used to portray the whole energy system, depicting energy technologies at every stage in the fuel supply chain, from fuel extraction through to final end-use. These models are heavily used in national decision-making and have been influential in the design of low-carbon policies, and so bare a burden of responsibility in realistically depicting energy system dynamics.

Whole-system energy modelling approaches have been successful at capturing the technological complexity and economic feedbacks of the energy system, and are used as integrating frameworks to explore the trade-offs in climate mitigation, fuel poverty and energy security priorities. However, building sustainable energy systems requires a focus on behaviour, along with technological development: Behaviour plays a major role in the uptake and use of energy technologies, in driving energy service demand, and its treatment cannot be excluded from the analysis of long-term energy transitions. Researchers are increasingly looking to integrate insights across disciplines to increase the behavioural realism of ESOMs and include mitigation opportunities from behaviour change, along with technological and fuel solutions, in these highly influential models.

This contribution will address the growing priority of better representing behaviour in energy modelling approaches by bringing to the wider mitigation modelling community outcomes from the International BE4 Workshop, which is to be held on April 20th and 21st, 2015, at University College London*. BE4 will bring together for the first time energy system researchers with expertise and interest in representing behaviour in energy/economy/engineering/environment (E4) models, aiming to develop a common understanding of the state-of-the-art in this emerging field, to identify knowledge gaps, and for the community to gain exposure to research in other fields which has successfully integrated behaviour into other modelling approaches. The workshop will have high-profile speakers and sessions describing state-of-the-art research. BE4 is funded by IEA-ETSAP, a consortium of teams led by the IEA that actively cooperate to establish, maintain, and expand E4 model capacity, and WholeSEM, a consortium which plays an underpinning role for the UK's national strategic energy modelling activity.

BE4, and this presentation, will address the following themes:

- Heterogeneity in the population;
- Hidden costs in decision-making;
- Non-cost-optimal decision frameworks;
- Discrete choice analysis in whole-system approaches;
- Agent based modelling approaches;
- Integration of social sciences with E4 modelling.

Arising from this workshop, this conference contribution will review the challenges that face integrated energy and mitigation planning tools across temporal and spacial scales.

*http://www.wholesem.ac.uk/wholesem-events-repository/be4-workshop

P-3316-03

Energy efficiency and behavioural change in Uganda's small-scale industry

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Energy efficiency counts as a low-hanging fruit in the combat against climate change and the transformation towards a low-carbon future. Investments in energy efficient technologies and the uptake of energy management practices offer a lot of benefits to industries in developing countries, but these are often not reaped. This so called energy efficiency gap exists in Uganda as much as elsewhere. Small-scale enterprises particularly struggle with the closure of this gap due to a combination of financial, organizational and informational barriers, as different studies have shown. This contribution will show that there is also a behavioural story to be told. Removing behavioural barriers and using psychological insights to design tailored policy packages belongs in the climate mitigation toolbox as much as in the development toolbox.

This contribution takes an innovative interdisciplinary approach combining development economics, behavioural sciences and environmental psychology to analyse the behavioural drivers and barriers of energy management in Ugandan micro- and small enterprises. The paper is an empirical contribution that draws on 45 on semi-structured interviews and focus group discussions conducted in Eastern Uganda in April 2014.

The main findings are that behavioural barriers impeding energy efficiency contribute to the limited performance of these enterprises. the cognitive focus on and preference for short-term benefits, habits and a status quo bias as well as a lack of trust impede the uptake of energy efficient technology and energy saving business practices by the MSEs. It has become clear that those entrepreneurs who have started to manage the electricity consumption of their business were supported by direct, first-hand experience with energy efficient technology and practices, followed implementation intentions taken at energy training workshops and benefited from social learning, i.e. from other, similar businesses serving as role models. The possibilities for social learning among the entrepreneurs interviewed are limited by competitiveness thinking and mistrust; at least as long as the entrepreneurs could not actually see for themselves what positive impact energy efficiency has on a neighbouring business. While the qualitative approach to this study does not allow for larger generalizations, the findings indicate a positive effect of changing energy management behaviour on business development and performance, if context conditions such as sufficient business skills and market access are provided for. Strong behavioural drivers are likely to be conducive to energy management and enterprise performance, while the strength of strong behavioural barriers negatively impacts performance. Thus, supporting behavioural change in small-scale industries can have positive effects for mitigating climate change, economic growth and development.

P-3316-04

Towards solutions that transcend technology and markets: The role of choices and behaviour change

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Human choices and behaviour play a crucial role in climate change. "Human beings are the cause of the transformation, and only action by human beings can save

the world from its worst impacts" (US Secretary of State John Kerry, Sept 27, 2013). This session explores how research on choices and behaviour can facilitate interdisciplinary, integrative responses to climate change. Talks will draw on social science theories and present novel data that contribute to three types of solutions: Better engagement with the public, interventions that change behaviour, and policy responses. The explicit aim of our session is to go beyond technological and market solutions and focus on behaviour change solutions. A considerable though not exclusive focus of this session will be on energy efficiency and savings, offering solutions for the double challenge of climate change mitigation and development. The IEA estimates that 18 per cent of the global population lack access to electricity. At the same time, the energy sector accounted for over 70 per cent of global greenhouse gas emissions in 2011. Greenhouse gas emissions overall have grown more between 2000 and 2010 than in the previous three decades. Addressing carbon emissions and reforming the energy system will be vital for limiting global warming but poses different challenges for industrialised and developing countries. While technological innovation and carbon prize mechanisms will play a major role in transitioning towards a low emissions economy, it is questionable whether this technological and market frame is sufficient to realise this transition. Human decisions, behaviours and broader lifestyles are key to achieving a meaningful, acceptable and inclusive transition. Only taking a "people-focused" perspective will provide a buffer against market failures such as risk, imperfect information, hidden costs, access to capital, and split incentives. Contributions will discuss the key factors that contribute to behaviour change by presenting the results of empirical studies (e.g., interventions) and whether specific behaviours can "spill" over to other domains. We will also consider whether a behaviour change approach is too narrow in the face of broader patterns of habits and 'locked-in' lifestyles. This session will bring together social scientists including economists and psychologists, scientists, engineers and policy makers to explore the potential of behavioural, choice and lifestyle solutions to addressing climate change. The session finishes with our team working with three specialists in global environmental change. Michael Depledge (Professor of Environment and Human Health, University of Exeter, UK) will lead this discussion, drawing on his experience as advisor to the United Nations and the European Commission. Together we will sketch a map illustrating how social science theories and data might be used to enhance our responses to climate change and foster sustainable lifestyles. Six speakers are planned with 10 minutes for each presentation, plus a poster session and a panel discussion at the end.

P-3316-05

Behaviour change for household energy use: The example of visualising heat loss through thermal imaging

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Energy use plays an important role in climate change and is linked to issues of energy security and fuel poverty. Householders in particular play a key role in energy conservation through the decisions they make about purchases and installations such as insulation, and through their habitual behaviour. However, energy has been described as abstract and intangible thus making it difficult for individuals to relate to in a meaningful way and know the best actions to take. The present project summarises a programme of work that visualises household energy in order to encourage behaviour change and reduce carbon emissions related to the home. The visualisation tool is "thermal imaging" which makes the invisible visible by using infrared photography. Thermal images demonstrate how heat escapes and cold air enters the home. In Study 1, householders, who received a thermal image of their own home, reduced their energy use at a 1-year follow-up, whereas householders who received a carbon footprint audit and a non-intervention control demonstrated no change. In a second study, householders were nearly 5 times more likely to install draught proofing measures after seeing a thermal image of their home. The effect was especially pronounced for actions that addressed an issue visible in the images. A third study explored the level of tailoring that is needed to change householder intentions and behaviour. Thermal images were shared with more people (social multiplication) and associated with stronger intentions and actions, when they were tailored and personal to people's own home, compared to images that showed a typical home. But seeing any thermal image (whether personal or typical) led to better memory and higher behavioural intentions, compared to text only. Finally, an update will be given on an ongoing study that tests the power of thermal images as a communication tool with 6,000 householders invited to take part in a home improvement programme. This study compares the effect of thermal images that visualise the problem ('before') with thermal images that visualise the problem together with a solution ('before' - 'after), and with a control group that does not see any images. Limitations and challenges of this applied interdisciplinary research will be discussed briefly. The potential for thermal imaging visualisation in other contexts will be highlighted. In conclusion, thermal images seem capable of overcoming the invisibility of energy said to be a barrier to behaviour change.

P-3316-06

The Environment and Data: Using Quantitative Data and Methodology to Encourage Environmental Civic Responsibility

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This paper analyzes the innovative potential of working with the Households and Environment Survey, run biennially by Statistics Canada, while proposing new instruments of measurement using this nation-wide data. Previous research has focused on small geographic areas and not in nation-wide contexts. In addition to this, the focus of research around eco-citizenship has been mainly theoretical and/or used qualitative methods. While this work has been critical to scholarly understanding of the situation and conceptualization regarding eco-citizenship, it has mainly dismissed the vast amount of aggregate data available to researchers.

This paper considers emergent innovations regarding the ways in which we might incorporate this data, as well as new quantitative methods and instruments, into environmental sociology. The data available provides a unique opportunity to create and implement an index for the analysis of our current situation regarding Canadian participation in behaviours indicative of eco-citizenship. This research will subsequently allow me to develop further instruments and tools to build upon scholarly understanding of eco-citizenship at nation-wide and global levels.

This paper will also create a framework that could be developed for use in other countries, generating new information on the status of eco-citizenship. The author looks into the civic responsibility and governance issues surrounding the use of highly statistical, government collected data and exercising what may seem to be a top-down authoritative approach compared to usual environmental approaches emphasizing horizontal authority. While initially problematic, the author believes that it is not the use of data that defines this action but how that data is used. Therefore, what is being exercised is not responsiblization through statistics, but an engagement in environmental civic responsibility to bring citizens and communities into the knowledge and process.

P-3316-07

Mobility choices and climate change: which incentives are effective?

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Transport generated 22 per cent of anthropogenic CO2 emissions in the world in 2011 with three-quarters due to road transport and a continuous increase at least since 1990. There is a majority consensus among climate scientists and economists on a need for a sharp reduction of anthropogenic greenhouse gas emissions in the next few decades. Regarding transport it is recognized that improvements undertaken in vehicle energy efficiency will not be sufficient in the coming decades and that behavioral changes are also needed, such as shifting from individual

to public transportation or lower-emission modes per passenger-km or even reducing kilometers travelled.

Regarding behavioral changes, carbon taxes and vehicle taxes are advocated by economists as the most cost-effective instruments. Variants of economic incentives like personal carbon trading have also been proposed. Their roots can be found in the economic literature initially as a combination of economic incentive and quantity control, namely marketable or Tradable Permits. Due to the specific nature of tradable permits applied to personal consumption of fuel, potential supplementary outcomes when compared to a carbon tax are expected on psychological grounds rather than economic ones. One effect might come from making carbon visible at the end-user level, with a carbon account delivering frequent feedback on travel behavior (i.e. "carbon budgeting"). Another effect could come from the social norm associated with a personal allowance fixed within the frame of a public policy.

By the means of a series of discrete choice experiments in a transport choice context we estimate and compare the impacts of economic and psychological incentives in motivating environmentally responsible mobility behavior.

In a first experiment the potential effectiveness of personal carbon trading (PCT) in changing car travel behavior was compared to the conventional carbon tax (CT) by means of a stated preferences survey conducted among French drivers (N~300). We show evidence that PCT could effectively change travel behavior and hence reduce transport emissions from personal travel. There is however a definite reluctance to reduce car travel. We were unable to demonstrate any significant difference between the effectiveness of PCT and the CT with regard to changing travel behavior. However, in the experiment, the PCT scheme provided consistent results while this was not the case for the CT scheme. This was an indication of a potential "social norm" effect conveyed by a personal emissions allowance.

In the second series of experiments we explored the trade-off between travel price and travel time on 900 participants, while introducing in a controlled setting various effects such as information on CO2 emissions, injunctive and descriptive social norms, and fiscal incentives such as a carbon tax, a bonus-malus and a carbon trading scheme. By "framing" we mean the ways of presenting a choice based initially on objective economic properties (here the trade-off between travel price and travel time) that do change psychological aspects (information on CO2 emissions, injunctive and descriptive social norms) and sometimes economic aspects by imposing fiscal incentives (tax, quotas and bonus-malus).

Statistical evidence shows that providing CO2 information on emissions is highly effective and the injunctive norm reinforces this effect in the case of air and train. A quota scheme reinforces the injunctive norm effect in the case of these two modes. More strikingly, the amount of the financial sanction or reward has no effect on the probability of using the various travel modes, unlike the presence of the fiscal framing itself.

There are some policy implications of such results. First they confirm and reinforce the case for using psychologically positive framing effects in promoting effective pro-environmental behavior in transport choices. Providing basic CO2 emissions information on each travel alternative is likely to yield actual behavior changes. Normative messages through benchmarking (bonus-malus) or carbon budgeting (quotas) may reinforce the incentive especially for larger emitting modes. The amount of the financial (dis)incentive in itself might not matter regarding the effect on behavior change.

P-3316-08

Co-design of a place-based educational videogame on climate change: Future Delta 2.0

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Contribution to session no. 3316 (convened by Dr. Sabine Pahl)

This presentation describes a co-creation and evaluation process for a community-based interactive educational videogame on local climate change solutions, developed for a case study in the coastal municipality of Delta, British Columbia, Canada.

This project uses video gaming to enable interactive exploration of local climate change threats and solutions in a real place. Delta faces challenges such as sea level rise, agricultural decline, heat-waves, and growth fuelled in part by environmental refugees. The project builds on the Collaborative for Advanced Landscape Planning (CALP) team's earlier research in Delta, collaborating with various levels of government and multiple stakeholders, and demonstrating the power of science-based visualizations in raising awareness and motivation on climate change. The aim is to make climate change science and solutions more salient and creative, in a way that conventional educational methods often fail to achieve. The videogame will allow players to visualize what their own future might look like, and explore a variety of tough choices that citizens of Delta may need to make.

Taking advantage of earlier Future Delta videogame prototypes, the co-design phase focuses on local high-schools, in partnership with Delta School district. The game design borrows from commercial videogame techniques in order to provide a compelling virtual environment for: i) place-based learning in geography and science classes, and ii) student engagement on local climate change realities, collective action and policies for adaptation and mitigation. Teachers and students will design the game collaboratively with researchers, through an iterative process of focus groups and gameplay sessions. Participants provide input on integration of class/curriculum learning objectives, the fun of game play, and storyline ideas reflecting local themes and identity.

The presentation will report on the co-design process and preliminary evaluation results on input from students, teachers, families and friends, shedding new light on responses to climate change impacts and choices in a videogame environment.

3317 - Mainstreaming low carbon consumption : challenges and opportunities

ORAL PRESENTATIONS

K-3317-01

Low carbon living and energy demand as a shared social problem: from the little to the big

G. Walker

Bringing low carbon into being evidently means far more than innovating only in technological terms. Co-evolving social change is also necessary, on a scale that extends beyond those people that are already committed, beyond individual attitudes and behaviours, to the truly collective, societal and structural. In this paper I consider the implications in terms of both how we understand the nature of much of the energy consumption that makes up the carbon burden of contemporary living, the challenges involved in achieving 'preferred' forms of low carbon social change (in both energy and social justice terms) and ways of political articulating of what is at stake in governance terms. I will draw on recent research projects focused on the relation between social practice (shared forms of everyday living at home, at work and in moving around) and energy demand, including work on the spread of air conditioning, the mainstreaming of zero carbon homes, energy use in the living spaces of older people and flexibility in the temporal patterns and rhythms of daily energy demand

O-3317-01

Daily innovations, social practices and sustainable consumption – Some insights from real life

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Daily innovations aiming at reducing C02 emissions and energy consumption constitute the cornerstone of most of scenarios and visions of the future underpinning climate change mitigation related policies and options for the residential sector. Not without reasons: the ambitious targets claimed may necessarily be achieved partly thanks to the integration of a sophisticated set of socio-technical eventual innovations. Under certain conditions however. Provided that such projections of the future will be actually performed, incorporated and eventually mainstreamed in a given real social context. This communication will stress on the "reception" and appropriation processes of such visions in order to better understand such processes related to "real" conditions of innovations insertion/co-evolution. Based on selected case and field studies we will show that these are indeed deeply anchored in a particular historical, social and evolving context of a given Society and, as such, that Home Energy related innovations are hybrid and co-shaped devices resulting from of an intertwined process of innovation and social incorporation. By nature this process is dynamic, multi-scale and multi-players. After questioning the way most current policies and measures are formulated, as well as their main underlying assumptions illustrated by such notions as "public acceptance" or "social acceptability", we will pledge for a move towards broader and more suitable concepts. We will use some key-notions mainly derived from practice-based theory as applied to energy field, in order to develop concretely our argument through concrete and socially contextualise field studies. We will finally open up the discussion about how we could (should?) think and found differently Energy related policies in order to make them more efficient and impactful.

O-3317-02

International Consultation on Consumption Patterns for Sustainable Development

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The current debate on the post-2015 development agenda and the sustainable development goals leads to a discussion of crucial points related to the definition of pathways for sustainable development, which must take into consideration how citizens, businesses and governments consume and how such patterns of consumption can be changed. With this in mind, the Brazilian Center for Strategic Studies and Management (CGEE) in cooperation with the Akatu Institute for Conscious Consumption, the Brazilian Business Council for Sustainable Development (CEBDS), the Institute for Sustainable Development and International Relations (IDDRI), the Institute of Research and Development (IRD), the Swedish Agency for Growth Analysis, the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the World Centre for Sustainable Development (Rio+ Centre) organized the present international web-based consultation on consumption patterns for sustainable development. The consultation was addressed to a select group of people from academia, government, civil society and business sectors.

Agenda 21, adopted in 1992 at the United Nations Conference on Environment and Development (Rio 92) stated that "the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production" and recommended "a multipronged strategy focused on demand, meeting the basic needs of the poor and reducing wastage and the use of finite resources in the production process". In 2012, world leaders once again met in Rio de Janeiro to attend the United Nations Conference on Sustainable Development (Rio+20). The conference outcome document, «The Future We Want», reaffirmed the commitment to fully implement Agenda 21 and called for the construction of Sustainable Development Goals (SDGs) to go beyond the Millennium Development Goals (MDGs) and frame the path to sustainable development.

The survey intends to contribute to the ongoing international negotiations for the definition of the SDGs at the United Nations. This process represents an important stepping-stone towards the creation of a global model for sustainable development. It should engage and establish commitments for both developed and developing countries, as well as balance the social, economic and environmental dimensions of sustainable development, including the challenges presented by a changing climate. Therefore, the objective of the consultation is to map out society's perceptions on issues pertaining to consumption patterns in the context of sustainable development and climate change to enable a comparison of the different views, as well as to identify commonalities, in order to help bridge knowledge and information gaps that may arise in the negotiation of the SDGs and of a new international treaty on climate change in 2015.

O-3317-03

Mainstreaming low-carbon consumption: Opportunities, challenges and promising policy approaches

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Consumption-oriented climate mitigation approaches account for all emissions caused by regional consumption (including imported goods), while production-oriented approaches account for all emissions attributable to regional production (including exported goods). Although currently the production-oriented approach is predominantly applied in climate policy, the consumption-oriented approach offers several advantages. These include lower carbon leakage and reduced economic competitiveness concerns over the relocation of carbon-intensive production to regions without climate mitigation requirements. However, addressing emissions via consumption also comes with several new challenges. Policies aiming at radical changes in consumption patterns or reduction of consumption levels suffer from low public acceptance. The consumption-oriented policies with the highest acceptance are those that favour changes in consumption choices towards low-carbon products such as electric cars, net zero energy buildings or sustainably produced food. These policies still face three major challenges: First, they have to account for increasing consumption levels (rebound effects). Second, emissions embodied in the products (life-cycle emissions) need to be considered. Finally, the choice of policy instruments is limited by the path dependence of policymaking as well as the feasibility and public acceptance of the different instruments.

To address these challenges, a policy framework is developed that indicates how the carbon intensity of consumption could be reduced in line with the international climate target. The framework shows how the 2 degree climate target can be translated into carbon intensity targets for products. Comparing these targets with existing low-carbon products indicates that products in line with the required emissions reductions for 2050 are available for the main consumption categories (food, shelter, mobility, goods and services). Hence, to achieve the carbon intensity targets on the product level, the timely diffusion of existing low-carbon options is key. The framework therefore also describes how such carbon intensity targets can be achieved by describing the stylized development of consumption-oriented policies that were successfully implemented in the past. These include policies for mainstreaming low-carbon cars, energy-efficient buildings and appliances as well as sustainable timber products in the European Union. Learning from these policy experiences suggests that successful policy development is a stepwise process towards increasingly stringent standards. The stepwise increase in stringency typically starts with voluntary and information measures. Public procurement and financial incentives contribute to further diffusion of the low-carbon products. This provides the basis for introducing binding standards, which are then regularly tightened. Once established, standards can

also be extended to include additional products and may become more comprehensive (e.g. also include other life-cycle emissions).

The framework helps guide future policymaking and allows the identification of the type of scientific research and policy support required to extend and improve consumption-oriented climate mitigation policy. While in the area of meat consumption and air travel the development of low-carbon innovations is necessary to provide low-carbon consumption options, most other consumption areas call for the mainstreaming of existing low-carbon options. Thus it is essential to achieve a better understanding of how to accelerate the development towards low-carbon standards for all consumption categories. International climate policy can foster this development by supporting the harmonization of carbon footprint norms for products. This will help to guide low carbon consumption, enhance conformity with international trade and facilitate the extension to embodied emissions of existing consumption-oriented climate policy.

O-3317-04

Carbon emission mitigation by Consumption-based Accounting and Policy

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Carbon emission mitigation by Consumption-based Accounting and Policy (Carbon-CAP)

Current climate policies are mainly shaped via territorial emission reduction approaches. Yet, growing consumption is a main driver behind rising greenhouse gas (GHG) emissions. Further, our economy is increasingly a single, global economy: international trade has risen threefold since 1990 implying pollution embodied in trade is now responsible for a significant part of total GHG emissions. Complementing territorial mitigation approaches with policies from a consumption oriented perspective hence can have added value. They can explicitly address consumption as a driver for rising GHG emissions, next to the problem of carbon leakage. However, there are significant questions about consumption based carbon accounting (CBCA) systems (Gap 1: CBCA reliability) and demand side policies (effectiveness (Gap 2) and societal impacts (Gap 3)). Stakeholders hence can easily question their added value (Gap 4).

The Carbon-CAP project aims to (1) stimulate innovative European and international demand side oriented climate policies and services due to more reliable and improved shared insights about consumption based GHG emissions, and (2) to realize a more effective policy mix for achieving the objectives of the EU Climate and Energy package and the Roadmap for moving to a competitive low carbon economy in 2050, by quantitatively analyzing the added value of consumption-oriented climate mitigating polic ies.

Carbon-CAP will deliver insights in reliability and uncertainty in Consumption based carbon accounting (CBCA) and recommendations for an approach for implementation of a robust, reliably system for CBCA. A recommendation which demand side policy instruments have most added value in complementing existing territorial mitigation approaches, with their environmental and economic implications tested via three modelling perspectives.

This presentation will be part of our process of interactive learning between the project team and key players in the policy area. We will present our intermediate findings and will stimulate discussion and reactions in order to fine tune our approach and outcomes.

O-3317-05

Designing and experiencing social practices in LivingLab environments - A novel approach to transform routinized behaviour via materialized social innovations

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In recent years, theories of social practices have gained a lot of attention in the analysis of consumption. Social practices are the locus of the social, where action and structure are mediated. Social practices as a routinized type of behaviour consist of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things', and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge. In a nutshell: The interaction of material, skill and meaning. Social practice theories are just ideal for analysing routine behaviour. Thus consumption is not a practice itself but rather engaging in many practices requires a certain level of consumption of goods or services. Styles of consumption are interwoven with social practices of certain activities but also with daily routines i.e. in households. Consumers combine a number of different practices related to nutrition, mobility or housing and form them into lifestyles. The materials element shows how practices are directly or indirectly related to resource use for objects or infrastructures needed to engage in a given practice. Continuous engagement in a practice, rising numbers of practioners and differentiation thus keeps the engine running for continued extraction of natural resources. In order to observe, analyse and eventually identify promising interventions to support sustainable transitions of social practices, we developed a coherent research framework - the Sustainable LivingLab (SLL). In principle, a SLL is a user-centric innovation approach built on every-day practice and research, with an approach that facilitates user influence in open and real-life contexts (i.e. in households), aiming to create sustainable values and practices. Therefore, SLL approach builds on social practice theory for two reasons:

i) Social practice theories are ideal for analysing routine behaviour related to a specific case study, e.g. heating.

ii) Design processes with regard to user practices make it easier to spread sustainable social innovations such as novel product service systems (PSS). Studies in failed innovations have shown that the benefits of eco-designed products, technologies or infrastructures are hardly realised if designed without reference to user practices. In this sense, SLL aims to identify the potentials of PSS innovations to embrace social innovation . In order to employ a SLL research approach, we developed a three-phase- research design.

1) The first phase of insight research involves understanding the status quo. How do practices look like. For instance, how do people heat, how do people interact with their heating system? Which interpretative schemes do people show towards internal room temperatures? Which routines do persist unreflected? Insight research applies in-deep methods of social research. Data logging is accompanied by qualitative interviews and observations of daily routines.

2) Based on the findings from insight research, the prototyping looks out for ideas of sustainable interventions in practises. The objective is to generate ideas and to integrate participants' knowledge into the design of prototypes. PSS and transformational designs may be developed for different types of households that demonstrate rather adverse practices. Instead of automating processes, PSS or transformational designs intervene in practices and behaviour at the right spot (i.e. leaving the heating on while a window is open). We aim to trigger social learning process and support users to reflect upon their actions.

3) In addition, the prototypes developed can be validated using experimental designs and field testing via installing prototypes in a sample of households and log potential change in practices, e.g. in internal temperature or CO2 concentration. Field testing can be complemented by broad-based survey or agent based modelling. A mix and

combination of methods helps to generalise and validate small scale experimental field tests to a larger scale, such as urban transitions in quarters or cities.

The LivingLab approach and its three-phase model (insight research, prototyping, field testing) fits well for action and participatory oriented research. The methodology of research on sustainable consumption benefits substantially from experimental settings, its in-deep research of social practices and corresponding development of transformational designs. Results of action research and design will be presented.

3317-POSTER PRESENTATIONS

P-3317-01

Green Investment and Business Performance: The African Experience

OJ. Professor Adelegan (1) ; J. Adelegan (2)

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Addressing a paucity of research about industrial adoption of environmentally benign technologies in Africa and, more generally, in tropical developing countries, we examined the Nigerian pulp and paper industry as a case study. Qualitative interviews with twenty upper echelon executives representing five Nigerian firms challenge conventional expectations that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. Our findings suggest a strong positive relationship between cleaner technology use and corporate financial performance of African industrial firms. Our study also suggests the adoption of classical 'win-win' integrated preventive environmental strategy, eco-efficiency and green productivity which improves industrial efficiency and profitability. Nigerian pulp and paper firms are shown to have moved beyond end-of-pipe technologies and cleaner technologies and adopted industrial ecology and "zero emission" principles with appropriate reuse of the remaining waste streams turning the production system into a sustainable industrial ecosystem.

P-3317-02

Green Cities: Benefits of Urban Sustainability

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In the wake of the global financial crisis 2008-2010, the concept of a green economy was provided with fresh impetus following wide-spread discussions on a "Green" New Deal, to enable a "Green Recovery". Large investments were seen as necessary to support the recovery of the world economy. These financial investments offered an opportunity to invest in green economy sectors.

Nowadays many developed countries adopted the Green Cities concept as a new tool to face the environmental impacts in general, and the climate change impacts in particular.

With mainstreaming climate change concerns attention the world to adopt a new strategy for urban cities, we heard raising voices that asking to take GHGs reduction in account during the implementation of a new urban cities.

Regarding to the environment point of view, we have to take care about the whole natural sources we have, not to forget sustainability while we're looking for development.

Green building that the usage of a natural or green materials in its structure; saving and reduce of other resources as lighting, water consumption and waste management are the main concern to get Green Cities.

The increase of productivity of workers in green buildings could achieve labor-cost savings that maybe higher than energy cost savings; challenge in developing countries is doing away with subsidized, non-cost-reflective energy prices; the quality of life and health care are also equally significant.

City governments need to coordinate policies and decisions with other levels of government, but more importantly, they need to be equipped with strategic and integrated planning capacities. In poorer cities, the building up of such capacities is important, as is their access to financial resources for investing in the various sectors of green cities. Here it may be more prudent to adopt a more pragmatic and minimalist approach, which primarily commits municipal sectors such as water, waste, energy and transport to a limited number of overarching strategic goals.

P-3317-03

Breaking Bad: Why We Need to Target Implicit, Automatic Associations in the Fight against Climate Change

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There is growing recognition of the role of consumer behaviour in the dramatic increases in global CO2 emissions and, consequently, more awareness of the critical role of consumers as a major influence on climate change itself. Some leading international figures from the commercial world have proposed that we need nothing short of a 'green revolution' in consumer behaviour to deal with the threat posed by climate change. The argument is that consumers opting for low carbon alternatives would drive demand for more environmentally friendly products, and impact on manufacturing and production with significant environmental consequences. Furthermore, many leading figures have argued that the public are ready for this 'green revolution' as they report in numerous surveys that they are keen to adapt their behaviour to mitigate the effects of climate change. This has led to campaigns in a number of countries to reduce energy use, to promote greener transportation, to highlight lower carbon footprint alternative products etc. The carbon labelling of products to guide consumer choice has now been rolled out in a number of countries, at very significant financial cost. However, these everyday consumer habits seem strangely resistant to change and many governmental, commercial, and educational campaigns have not had the desired, or anticipated, effects on actual consumer behaviour and consumer choice. For example, using eye tracking technology we found little actual gaze fixation on carbon labels on products compared to gaze fixation on the other information that features on such products (see, for example, G. Beattie, 2012, How effective is carbon labelling for the consumer? Nature Climate Change, 2, 214-217). One reason for the overall pattern of disappointing results on behavioural change in this area might be that there has been too much focus on assessing and changing explicit, self-reported attitudes rather than on more implicit attitudes, formed on the basis of underlying associative connections. For example, for years, many people have learned to associate high carbon lifestyles with societal success (partly, of course, attributable to advertising) and this association can affect actual behaviour regardless of more rational decision making about adaptation and climate change. These implicit attitudes can now be measured using the Implicit Association Test (or IAT) and outcome measures from the IAT seem to predict the attentional focus of consumers, amongst other things, in a way that self report measures do not. In this paper, we will outline new experimental data on this topic, which examines the relative importance of implicit and explicit attitudes in determining consumer choice in which the environmental consequences of the various choices are made clear to shoppers through the inclusion of various environmental labels, including features like carbon footprint, organic and Fairtrade. The research also considers other critical variables like the influence of choice under time pressure, the social context of the behavioural choice, and relevant budgetary concerns. The research demonstrates that underlying implicit attitudes are a better predictor of actual consumer choice in supermarket shopping, especially under certain circumstances, like time pressure, where the behaviour

becomes more 'automatic', and less reflective. The paper will argue that it is crucial to understand how such implicit attitudes originate and evolve if we are to deal more effectively with anthropogenic climate change. This should provide us with a more promising start point for changing resistant consumer habits, in order to attempt to reposition consumers at the centre of the necessary 'green revolution'. In this paper, we will also outline a number of particular approaches to changing these automatic, implicit attitudes, which have worked in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Yves Rocher's experience: 50 years of commitments to the preservation of the environment

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Yves Rocher is a one-of-a-kind Brand, created over 50 years ago, that has chosen to master every aspect of its operations: Botanist, Harvester, Manufacturer and Retailer. This specificity enables the Brand to manage all the fields in its business and therefore to reduce its environmental impact at every stage of its products' life cycle.

With half a century of experience in Botanical Beauty, Yves Rocher sources almost 250 plant ingredients with a strategy based on 3 pillars: responsible sourcing, protection of natural resources and local communities, sharing of the benefits resulting from the use of plants. Yves Rocher created its Botanical Charter, illustrating its commitment to the preservation of Biodiversity. Since 2008, Yves Rocher has also actively participated in the Natural Resources Stewardship Circle (NRSC), organization of manufacturers from the beauty industry working together for a sustainable management of biodiversity in supply chains.

Besides, new exclusive active principles are created and developed every year by the Yves Rocher R&D teams, using the most environmentally-friendly extraction technology. Formulation guidelines have been implemented, and Yves Rocher, as a forerunner in the cosmetics industry has banned since 1989 all animal testing for its products and ingredients.

Furthermore, Yves Rocher eco-designs 100% of its packagings, reducing non-renewable resource consumption, designing packagings that can be recycled at existing facilities and encouraging customers to sort their packaging waste. In order to accompany teams engaged in product development, Yves Rocher developed «eco-design packaging guidelines». This tool is updated annually and is shared by marketing, purchasing, development and R&D teams. It provides instructions to follow in terms of eco-design for Yves Rocher products.

Yves Rocher industrial facilities fight global warming by reducing their fossil energy consumption, promoting renewable energies (wood-burning heating in Britanny, saving about 1600t of CO2/year), reducing CO2 emissions (-10%g C02/product since 2010), improving water efficiency (-19% water consumed/t of bulk produced since 2010).

Since 2010, Yves Rocher has integrated biodiversity management to the company's strategy. In Brittany, 100% of the Yves Rocher industrial sites are « havens of Biodiversity ». The Brand is also a genuine Biodiversity Ambassador, hosting more than 3000 participants/year at its awareness events and programs at the Botanical Garden and its own Eco-Hotel Spa.

Environment preservation is at the heart of the Yves Rocher strategy with the support of the Yves Rocher Foundation, in order to leave a positive footprint:

Yves Rocher aims at establishing a new relationship to nature, acting with responsibility towards natural resources and being a biodiversity ambassador to its employees and its 30 million customers throughout the world.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation- Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its "Plant for the Planet" program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the end of 2015, across about thirty plantations worldwide. This program is supported by the Yves Rocher brand thanks to the sales of partner products to customers and to the opening of loyalty cards to customers (1 product sold/1loyalty card created= 1 tree planted by the Yves Rocher Foundation).The Women of the Earth Award was created in 2001 to reward women for their environmental action, initiative and fight. Today, 350 women across 50 countries have received awards.

In 1992, Yves Rocher counted among the four French companies invited to the Rio Earth Summit, and Jacques Rocher, advocated the cause of forests with the «Call for tropical forests", a petition signed by 300,000 customers. Yves Rocher has also been actively involved into the UN Convention of Biodiversity and UNCTAD, and testified in the COP 10 in Nagoya in 2010, COP 11 in Hyderabad in 2012, UN Business and Biotrade events in Montréal and Geneva in 2013 and COP 12 in Pyeong-Chang in October 2014. Climate change is more than ever an urgent issue. Yves Rocher shall keep-on working to reduce its environmental footprint at every step of its value chain, in order to leave a positive footprint.

P-3317-05

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

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In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of representations, discourses and practices adopted and embedded by the GE actors. According to those promoting it, GE is the path favored to accomplish sustainable development within the current context of environmental and socioeconomic global crisis. While this notion stands as a common reference for an increasing number of initiatives, a stabilized and commonly shared definition is still lacking in economic theory as well as across the international community. In fact, «in line with sustainable development and biodiversity, this notion is poorly defined enough and polysemic to be apparently the object of consensus» (Chartier and Foyer, 2012, personal translation). In fact, GE can be considered as both a discursive and socio-economic construction, as it covers a multitude of meanings that change over time and space. This is evidenced by the rhetoric deployed around this notion, showing that actors internalize different aspects of the notion depending on their interests and preferences. Actors sometimes refer to the environmental economics principles and sometimes those of ecological economics. However, the language used is indicative of different and even contradictory views of economy, human well-being, growth, environment, etc. «Green growth», "sustainable development", "green societies", «green investments», «green deal", etc., are frequently associated with the theme of GE. Utilizing a Foulcadian perspective, I question how GE discourses contribute to giving GE an existence in forming the objects of which they speak. Thus, the analysis of GE discourses through their form and content is crucial. Although drawn from ongoing research, this contribution will demonstrate preliminary findings and present one of the questions that frame this work: what do the merging and spreading of green economy rhetoric, discourses and representations tell us about the (nature of the) relationship between environment and economy, and more globally, capitalism? I consider discourse as "an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices" (Hajer and Versteeg 2005). In this light, discourse is seen as a social construct and a particular assemblage of discursive elements that structures realities and allows actors to understand their world. As Fairclough (1993) underlines, the role of discourse is not just of representing realities, "but of signifying the world, constituting and constructing the world in meaning". My

research explores the performative character of GE within the wider research project I am currently conducting, which aims to analyse whereby GE could contributes to (i) a shifting-produced process in the hegemonic capitalist model or, in contrast (ii) keeping, sustaining and reinforcing the capitalist dynamic ideologies through new register of justification and a new spirit in the terms of Boltanski and Chiapello (1999). In order to investigate the potential dynamic of change or continuity of the GE notion on environmental policies, the identification of the different storylines (Hajer, 2005 ; Dryzek, 2005) helps to map the discourses that encapsulates key ideas of GE. In my study, I assume that a particular and selected vision of the world is carried out through GE rhetoric and discourses, conveying imaginaries of hope and functioning with speculative argumentative thinking. To illustrate that, I will first trace the discursive and socio-historical co-construction of the GE notion through its evolution in time and space. I will then present an analysis of selected institutional discourses attempting to make sense of the different ways and options proposed to envision a "happy marriage" (Goldstein, 2014) between environment and economy: presented through "green" options and promoted via positive and appealing discourses, these propositions justify adjusting present actions to the GE promise, e.g. the increase of economic growth as "a path towards planetary salvation" (ibid). Considering how such a vision comes to be justified and formulated, gains prevalence over others and finally unfolds as coherent understandings of socioeconomic realities, prefigures in my view an attempt to construct a growing sense of belonging to a common future. Indeed, I assume that ontologies of the world are renewed through selected, then stabilized discourses and "self-evidence" (Vadrot, 2013).

P-3317-06

Obstacles: Social practice in everyday life

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"Can the Green Economy save the climate?" The answer is simple at the moment - it is: No!

To explain the strict answer I tell a short story which happened during the turn of the year from 2012 to 2013. The story: I regularly buy a coffee in the cafeteria of our student union. In December 2012 I paid for a cup of cappuccino € 1.20. Coming back after Christmas Break I was looking forward to drink my regular morning cappuccino which now costs € 1.50. Astonished about the 25% price increase I asked the till girl: "Why is the price so much higher now?" She replied: "The students' union executive body decided last autumn that they want us to provide fair trade coffee. Therefore, you get a better coffee now and that makes it more expensive!" "Oh", I said and started to think:

1. What is the price difference between a standard and a fair trade coffee?
2. How many cups of coffee does one get out of a 500gr-package of coffee?

A visit to my local supermarket revealed a price difference of about € 3.00 per package. Due to economies of scale the price difference is certainly smaller for the cafeteria. I calculated that a package of coffee will provide approximately 50 cups of cappuccino. The price increase for introducing fair trade coffee (by the way: the new and better coffee doesn't really taste or look different) should be € 0.06. My conclusion: The student union tried to make an additional profit of € 0.24. Student's protests lead them to lower the price to € 1.35. Let's accept that the additional € 0.09 covered a wage increase for the till girls. This is definitely not a scientific proof but it is an evidence for a practice of many firms.

Since the 1980 it is an established idea in the marketing literature that the green consumer will show up with increasing importance for producers and retailers. The growth rates during the last decades were disappointing and the marketing of green products was more or less a failure. But firms were successful in one aspect: Consumers are absolutely sure that green or sustainable products are imperatively more expensive than ordinary products. That the difference between ordinary and green products in many cases boils down to mere credence characteristics and only in some case to search or experience characteristics doesn't make it easier.

The multi-level approval of the transitions theory (Geels; Kemp; Shove and others) conceptualizes a transition process - i.e. towards a green economy - as a joint effort of a variety of different actors. It needs at least politicians, sometimes scientists, producers, retailers and consumers (individual households or firms in a supply chain) who have to act reciprocally and with a common interest without knowing for sure what the other will do: "do ut des!" Producers and retailers have to take entrepreneurial risks by producing "green" - consumers have to believe and trust in credence characteristics of products by consuming "green". Our own research about environmental friendly products doesn't reveal a lot of trust on both sides. In the transition from grey to green (recognizable by labeling schemes) reciprocity seems to be crucial.

One important factor in the transition process is the aspect of culture which includes norms, daily routines and taken for granteds. According to Anthony Giddens and others (Schatzki, Reckwitz, Bourdieu, Strengers, Wenger) we rely on social practices which are shaping our everyday actions. Decisions and actions of firms and individuals are based (1) on own experiences (formerly successful actions), (2) on recognized actions and decisions of relevant others, (3) on our expectations of the expectations of relevant others. Furthermore, the leeway to change behavior is (4) limited because preceding decisions and actions are binding and changes might be costly.

Conclusion: The green economy is an ambitious project which requires a massive transition. To save the climate needs a shift of the mindset of the actors mentioned above. It requires a change of routines and a growth of trust. Considering the theory of practice as an option to conceptualize routine and somehow repetitive behavior the contribution shows limits and possibilities for actually generating a transition.

3318 - Sustainable strategies to mitigate climate and improve public health in developed and developing countries

ORAL PRESENTATIONS

K-3318-01

Norway's knowledge platform on SLCFs - holistic thinking and multiple benefits for climate change and air quality

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Short-lived climate forcers (SLCFs) are a relatively new field in a governmental context. In 2013, Norway published its first knowledge platform on SLCFs. The key objective was to perform an integrated assessment of climate, health and environmental effects of Norwegian emissions of SLCFs and propose measures and instruments for reducing such effects by 2030. Achieving the 2-degree target relies on substantial CO2 reductions. The Norwegian knowledge platform focuses on how measures targeting SLCFs could complement CO2 mitigation measures.

The scientific knowledge was quite immature and developed rapidly in parallel with the Norwegian Environment Agency's assessment. This paper outlines methodological challenges and how these were approached to establish a framework for the analysis of measures. The development of different reduction strategies for consideration by the Norwegian Ministry of Climate and Environment, are discussed. The choice of metric to compare the climate effect of different SLCFs was a key to our analysis. Development of national BC

and OC emission inventories and valuation of health effects were other essential building blocks to enable an integrated assessment of measures. Calculation of the net climate effect of measures, i.e. taking into account both warming and cooling effects of emission reductions, is also important.

The results show that in the short term, the climate effect of Norwegian annual emissions of SLCFs is comparable to that of CO2. Measures aimed at SLCFs cannot replace CO2 measures in either the short or the long term, but reduced emissions of SLCFs will reinforce the global climate benefits of rapid reductions in CO2 emissions. Thus, both SLCFs and CO2 emissions should be mitigated in order to reduce the rate of warming over the next decades.

In some cases, we found that measures with a positive health impact had a negative climate impact. Our study concludes that integrated approaches to assess climate change and air pollution may form a better basis for policy development. Currently, the Norwegian Environment Agency is considering how the SLCFs best can be included in the analysis of greenhouse gas reductions.

K-3318-02

Improving health by acting on air pollution and climate change: the challenges faced by Chinese cities

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As the most iconic example of the air pollution and climate change in the world, China has experienced an economic expansion during the past decades which has led to a dramatic increase in emissions of both ambient pollutants and greenhouse gases. Heavy air pollution and temperature warming has been observed in China over the past century. China is also the biggest country for its population, and is confronted with the most rigorous aging population problem in the world. Global warming and aging are emerging 21st Century challenges. In addition, haze and heat are two major threads for public health in Chinese cities, as illustrated by the situation in Beijing. The haze pollution in Beijing became more and more serious in recent years. One of the worst episode in January 2013 lead to significant excess mortality. Between January 17 to January 31, at least 164 persons died because of high PM2.5 concentrations. Respiratory and cardiovascular diseases were especially sensitive to PM2.5. Reducing PM2.5 could therefore significantly improved health and well-being in Chinese city.

We also investigated the health risk tradeoffs among heat, population aging, and adaptation under a changing climate by integrating the full range of the climate models. We estimated the exposure-response relationship between observed daily mortality of persons 65 years of age and older and the temperature data in Beijing. Then, we obtained downscaled future temperature projections from 31 climate models and two future representative concentration pathways (RCPs) scenarios for Beijing. These two inputs were then combined to estimate future mortality related to heat effects, which were compared to heat-related mortality in the baseline period (1980s). Last, we incorporated population projections under three variant scenarios and the different heat adaptation scenarios to the above two inputs to project the changes of future heat-related mortality.

Under the population high variation scenario, in the 2080s and RCP8.5, Beijing was projected to experience a median of 15894 heat-related deaths per year of persons 65 years of age and older, which is approximately 6 times the projected value for the population without variation scenario. In the 2080s, with the biggest adaptation (under the 30% adaptation scenarios), the increase in heat-related death is approximately 7.4 times and 2.6 times larger than in the 1980s in RCP8.5 and RCP4.5 respectively.

Aging population will enlarge the heat-related health risk under the warming climate. Even under the high adaptation scenario, by the 2080s, the heat-related deaths would still increase. Our results provided evidence that adaptation would diminish the magnitude of future heat-related health risk, but not completely offset the heat impact from climate change. Our findings can lead to improved understanding of public health intervention policy making and adaption strategy planning for the dual problems of climate change and aging population.

O-3318-01

Mitigating air pollution to achieve health and climate benefits

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Air quality is a major modifiable health burden around the world, especially in rapidly developing cities. Exposure to air pollution, including fine particles (PM2.5) and ozone, has adverse effects on human health throughout the lifespan. Adverse effects of air pollution include the development of chronic diseases such as lung cancer, chronic heart and lung diseases, as well as adverse effects on the reproductive system and on neuro-development. Action to mitigate air pollution brings immediate and lasting benefits for the health and well-being of the population. In addition, well-designed air pollution mitigation actions have the potential to reduce societal impacts on the climate system. In order to inform global, regional and urban scale air pollution and climate planning, there is a need for multi-scale health impact assessments that estimate the potential health impacts and/or benefits that may result from coordinated mitigation strategies. We describe several such recent and/or ongoing efforts of this kind. For example, the recently-completed AC-HIA project estimated the influence that policies aimed at reducing air pollution emissions could have on global, regional and urban public health in 2030 and 2050, compared to 2010, taking into account the influence of climate change and alternative air pollution mitigation scenarios. Assessments were carried out across three different geographic scales with increasing spatial granularity, for the entire world, for Europe, and for the Paris metropolitan region. To mitigation scenarios were evaluated: a business as usual scenario based on national regulations already on the books, and a maximum feasible reduction scenarios based on available technologies for air pollution control. The results showed the potential for substantial increases in global deaths due to PM2.5 and ozone under the business as usual scenarios, especially in south and east Asia. On the other hand, substantial health benefits could be achieved under the maximum feasible reduction scenario. In general, health assessments carried out at finer spatial scales yielded greater health benefit estimates. This and other studies are pointing the way to a new generation of tools for integrated air quality and climate planning.

O-3318-02

Health and climate dual impact of African anthropogenic combustion aerosol emission change in 2030

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Fossil fuel (traffic, industries) and biofuel (domestic fires) emissions of gases and particles in Africa are expected to significantly increase in the near future, particularly due to a rapid growth of African cities and megacities.

In this study, we will present the most recent developments of African combustion emission inventories, including African specificities. A regional fossil fuel and biofuel inventory for gases and particulates described in Liousse et al. (2014) has been developed for Africa at a resolution of 0.25° x 0.25° for the years 2005 and 2030. For 2005, the original database of Junker and Liousse (2008) was used after modification accounting for updated regional fuel consumption and emission factors. Two prospective inventories for 2030 are derived based on Prospective Outlook on Long-term Energy Systems (POLES) model (Criqui, 2001). The first one is a reference scenario (2030ref) with no emission controls and the second one is for a «clean» scenario (2030ccc*) including Kyoto policy and african specific emission control. Our results

predict very large increases of pollutant emissions in 2030 (e.g. contributing to 50% of total anthropogenic organic particles), if no emission regulations are implemented.

These inventories have been introduced into RegCM4, a regional climatic model. In this paper we will focus on modelled aerosol concentrations and optical depths in 2005, 2030ref and 2030ccc* scenarios. Spatial distribution of aerosol concentrations will be presented with a zoom on a set of urban and rural sites. Finally, aerosol radiative forcing and impact on mortality rates caused by anthropogenic PM2.5 pollution increase from 2005 to 2030 will be shown for each scenarios.

To conclude, this paper will discuss the effectiveness of scenarios to improve emissions, aerosol concentrations, radiative forcing and mortality rates, underlining the need for further measurements, scheduled in the frame of the on going DACCIWA program (EU FP7).

O-3318-03

The Importance of Revising Indonesia NAAQS for the Local Health Benefits and to Mitigate GHGs

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Indonesian government actively joins in efforts to reduce global GHGs emissions. Various regulations were issued such as Presidential Decree No. 61 of 2011 on the National Action Plan to Reduce Emissions of GHGs and Presidential Decree No. 71 of 2011 on the National GHGs Inventory System. Unfortunately, local air pollution issues seem left behind, even until these days many big cities in Indonesia do not have an adequate integrated air quality management, such as limited emission inventory, the NAAQS is not well enforced, and lack of monitoring equipment. Black carbon (BC), a constituent of fine particulate matter (PM2.5), and tropospheric ozone (O3) are harmful air pollutants associated with premature mortality that also contribute to global climate change. Recent study shows that BC and O3 emission reductions would have immediate and multiple benefits for human health. Therefore, policy designed to reduce GHGs can have co-benefits for air quality or vice versa. This study examines the current Indonesia NAAQS 1999 compared to WHO AQG 2005, mainly on particulate matter (PM) and O3. This study also evaluates ambient monitoring data of PM and O3, and Indonesia's current emission control measures targeting BC and ozone precursor. By linking these three issues above, this study simulates the impacts of mitigation measures on ambient concentrations of PM2.5 and O3 to calculate their associated changes in health-related benefits. The WHO AQG 2005 for PM2.5: 10 µg/m3 annual mean; 25 µg/m3 24-hour mean. While for PM10: 20 µg/m3 annual mean, 50 µg/m3 24-hour mean. As comparison, Indonesia NAAQS 1999 for PM2.5: 15 µg/m3 annual mean; 65 µg/m3 24-hour mean. For PM10: annual mean is not available, 150 µg/m3 24-hour mean. The WHO AQG 2005 provides interim targets as an approach to achieving the air quality guideline value. Indonesia, with higher levels of air pollution, should select a clear achievable interim target level based on air quality infrastructure. There is a substantial lack of monitoring stations for both PM2.5 and PM10; most monitored PM in Indonesia is TSP. It is very limited epidemiology studies related to air quality too. Therefore, it is not easy to show the health benefits of mitigating emissions of air pollutants and GHGs. Some mitigations exist such as emission control from industrial stacks, I/M, public transportation, and relatively new discourse on low-carbon infrastructure. Revising Indonesia NAAQS is needed to make sure public health is guaranteed. Air quality and health co-benefits, because they are mainly local and near-term, offer better motivation for transformation to a low-carbon paradigm. It will be easier to set the target to mitigate the GHGs related to air pollutants.

O-3318-04

Health co-benefits and co-harms of reducing indoor air-pollution in Sub Saharan Africa

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Local air pollution harms health

Household use of solid fuel is the most widespread source of indoor air pollution worldwide. Globally, 2.6% of all ill-health is attributable to indoor smoke from solid fuels, nearly all in poor regions. Solid fuels are extensively used for cooking and home heating in developing countries, especially in rural areas. Solid fuel is usually combusted in inefficient cook stoves, producing a variety of health-damaging gases and particles, such as black carbon, organic carbon, methane, and carbon monoxide. More than 1.6 million deaths and over 38.5 million disability-adjusted life years (DALYs) were attributable to indoor smoke from solid fuels in 2000. Cooking with solid fuels is thus responsible for a significant proportion, about 3%, of the global burden of disease. Approximately 1.5 million deaths every year from respiratory infections can be attributed to the environment, including the effects of indoor air pollution. To encourage the use of cleaner burning fuels, the step is usually from wood to charcoal or kerosene and to Liquid Petrolium Gas might be effective ways to reduce air pollution exposures.

Reaping climate co-benefits by reducing climate active pollutants

Recent IPCC report stressed the role of many causative agents of Indoor air pollution,as having in addition a greenhouse gas effect, in particular black carbon. Other common pollutants such as nitrogen oxide, sulfur dioxide, particulate matter and carbon monoxide have been shown to be associated with several adverse health events such asthma attacks and incidence , chronic obstructive pulmonary diseases and lung cancer.

From a climate policy angle, reducing CAPs (Climate active pollutants) reaps Health Co -benefits. There are some evidences that stove improvements can substantially reduce indoor air pollution and the risk of lung cancer, respiratory diseases, Asthma, cataract, etc. Therefore, efforts should be made to reduce the burden of disease through public health and primary care programmes. Programmes can be designed to encourage urban and rural households that use solid fuels to move up the "energy ladder" to cleaner fuels such as kerosene or liquid petroleum gas. Household changes to improve ventilation and behavioural modifications to reduce exposure could be the cost effective interventions to reduce the burden of diseases.

Avoiding co-harm

Co-harm is a negative health effect, which has never been mentioned in this context. Without smoke, indoor abundance of mosquitoes increases and there is a higher risk of malaria transmission. 2009). There is a need to couple interventions for less smoke with those against malaria. Air pollution reduction rarely promote the twin goals of protecting health, avoiding increase in malaria and climate but can pose tradeoffs. All particles are dangerous for health, for example, some are cooling, such as sulfates, and some warming, such as black carbon. Indeed elimination of all anthropogenic particles in the atmosphere, may be a major success for health and would have only a minor net impact on climate.

3318-POSTER PRESENTATIONS

P-3318-01

Use of sattelite imageries and Numerical weather prediction output in Forecatsing Dust/Haze over West Africa

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Dust Haze occurrence over the sub-Saharan Africa is an annual phenomena, which has attractedquite a lot of attention from both forecasters and scientists. Between november and march,observations show that large dust plumes are transported from both the Sahara and Sahel towardsWest African Countries and accross the Atlantic Ocean. Predicting Dust haze generation should be animportant application of meteorology to development in this area both for economic and socialaspects. The main objective of the present study is to develop methodologies for betterinterpretation and use of NWP and Satellite products in forecasting Dust Haze generated

by thepredominant mechanism associated with pressure gradient tendency; improve knowledge andtechniques required to exploit potential predictability of Dust Haze;verification of weather forecasts.One should however keep in mind that atmospheric soundings are needed when other generationmechanisms are concerned.

P-3318-02

Black carbon emissions from biomass and fossil fuels: Indo-Gangetic Plains, India

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Most of the climate change debate and policies has focused on mitigating long-lived greenhouse gases (GHGs) to reduce global warming. But recently abating short-lived climate pollutants (SLCPs) such as black carbon (BC) has entered these discussions. BC emission from biofuel cooking in South Asia and its radiative forcing is a significant source of uncertainty for health and climate impact studies. Quantification of BC emissions in the published literature is either based on laboratory or remote field observations far away from the source. We use field measurements taken simultaneously inside urban and rural households (LPG and biomass users), ambient air and vehicular emissions from highways in area of the Indo-Gangetic-Plains region of India to establish the role of both solid biomass based cooking in traditional stoves, gas stoves and diesel vehicles in contributing to high BC. Household were also interviewed to understand barriers related to clean fuel accessibility and adoptability within users.

The major finding of this study till now is able to interpret the BC concentrations during cooking hours, both indoors and outdoors have anomalously large concentrations ranging from 3.82 µg to 105.64 µg for indoor during morning hours (05:00 to 09:00) and 1.32 µg to 130.70 µg for early evening hours (17:00 to 20:00). The BC emission during the non-cooking hours was also large, in the range of 1.05 to 95.44 µg. The peak outdoor BC concentrations are ranging from 6.54 µg to 40.81 µg in morning hours while 3.07 µg to 27.92 µg in evening hours. BC emission from transportation was also found high in morning and evening hours, have large concentration reaching 4.38 to 52.12 µg in morning hours and 1.71 to 49.02 µg in evening hours. The imprint of the cooking hour peaks were seen in the outdoor BC both in the village as well as in the highway. The results have significant implications for climate and epidemiological studies.

P-3318-03

The Fertilizer and Carbon Sequestration Potential of an Accelerated compost in two soil types

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Compost has the potential to trap carbon in the soil while supplying the nutrients needed for the crop use. This study therefore investigated the fertilizer and carbon sequestration potential of an accelerated compost (a new commercial compost from market organic wastes and animal manure with composting accelerated with a specific microorganism). This experiment was laid out in Randomized Complete Block Design with three replications. The treatments were accelerated compost (AC) at the rate of 60, 90, 120, 150 and 180 kg N / ha. The mineral fertilizer (NPK 15-15-15) and conventional compost (CC), both at 60 kgN / ha, as well as the control (no soil additive) were the checks. Data were collected on the maize grain yields at both main and second cropping and post cropping soil organic carbon. Data were analysed using Analysis of variance and means compared with standard error of means. The result of the grain yield at the main planting showed that, on an Alfisol, the 60 kg N / ha AC (3.33 t / ha) compared favourably with 60 kg N / ha NPK (2.97 t / ha) but performed significantly ($p<0.05$) higher than 60 kg N / ha CC (2.76 t / ha). On an Ultisol, the 60 kg N / ha AC resulted into significantly higher grain yield (3.42 t / ha) than the 60 kg N / ha NPK (2.79 t / ha) and 60 kg N / ha CC (2.74 t / ha). At the residual planting, on an Alfisol, both the 60 kg N / ha AC (2.31 t / ha) and 60 kg N / ha CC (2.41 t / ha) performed significantly higher than the 60 kg N / ha NPK (2.21 t / ha), while the same trend was observed on an Ultisol. The AC sequestrated more carbon (58 % extra compared to the control) than the CC (9 % extra compared to the control) at the same 60 kg N / ha rate on an Alfisol. Also on an Ultisol, Accelerated compost sequestrated more carbon (14 % extra compared to the control) than the CC (8 % extra compared to the control) at the same 60 kg N / ha rate. It could therefore be concluded that the shortness in maturity of accelerated compost does not limit its fertilizer and carbon sequestration potential.

P-3318-04

Modélisation de l'impact de la pollution atmosphérique urbaine aux échelles régionale et locale en Afrique de l'Ouest

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Regional climate modeling of the impact of urban air pollution at regional and local scales in West Africa

Mainly based on modeling, this study will highlight the impact of particulate and gaseous pollution from the West African megacities on regional climate and urban meteorology. The West African region has very large cities which promote strong anthropogenic urban air pollution. Using the Regional Climate Model (RegCM4) at the scale of West Africa will permit focus on the impact of urban air pollution on the climate of this region. Knowing that megacities affect their environment at local scales, up to the street, where RegCM4 is no more suitable, the Weather Forecast Research and its chemistry module (WFR-CHEM) with finer resolution will be used to study the chemistry of pollutants in the megalopolis. This part will focus essentially on aerosols (BC, OC, SO4 and NO3) and gases (CO2, CO, SO2 and VOC) combustion.

In the preliminary result, we have activated the dustss module to see what it brings disturbance on climate parameters. The tests with the model RegCM reproduce well the patterns of precipitation. Also we compared the temperature of the model with and without chemistry with observations. Thus the presence of dusts has a cooling effect and tends to improve the system. In further work we will characterize and quantify urban air pollution in Abidjan and Lagos. First, it will be for me to refine the inventories of particulate emissions in two megacities of West Africa (Abidjan and Lagos). Also analyze the impact of particulate and gaseous pollution on regional and local climate, while using the WRF_CHEM model for urban study.

3320 - Food Systems and Food Security: Health and Environment

ORAL PRESENTATIONS

O-3320-01

The global and regional health impacts of future food production under climate change

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Background: One of the most important consequences of climate change could be its impact on agriculture. While much research has focused on questions of food security, less attention has been devoted to assessing the wider health impacts of future changes in agricultural production. We estimate excess mortality due to agriculturally mediated changes in dietary and weight-related risk factors by cause of death for 155 world regions in the year 2050.

Methods: We linked a detailed agricultural modelling framework, the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), to a comparative risk assessment of changes in fruit and vegetable consumption, red-meat consumption, and body weight for deaths from coronary heart disease, stroke, cancer, and an aggregate of other causes. We calculated the change in the number of deaths due to climate-related changes in weight and diets for the combination of four emissions and three socio-economic pathways, which each included six scenarios with variable climatic inputs.

Findings: The model predicts that by 2050 climate change will lead to per-capita reductions of 3%, 4%, and 1% in global food availability, fruit and vegetable consumption, and red-meat consumption, respectively. Those changes were associated with 529,000 climate-related deaths globally (95% CI: 314,000-736,000), representing a 28% reduction in the number of deaths that would be avoided due to changes in dietary and weight-related risk factors between 2010 and 2050. Twice as many climate-related deaths were associated with reductions in fruit and vegetable consumption than with climate-related increases in the prevalence of underweight, and most climate-related deaths were projected to occur in South and East Asia. Adopting climate-stabilization pathways reduced the number of climate-related deaths by 29-71% depending on their stringency.

Interpretation: The health impacts of climate change from changes in dietary and weight-related risk factors could be significant, and exceed other climate-related health impacts that have been estimated. Climate change mitigation could prevent a substantial number of climate-related deaths. Strengthening public-health programmes aimed at preventing and treating diet and weight-related risk factors could be a suitable climate change adaptation strategy.

O-3320-02

Understanding the impact of international climate policies on regional food security using an Integrated Assessment Model

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We evaluate changes to regional food security under different international climate policy structures using an integrated assessment (IA) model, the Global Change Assessment Model (GCAM). Climate change mitigation policies may affect food security through complex interactions of changing food prices by altering land use patterns and changing income by influencing economic development and poverty reduction. IA models provide a consistent framework for evaluating these effects using assumptions that are consistent with the estimates of the costs and other impacts of climate policies.

First, we develop a measure of food security that can be estimated in GCAM based on economic accessibility and nutritional value. Specifically, national and regional food accessibility is approximated by the fraction of income spent on staple commodities, weighted by total food calorie availability and the share provided by staples. To better capture regional variability, we develop this measure by estimating regional consumer prices of staple commodities from the global producer prices modeled in GCAM. Second, we evaluate the implications over different socioeconomic scenarios, represented by the Shared Socioeconomic Pathways (SSPs). Finally, we estimate the impact of a universal carbon tax (UCT) on greenhouse gas (GHG) emissions to reach global climate targets reflected by the Representative Concentration Pathways (RCPs), without and with transfer payment using two illustrative allocation regimes.

We find that the socioeconomic pathway and the climate policy regime have important implications for food accessibility. More optimistic SSPs generally improve food accessibility with greater marginal benefits in poor and already food insecure regions. Second, impacts on food accessibility caused by a UCT mitigation policy differ across regions with greater impacts in developing countries. Third, regional variability of food access is further modified with payment transfers in global carbon trading. In particular, an allocation regime based on future population is expected to favor developing regions and thus moderate regional inequality of food access, while an allocation regime based on historical emissions tends to exacerbate the cross-region variability.

By exploring the magnitude and distribution of impacts on food security under alternative climate policy scenarios, we capture an important dimension of regional impacts of climate policy beyond mitigation costs.

Acknowledgement: This material is based upon work supported in part by the U.S. Army Research Laboratory and the U.S. Army Research Office via the Minerva Initiative under grant number W911NF-13-1-0307.

O-3320-03

Household and food security: what lessons can we learn from food secure households?

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The potential impacts of climate change on food security in East Africa, while complex and variable due to highly heterogeneous landscapes, are a cause of concern. How well people are able to adapt to, or reduce climate change effects will depend on whether they are able to

change their behaviour and adopt improved agricultural technologies and management strategies.

While there is a rapidly growing literature on vulnerability and adaptation to increased climatic variability and climate change, significant knowledge gaps still exist, especially regarding the assessment of adaptation options in different environments and how these might be appropriately targeted to different types of households to reduce food insecurity.

This study therefore addresses a series of questions, such as: what are the key factors that contribute to household-level food security; what lessons can we learn from food secure households; and what agricultural interventions, options and management strategies are likely to benefit female-headed households in particular. It uses a unique dataset of 600 households to explore a wide range of indicators capturing different aspects of household performance and well-being for different types of households — female-headed, male-headed, food secure, food insecure — and assess livelihoods options and strategies and how they influence food security. The analysis is based on a very detailed farm characterisation survey carried on in three sites in Kenya, Uganda and Tanzania.

The results of this study show that food secure farmers appear to be the ones that diversify the most, have a variety of crops on their farms and are market oriented. In addition, domestic asset increases the likelihood of being food secure for female headed households. Yet, a different livelihood portfolio is pursued by men and female head of household, with women less likely to grow high-value crops then men and with a less diversified crop portfolio.

These findings can inform the targeting of national and regional policies to enhance adaptation in agricultural smallholder systems of East Africa. Implications of these findings include identifying actions that are likely to contribute more to food security and that can better enhance food security for female-headed as well as male-headed households. These usually include interventions that enable households' access to information about new technologies and practices especially though innovative communication effort, and new market opportunities.

O-3320-04

IPCC AR5's contribution to the understanding of the future of fisheries and aquaculture and the knowledge gaps that have yet to be covered

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The IPCC AR5 provides highly relevant knowledge on the future implications of climate change on global fisheries and aquaculture resources. This presentation sets out to highlight how the IPCC AR5 contributes to the discussion on climate change and its direct and indirect effects on fisheries and aquaculture, our understanding of vulnerabilities within the sector and dependent communities and economies, and adaptation and mitigation options from within the sector. Furthermore, it will identify knowledge gaps of the IPCC AR5 that remain to be covered as well as provide additional knowledge not yet captured by the AR5. The presentation will provide examples of vulnerability questions and methodologies being applied from within the sector, covering inland, marine fisheries and aquaculture systems. Concrete examples of how fishers, aquaculture farmers, post-harvest systems and dependent communities are perceiving and reacting to climate variability and change will be shared. Filling knowledge gaps and up-scaling our efforts are important in order to better comprehend how food, nutrition and livelihood security as well as economic growth objectives from fisheries and aquaculture are required to change in order to be climate smart.

The abstract is submitted on behalf of the Global Partnership for Climate, Fisheries and Aquaculture (PaCFA).

3320-POSTER PRESENTATIONS

P-3320-01

Climate change impacts on the leaf miner, a major pest of the oil palm in Nigeria

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This study examines application of climate variability to abundance and impacts on the leaf miner, Coelaenomenodera elaeidis, a major pest of the oil palm and its parasitoids in Africa. It analyses temperature, rainfall and relative humidity conditions from 1961 - 1970 as a reference point for baseline climatic conditions and description of same conditions between 2001 - 2010; Evaluates projections up to 2050; and describes impacts on leaf miner abundance. Leaf miner was sampled in the main station of the Nigerian Institute for Oil palm Research, between January 2009 and December 2010. Means, standard deviation, variances, covariance's, seasonal and climatic patterns for temperature, rainfall and relative humidity were computed. Least square method was used to estimate the trend in the series and the trend equation. Time series analysis was used to analyse the data and generate trend equations. The models for temperature, rainfall and relative humidity were generated. A forecast up to 2050 was generated indicating an upward trend in temperature and a downward trend in rainfall and relative humidity, with concomitant increase in leaf miner abundance between 1980 and 2010.

P-3320-02

Mapping irrigation potential from renewable groundwater in Africa: a quantitative approach

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Groundwater provides an important buffer to climate variability in Africa. Yet groundwater irrigation contributes only approximately 1% of the cultivated land as compared to 14 % in Asia. As opposed to previous country-based estimates, this paper derives a continent-wide, distributed (0.5 degree resolution) map of groundwater irrigation potential, indicated in terms of fractions of cropland potentially irrigable with renewable groundwater. The method builds on an annual groundwater balance approach using 41 years of model data, allocating to groundwater irrigation the groundwater recharge in excess after satisfying other current human needs and environmental requirements, while disregarding any socio-economic and physical constraints in access to the resource. Due to high uncertainty of groundwater environmental needs, three scenarios, leaving 30, 50 and 70% of recharge for the environment, were implemented in a conservative estimate of the potential. In addition, current dominating crops and cropping rotations and associated irrigation requirements in a zonal approach were applied. Results show an inhomogeneously distributed gross groundwater irrigation potential across the continent, even within individual countries, reflecting recharge patterns and extent of cropland. Results further show that average annual groundwater available for irrigation ranges from 708 to 1669 km3 depending on scenario. The total area of cropland irrigable with groundwater ranges from 44.6 to 105.3 million hectares, corresponding to 20.5% to 48.5% of the cropland over the continent. Accounting for existing groundwater irrigation, residual irrigation potential remains high and relevant for poverty alleviation in the Sahel and Eastern Africa region where climate variability could have important impact on population. This could significantly increase the food production and productivity in the region from a reliable and renewable resource.

P-3320-03

Dynamics in climate change, agriculture and food security in the sub-saharan Africa: a review

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There have been decreases in food supply caused by extreme weather events. Regardless of where extreme weather occurs, the effects on food availability and price are disproportionately felt by the world's poor. Moreover, crop failures due to extreme weather not only affect those buying and selling in the global marketplace, but also have a direct impact on subsistence farmers. Understanding how such extreme weather events – which are predicted to become more frequent under climate change – affect both yields and total production of the world's staple food crops is thus an issue of both scientific and societal importance. Climate change is occurring more rapidly than anticipated and the increase in extreme weather events threatens more disruptive effects to agriculture. The vulnerability of food production systems has been demostrated over and over again. Food security is the state achieved when food systems operate such that «all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life». Food security is underpinned by food systems and is diminished when food systems are stressed. This stress can be caused by a range of factors in addition to global environmental change (e.g. population pressure, changes in international trade agreements and policies, migration) and may be particularly severe when these factors act in combination. Agriculture contributes on average34 percent to the GDP of Sub- Saharan Africa (SSA) countries and employs 64 percent of the labour force. It accounts for about 40percent of exports and provides various ecosystem services. Agriculture and rural development are thus the key pillars of the SSA economy. Sub – Saharan Africa is characterized by a growing population (2 – 3%) and an increasing number of households depending on farming activities. Soil degradation due to population pressure, intrinsic soil fragility and harsh climatic conditions have decreased the amount of cultivable land per capita and led to food insecurity since farmers have very limited means to purchase agricultural inputs (mineral and/or organic manure, working tools, and technical capacities, etc.) to increase soil productivity. Review of average crop yield for cereals, roots and tubers in 41 African countries showed 13 countries registering decline in cereals yield and 15 registering decline in yields for roots and tubers. Decline in rainfall has significantly altered the traditional farm calendar and soil degradation overstretched local farmers' soil management capability. Population resilence to these changes are related to several coping and adaptive strategies including crop diversification, mobility, livelihood diversification and migration. Adaptation which is a process of adjusting to a changing climate through explicit and planned interventions, or spontanous consequence of inherent flexibility, can mitigate its impacts. While adaptation to climate change is seen by most observers as the most preeminent issue for African countries. There is a strong parallel development of initiatives that aim at stabilizing GHG concentration in the atmosphere(mitigation); in reality, mitigation and adaptation should not be pursued independently as they are complementary. Most mitigation options will reduce impacts of climate change and several adaptation strategies will lead to reduction of GHG disposal in the atmosphere. With the slow progress in achieving mitigation, it is suggested that a viable option of adaptation is developed to prevent the anticipated negative imapcts of global change. Conservation agriculture, which involves minimal soil disturbance can improve water use efficiency by crops and helps in carbon sequestration processes and also improve on the capacity of crops to withstand weather stresses.Also, raising productivity through improved irrigation will likely be the key to ensuring food security as weather pattern shift.

P-3320-04

Sustainable Agriculture and Climate Change: Producing Potatoes (Solanum tuberosum L.) and Bush Beans (Phaseolus vulgaris L.) for Improved Food Security and Resilience in a Canadian Subarctic First Nation Community

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Aboriginal people in Canada's northern regions are vulnerable to climate variability in addition to experiencing disproportionately high rates of diet-related illnesses including obesity, diabetes, and heart disease. Food insecurity is a contributing factor along with a loss of traditional lifestyles. Current food systems within these regions rely heavily on imported foods that are expensive (when available), and unsustainable. A warming subarctic and arctic climate offers the opportunity for local agricultural production that can increase food security and promote a more sustainable food system. In this study the feasibility of sustainably growing potatoes (Solanum tuberosum L.) to enhance food security in remote subarctic communities is explored through a case study in Fort Albany First Nation in northern Ontario, Canada. Potato crops were grown over a two-year period and rotated into plots that had been planted with green bush beans (Phaseolus vulgaris L.) Results showed that potatoes and bush beans could be grown successfully in the subarctic with yields comparable to more traditional agricultural methods. In subarctic Canada, sustainable local food production helps to promote social capital, healthier lifestyles, and food security.

P-3320-05

Weather, Climate and Food Security

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Safety and Security, though almost synonymous opposites of "risk", can have different meanings. Thus, for example, food safety is only one of the nine attributes of food security.

To meteorologists, food security is dominated by the impacts of weather and climate on food systems. But the link between the atmosphere and food security is more complex. Extreme weather events such as tropical cyclones impact directly on agriculture, but they also impact on the logistical distribution of food and can thus disrupt the food supply chain, especially in urban areas. A holistic approach is required to understand the phenomena, to forecast catastrophic and to predict their societal consequences.

In the Food Security recommendations of the Rio+20 Forum on Science, Technology and Innovation for Sustainable Development it states that it is important "To understand fully how to measure, assess and reduce the impacts of production on the natural environment including climate change, recognizing that different measures of impact (e.g. water, land, biodiversity, carbon and other greenhouse gases, etc) may trade-off against each other..."

The International Union of Geodesy and Geophysics (IUGG), through its Union Commission on Climatic and Environmental Change (CCEC) is leading the WeatCliFS consortium of international scientific unions to examine weather, climate and food security as well as to look at the interaction of food security and geophysical phenomena. The following fundamental question underpins WeatCliFS: What technologies and methodologies are required to assess the vulnerability of people and places to hazards [such as famine] – and how might these be used at a variety of spatial and temporal scales? This poster will review the work undertaken to date.

P-3320-06

International Joint Laboratory Patho-Bios, an efficient observatory of Plant Pathogens in West Africa in the context of climate change

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The International Joint Laboratory (LMI) entitled observatory of Plant Pathogens in West Africa: Biodiversity and Biosafety (LMI-Patho-Bios) has been formally launched in Burkina Faso on the 30th January 2014. LMI-Patho-Bios was initiated by the national research institute of Burkina faso, "Institut de l'Environnement et de Recherches Agricoles (INERA)" and the French Research Institute for Development (IRD) which have signed a memorandum of understanding to drive a five years research project on bio surveillance of plant pathogens. LMI-Patho-Bios is established at INERA on two sites. It is mainly located at Kamboinse research station of INERA (Ouagadougou) with a secondary location at Farako-Ba research station (Bobo-Dioulasso). LMI-Patho-Bios is interested on all important crops in West Africa including cereal crops (rice, maize, sorghum, millet), root and tuber crops (yam, cassava, sweet potato and potato), legume crops, vegetable crops and fruits. Its main goal is to develop a powerful open field observatory platform for bio surveillance in order to study plant pathogens interactions, diversity and evolution of pathogen populations in the context of global warming change which is expected to lead to major changes in plant diseases epidemic risks. Rice is used as model crop in such a platform which will significantly contribute for better understanding of the emergence of new plant diseases in a context of continuing climate change. Surveys will be made on common experimental plots located in different agroecological area in Burkina Faso and in West Africa to follow the dynamics and aggressiveness of pathogen populations. The major activities consist on diagnosis and characterization of plant bio-aggressors as well as epidemiology study of rice pathogens: viruses (RYMV, RSNV), bacteria (Xanthomonas oryzae, Burkholderia sp), fungi (Magnaporta grisea), and nematodes (Meloidogyne spp.). LMI-Patho-Bios has also developed a strong regional network with several national research systems (NARS) and Universities in Sub-Saharan Africa (SSA) and contribute in the capacity building of researchers, research technicians, students and agricultural extension officers. Finally, the joint laboratory will train and promote knowledge dissemination to farmers and extension officers on good agricultural practices in terms of recognition and proper management of bio-aggressors. Furthermore, LMI-Patho-Bios will contribute to develop strategic technological tools to help African farmers to better adapt to, and to mitigate the effects of climate change.

P-3320-07

Post harvest challenges & economic consequences and opportunities. Case study of Rwanda

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The total agricultural product loss of 23.5% in Rwanda is due to poor post-harvest processing of agricultural products, when valued in monetary terms reflects a tremendous loss in the economy. Deficits in food items or financial loss should not have occurred if post-harvest losses were reduced through proper processing and preservation from harvest to consumption. Such a situation does not only reduce the national income but also it generates a problem of malnutrition in population, 43% in children in Rwanda is subjected to malnutrition. The loss ranges from 5 to 40% of production in Sub Saharan Africa. This exceeds the total food aid received by countries in Sub Saharan Africa.

Both government and private institutions needs to invest in much effort in research and extension toward improving and modernizing post-harvest facilities for attaining more efficient market infrastructure and distribution channels. The aim of this research is evaluation of post harvest losses of different cereals crops, evaluation of the economic impact caused by post harvest losses by quantifying the price discounts which small farmers face when selling damaged cereal and establishment of a postharvest model that can tackle the postharvest losses.

Different methods will be applied and include quantitative methods and qualitative methods. Interview, use of algorithm that operates on two data sets of a set of postharvest loss profiles and a set of seasonal data to assess the post harvest losses level. The double-hurdle model and standard regression models will be used to identify the level of impact of post harvest losses damages to evaluate the economic loss caused by this damage.

P-3320-08

For a sustainable agriculture according to land suitability, dietary needs and climate scenarios

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A large portion of agricultural production is funneled into animal feed or biofuels despite widespread hunger and undernutrition. Predictions foresee global demand for biofuels increasing from 81 billion of litres in 2008 to 172 billion litres in 2020, coinciding with an additional 40 million hectares of land converted for biofuel crops. According to the Milan protocol (http://www.milanprotocol.com/), a third of the global food production is used to feed livestock. Of the some 7 billion people on earth, 1 billion are without access to drinking water, which causes the death of 4,000 children each day. In contrast, 15,000 litres of water are needed for the production of a single kilogram of beef. In this work we tried to evaluate the advantages and feasibility of options to optimize the production, promotion and distribution of food with a high protein content (so as to remain equal nutritional quality of the meat) to reduce the footprint of water consumption and GHGs' emissions from the agricultural sector and to recover the availability of agricultural land as well. As example it is recognize that if the same amount of plant protein produced from protein-rich legumes is used directly for human consumption rather than for feed (currently 95%) up to 75 times the land currently required to grow feed crops could be recovered, up to 40·103 cubic meters of water could be saved per each recovered hectare and, also, emissions should be contained thanks to the nitrogen-fixing behavior of promising protein-rich crops.

By means of crop modeling coupled with emission-climate and diet scenarios, and adopting an ensemble approach that favors robust evaluations comprehensive of uncertainty flagging, we show how to it is possible to formulate different agri-food solutions for a sustainable agriculture compatibly to land suitability, water availability, dietary needs and climate projections. In particular, agri-food options we investigate include i) identification of protein-rich legumes and their suitable area of culture according both with the current and projected climate, ii) their contribution to limit environmental footprints (GHG, water, land) and iii) the optimal compromise of crop production used for human consumption vs feed such as to ensure a balanced diet between meat and lacto-ovo-vegetarian consumptions compatible to climate change, water consumption and land recovery issues.

P-3320-09

Predetermination of floods in the Senegal River Valley: application between Bakel and Matam

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The risk of flooding in the valley of the Senegal River remain important. These floods more and more recurrent can be explained by a combination of several factors. Extreme weathers due to climate change have significantly increased the intensity of the rain causing flooding in many regions and countries around the world. Important contributions uncontrolled tributaries of BAKOYE and FALEME, releases made at Manantali representing approximately 40% of volumes sold, but also the low volume of water released downstream of the Diama dam contribute to inundation. The consequences of these floods are sometimes heavy in terms of loss of life, of health, of education, of economy

and of infrastructure. The determination of flood risk areas is important to anticipate and protect populations. For this we used coupled models HECRAS and ARC-GIS to determine the areas likely to be flooded between Bakel and Matam. These flood risk were studied with decennial, centennial and millennial flows. The results are promising and suggest that HEC-RAS with ArcGIS can be used to set up an early warning system on the Bakel, Matam reach.

P-3320-10

Modelling the current and future dry-season distribution of Encosternum delegorguei (Hem., Tessaratomidae) in sub-Saharan Africa

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Rural communities in South Africa, Malawi and Zimbabwe annually harvest from winter aggregations of the edible stinkbug Encosternum (=Haplosterna) delegorguei Spinola. Using a regional maximum entropy modelling method (MAXENT) for winter field records of E. delegorguei, current and future climate scenarios were identified. Winter precipitation and to a lesser degree summer precipitation and winter temperature were the climatic variables found to limit the regional distribution of E. delegorguei. The receiver operating characteristic analysis (ROC) yielded an AUC (area under the curve) value of 0.995, indicating a reliable model although interpretations must consider the influence of elevation for this insect. A testable hypothesis regarding future distribution of E. delegorguei in the face of climate change has been formulated for its winter range. Predator-prey relationships and food source are also influencing the occurrence of E. delegorguei and may override the influence of climate. The modelled current distribution identifies potential new sites in areas of similar climate which may be unknown to harvesters. Areas for mini-livestock pilot studies provide opportunities for extending commercial potential and ensuring a sustainable nutritional food during a period of food scarcity.

P-3320-11

Economic implications of climate change in Sub-Saharan agricultural system: short term impacts and opportunities for irrigation

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This research examines the climate related impacts and adaptation options in Sub-Saharan Africa agriculture in a recursive dynamic Computable General Equilibrium (CGE) framework with world coverage. Differently from most of the global CGE models treating the land supply in a very simplistic way, here we introduce land heterogeneity differentiating between rainfed and irrigated cropland. The irrigation production function is built upon the estimates on unitary investments from FAO and considering the current level of irrigation in Sub-Saharan Africa. Under this new specification, each agricultural sector can substitute rainfed land with an irrigated bundle composed of irrigated land and capital and allows considering differentiated climate change impacts.

The first step of the analysis is the assessment of the climate change impacts. The reference scenario is the SSP5, to ensure consistency with the climate scenario described below. It is worth mentioning that the time frame of the analysis is 2030, even though climate change impacts are expected to increase more than proportionally later than 2030. However, aadaptation strategies imply decisions in the very short term and can lead to delay in taking actions against future climate change. For the impact assessment, two climate scenarios in line with RCP8.5 are analyzed. The first assumes constant CO2 (1960 level, 316.27 ppm), while in the second scenario CO2 increase over time mirroring RCP8.5 concentration. Biophysical changes in land productivity by crop and land type are taken by the LPJ-ML model run according to the CanESM General Circulation Model and are exogenously introduced in the CGE model.

Without "CO2 fertilization effect", due to the short term considered, a few countries/regions, namely Nigeria, Senegal, Madagascar, Botswana and Rest of West Africa are better off in terms of agricultural production; on the other hand, Malawi, Mozambique and the Rest of South Central Africa are the most damaged countries in terms of yields reduction. Where agricultural production drops, the dependence from imports increases, clearly highlighting the effects of economic vulnerability to climate change. The overall effect on Sub-Saharan African economies is summarised by the GDP growth change compared to the reference scenario and ranges between -1.6% (Mozambique) and +1.6% (Nigeria). The "CO2 fertilisation effect" scenario has uniformly a positive effect on yields. Mozambique is the only country with production losses in all agricultural sectors compared to the reference scenario. The impact on GDP is generally positive; only Mozambique and Rest of South Central Africa experience a GDP loss of 0.6 and 0.1%, respectively.

Overall, when the «CO2 fertilization» effect is not accounted for, Eastern and South Central Africa experiments negative changes in yields also in such a short time horizon. Extending irrigation practices represents a key strategy to cope with climate change and at the same time to favour development. We compute ex-ante the additional irrigation required such to compensate the production losses due to climate change and recover the output of the "no climate change" scenario. This information is combined with country specific unitary costs of irrigation projects from FAO to estimate the required amount of investments. Such an additional flow of capital for irrigation in the agricultural sectors is subtracted to the rest of the economic system. This approach allows highlighting the inherent trade-off within adaptation plans: allocating more investments to agriculture deteriorates the capital stock available for developing the rest of the economic system.

The outcome of increased irrigation in the country targets is heterogeneous. In most cases, irrigation provides higher benefits than costs. This is explained by the higher marginal productivity of capital for irrigation than in other productive sectors, reflected by the large increase in crop yields when cropland is equipped with irrigation systems. Nevertheless, in Mozambique and Rest of South Central Africa, the most vulnerable countries to climate change, extending irrigation is not sufficient to bring back production to the reference scenario levels. This lack of responsiveness can be explained by the low degree of internationalization of the agricultural sectors that limits the expansion of exports in spite of higher productivity.

P-3320-12

The contribution of fruits and vegetables production to poverty alleviation, nutrition and environment in Africa

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Over the last 20 years, the demand for fresh fruits and vegetables, both in their crude and processed form, has significantly increased. According to Mal et al. (n.d.), it is only in recent years that there is an increasing awareness of the potential of native tropical fruit species as sources of dietary vitamins, minerals and energy. Rising incomes and growing consumer interest in product variety, freshness, convenience and year round availability are among the main reasons for this increasing demand (Diop & Jaffee, date). Ruel et al. (2005) recognises that the consumption of fruits and vegetables increase when gross domestic product per capita goes up, but cautions that this is not a fully linear relation as the overall percentage of the food budget allocated to fruits and vegetables is low (4-16%). Fruit and vegetables are rich sources of micronutrients, needed by children for optimal growth and development (WHO/FAO, 2004). Energy, protein, vitamins (A, C, D, and B-complex), and minerals (iron, zinc, iodine) are required for the growth of muscle tissue and bones, brain development, and bodily functions such as the immune

system or co-factors for enzymes. WHO (2009) estimates that 250 million preschool children are vitamin A deficient and as a consequence between 250 000 to 500 000 become blind every year. Most national and international dietary guidelines are in agreement that consumption of fresh fruit and vegetables is a healthy food choice and generally needs to be increased. The World Health Organisation recommends a minimum daily intake of 400 g of fruit and vegetables especially for children, and many countries have programmes to promote consumption (FAO/WHO, 2004).Several initiatives have recognised the importance of the consumption of fruits and vegetables to deal with micronutrient deficiencies. One of these is the Global Fruit and Vegetable for Health Initiative (PROFAV/PROFEL), launched by FAO and WHO in 2003. This was followed by the elaboration framework for action in 2004 which objective was to guide the development of cost-effective interventions to promote adequate consumption of fruits and vegetables for health at national or sub-national level (FAO/WHO, 2004). In addition, regional workshops have been held between 2004 and 2014 promoting the consumption of fruits and vegetables, within healthy diets and lifestyles, in the different continents. In 2007, the World Vegetable Centre (AVRDC) submitted a pre-proposal on High-Value Crops - Fruits and Vegetables to the Consultative Group on International Agricultural Research (CGIAR). The objective of this proposal was broader since it aimed at helping the poor to take advantage of the economic and nutritional value of high-value fruit and vegetables for income generation, job creation, food security and health, taking into account environmental sustainability. However, this proposal did not go ahead.

This papers reviews the literature and analyse FAOSTAT database to investigate how the production of fruits and vegetables contribute to:

1. Poverty alleviation;
2. Improved nutrition and health;
3. Improved natural environment and ecosystem services

The focus of the paper is Africa. Food consumption patterns have been progressively analysed in developing countries over the past 30 years. However, food production and consumption patterns remain poorly understood in Africa, particularly for fruits and vegetables.

P-3320-13

Using phosphorites mine wastes to improve soil fertility and crop production in Togo and in the West African region for food security in a context of climate change

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Phosphorites are been mined in the areas of Hahotoe-Kpogamé (Southern Togo) in the Tertiary coastal basin since 1960. The exploited raw phosphorite is naturally enriched with trace metals (Cd, Pb, Cr, Cu, Ni, V, Zn, Ba, Sr, F, U) and rare earths. Phosphorites are transported to the factory of Kpémé close to the beach where they are washed by seawater using sieving and hydrocyclone separation techniques. It results from this process coarser waste and muddy fine grained clayey phosphorites tailings. The solid waste is disposed on soil, on the beach and the muddy waste fraction is dumped directly into the sea without any treatment..About 2.9 million of tons of mining waste are dumped annually into the coastal waters of Togo and causes transboundary marine pollution between Togo, Benin and Nigeria, coastal habitat degradation and the reduction of fish stock.

The phosphorite factory of Kpeme Togo has 5 chains for the treatment of raw phosphorite to commercial pure phosphorite. Each chain produces 1600 tons of muddy phosphorite waste per day. Chemical analysis showed that phosphorites waste contain up to 18 % P2O5, clay minerals and numerous nutritive elements such as Co, Cu, Ni, Cr, Fe, Zn, Mo, Se. and can be used for soil fertilization and crops productivity according laboratory and field experiment. Coagulation and flocculation methods in big decantation basins, or decantation in hydrocyclones are necessary to recover high amounts of solid waste that can be treated and use directly for soil fertilization in Togo and other countries in the West African region for food security in a context of climate change.

P-3320-14

Marriage of traditional knowledge and modern science to build the resilience of food security systems in Pacific Island Countries

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Pacific Island Countries prioritized increase agricultural production as a way for sustainable development. Agricultural products can also contribute to energy security as demonstrated by many developed and developing countries in the world. However, the question remains as to how we can increase agricultural productivity against increasing pressures and uncertainties and with limited information on soil, climate and crops or how we can optimize crop productivity and get the best outcomes from our crop management practices and limited arable land areas. . Research conducted on both high islands and atolls reveal different level of vulnerabilities including types of crops they cultivate and methods and technologies used. Understanding the vulnerability of the food security systems at the community level is very important in order to strategically build their resilience. Farmers in studied countries in the Pacific apply both traditional practices and modern innovations to improve their resilience. Employing the holistic approach including climate and weather information (current and future), soil information (physical and chemical), crop or variety suitability and optimized integrated crop management (traditional and modern practices) to improve crop productivity is the way forward for a resilience food security system.

P-3320-15

Agriculture is neither the culprit, nor the solution, to climate change

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It may be obvious, but agriculture's primary function is to produce food. It is in the nature of agricultural systems that they do leak greenhouse gases as part of the food production function, and they undoubtedly contribute to climate change. However, any greenhouse gas component that is emitted was prior fixated from the atmosphere and will be recycled to and from atmosphere eventually. This is fundamentally different from the process of burning fossil carbon compounds that adds ever more carbon dioxide to the atmosphere for an everlasting effect of climate warming. Carbon sequestration is seen as solution to this problem, and one option that has been widely promoted is the increase and (long-term) storage of soil carbon in agricultural soils. Thus (based on the past versus now principle of life cycle analysis approaches), producers can now promote their production as environmentally friendly when they increase the carbon stock in their soils. The problem is that soil carbon cannot increase endlessly, and so this approach benefits producers who switch away from systems with bad environmental performance rather than producers that were environmentally friendly all along. On top of that, soil carbon gains only make up a minor fraction of the carbon fixated by agricultural systems initially. Therefore, we propose the following concepts to re-assess the role agriculture plays in climate change:

- Producers benefits should be based on the amount of soil carbon stored (and thus also benefit from increasing them), but the emphasis would be on maintaining the soil carbon stock
- Greenhouse gas emissions from agriculture should be charged against the carbon the system fixated in total (net primary productivity - nitrous oxide - enteric methane - soil respiration), as tremendous amounts of fixated carbon are exported from farms each year to feed the human population

The onus should not be on the farmer to responsibly store the carbon resource they produce, similar to the oil industry that is not responsible to educate the consumer towards responsible consumption and utilization of its

products. However, if it is our goal to remove carbon from the atmosphere, utilizing the tremendous amounts of biomass produced each year on agricultural soils might be a more suitable solution for long-term storage than highly technical and energy consuming alternatives. For this purpose, storage of nutrient depleted crop straw or already collected and concentrated manure and waste products could prove to be cheaper and more successful.

P-3320-16

Fitting neglected and underutilised crops into climate change adaptation strategies

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Agriculture is the predominant activity sustaining livelihoods in sub-Saharan Africa with about 70% of the region's population relying on agriculture for their sustenance. In this region, about 95% of agriculture is primarily rainfed and relies mainly on a few starchy cereal and root and tuber crops for dietary provision. Climate change and variability are expected to result in increased variability of rainfall as well as severity and intensity of extreme weather events such as drought and floods. This places pressure on food and nutritional security within a region that is already behind with achieving Millennium Development Goal - 1. Consequently, there has now been movement across the region to develop climate change adaptation strategies at various levels. These strategies, which include climate smart agriculture, are mainly focussing on the major crops. There is a need to include alternative crops - the neglected and underutilised crop species (NUCS). These are crops that have historically formed the rich tapestry of the agro-biodiversity that exists within the region. By definition, NUCS are crops that have not been previously classified as major crops, have previously been under-researched, currently occupy low levels of utilisation and are mainly confined to smallholder farming areas. Historically, NUCS have played an important role in ensuring community and household food and nutrition security through providing healthy alternatives when the main crop failed or during periods in-between subsequent harvests. The promotion of a few major crops during the Green Revolution subsequently led to their relegation to their current although they still offer much potential. Across much of SSA, water availability remains the major limiting factor to crop production, threatening food security of vulnerable groups. It is also expected that water would be the primary medium through which impacts of climate change and variability would be experienced. Most NUCS are believed to be resilient and adapted to a range of ecological niches, low input agriculture and may have tolerance to abiotic stresses such as drought. This makes them important future crops for SSA's smallholder farmers on marginalised lands especially under predicted climate change. Their inclusion in climate change adaptation strategies would offer sustainable solutions built upon existing agro-biodiversity of communities within the region.

P-3320-17

L'eau virtuelle des produits agricoles d'importation : Un moyen de contrecarrer le problème du manque d'eau en Algérie

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L'Algérie est classée parmi les 17 pays qui souffrent le plus du manque d'eau à travers le monde.

En effet, avec moins de 300 m3/habitant/an d'eau renouvelable, l'Algérie dispose de moins de 30% du seuil théorique de rareté fixé par la Banque Mondiale à 1000 m3 /hab./an.

Etant dans l'impossibilité d'étendre sa SAU et/ou d'augmenter les surfaces irriguées, pour combler le déficit alimentaire, l'Algérie a recours à des importations massives de produits alimentaires, particulièrement les céréales et leurs dérivés.

Ajouté à cela les produits agricoles non-alimentaires.

Ces importations, bien qu'elles représentent une hémorragie financière très importante pour le pays, elles ont au moins un aspect positif représenté par les quantités impressionnantes d'eau virtuelles qu'elles procurent à l'Algérie estimées à plus de 40 milliards de m3 pour l'année 2012.

C'est dans ce cadre que s'inscrit notre étude dans laquelle nous essayons de quantifier ces quantités d'eau virtuelles qui contribuent grandement à soulager temporairement le pays de son problème de manque d'eau.

P-3320-18

Small farmers and their perceptions of climate, environmental and social changes: the stories behind vegetable production that could affect food and nutritional security in Brazil

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Brazil's National Council for Food and Nutrition Security (CONSEA) defines and advocates food security as "the realization of everyone's right to regular and permanent access to quality food in sufficient quantity without compromising access to other essential needs, based on health promoting food practices that respect cultural diversity and that are socially, economically and environmental sustainable." The Brazilian Federal Constitution has institutionalized the right to adequate food as a Citizens Social Right. Even so, access to adequate food is far from a reality in Brazil. Results of a Health Ministry's study (2009) shows that only 18.9 % of the population consumes five servings daily (400 grams of vegetables/day) as recommended by the World Health Organization. In a context of rapid urbanization, an ever greater majority of the Brazilian population is concentrated in urban areas, where food demand thus rises. The increasing distance between the cultivation sites and where they are consumed results in increased food losses due to the high perishability of vegetables. This, together with the greater need for packaging, refrigeration and transportation raises prices, reducing the poorer populations' access to these foods which are crucial for a healthy human diet. Studies suggest that the intake of more than five portions of fruit and vegetables a day significantly reduces risk of death. Oyebode et al. (2014) found that vegetables had the strongest health protective effect compared to other foods, with each daily portion reducing overall risk of death by 16%. In this sense, the Brazil Health Ministry recently (2014) launched a new nutritional guide which emphasizes the consumption of natural or minimally processed foods in great variety, noting that especially foods of plant origin are "the basis for diets that are nutritious, delicious, appropriate, and supportive of socially and environmentally sustainable food systems.» Diets link environmental and human health (Tilman and Clark, 2014), and the incentive for vegetables consumption should rely on a well-organized food system that can provide the population with healthy products, produced in a sustainable manner and resilient against the effects of climate change and other environmental stresses. However, olericulture production in Brazil is marked by a profound lack of reliable data about the number of farmers, their cultivation methods, use of natural resources, etc. There is an even greater lack of knowledge about the human dimension of the food system, including factors and experiences which will influence whether small farming will be sustained and able to contribute in meeting the future demand and the governmental prescriptions for a healthy diet.

Based on field research in the micro-region of São José dos Campos in the state of São Paulo, Brazil, this work investigates who the vegetable producers are and how they are experiencing and adapting to the changes in market-related, environmental and socio-economic conditions affecting their work and lives. The micro region studied is composed of eight municipalities, with 1,406,315 inhabitants, and is part of the Expanded Metropolitan Complex of São Paulo, one of the most populous urban agglomerations in the world with more

than 20 million inhabitants. The field research, conducted between 2013 and 2015, included an initial investigative phase to locate the farmers within the micro region, followed by more in-depth field visits to the agricultural sites and semi-structured interviews with the farmers. The method adopted was the narrative analysis focusing on the stories told by the farmers. Some data extracted from the interviews was also georreferenced using GIS tools in Arc GIS 10.1 to assist in the visualization of the producers' characteristics along the study area. The results showed beyond the economic, health and environmental aspects involved in the management of their crops. It shows their beliefs and values related to their activity; the role of the institutions in their productive condition; their perceptions about the recent extreme events affecting the Brazil's Southeast Region and how their production is being affected; the pressures related to urbanization and population concentration, such as elevation of land prices and insecurity due theft and violence; and difficulties to perpetuate their activity and keep the interest of their heirs in the face of changes in consumption patterns, market channels and the globalization process in the food system.

P-3320-19

Traditional faming practices and water management for Climate change adaptation in Sri Lanka

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Sri Lanka is one of the few countries in the world that has had a thriving and vibrant irrigation based civilization for over two thousand years. The cascade system, they used for traditional organic cultivation of paddy, harmonized environment and development in an environmentally sound and sustainable manner. Sri Lankan history is deeply connected with its hydraulic civilization and its erroneously named as a community based cascade ecosystem irrigation. In Sri Lanka water is collected using man-made interconnected cascade tanks ecosystems in dry areas mainly for paddy cultivation. These tanks comprise of various components of ecological importance. Tank cascade ecosystems were constructed mainly in two ways, either by impounding a river or by diverting the river through canals. In early days villages were built around tanks to allow easy access to water for agricultural purposes. Tanks were also important for cultural, spiritual and religious reasons, as water is a symbol of life and purity. While the challenges are daunting, they also provide opportunities for local communities, business and government to innovate for the benefit of communities, economies and the global environment. The cascade ecosystems, throughout the Sri Lanka in particular, are under unprecedented pressure, threatening prospects for sustainable development. Tanks were constructed mainly in two ways, either by impounding a river or by diverting the river through canals. In early days villages were built around tanks to allow easy access to water for organic agricultural purposes. Tanks were also important for cultural, spiritual and religious reasons, as water is a symbol of life and purity. Cascade ecosystems were originated within the community and practiced over many generations. Presently managed by community Farmer Organizations and government. The all the cascade ecosystem based irrigation systems were operated and managed by the community and responsibility rested with the chief of the village community based organization. Ecosystem that helped the community in passing through the difficult times during the droughts; a system that nurtured the development of drought insurance through animal husbandry and fragmented land ownership; and that provided opportunities for inland fishing and human and animal nutrition. The ecosystem operate with collection of rainwater harvesting technology; a soil moisture and groundwater maintaining technology; a soil erosion and siltation control technology; a technology that ensured the maintenance of ecological balance; a technology that promoted social cohesion and need for community leadership; a system that accommodated spiritual development which promoted egalitarian attitudes. On the basis of their form and appearance, the cascading systems would have operated as an ideal community based adaptation to climate change.

P-3320-20

Agriculture Adaptation to Climate Change in Brunei Darussalam: A Step towards Food Security

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The world's population is increasing rapidly and expected to reach 8 billion by the year 2020. The standard of living is also increasing with the advancement of new technologies and thus increasing the life span of individuals. The demand for food production will increase too and particularly the developing countries will face a new set of challenges. The impact of increased demand for food production will significantly felt in the agricultural sector. Rural economies, which are based upon and dominated by agricultural, pastoral and forest production, are highly sensitive to climate variations and change. So too are the livelihoods and food security of those who participate directly in these activities, supply inputs to them, or use their outputs to produce other goods and services. The climate change is a major threat to the existing agricultural practice in many developing countries. The continuous increase in temperature with intensive precipitation over a short period will have adverse affect on the agricultural output of Brunei Darussalam. There were 115 reported cases of flooding and 105 landslides during the last rainy season, the worst and most severe rainfall ever happened in Brunei. Over the past few decades, Brunei is experiencing a rapid change in climatic condition particularly on the increased temperature (0.0375oC) and rainfall (37.62 mm) received annually. The economy of Brunei is mostly relying on oil and gas sector which consist of up to 90% of the country exports. In 2007, Brunei's oil production saw a reduction of 11.5% to approximately 193,000 barrels per day compare to the output in 1979, which surpassed 240,000 barrels per day. Wawasan Brunei 2035 (Brunei's National Vision) has been established by Brunei Economic Development Board (BEDB), as to give awareness to the population not to rely fully on oil and gas productions. The vision formulates a plan to increase employments, enhancing the current education and upskill the labour force by introducing more institutions to the related work, and initiate a more sustainable economy. Due to ample amount of land availability, Brunei can make use of the land resources as potential assets. An improved and regulated country's agriculture can give a better and sustainable future, not just to the population but also increase the government revenues. Intensification of agriculture and the associated increase in productivity has already saved about one billion hectares of wildlife habitat across the world (Pratley, 2008). Therefore, the study aims to synthesize the relationship between climate change and agriculture production in Brunei Darussalam. The study focus on the adaptation or coping strategies with emphasis on training to agricultural extension workers and farmers to ensure increased productivity, a step towards food security. Technical change is one of the key elements that influence the pace of agricultural growth in the developing countries. Agriculture in Brunei Darussalm must undergo a transformation to become 'climate-smart' in order to prevent climate change from further exacerbating food insecurity. To adapt to climate change, farmers need new and improved technologies, skills and knowledge, or in many cases, to be linked to existing technologies which are currently inaccessible. These may include, for example, improved water management using rainwater harvesting or soil stabilization techniques; soil conservation and erosion control through terracing and agro forestry; and greater use of renewable energy through biogas and solar PV.

P-3320-21

Genetic analysis of drought tolerance among selected bread wheat (triticum aestivum) lines

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Wheat production in most parts of the world including the Sub-Saharan Africa is currently being threatened by the

increasing incidences of periodical droughts emanating from climate change. This is causing the entire continent, including South Africa, which is the region's largest producer of the crop to increasingly depend on imported wheat. There is, therefore, a need to continuously search for useful variation for drought tolerance improvement among wheat breeding stocks within the local seed banks and among international nurseries. Currently, there is little documentation of the potential genetic contribution of these lines with reference to drought tolerance. This is limiting the development and adoption of better adapted varieties which is causing a decline in dry land wheat production and productivity. The use of biochemical selection methodologies and next generation sequencing technologies such as genotyping by sequencing (GBS), can greatly contribute to the understanding of the genetic bases of drought tolerance in wheat which have a huge and complicated genome. This study therefore, evaluates 100 genotypes for drought tolerance under controlled water application. Ninety (90) of the lines are from the CIMMYT germplasm of which 30 are from the drought, and 60 are from the heat nurseries. Ten are commercial check varieties. The specific objective of this study is to determine the genetic diversity present among the selected wheat lines for drought tolerance based on phenotypic, biochemical (proline and mannitol accumulation due to drought stress) and molecular (genotyping by sequencing (GBS) analysis. The greenhouse experiments are being carried out at the University of KwaZulu Natal and the field experiments are at Ukulinga Research Farm. Biochemical quantification is done at the University's Analytical Chemistry laboratories, while genotyping is being done at the Agriculture Research Council (ARC) of South Africa. Data collection for these three aspects of the study is underway and all the data analysis will be done by end of April. This study will recommend further evaluation of lines which will be found to be having considerable drought tolerance coupled with high yields for dry land commercial cultivation. Also, some drought tolerant lines will be selected to be parents for crossing with high yielding but susceptible commercial cultivars to transfer the drought tolerance traits (genes).

P-3320-22

How can food insecure smallholders gain the full potentials of climate smart agriculture (CSA)

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Integrated farming systems are often mentioned as strong contender of Climate-smart agriculture (CSA) for meeting food security, adaptation and mitigation objectives. Studies on CSA-adoption typically identify two strands of recommendations: One strand finds that "Farmers' are already doing climate-smart practices" and some add "... so let's learn from them". The other strand concludes that "Farmers are not yet optimizing the full potential of CSA", meaning "more training or awareness-raising is needed". Thus to optimize the full potential of integrated farming systems for CSA, we hypothesize that lessons be exchanged between the two strands. Therefore, to identify factors that can reduce the gap between these two categories, we synthesized household survey results from over 800 households in semi-tropical Viet Nam. We characterize households in 25 villages across northern and central Viet Nam who have adopted and those who have not adopted integrated farming systems, including agroforestry, home gardens, and rice-fish cultures. The data was using direct measurements or proxies for food security status, adaptive measures, and biophysical inventory including biodiversity and carbon stock covering.

We highlight several gaps between farmers' practice and scientific knowledge in each of the three pillars of CSA, relating to differences between adopters and non-adopters of integrated farming systems. Households with integrated farming systems are able to make synergies between a stable household economy (food security) and adaptation. In particular, households with agroforestry had shorter economic recovery period after natural disasters than those without. In contrast, food insecure households had smaller land area, fewer integrated farming systems and less diverse production.

Land use policies have a strong influence on farmers' crop choice through designated land uses, subsidies and seedling supply. Home gardens, which are excluded from land us policies, were an underestimated resource for diversity. In particular, food secure households with home gardens were more benign to experiment. Lastly, as no mitigation mechanisms in place, farmers benefited neither from the carbon sink potentials of tree plantations nor greenhouse gas emission-reducing agricultural practices.

The study concludes that realizing the full potential of CSA-synergies requires (1) a carefully selected portfolio of context-specific technologies and improved local practices, (2) that farmers and local land use planners are able to estimate costs-and-benefits of business-as-usual versus adaptation and mitigation options, and (3) an enabling policy environment streamlined towards CSA.

P-3320-23

Clam farming in the Lagoon of Venice. How to adapt to local and global changes?

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Culture based fisheries and aquaculture deeply rely on the coastal and marine environmental conditions and can be highly vulnerable to anthropogenic pressures and to climatic changes. Adaptation and mitigation measures to local and global changes need to be supported by information and assessments..

With this aim, a downscaling experiment linking a regional atmospheric model to local ecosystem and a target species population dynamic model was conducted to evaluate the effects of IPCC climate change scenarios on a temperate coastal lagoon ecosystem, the lagoon of Venice, along with goods and services provided by this ecosystem. Our results indicate that the changes in water temperature and reduction in plankton productivity caused by the modification of seasonal precipitation patterns will affect habitat suitability for clam growth and aquaculture. Our simulations show that aquaculture will suffer under projected future climate conditions and indicate that implementation of site- and condition-specific adaptive aquaculture management policies can mitigate the adverse effects of GC. This conclusion can be generalised to other temperate coastal systems and might be of particular importance in ecological- social-economic systems where clam farming is crucial for a self-sustaining economy.

P-3320-24

Climate-smart Agriculture put into Practice: The case of Rice Production in Southeast Asia

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The concept of Climate-smart Agriculture (CSA) encompasses both mitigation and adaptation practices that are fused into one comprehensive approach for devising sustainable farming systems. Rice production is an ideal model crop to illustrate the coherence of these principles as the CSA approach can draw upon a wealth of knowledge and previously developed farming practices for coping with adverse climatic conditions (to be tapped for adaptation) and for increasing resource use efficiencies (to be tapped for mitigation). Plant breeding has a proven track record to increase resilience of the rice crop against drought, submergence, salinity and heat stress. New biotechnology tools allow expeditious and precise changes in rice varieties that increase their performance under climatic stresses.

Rice is a major source of the Greenhouse Gases (GHGs) methane and - to a lesser extent - methane. Given that high rice yields are imperative to food security, the key to reducing GHGs is increasing resource-use efficiencies, namely of water and fertilizer. Methane is produced by the microbial community in flooded soils. In turn, water saving techniques such as Alternate Wetting and Drying (AWD) can be deployed to effectively reduce methane emissions while

– if implemented properly – rendering several co-benefits such as reduced input costs and stable yields in water scarce years. More judicious use of nitrogen fertilizers decreases emissions of nitrous oxides; this approach is now incorporated into interactive mobile phone apps to convey site-specific recommendation to farmers in several rice-growing countries.

Given the significance of rice production in Southeast-Asia, this production system also constitutes the key component of comprehensive initiatives for upscaling CSA technologies, such as the recently established 'Climate-Smart Villages'. In these villages, the entirety of land use is assessed in terms of interventions towards increased climate resilience and mitigation options through participatory action research. Thus, the previous and ongoing initiatives on rice production offer to derive meaningful 'lessons learnt' for future CSA dissemination of rice as well as for other land use systems.

P-3320-25

Potential Contribution of Supplemental Irrigation as a key Strategy of Local Adaptation to Climate Change in small holder farming in the Sudan Savanna zone of West Africa

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Irrigation is a key strategy to help farmers to adapt to potentially drier and shorter growing season projected for climate change effects in most parts of Africa, especially West Africa. Field experiments were conducted during the 2013 and 2014 in order to evaluate supplementary irrigation strategies for improving water productivity. Maize was planted on different sowing dates either rainfed or with supplemental irrigation using rainwater harvested. In general the date of sowing highly significantly affected on weight of grain under both rainfed and irrigated plots. Application of irrigation caused an significant increase in weight total dry matter biomass in 2013. In 2014, water productivity was 11.71 kg/ha/mm, 7.16 kg/ha/mm and 5.40 kg/ha/mm at early, medium and late dates respectively. A simulation study was done using the Decision Support systems for Agrotechnology Transfer (DSSAT 4.6)-CERES model in order to optimize irrigation level at 3 option of sowing dates. Model´s predictive capability was first verified by using some yield, phenelogy and treatments from current experiment. Simulations were then carried out for 31 years period with measured daily climatic data derived from 2 stations. The modeling showed that a window of sowing date can be implemented when it is associated with supplemental irrigation. Application of a higher amount of water or higher frequency of limited amount of water to rainfed maize could substantially increase crop yield and make it stable over years.

3321 - Health Responses

ORAL PRESENTATIONS

O-3321-01

From here to there: promises and perils in scaling up health adaptation

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Objective: document lessons learned and identify opportunities and barriers to scaling up health adaptation projects in low- and middle-income countries to address current and future climate variability and change

Data sources: evaluation reports and other materials covering the first five years of implementation (2008-2013) of three multinational health adaptation projects covering fourteen countries (Albania, Barbados, Bhutan, China, Fiji, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Macedonia, Philippines Russia, Tajikistan, and Uzbekistan) and qualitative data collected through a focus group consultation and interviews with 19 key informants purposively selected for their expertise and role in health adaptation to climate change

Methods: a qualitative review and synthesis of documents for evidence and examples of: attaining objectives and planned results of interventions; sustainability; stakeholder participation and community engagement; country ownership and socio-political constraints; human resources and capabilities; replicability and scalability; and health adaptation monitoring and evaluation

Main conclusions: The national projects increased resilience for particular weather-sensitive health outcomes by focusing on incremental improvements in policies and programs to address the current adaptation deficit associated with climate variability, and by beginning to establish enabling environments for additional adaptation. Irrespective of resource constraints, low and middle-income countries need to prepare for climate change through better understanding of potential risks, strengthening health systems, ensuring adequate policies and legislation, facilitating institutional support, and public education and awareness programs, including disaster preparedness measures. However, no project planned nor considered how to scale up successful community-based activities. Further, the activities undertaken may not be sufficient to address significant increases in climate variability and change. National health plans and budget processes need to move beyond focusing on shorter-term activities to address climate variability to also promoting mitigation and to transforming adaptation policies and programs into multi-faceted, collaborative (multi-disciplinary), and iterative activities, with support for capacity building, knowledge communication, and institutionalized monitoring and evaluation.

O-3321-02

Climate change impact on heat-related mortality under some RCP scenario

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Background: In 2014, we reported the future heat-related excess mortality projections as Chapter 2 of the book by World Health Organization. In this projection, we used SRES A1B scenario and the target was elderly population, i.e., 65+ years. We updated the projection using RCP scenario and for all age groups combined.

Methods: We defined excess mortality identical to the WHO book: The relation between daily maximum temperature and mortality is V-shaped, and the temperature at which the mortality is lowest is called «optimum temperature (=OT).» When the temperature is higher than OT, the mortality risk is higher than that at OT. We define this difference between the mortality at higher temperature and that at OT as excess mortality.

For projection, we used RCPs 2.6, 4.5, 6.0 and 8.5 with SSPs 1, 2 and 3 Target periods were 1981-2000 as the baseline, 2020s, 2050s and 2080s. The general circulation models (=GCMs) we used are GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A, MIROC-ESM-CHEM and Noresm1-M. As of now, RCP&SSP-specific mortality rate has not been publicly available. Thus, we calculated mortality using IIASA SSP-specific population data by country, sex and 5-yaer age category.

Results: Regardless the GCM, excess mortality increased along with the time, and large increase was observed in China, India and Europe. Along with the temperature rise, the increase in excess mortality varied with the GCM, but the difference was smaller for nearer future. The difference due to the SSP appeared smaller compared with the difference due to the model.

Discussion: Impact of climate change on heat-related excess mortality will occur not only developing countries but also developed countries. This is specific to heat-related mortality, unlike other major health impacts such

as malnutrition, malaria, dengue fever, diarrhea and deaths due to coastal floods. Although «autonomous adaptation,» i.e., optimum temperature becomes higher along with the warming climate without specific adaptation policy, would occur, this ubiquitous impact all over the globe would require us to take actions for mitigation and adaptation.

Conclusion: Heat-related excess mortality would affect both developing and developed countries, and shows a good example of the necessity of cooperation all over the world.

Acknowledgements: This study was supported by the Environment Research and Technology Development Fund (S8 & S10) of the Ministry of the Environment, Japan, and the Global Research Laboratory (grant K21004000001-10A0500-00710) through the National Research Foundation of Korea (NRF), funded by the Ministry of Education, Science, and Technology, Korea.

O-3321-03

Global Risk Assessment of the Effect of Climate Change on Selected Causes of Death in 2030s and 2050s

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Climate change is likely to affect human health with important differences by world region. As climate change is likely to affect proximal and distal (upstream) risk factors for a wide range of health outcomes, the quantification of these risks and burdens is complex, and few global models are available. We will report the finding of a global assessment of the impact of climate change on selected mortality outcomes undertaken for the World Health Organization.

Future cause-specific mortality in 2030 and 2050 (in the absence of climate change) was estimated using regression methods for three development futures: base case, high growth and no-growth scenarios. Global climate-health models were developed for a range of health outcomes known to be sensitive to climate change: heat-related mortality in elderly people, mortality associated with coastal flooding, mortality associated with diarrhoeal disease in children aged under 15 years, malaria population at risk and mortality, dengue population at risk and mortality, undernutrition (stunting) and associated mortality. Future climate change was characterized by a medium-high emissions scenario (A1b) run through three climate models. The counterfactual was a future world with population growth and economic development but with baseline (1961-1990) climate. The annual burden of mortality due to climate change was estimated for world regions. For most pathways considered, the results reflect both positive and negative impacts on health.

Compared with a future without climate change, the following additional deaths are projected for the year 2030: 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoea, 60 000 due to malaria, and 95 000 due to childhood undernutrition. WHO projects a dramatic decline in child mortality, and this is reflected in declining climate change impacts from child malnutrition and diarrhoeal disease between 2030 and 2050. On the other hand, by the 2050s, deaths related to heat exposure (less than 100 000 per year) are projected to increase. Impacts are greatest under a low economic growth scenario because of higher rates of mortality projected in low- and middle-income countries. By 2050, impacts of climate change on mortality are projected to be greatest in south Asia. These results indicate that climate change will have a significant impact on child health by the 2030s.

A main limitation of this assessment is the inability of current models to account for major pathways of potential health impact, such as the effects of economic damage, major heatwave events, river flooding and water scarcity. The assessment also did not consider the impacts of climate change on human security. Current models can capture only a subset of potential causal pathways, and none account for the effects of major discontinuities in climatic, social or ecological conditions.

Global climate change is projected to have substantial adverse impacts on future mortality, even considering only a subset of the expected health effects, and under optimistic scenarios of future socioeconomic development and with adaptation. This indicates that avoiding climate-sensitive health risks is an additional reason to mitigate climate change. The results indicate that significant impacts of climate change cannot be avoided, and supports the case for strengthening programmes to address health risks including undernutrition, diarrhoea, vector-borne disease, and heat extremes, and for including consideration of climate variability and change within programme design. The strong effect of socioeconomic development on the projections of future risks emphasizes the need to ensure that economic growth, climate policies and health programmes particularly benefit the poorest and most vulnerable populations.

O-3321-04

Managing climate-sensitive health risks in vulnerable Pacific Island communities with minimal adaptive capacity: Lessons from Rabi Island

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In coming years, the Pacific is expected to experience increasing climate extremes as periods of drought and heavy rainfall, cyclones and heat become more frequent and intense, oceans become warmer and more acidic, and sea-level rise affects artesian water causing flooding. Pacific Island communities are especially susceptible to the health impacts of climate change due to their isolation, limited land area, low lying topography, and generally high levels of inherent vulnerability, together with poverty and widespread reliance on subsistence farming. The poorest communities especially are inadequately resourced to manage current climate and health risks, and have even less capacity to prepare for and adapt to long-term climatic changes. Despite the acceptance that communities in the Pacific are highly vulnerable, very little is known about how these risks may best be managed with so few resources and the structural disadvantages typical of small island developing states. Existing data in the region relevant to climate and health is sparse, may not be relevant to particular communities, and may miss important local features. This study is an in-depth assessment of vulnerability on Rabi Island. We document current health concerns, especially in relation to climate-relevant health risks. We evaluate contemporary coping mechanisms and capacity for adaptation, in order to develop feasible and acceptable strategies in the context of extremely limited resources.

Rabi Island is a small volcanic island in Fiji situated to the east of Vanua Levu, one of Fiji's two main islands. Rabi is home to around 5000 Banaba Islanders who were brought there from Kiribati 70 years ago, displaced by phosphate mining on their home island. The islanders have maintained their Banaba culture and language and have dual Kiribati-Fijian citizenship. In many ways, Rabi is typical of Pacific vulnerability to climate change - underlying poor health, poverty and exposure to extreme events such as cyclones - but with the added complexity of being an ethnic minority population that is especially isolated from the rest of the country. Income is very low, houses are crowded, and islanders rely on fishing and subsistence farming. Aside from coconuts that are collected for processing, there is a single cash-crop, kava, that generates most of the income on the island. Vector-borne disease, food- and water-borne and other communicable diseases, ciguatera (fish poisoning), malnutrition and direct physical trauma during extreme events are current health problems. Existing climate vulnerabilities, including threats to food security, are likely to be amplified with climate change.

We present the findings from our vulnerability assessment using data from a detailed random household survey (156 item questionnaire, 200 households, yielding data on 1500 individuals) and from focus groups of women and men in each village using Participatory Rural Appraisal

methods. We explore locally feasible opportunities to boost community resilience in the face of climate change and adaptation interventions to minimise adverse health outcomes. We discuss the relevance of our findings to other vulnerable communities in the Pacific and elsewhere.

O-3321-05

Impacts of Climate Change on Vector Borne Diseases in the Mediterranean Basin - Implications for Preparedness and Adaptation Policy

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The Mediterranean region is vulnerable to climatic changes. A warming trend exists with an increase in warm days and nights, longer and warmer summers, an increase in the frequency and the severity of heat waves and a reduction in rainfall amounts. Therefore, it is expected that vector-borne diseases (VBD) in the region will be influenced by climate change since the ecology, development, behaviour, and survival of insects and the transmission dynamics of the diseases they transmit are strongly influenced by climatic factors (especially temperature, rainfall, and humidity). The same factors also play a crucial role in the survival and transmission rate of the pathogens.

The main parameter that affects the rate of multiplication in the insect is temperature. When the temperature increases, it tends to cause an upsurge in the growth rates of mosquito populations, decrease the interval between blood meals, shorten the incubation time from infection to infectiousness in mosquitoes and accelerate the virus evolution rate.

Most cities in the Mediterranean are densely populated. Air conditioning is used, but as part of the local mentality windows remain open for most of the hot months. Many activities, particularly social gatherings, occur in outdoor locations such as shaded balconies and outdoor restaurants - all ideal for contact with the vector.

For some disease emergence in the Mediterranean basin (i.e. West Nile virus) the linkage with climate change was proved recently; for others (such as dengue) the risk for local transmission is real.

Consequently, adaptation and preparation for changing patterns of VBD distribution is crucial for the Mediterranean countries.

We analyzed nine representative Mediterranean countries and found that they have started to prepare for this threat, but the preparation levels among them differ greatly. Policy mechanisms at the regional level are limited, and depend on international organizations.

The Mediterranean countries should enhance collaboration in order to address cross-border aspects of vector transmission since the vectors of infectious diseases know no political borders.

Based on the Mediterranean Action Plan (MAP)'s success in advancing national legislation and regional cooperation, we suggest that this existing framework will address the risk of VBD transmission.

Regional-level policy mechanisms should include: monitoring and surveillance systems, capacity building in and across environment and health sectors, and stakeholder awareness and participation. Regional vector management should be advanced by the Mediterranean countries before the VBD develop into regional outbreaks.

O-3321-06

A vulnerability/resilience framework approach

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The presentation will draw on the literature on the health impacts of climate change, and will re-position the arguments in a vulnerability/resilience framework. It will be argued that many communities are located in territories that are inherently prone to being negatively affected by global warming in terms of health and this will have major negative impacts on human capital in these territories. This will be the vulnerability side of the argument. The resilience side of the argument will relate to what can be done, policy-wise, to strengthen the ability of communities to evade health problems and survive, recover from, and even possibly improve their health condition, in the face of global warming. These could include adaptation and mitigation measures. The outcome of inherent vulnerability and policy induced resilience could result in a net strengthening of human capital.

O-3321-07

Adaptation to potential shifts in malaria breeding sites: larvicide application in Sub-Saharan Africa, guided by risk maps based on remote sensing

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Climate change is likely to lead to shifting patterns of temporal and spatial distribution of many vector borne diseases, such as malaria. Firstly, this could lead to new areas becoming suitable for malaria transmission, particularly in higher altitudes and latitudes. Secondly we could observe epidemic patterns of malaria transmission and thirdly within the area of current endemicity, we could see e.g. a prolongation of the transmission period and a change in the productivity of breeding sites.

In Sub-Saharan Africa, significant progress has been made in providing access to bed-nets impregnated with insecticides and in offering subsidized, but still expensive malaria treatment. Both control measures are likely to have less than optimal effectiveness: Health care seeking drops drastically in the high transmission /high agricultural work season due to high time costs of farmers and an ebb in household cash resources before the next harvest. Second, many farmers sleep in makeshift straw huts in the midst of their fields and are thus not protected by bed nets. Unfortunately the third pillar of control, blocking larval production in breeding sites through applying larvicides, has hardly been used for malaria control. Larviciding was abandoned due to the large biological side effect of the then used DDT. However, biological larvicides, derived from Bti (Bacillus thuringiensis israeliensis) and others have been developed in the meantime. They have been effectively applied for decades in high and middle-income countries in larval control programs without showing any adverse human or biodiversity side effects. In Africa however, larviciding is largely absent in malaria control. This is generally attributed to the perceived high costs of biological larvicides and the high cost of treating all breeding sites around human settlements every two weeks during the rainy season.

We developed and validated a technique using SPOT-5 satellite images to predict which breeding sites would carry Anopheles larvae and at which larval productivity. The remote sensing predictions were tested and validated with field entomological and ecological data until a high degree of agreement was achieved. We used this novel technique to test two separate hypothesis that (i) applying larvicides is a cost-effective measure for malaria control, compared to currently applied control measures; and (ii) that it makes cost-effectiveness sense to apply the larvicides only to the breeding sites with the highest larval productivity.

We present first cost and effectiveness results of a three-armed cluster-randomized trial with three arms: (i) larvicidal treatment of all breeding sites within a radius of 1,5 km of the village borders; (ii) larvicidal treatment of only those 50% of breeding sites which are identified and validated as high-productivity sites: and (iii) control clusters of villages with no larvicide application of any

kind. All study arms receive the current national routine malaria control measures.

The results show that larvicidal treatment is highly effective both in larvae removal for 2 weeks under field conditions and to significantly reduce adult mosquito abundance in reference villages. First cost data indicate that the costs of locally adapted larviciding compare favorably to those of impregnated bed nets and that the targeted 50% larvicidal intervention is about 35% less costly. Analysis of data on the effect of malaria transmission to children under five years is under way.

O-3321-08

The Effect of Training on Health: Biogas Development Interventions to Enhance Health Resilience to Climate Change in Informal Urban Settlements in Ethiopia

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This paper measures the impact of community-level Overseas Development Assistance (ODA) on public health, specifically focusing on the provision of training. It is often the case that biogas programmes do not include any training component accompanying the intervention, believed to be either too expensive or simply overlooked. However, improved sanitation facilities do not automatically translate into better health standards, unless increased awareness and education can support behavioural changes to ensure long-lasting development.

The context of this research is an informal urban settlement in Ethiopia, characterised by extreme poverty, poor sanitation and exposure to climate-sensitive risks, where a biogas sanitation project funded by ODA was implemented in 2013. The development intervention included environmental and sanitation training, provided to 45 heads of the 200 beneficiary households of the project. Quasi-experimental techniques with propensity score matching methods are applied using two waves of panel data, generated from a dedicated survey conducted among all the households.

The study finds that training, provided within the biogas and sanitation development intervention, had positive effects on a number of health indicators including self-assessed health and lower use of contaminated water from the river. Although training beneficiaries carries additional costs during implementation, the benefits are significant, suggesting long-term behavioural changes. Participants who live closer to the biogas facilities enjoyed further health benefits, reinforcing arguments for the scaling-up of biogas development and sanitation interventions inclusive of training in informal urban settlements to enhance health resilience to climate change.

3321-POSTER PRESENTATIONS

P-3321-01

Assessment of health-related impact of climate change in Taiwan

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Objective: To provide a general framework of health impact assessment due to climate change in Taiwan. Health impacts such as heat or air pollution-related mortality and hospital admissions of cardiovascular disease and respiratory diseases, variability of meteorological factors on the dengue fever and diarrhea incidents, will be assessed for the projected climate change in 2020 to 2050.

Methods: Meteorological records during the past few decades will be collected from the Data Bank for Atmospheric Research of Taiwan. Hospital admissions and mortality data will be obtained from the National Health Insurance (NHI) dataset and Multiple Cause of Death Automated Data Entry System. Environmental monitoring data will be obtained from the Taiwan EPA website. The comparative risk assessment (CRA) method of the World Health Organization will be employed for comparisons of risk factors (such as frequency and intensity of extreme heat waves, storms, and droughts) and climate-sensitive health outcomes. Dose-response relationships for baseline climate during the period 1990-2010 will be determined and climate-attributable burden of disease (the numbers of deaths and disability adjusted life years, DALYs) for different climate scenarios predicted for the future period 2020-2050, as well as avoidable burden resulting from the effects of mitigation of GHG will be estimated. Quantitative statistical methods will be developed for uncertainties in the health impact assessment.

P-3321-02

Climate Change and the use of Serious Games: responses for Neglected Tropical Diseases in Southwestern Amazonia

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In the Brazilian Amazon Region, Land Use/Cover Change – the main contributor to the national emissions of Green House Gases and, therefore, to climate change – equals to deforestation through anthropogenic forest-fires. The associated biodiversity loss affects the spread of vector-borne Neglected Tropical Diseases (NTDs), due to the susceptibility of infectious diseases' vectors to environmental degradation, which in turn disrupt natural cycles. Balanced ecosystems, where those natural cycles occur, act as buffer zones between zoonosis and susceptible human populations – the Ecosystem Service known as "Infectious Diseases Regulation". This paper addresses the potential benefits of using a "serious game" as part of community-based healthcare practices, to educate local citizens and health professionals about ways of controlling and reducing the spread of NTDs in remote regions, especially in the tri-national South-western Amazonia. American Cutaneous Leishmaniasis represents an ideal challenge for the application of complex ludic educational tools, because its complex and poorly understood transmission cycle involves humans, their dogs, insect vectors, sylvatic reservoirs and other domestic animals (chicken, pigs, etc.) that attract both vectors and sylvatic reservoirs to the peri-domicile. The existing efforts to control American Cutaneous Leishmaniasis' transmission have relied, so far, on the development of either drugs (to break disease transmission with the appropriate treatment of humans and, in some countries, dogs, or to prevent people and dogs being infected, by the use of insect repellents) or vaccines (for dogs, so far). These chemically oriented efforts have helped at a slower pace than the spread of these diseases. Therefore, an effective educational tool to improve knowledge, attitudes and practices related to local people's living conditions that maintain high levels of American Cutaneous Leishmaniasis' transmission is challenging and timely, especially for the locals, who suffer the burden of such Climate Change prone Neglected Tropical Diseases. Education was among the first applications of "serious games" and remains an important focus of Information Technology work in this area. This paper introduces a prototype game called Dr Ludens' LSG (Leishmaniases Serious Game), expected to be the first game of a Doctor Ludens' series. It focuses on American Cutaneous Leishmaniasis, and aims to involve lay citizens and primary health-care personnel in collective tasks around their local community and individual households, where they attempt to decrease vector density and to protect people and dogs against vector bitting. This game can be easily extended to Visceral Leishmaniasis, as well as to other vector-borne endemic diseases, such as Dengue Fever, Chikungunya and Malaria. The design process of the game architecture of the so-called Dr Ludens' LSG, developed by a multidisciplinary team of computer and epidemiological scientists, is described, as well as a recent evaluation by a group of Leishmaniases' experts. These researchers have identified several positive aspects of our prototype, as well as suggested a number of improvements to make its future deployment more effective and widespread. The implementation of these suggested improvements is intended to be done before

releasing Dr Ludens' LSG to selected local people at the study region A longitudinal study of its use and potential educational benefits towards the Knowledge, Attitudes and Practices of these selected users, in regards to their diseases' preventative measures, is also envisaged. With the rapid spread of internet connectivity to otherwise remote regions, there is vast potential for application of the new generation of highly connected interactive games to disease prevention and control, by means of education and information campaigns conducted through gaming. When people see, clearly, interconnections between Climate Change and their own lives, including their increasing risk of contracting infectious diseases, they become more likely to adopt a low carbon way of life.

P-3321-03

Impact of Climate Change on Influenza Mortality in US: A Generalized Additive Model Analysis

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Each year approximately 5-20 percent of US residents suffer from influenza and more than 200,000 are hospitalized (CDC, 2014). The effect of annual influenza on the health care system is rather substantial, 3.1 million hospitalized days and 31.4 million outpatient visits with direct medical costs estimated at over $10 billion (Molinari, 2007). The influence of weather and climate on influenza transmission and mortality has been studied in a variety of ways and with varying levels of complexity, especially in epidemiology, however, there is little robust empirical evidence. Exposure to extreme temperatures and/or extreme humidity levels increases the risk of mortality mainly through impacts on our cardiovascular and respiratory systems. Epidemiological studies (Barecca and Shimshack, 2012; Deschenes and Moretti, 2007; Lowens, 2007; and Martens, 1998) state that colder temperatures have greater influence on mortality than warmer temperatures but hot temperatures are more likely to affect the inter-temporal distribution of mortality by expediting the time-to-death of those individuals already nearing death. Humidity can also affect human health through a variety of mechanisms. Low humidity levels can lead to dehydration and increase the spread of influenza (Lowen et al., 2007; Shaman and Kohn, 2009; and Xie et al., 2007), while high humidity levels exacerbate the effects of heat stress because humidity impairs the body's ability to sweat and cool itself (Ahrens, 2009). Low humidity conditions, which are often accompanied by low temperatures, enhance survival times of viral aerosols (Loosli, 1943; Harper, 1961; and Schaffer, 1976). This paper utilizes generalized additive models (GAM) which includes a link function g(.) relating the mean μ to the linear predictor Xβ. The general form is; $g(\mu) = X\beta$

Essentially, GAM is a nonparametric extension of generalized linear models (GLM), used often for the case when there is no a priori reason for choosing a particular response function and the response functions needs to be generated from the data itself. GAMs (Hastie and Tibshirani 1986, 1990) are semi-parametric extensions of GLMs; the only underlying assumption made is that the functions are additive and that the components are smooth. A GAM, similar to a GLM, uses a link function to establish a relationship between the mean of the response variable and a smoothed function of the explanatory variable(s). The idea behind using smooth functions is to removes the small variations while maintaining the major trend of each variable with a view to increase the efficiency in estimating the model. The non-parametric of GAM means that it does not assume a rigid form for the dependence of the response variable on the predictors. Another strength of GAMs is their ability to deal with highly non-linear and non-monotonic relationships between the response and a set of explanatory variables.

Our results provide robust evidence of non-linear impact of both temperature and humidity on influenza mortality rates. The risk of influenza mortality is highest between minimum temperatures of −30°C□ and −10°C and declines as the minimum temperature goes above 8°C. In the case of maximum temperature, the risk of influenza mortality is highest in the range of −15°C and 5°C, while the effect of minimum specific humidity is highest between 5 g/kg and 20 g/kg. The medical and epidemiological literature suggests that dry conditions result in moisture losses and lead to dehydration and increases spread of influenza by increased viral shedding (Salah et al., 1988; Loosli, 1943; Harper, 1961; and Schaffer, 1976). Results also suggest that influenza mortality is insensitive to high temperature levels. When considering the mean temperature and mean specification our results indicate that the highest risk of influenza mortality is between −20°C and −10°C and for mean specific humidity, the risk is highest between 7.5 g/kg and 15 g/kg. This range is particularly significant as Lowen et al. (2007) reports that the infection and transmission of influenza virus is highly efficient at relative humidity (RH) of 65 percent - equivalent to specific humidity of 11.3 g/kg, is within this range. Thus, our findings provide empirical evidence to epidemiological experiments. These results provide comprehensive empirical evidence influential epidemiological works under laboratory condition by Cannell et al. (2008), Lofgren et al.(2007) and Lowen et al. (2007).

P-3321-04

Modelling adaptation in climate change impact assessments of heat-related mortality

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The potential for populations to respond to warmer temperatures under climate change scenarios by adaptation means that non-stationary heat-related mortality models should be applied in climate change impact assessments. However, there remains a long-standing debate as to how the adaptation response, which includes physiological acclimatisation as well as a range of behavioural adaptations, should be modeled in these assessments. The relatively limited state of knowledge on how populations may adapt to a warmer world, as well as limited knowledge on the extent to which populations may adapt, means that some climate change impacts assessments do not account for adaptation response at all. Such an approach is unrealistic and zero adaptation is improbable. Nevertheless, numerous studies have adopted this simplistic approach because there is no uniformly accepted method for modelling adaptation. Other studies have attempted to consider adaptation response by employing statistical methods, of varying complexity, including regression techniques that control for historical adaptation, interpolation of present vulnerabilities to the future, and the application of "analogue" cities whose present climate best approximates the estimated climate of a target city as expressed by climate model projections. Even considering the existence of these disparate approaches, there has to date been no comprehensive comparison of them. In turn this has precluded the development of a standard and commonly applied technique for modeling adaptation in heat-related mortality climate change impact assessments. We outline an ongoing study that aims to compare a number of approaches for modelling adaptation by using a consistent set of input data and temperature-mortality models for several cities, with a means to understanding the relative merits of the different approaches. An ambitious goal of our research project is to recommend a standard method that may be adopted by future climate change impact assessments of heat-related mortality and to this end address an important gap in knowledge and techniques on health responses to climate change.

P-3321-05

Whether Changing Environmental Conditions of Living negate the impact of Socio-economic Development on Health Outcomes of Urban Poor?

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In recent years, climate change has almost becomes synonyms with development of environmental hazards affecting all living being. The adverse affects are particularly large on those segments of populations where current burden of climate-sensitive disease is high. One

such category is urban poor which is characterized by cramp living spaces, lack of sanitation and safe drinking water, poor and unhygienic environmental conditions, poor socio-economic status etc. As a consequence, their major health and morbidity indicators (due to communicable and non-communicable diseases) and mortality rates are higher than other sections of population viz, rural and urban non-poor. It has also been observed that unlike the rural areas, programs to address socio-economic development and healthcare needs in urban poor localities have limited impact on health outcomes. Why? Is it because living environment is quite degraded (inputs are rendered ineffective) or the interventions are not penetrating or accessed by all people to realize any measurable outcome?

This paper examines this phenomenon by taking India as a case. It compares the health outcomes for urban poor and non-poor in contemporary Indian communities against the socio-economic and healthcare developments, over a period of one decade. It also seeks to answer why development interventions are relatively less effective in case of urban poor, whereas it should have been other way around because urban poor have more intense poverty conditions and even small inputs would have made a difference.

The analysis is based on data are drawn from two large nationwide surveys (NFHS II and III) carried out in 1998-99 and 2005-06 segregated for urban poor (and non-poor) using wealth index (a composite index reflecting on quality of life and possession of household goods).

The findings are likely to provide more insight in to the development programming for urban poor against the backdrop of climate changes.

P-3321-06

The Effectiveness of Heat Early Warning System in South Korea

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Heat early warning system is a first heat-wave measure to cope with the heat wave. And this system has been operating in many countries today. Evaluation of the effectiveness of heat early warning system may be utilized to present a further improvement. And, these days, it has been reported that the operation of heat early warning system brings to a decrease in number of emergency services or deaths related to stroke. The aim of this study is to quantitatively examine the associations between the operation of heat early warning system and the reduction of mortality in South Korea.

In South Korea from 2008 to 2012, heat-waves occurred for a total of 8 times, 26 days. I completed cardiovascular-related death counts in four periods. The four periods were defined as the days in heat-wave and above the threshold, the days in heat-wave and below the threshold, the days in non heat-wave and above the threshold, and the days in non heat-wave and below the threshold. And, the threshold was defined as the temperature at which the risk of mortality begins to increase with increasing temperature.

The daily average of CVD-related death counts were 19.83 and 20.44 for 18 days in heat-wave and above the threshold and 16 days in heat-wave and below the threshold, respectively. In case of 1-day lagged effect, the daily average of CVD-related death counts were 18.28 and 21.13 for 18 days in heat-wave and above the threshold and 16 days in heat-wave and below the threshold, respectively. In summary, the operation of Korea's heat early warning system has a positive effect on bringing a reduction of deaths caused by heat-wave.

P-3321-07

Assessing Health Vulnerability to Climate Change in Morocco: Governance and Adaptation Options

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The climate factor plays an important role in most systems critical to life. Its considerable effect on many physical and biological systems has the potential to increase humans' vulnerability to climate change. Among these vulnerabilities, human health is highly considered. Actually, and in addition to the health risks of extreme climate events, many infectious diseases are expected to change their geographical or seasonal patterns and incidence due to climate change and variability. More specifically, climate change will likely affect the distribution, prevalence and lifecycle of several vector-borne diseases - such as Malaria and Leishmaniasis - and water-borne diseases - such as Schistosomiasis. These disregarded diseases still ravage lives covertly in many parts of the Global South and are likely to be a major human health burden in the coming years due to climate change and other factors. However, and despite this alarming fact, there is still limited specific scientific evidence in this area that can serve as a relevant reference for policy-making processes in many countries.

In Morocco, infectious diseases are still a public health problem. Despite the adoption of a related domestic policy and the consideration of these diseases as reportable, the number of reported cases - both indigenous and imported - is constantly increasing. Given the knowledge gap in this area, the aim of this research is twofold: 1) Undertaking a vulnerability analysis of possible climate change impacts on infectious diseases in Morocco from an eco-epidemiological and socio-economical approach; 2) Assessment of Morocco's adaptive capacity and identification of existing gaps which may affect the health security of population in the future with regard to infectious diseases and their interactions with climate change. Throughout the analysis, the policy options needed to effectively monitoring and managing climate change impacts on human health - with a focus on adaptation options specific to Moroccan context - will be highlighted.

P-3321-08

Different heat wave definitions and their association with emergency department visits in seven major cities of South Korea

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BACKGROUND:
On-going climate change is accompanied by an increase in the frequency, duration, and intensity of climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, impacting on human health directly and indirectly.

OBJECTIVES:
We examined the association between heat waves and emergency department (ED) visits and estimated the impact of heat waves on emergency department visits in seven major cities of South Korea to understand the health effect of climate change quantitatively. In Korea, heat-wave warning is issued by the weather office if the daily maximum temperatures is expected to be higher or equal to 33℃ for 2 consecutive days. This definition is the same for all cities in Korea. We also would like to evaluate the effect of different definition of heat-wave using city-wise relative temperature rather than absolute temperature.

METHODS:
Different heat waves were defined as having at least 2 consecutive days with daily mean temperatures at or above the 98th percentile for warm season in each city and with daily maximum temperatures at or above 33℃ for all cities. We estimated the relative risks (RRs) of ED visits for heat-related, cardiovascular, and respiratory diseases on heat-wave days compared with non-heat-wave days using city-specific Poisson generalized linear models adjusted for daily mean temperature, relative humidity, day of the week, and time trends. In addition, we used time-stratified case-crossover with 28-day stratum to estimate the increase risk of ED visits associated with heat-wave, then and compared the estimates from time-series analysis with those from time-stratified case-crossover analysis. We also estimated the association between ED and duration of heat-wave with two different definitions using time-series

and time-stratified case-crossover analyses

RESULTS:
Heat waves defined as having at least 2 consecutive days with daily maximum temperatures at or above 33℃ for all cities were associated with RRs of 2.79 (95% CI: 1.84, 4.23), 2.19 (95% CI: 1.39, 3.46), and 1.5 (95% CI: 1.07, 2.11) for heat-related ED visits in Seoul, Gwangju, and overall across all cities respectively, and heat waves defined as at least 2 consecutive days with daily mean temperatures above the 98th percentile for warm season in each city were associated with 2.44 (95% CI: 1.47, 4.06), 2.29 (95% CI: 1.66, 3.16), 1.74 (95% CI: 1.07, 2.82), and 1.80 (95% CI: 1.44, 2.25) for heat-related ED visits in Daegu, Seoul, Gwangju, and overall across all cities respectively. These estimates indicated the significant increases in the number of ED visits on heat-wave days compared with non-heat-wave days with both definitions. Most of estimates suggested positive associations between heat waves and heat-related ED visits and varied among the cities. Most estimates of heat wave risk for cardiovascular and respiratory ED visits were very weaker than those for heat-related ED visits although these findings were not statistically significant. However, the estimates of heat waves risk for cardiovascular ED visits were 1.34 (95% CI: 1.10, 1.63) under 33℃absolute temperature and 1.39 (95% CI: 1.09, 1.77) under 98th percentile temperature in 65+ year age group. The time-stratified case-crossover analysis produced results similar to those found in the time series analysis for the associations between heat waves and ED visits. The estimated risk for heat-related ED visits for every 1-day increase in heat wave duration was the highest in Seoul with RR of 1.49 (95% CI: 1.29, 1.72), and the estimates of 1.48 (95% CI: 1.17, 1.88), 1.28 (95% CI: 1.04, 1.58), and 1.20 (95% CI: 1.10, 1.31) significantly indicated the positive associations between heat wave duration and heat-related ED visits in Daegu, Gwangju, and overall across all cities respectively.

CONCLUSIONS:
Our findings using different definitions and character for heat waves and ED visits data from NEDIS provide supportive evidences of the health effect of heat waves for further study and policy makers to reduce the health risk of heat waves varying among areas in South Korea.

P-3321-09

Northern populations in a changing climate

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The Republic of Sakha (Yakutia) located in the north-eastern part of the Asian continent. On an area of 3083.523 sq. km is home to about one million people. The indigenous population of the region (Yakuts, Evens, Evenks) is about 53% of the total population. Territory of Republic belongs to the zone with the uncomfortable conditions for living of the population. The main environmental factors are cold exposure, temperature, violation of photoperiodic, geomagnetic, gravitational perturbations and deficiency of trace elements. According to a research, the indigenous population of the northern territories in the process of adaptation to extreme environmental conditions to formulate and institute specific features of the constitution and metabolism to ensure efficient functioning of all body systems. These features of the northern populations of researchers attribute the high density of the body, a relatively strong development of osteo-muscular component of the body, increased fat metabolism, high reserve capabilities of the antioxidant system, increasing the basal metabolic et al. At present, the processes of industrialization and urbanization, accompanied by psycho-emotional stress, changes in diet and lifestyle, lead to the failure of established mechanisms of evolutionary adaptation to extreme factors and lead to the development of pathological conditions. About stress adaptation reserves of the organism under the influence of complex environmental factors and suggest low life expectancy, high rates of morbidity and mortality among the population of northern regions. That is, these populations carry the double burden of the adverse effects of both natural and socio-economic factors affecting health. In terms of the future of climate change, these groups are among the most vulnerable. Climate warming is expected to change in the spectrum of diseases, increase the proportion of infectious diseases, the number of cardiovascular events, of stressing factors, the changing of nutrition. Therefore it is necessary to forecast possible trends in health and consider possible measures to maintain the health and life of humans.

P-3321-10

Integrating climate information into decision support tools for public health

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More frequent and severe extreme climatic events have been accompanied by the accelerated emergence of new infectious diseases worldwide. Infectious disease epidemics directly impact the health of local populations, strain healthcare systems, and cause substantial economic loss. Given climate change, globalisation, increased air travel and connectivity with endemic areas, there is a need to strengthen local resilience to infectious disease threats via innovative decision support systems. Seasonal climate forecasts provide an opportunity to incorporate precursory climate information into decision support systems for climate-sensitive diseases. This aids epidemic planning months in advance, for diseases such as dengue fever, cholera and malaria.

Here, we present a versatile Bayesian hierarchical statistical mixed model framework, designed to quantify the extent to which climate indicators can explain variations in disease risk, while at the same time taking into account their interplay with observed confounding factors and also intrinsic features of disease dynamics. Using forecasts of climate, timely spatio-temporal probabilistic predictions of disease risk can be obtained, to guide prevention and control activities. The framework can be adapted to model any climate-sensitive disease at different spatial/temporal scales and geographical settings. We provide case studies, quantifying the impact of climate on dengue fever in South America and South East Asia. We also illustrate how model results could be translated into actionable warnings for public health decision makers.

P-3321-11

Community-Based Heat-Stress Vulnerability Assessment with Monitoring, Social Survey, and Crowd-sourcing Technology for Health Adaptation

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Increased mortality was observed on heatwave days worldwide in recent years. According to the projected mortality changes in high income Asian countries such as Taiwan in 2030 and 2050 by World Health Organization, the increase in heat-related mortality is the highest compared to mortality change of all other potential causes due to climate change. A proactive heat-stress vulnerability assessment was conducted in support of reducing health risks and formulating health adaptation strategies in Taiwan, with emphasis on community-based heat-stress exposure assessment and response-capacity evaluation using social survey and crowd-sourcing surveys. This presentation showcases scientific findings from this trans-disciplinary research framework using Taiwan, a sub-tropical island, as an example. A novel two-tier heat-stress vulnerability assessment was conducted with multiple innovative facets. First, physical (heat), chemical (air pollution), and social (behavior and response capacity) aspects of vulnerability were assessed with crowdsourcing technology as well as mature methodologies in atmospheric chemistry monitoring/modeling and survey research. Secondly, both direct (heat) and indirect (air pollution) exposure pathways due to temperature were assessed. Thirdly, taking advantages of the bottom-up and top-down approaches, a two-tier framework is adopted to examine important factors and associated physical, chemical, and social mechanisms at the community level as well as to identify the spatial distribution of vulnerable groups and areas at the national

level. Fourthly, the controllable factors of exposure to heat-stress and air pollutants and those of individual and community response capacities were targeted so that the health risks can be minimized by either interrupting the exposure pathway or enhancing the response capacity of the stressed population. Lastly, the vulnerability factors studied correspond directly to the respective policy options in social and health promotion programs and heat-warning system establishment so as to facilitate the science-policy dialogue. Recommendations for health adaptation strategy were made accordingly to enhance resilience of individuals and communities facing the challenges of more frequent heat waves in the future.

P-3321-12

Climate Change, Episodic Drought, and Valley Fever Epidemic in California

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Valley Fever (Coccidioidomycosis) is a reemerging infectious disease that is endemic to the southwest United States (California, Arizona, Utah, Texas, Nevada, and New Mexico), Mexico, Central America, and South America. The disease results from inhalation of spores from soil fungi Coccidioides immitis or Coccidioides posadasii, which typically occur in separate regions but manifest the disease similarly. Environmental factors associated with low elevations, sandy soil, and less than 20 inches of rain per year favor the persistence of the fungi and risk of infection. The recent increase in incidence of Coccidioidomycosis in several California counties has been attributed to large amounts of dust due to several years of drought followed by rainy seasons. However, no research has been conducted to unpack the complex linkages between climate change, soil fungal diversity, and social conditions that lead to human vulnerability Coccidioidomycosis. We are investigating communities in the deserts of the Southwest United States, such as Borrego Springs, California, as part of the "front line" of global climate change and regional drought mitigation. Borrego Springs faces an impending water crisis, with some studies suggesting the town will run out of economically viable water within 30 years. With El Nino Southern Oscillation (ENSO) conditions expected to bring rain to the region after a prolonged drought, we hypothesized significant increase in the incidence of Coccidioidomycosis. The unknown risk of Coccidioidomycosis, the longevity of infection, and the lack of proper diagnosis are expected to contribute to increasing burden of this disease in the region. This study further explores local and regional health responses, and the challenges associated with linking Coccidioidomycosis climate change impacts and adaptation in California. The study tests hypotheses linking Coccidioidomycosis incidence to soil moisture and seasonality for California communities. The study addresses barriers, benefits, risks, and trade-offs of these local health responses and we discuss the integration of climate mitigation and adaption options to reduce the negative impact of climate change on Coccidioidomycosis prevalence in a vulnerable community.

P-3321-13

The international negotiations under the United Nations Framework Convention on Climate Change: Insertion of the Health Sector and Implications for Foreing Policy

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The scenarios outlined by the Intergovernmental Panel on Climate Change and research centers around the world reaffirm the intrinsic relationship between Climate Change and Human Health. Nevertheless, the international negotiations taking place under the United Nations Convention does not fully reflect the concerns, prevention, promotion and recovery of global health. The detachment between the scientific world and the reality embraces a serious systemic risk that threatens human and planetary survival.

The time is ripe for concrete insertion of Health concerns in climate negotiations. With the creation of the Durban Platform, a new climate protocol is being negotiated, able to determine all future developments in the fight against Climate Change.

In this sense, the interrelationships between domestic and international politics conform to the formation of the international position of a country. Thus, the health sector has the potential to offer successful solutions to the climate negotiations, bringing new complexity able to change the whole structure of the negotiation and its outcome favorably.To this end, this work offers, in addition to these discussions, a number of policy recommendations to be used directly into the climate negotiations, as in the format and language of international treaties.

This is the historical and timing of insertion of Health concerns in discussions on Climate Change, as they determine the success of the agreement and cooperation between countries.

P-3321-14

Impact of Climate Change on Child

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Climatic shocks have adverse economic consequences for both developed and developing nations. However, the economic costs are far greater in developing nations which face greater risks and vulnerabilities due to climate change (UNDP, 2007; World Bank, 2010). Given a rise in the incidence of such shocks, recent development literature has attached increasing importance to studying their impacts. For children, climatic shocks exacerbate vulnerability and place them at increasing risk. Specifically, some of the risks include separation from families, deprivation in terms of schooling, adverse impacts on children's nutrition and learning outcomes, and increased susceptibility to abuse and exploitation. Therefore, studying the impact of such shocks on child welfare is imperative. Children are not only most at risk but early intervention is the most effective means in fostering long-term change.

The particular focus of this study is to analyze the impact of two different climatic shocks: floods and drought, on child human capital across Ethiopia, India, Peru and Vietnam - countries with diverse socio-economic backgrounds. Human capital, in this context, subsumes both child learning and health outcomes. The discussion of the impact of climate shocks on human capital is made in the context of both income and substitution effects and the possibility of a positive climatic shock impact is explored. If the income effect dominates we can expect a negative impact on our outcome variables, while the converse is true if the substitution effect dominates. Additionally, the study aims to elaborate the role of child, parental, household and community characteristics as well as institutional help in buffering these climatic shocks.

The data source is the Young Lives Project* and cross-sectional household data is utilized for the year 2009. The study examines the data on the older cohort of children, whose lives were documented from ages 14 - 15, and covers both urban and rural areas. The enrolment rate and three measures of cognitive ability: Peabody Picture Vocabulary Test (PPVT), CLOZE test and Mathematics test scores are used as proxies for child learning outcomes. The health outcome variables being studied are the WHO defined Body Mass Index (BMI) z-scores and Height for Age (HFA) z-scores.

* Young Lives is a 15-year survey investigating the changing nature of childhood poverty in Ethiopia, India (Andhra Pradesh), Peru and Vietnam (www.younglives.org.uk). Young Lives is funded by UK aid from the Department for International Development (DFID) with co-funding from 2010-2014 by the Netherlands Ministry of Foreign Affairs and from 2014-15 by Irish Aid.

P-3321-15

Inuit Traditional Knowledge for Adapting to the Health Effects of Climate Change

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The Inuit Traditional Knowledge for Adapting to the Health Effects of Climate Change (IK-ADAPT) project was launched in May 2012. Funded through the Canadian Institutes for Health Research (CIHR), IK-ADAPT combines scientific research and Inuit traditional knowledge to develop an evidentiary base to inform policy and programming needed to adapt to the health effects of climate change. Working with Canadian Inuit communities in the Inuvialuit Settlement Region, the Northwest Territories, Nunavut, and Nunatsiavut, as well as knowledge users at multiple levels, the project is examining ways to preserve, promote, and disseminate Inuit knowledge in order to prevent, prepare for, and manage the health impacts of climate change. Having just come to the end of its final phase, this presentation provides an overview of the project, shares results from projects conducted under IK-ADAPT, and identifies next steps for enhancing the resilience of communities and northern health systems in light of a rapidly changing climate.

P-3321-16

Arsenic Contamination in drinking water and Valuing Health Damages: A case study of Bihar

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The present study attempts an empirical investigation on the health effects of Arsenicosis on individuals in the rural areas of Bihar. Systematic random sampling was used for the selection of households and 388 households were selected from Maner and Shahpur blocks of Bihar. We used a field test kit to test the arsenic contamination level of water samples which were collected from each household. The water test results reveal that Maner's drinking water is more contaminated (excess of iron and arsenic in drinking water) than Shahpur's. 82.22% of households in the study area are having poor water quality, while 72.42% of households are having excess of arsenic in their drinking water. The mean concentration of arsenic contamination for entire study area, Maner and Shahpur is found to be 89.31 ppb/l, 111.34 ppb/l and 61.93 ppb/l respectively. The study estimates incidence rate of Arsenicosis diseases for three categories of sample: for the entire sample surveyed; for male population; for female population; and found incidence rate as 92.24, 81.53, and 105.22, respectively. The incidence rate of Arsenicosis diseases among female is highest and lowest among male children. We predicted Bivariate (marginal) probability of success in the outcome, which is defined as the probability of observing the Arsenicosis diseases for surveyed household, is estimated and found to be 0.42. Arsenicosis disease is regressed with set of independent variables. Water source found to be significant and positively related to the Arsenicosis diseases. This indicates that the household which is using poor water sources is reporting more cases of illness. This also reveals those who used drinking water from hand tube wells are more vulnerable to the Arsenicosis diseases as most of the sample households draw water from hand tube wells. The study also reveals the awareness is significant and negatively related to the Arsenicosis diseases. It reveals that if household is aware about the water source there is decrease in Arsenicosis diseases. The study also finds doctor visit, work loss, and arsenic level all are significant and positively related to the Arsenicosis diseases. We find arsenic contamination level is significant and positively related to Arsenicosis diseases. This indicates the household drinking water is contaminated more and leads to more cases of Arsenicosis diseases. We also regress defensive activities i.e. water purification on set of explanatory variables. We find per capita income as significant and positively related to household defensive activities on water purification. This indicates that the higher income household installed more water purification devices. Adequate of sanitation is significant and positively related to water purification. This is also same with the per capita income and is an important finding. Depth of the hand tube well is significant and positively related to water purification strategy. This indicates that there are the lesser number of households have deep tube wells. One probable reason to this is that the more the depth of the hand tube well, better the water quality is. Water source and awareness are significant. The study estimates the cost of illness to the household due to contaminated drinking water that comprises treatment cost and wage loss. The study finds that the poor households are more affected than the well off. The annual wage loss cost of treatment and cost of illness for sample households are estimated as INR 2437.92, INR 5942.40 and INR 8380.32 respectively. The total annual cost of illness for both the block is estimated as INR 265979691.6. The defensive activities undertaken by higher income group household are taking water purification while the lower income group household could not undertake the water purification. The cost of illness may be taken as the willingness-to- accept by the affected household. Therefore, providing safe drinking water benefits both social and economic value. The results of the present study indicate that water source and awareness are the two most significant factors on both illness and defensive activities. Due to lack of alternative safe water sources, the households are left with no choice but to use the existing available source for drinking water. The government may use various channels to make the households aware that safe water is a fundamental right. Therefore, piped water may be an effective alternative water supply to all the households. The result of this study would provide policy inputs to the policy makers to make their strategies more effective in providing drinking water which may help to reduce the Arsenicosis in a cost-effective and sustainable manner.

P-3321-17

2015 Lancet Commission on Health and Climate Change: Emergency Actions to Protect Human Health

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In 2009, the UCL-Lancet Commission on Managing the Health Effects of Climate Change called climate change "the biggest global health threat of the 21st century". Five years on, a new multidisciplinary, international Commission has formed to to map out a comprehensive response to climate change, in order to ensure the highest attainable standards of health for populations worldwide.

The Commission represents a collaboration between over 80 European and Chinese climate scientists and geographers, social and environmental scientists, biodiversity experts, engineers and energy policy experts, economists, political scientists and public policy experts, and health professionals - all seeking a response to climate change which is designed to protect and promote human health.

The Commission's work is divided in to five inter-related chapters. It begins by conducting a review of the climate science and its subsequent impacts on human health since 2009, before assessing and presenting policy response options around four central themes: community resilience and adaptation in low-income countries; energy choices and technical solutions; economic tools and the finance; and political mechanisms. At every point, the Commission understands the policy solutions to the extent that they improve public health.

The Commission's work suggests that current greenhouse gas emissions projections and consequent climate change pose an unacceptably high and potentially catastrophic risk to human health. In response to this, the Commission then concludes and describes a path whereby tackling climate change could become the greatest global health opportunity of the 21st century.

It also notes the unique and crucial role of the health community in responding to climate change. This is described in terms of the importance of adequate health impact assessments to guide mitigation and adaptation policy; the role of health and health systems as a tool for building community resilience; and the power of the health professional as a messenger that can communicate the risks and opportunities of climate change as local, immediate, and personal.

The Commission's work has now been completed, and will be published in The Lancet in May 2015.

3322a - Representation of technological dynamics and societal transformation

ORAL PRESENTATIONS

O-3322a-01

Unprecedented urbanization and challenges to model them in IAMs

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World has witnessed unprecedented urbanization- with 2.8 billion urban residents added between 1950 to 2000 and more 2.8 billion more by 2050. Projections show that future population rise will mostly comprise of the urban population. Rapid urbanization leads into rapid rise in energy use and CO2 emission since such urbanization in taking place rapidly in economically growing regions of the developing world where per capita CO2 emission in urban areas are far higher than the national averages. Our analysis shows that urbanization is the key and irreversible global trend for now. Recent IPCC Mitigation report makes it explicitly clear that the next 2-3 decades are crucial for low carbon development and our ability to orient new urbanization to low carbon pathway will define our ability to tame global emissions trends. New urbanization calls for rapid deployment of infrastructure in small and medium scale cities and lock-on cities into particular carbon trajectory. For example, China has unveiled a new urbanization plan in March 2014 to boost urbanization to 60% by 2020 that aim to invest 7-8 trillion dollars in urban infrastructure by 2020. The implications of the choice of urban forms, urban design and infrastructure in new urbanization on global emission occurs though embodied emission in materials used in infrastructure, such as cement, steel, aluminum and others which are carbon intensive as well as through the direct emissions due to use of those infrastructure which also lock urban system into particular technological choice. Studies based on Integrated Assessment Models have shown our cumulative carbon budget for 2000-2050 to be about 1000 GtCO2 to stay under 2°C climate stabilization; some early studies are showing that over one third of that could come from infrastructure sector alone assuming residents in the developing countries catch up to the level of per capita infrastructure stock of the average developed country residents. However, given the enormous potential of urbanization to influence global carbon emission and its multi-faceted implications, our analysis suggests that the ability to model urbanization and its implications in the current Integrated Assessment Models and other large scale global models remains extremely poor. We argue that the next frontier in global and regional IAM models lie in addressing the full scale implications of the type and extent of urbanization in economic, infrastructural, social, geosphere and bio-spherical domains. This presentation will dwell on these issues and opens much needed dialogues and discussions on how to take-on this challenges in the modelling community to develop a new generation of Integrated Assessment Models.

O-3322a-02

Title not communicated

P. Ciais

Abstract not communicated

O-3322a-03

Links between energy systems models and economic models: learning from the IEA ETSAP experience

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In a climate constrained future, hybrid energy-economy model coupling gives additional insights into interregional competition, trade, industrial delocalisation and overall macroeconomic consequences of decarbonising the energy system. Decarbonising the energy system is critical in mitigating climate change. In this paper, we summarise modelling methodologies developed in the IEA ETSAP (Energy Technology Systems Analysis Programme) community to assess economic impacts of decarbonising energy systems at a global level and at a national level.

ETSAP is a unique network of energy modelling teams from approximately seventy countries involving 177 institutions over the world, well beyond the number of its contracting parties, who are the governments of eighteen countries and the European Commission. ETSAP was one of the multilateral technology initiatives (formally called Implementing Agreements) initiated in 1976 under the aegis of the IEA. ETSAP evolved from initially analysing existing tools to evaluate R&D strategies to the combination of the energy flow optimization approach with macroeconomic top-down modelling, technology learning and stochastic modelling.

This paper summarises a range of different methodological approaches to developing linkages between energy systems modelling and economic modelling, drawing on a significant and rich and body of analysis. The energy systems models discussed are bottom-up (BU) techno-economic linear optimisation engineering TIMES models. TIMES is a techno-economic model generator for local, national or multi-regional energy systems, which provides a technology rich basis for estimating energy dynamics over a long-term (20-50 years), multi-period time horizon. TIMES computes a time varying inter-temporal partial equilibrium on inter-regional markets. The objective function maximises total surplus. This is equivalent to minimising the discounted total energy system cost while respecting environmental, technical and scenario constraints. This system cost includes investment, operation and maintenance and fuel import costs, less export income, terminal technology values and salvage values. The top-down (TD) macroeconomic models range from single producer-consumer agent production function models, to multi-region structural computable general equilibrium (CGE) models. The paper compares soft-linking approaches (e.g. between TIMES and CGE models) and hard-linking (e.g. TIMES-MACRO).

The analysis demonstrates that the range of economic impacts of decarbonisation is regionally dependent upon the stage of economic development, the level of industrialisation, energy intensity of exports, and competition effects due to rates of relative decarbonisation. Developed nation's decarbonisation targets are estimated to result in a manageable GDP loss in the region of 2% by 2050. Energy intensive export driven developing countries such as China and India, and fossil fuel exporting nations can expect significantly higher GDP loss of up to 5% GDP per year by mid-century.

The national modelling studies outlined here show that

burden sharing rules and national revenue recycling schemes for carbon tax are critical for the long-term viability of economic growth and equitable engagement on combating climate change. Traditional computable general equilibrium models and energy systems models solved in isolation can misrepresent the long run carbon cost and underestimate the demand response caused by technological paradigm shifts in a decarbonised energy system. The approaches outlined here have guided the first evidence based decarbonisation legislation. They continue to provide additional insights as increased sectoral disaggregation in hybrid modelling approaches is achieved.

The paper concludes with a number of challenges that are necessary to address, including i) the uncertainty in exchanging price information from BU to TD models in soft-linking hybrid models and ii) the difficulty in capturing satisfactorily the changes in investment flows that arise due to large structural changes in the energy system.

O-3322a-04

Developing pathways for zero poverty and zero emissions

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Poverty eradication has been a priority of developing countries for a long time, and this is reflected in the UNFCCC. Much more recently, framing a global goal on mitigation has been advanced, aiming at net zero emissions by 2050. In the post-2015 development agenda, the first Sustainable Development Goal is to "end poverty in all its forms everywhere". How to achieve zero poverty and zero emissions?

The problem is easy to state, any 'solutions' are hard to realise. It is easy to support Oxfam excellent slogan, to "make poverty history". And relatively easy to model zero emissions - though at what cost. Yet in developing countries, climate action needs to be in a way that reduces poverty and inequality.

Among South Africa's many development challenges, the National Development Plan identifies poverty and inequality as the foremost [1]. The same plan also refers to reducing emissions, and the climate policy of GHG emissions following a 'peak, plateau and decline' trajectory [2]. To achive both zero poverty and emissions in South Africa's energy economy is challenging [3].

Ongoing research seeks to model multiple development-climate objectives in SA's energy economy, aiming to provide information that is credible, analytically rigorous and is a story that enables interest to imagine themselves in a different future. This builds on a long-standing energy model development at the ERC, and more recently links with top-down economy-wide models, also with teams in other developing countries [4, 5].

Scenario of deep decarbonisation for South Africa - 14 Gt CO2-eq in SA's energy sector (scenario 14 Gt energy) from 2016 to 2050 [3] - and meeting the multiple development objectives is possible. The results of linked modeling of the 14 Gt energy scenario suggest it is technically plausible, but has negative welfare effects.

Earlier work has made the case instruments such as sustainable development policies and measures (SD-PAMs) would better frame action in developing countries [6-11]. But if zero poverty cannot be achieved, as recent results suggest, what is the implication for ambitious climate action? The ERC's research agenda will continue to analyse these wicked problems, and can only benefit from exchange of creative thinking with others grappling with this trilemma [12].

We do not think, however, that mathematical models alone will provide any 'solution space' (we tend to think of it more as a process). Through experience with long-term mitigation scenarios for South Africa [13, 14] and the Mitigation Action Plans and Scenarios (MAPS) programme in Brazil, Chile, Colombia and Peru, we think that the co-production of knowledge and its use of facilitated stakeholder process is powerful in helping a transition to zero poverty and zero emissions societies.

To realise zero poverty and zero emissions, a new social contract is needed [15]. What might the general idea of a social contract look like in a story of a different South Africa? SA has unemployment of 25% (40% by a broader definition), with even higher shares among youth. This emerged with past industrial policy focused on energy intensive sector growth. But if employment were reduced in mining, energy supply and beneficiation, where would it be created? One cannot simply assume unemployed are absorbed by an economy-wide model, without asking whether unskilled youth with no work experience would indeed find real jobs. Some SA economists believe employment-intensive sectors like agriculture and textiles are dead-ends. Others think more employment-intensive growth is possible, and may be helped by a small wage subsidy. We will continue to research, in various ways, the goals of zero poverty and zero emissions.

O-3322a-05

Tipping point policies for energy transformation - assessing their likely effect

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A global climate agreement will not soon lead to a single global carbon price. But 10 years of efforts by individual and groups of jurisdictions have provided valuable lessons on the design of other types of market-oriented and regulatory policies that can foster tipping points in the costs (financial and psychological) of energy system transformation. Assessing the likely effect of such policies is a challenge for energy-economy-emissions modelers. This talk summarizes some of the challenges and possible solutions.

3322b - Development of pathways: their mix of endogenous and exogenous uncertainties and their future under a changing climate

ORAL PRESENTATIONS

O-3322b-01

Modelling Efficient and Equitable Scenarios for a Carbon Constrained World with TIAM-MACRO

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We generate efficient climate change mitigation scenarios of low emission pathways for carbon dioxide and other greenhouse gases (GHGs) such that global warming remains below 2 °C with high probabilities. Then, we balance the cost of mitigation for different world regions based on equity principles and fairness. The study assumes early mitigation actions starting already in 2020 and quantifies the market penetration of carbon-free technologies, the emission pathways and the economic costs for an efficient reduction of GHGs emissions. The prerequisite is that the CO2 equivalent concentration will remain similar to the present levels while the temperature rise will stay below 2 °C of warming. The associated budget of Remaining Carbon Equivalent Emissions Quotas (RCEEQ) is 273 GtC for CO2 plus another 180 GtC-eq. for other GHGs, valid from the period 2020 onwards, and is imposed as constraint. This value of RCEEQ is in accordance with the

Summary Report for Policy Makers of the 5th Assessment report (5AR) of the UN Framework Convention on Climate Change.

Then, we evaluate interregional capital transfers originated from the industrialized world to support mitigation efforts of low income regions to ensure their participation to a binding agreement. Interregional equity transfers are established via a market of emission permits and are presented for different distribution rules concerning the initial endowments of permits. This refers to the effort-sharing or the resource-sharing regimes. Another option considered in the analysis is the introduction of interregional capital transfers in financing a huge joint implementation program covering fully the extra cost of a carbon-free energy system of developing countries up to a stage of full compensation of the economic losses for low income regions.

As all world regions profit from the reduction of damages under the RCEEQ constraint, it makes also sense to estimate the associated regional benefits and to compensate regions for their mitigation cost net of benefits. This capital transfers could take place with the help of burden sharing and emissions trade schemes or through join implementation projects. Therefore, the study undertakes a sensitivity analysis where a) different degrees of cumulative RCEEQ constraints are assumed to differentiate on the needed capital transfers that assure fairness and equity b) different allocation schemes apply while in the case of full compensation we consider the needed capital transfer net of damages and finally c) a scenario of late actions under the same RCEEQ constraints is introduced to investigate potential advantages and disadvantages in terms of regional GDP impacts and the timely restricted overshooting of temperature change. Finally we conclude on scenarios and compensation schemes that allow to define a well-balanced set of regional impacts.

This generation of efficient and equitable scenarios became possible using the Integrated Assessment Model TIAM-MACRO, a technology rich, hybrid general equilibrium model integrating a full scale bottom-up engineering model with macroeconomic top-down models that allows for international trade, developed for the IEA-ETSAP community (Energy Technology Systems Analysis Program www.iea-etsap.org). The model addresses the key concern for all parties of international climate negotiations which is the national economic effect of implementing climate mitigation targets and tries to define fairness in implementing early actions mitigating global warming. Coupling technology rich energy models, such as MARKAL/TIMES and economic models gives additional insight into interregional competition, trade, industrial delocalization and overall economic consequences of decarbonizing the energy system.

O-3322b-02

Bottom-up Economic Climate Change Impacts at the National Level: Known Trends, Unknown Tails, and Unknowables

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Economists attempting to evaluate the impacts of climate change are often caught between hard theory and exceedingly rocky empirics. Impact assessment models are necessarily based on highly aggregated - and sometimes highly simplified - damage functions. This study takes an alternative approach: a bottom-up, physical impact assessment and respective monetization, attempting to cover a much broader set of impact fields, feeding directly into a macroeconomic and welfare analysis at the national level. To ensure consistency, our approach applies impact assessment at the sectoral impact chain level using shared socioeconomic pathways, consistent climate scenarios, computable general equilibrium evaluation, and non-market impact evaluation. The approach is applied to assess a broad scope of climate impacts in Austria. Results indicate significant impacts around 'known knowns' (such as changes in agricultural yield from climatic shifts), with uncertainty increased by 'known unknowns' (e.g. changes in water availability for irrigation, changes in pest and diseases) but also raises the question of unknowns and unknowables, which may possibly dominate future impacts (such as exceedance of critical ecosystem function for supporting agriculture). Climate change, ultimately, is a risk management problem, where insurance thinking warrants significant mitigation (and adaptation) action today.

Analysis of the study result indicate that the current welfare damage of climate and weather induced extreme events in Austria is an annual average of € 1 billion (large events only). This has the potential to rise to € 4 to 5 billion by mid-century (annual average, known knowns of impact chains only), with an uncertainty range of € 4 to 9 billion. When extreme events and the tails of their distribution are included, even for a partial analysis focused on extremes, damages are seen to rise significantly, e.g. with an estimated increase to € 40 billion due to riverine flooding events alone by the end of the century. These highlight the need to consider the distribution of impacts, as well as the central values.

O-3322b-03

Economics of flood risk in Italy under current and future climate

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We estimate current and future economic impacts of fluvial flood risk in Italy in view of climate change under a business-as-usual emissions scenario. The methodology combines a high resolution spatial flood hazard and exposure analysis for an ensemble of climate projections with a regionally-calibrated version of a global Computable General Equilibrium (CGE) model. The economic effects, output losses, are estimated per region in terms of Gross Regional Product change till 2100. Losses are estimated for two disaster risk management scenarios: with and without adaptation to changing flood conditions. Our results show that in Italy, because of climate change, current aggregated ensemble-average Expected Annual Output Losses increase fourfold without adaptation, exceeding 600 million Euro per year by the end of the century. With adaptation the increase is limited to 7 percent. The paper provides the distribution of adaptation benefits across regions, of which the cumulative value exceeds 23 billion Euro over the long term (2014-2100).

O-3322b-04

Title not communicated

M. Aglieatta

Abstract not communicated

O-3322b-05

CIECIA: A New Climate Change Economic IAM and its Assessment of Global Cooperating Abatement Schemes

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From the perspective of global economic general equilibrium, this study developed a new climate change IAM named CIECIA. The economic core of this IAM is a multi-country-sector general equilibrium model. The endogenous technology progress mode is introduced into CIECIA. Based on this IAM, three assessment principles of global cooperating abatement scheme, including effectiveness, feasibility, and fairness are presented. This study simulated and analyzed 6 kind of main global cooperating abatement schemes. The simulated results indicate that all the selected schemes can satisfy the climate protect target to 2100. Thus, they are all effective schemes. However, the schemes have quite different

feasibilities and fairness. The Stern Scheme benefits the developed countries, but is unfair to the developing countries. The Nordhaus Scheme promotes the economy of developing countries. However, it will have negative impact on the benefits of developed countries. The per Capita Emissions Cumulative Convergence and the per Capita Emissions Convergence Schemes benefit the development of middle and low developing countries most. However, these two kind of schemes will cause tremendous losses to main economic entities in the world including China. The Pareto Improvement Scheme which is developed from the Steady Economic Growth Scheme balances the fairness and feasibility in carbon abatement process and realize the Pareto improvement of economic utilities in all the participating countries. Thus, the Pareto Improvement Scheme is the most reasonable global cooperating abatement scheme.

O-3322b-06

Connection between development, other 'externalities' and climate

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This talk will present results from the first international modeling comparison project focusing on the co-benefits from climate mitigation for air pollution, health and energy security objectives. The talk will focus on the extend of the co-benefits for different major economies and the climate goal of 2C.

3322 - POSTER PRESENTATIONS

P-3322-01

Energy-economy-environment applied models: insights, developments and limitations

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The IPCC Fifth Assessment Report shows the end of the controversy between top-down and bottom-up models that was the essence of the results from previous reports. State-of-the-art models have evolved towards more integration, thus becoming ever more complex.In this new era of integrated and hybrid models, models are classified according to criteria such as coverage, flexibility and sectoral details rather than the deep mechanisms themselves within the model.

The current approach to tackle the uncertainties is to create scenario ensembles to compare the reactions of models.Indeed, this top-down approach examines model results rather than starting with a description of model structures to characterize the outcome of model behavior.By contrast, we seek to complete this type of studies by developing a bottom-up approach to create a taxonomy based on the depicted representation and the implicit assumptions within the models.Therefore, we propose to examine the constitutive building blocks of the model to control the structural uncertainty inherent to the forward-looking analysis.Thus we posit that the full picture is needed to understand the forward looking potential of each model.Our goal is to understand the deep mechanisms driving the joint evolution of the energy, economy and environment systems.

This paper presents an updated an thorough taxonomy of the state-of-the-art models from the Fifth Assessment Report.This taxonomy builds on the existing taxonomy, in particular on the historical (and obsolete) opposition between top-down and bottom-up models to bring to light the building blocks of the models.Understanding the building blocks of the models gives an overview of their inner mechanisms as well as the explicit or implicit assumptions in the model.Furthermore, it presents all models in an unified manner in a summary table with a unified vocabulary.The comprehensive review of the models allows a relevant assessment of their potential to produce forward-looking scenarios to reveal insights about the decisions to be made for climate change mitigation.This paper then examines the forward-looking analysis potential of each approach and concludes on their respective uses.

This bottom-up approach is a complex endeavor, but the analysis of building blocks constitutive of the models sheds light on the diversity around key drivers.We identified several groups of deep mechanisms: demand drivers in relation with structural changes, the incorporation of technology, the representation of economic choices and the evolutionary factors of society.Therefore, we want to understand the drivers of the transition both in the short run and in the long run to discuss the global articulation between climate change mitigation and economic development.

P-3322-02

Transparency in Integrated Assessment Modeling

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The basis for concern over anthropogenic climate change is founded in the physical sciences but the rationale for action is rooted in the social sciences. Integrated assessment models (IAMs) are the main tools for combining physical and economic analyses to assess climate change policy. To a large extent, however, these models are black boxes to those outside the integrated modeling community. Economic assessments of climate change consequently risk misrepresenting physical understanding of the climate system, while physical science may fail to focus on the most salient issues for economic and policy assessments. Here we open the lid and resolve physical science differences between three of the most studied IAMs. We argue for greater cross-disciplinary transparency in this highly policy-influential field and for greater debate over the appropriate level of model complexity. Researchers, and research funders, should resist the temptation to increase complexity beyond the point where disagreements and uncertainty about modeling assumptions can be easily identified and debated openly with relevant experts. We suggest alternative ways to improve representativeness and extend the use of IAMs while maintaining and promoting transparency.

P-3322-03

Is there a reason for strong mitigation ? The role of time preference, inequality aversion and catastrophes

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The debate about how strong and quick mitigation policy should be in the coming decades has mostly revolved around the discount rate, with the conclusion that only a discount rate much lower than ordinary market rates can justify drastic action toward abating emissions. There have been, however, some questions about what the relevant market rate is (the riskless market return is actually quite low), and some explorations of more pessimistic estimates of the extent of damages for temperatures rising more than 3°C above the pre-industrial temperatures.

In this paper, we develop a variant of RICE, called NICE (for Nesting Inequalities, Climate and Economy), which separates the ethical parameters of the social objective from the behavior of the economic agents and introduces empirical estimates of inequalities in living standards within the twelve regions of RICE.

The first feature (separating ethical parameters from

behavior) enables us to take the agents' saving behavior as given while we test the policy implications of various configurations of the key ethical parameters of the social objective: the pure rate of time preference and the degree of aversion to inequality across and within generations. The second feature (inequalities within regions) enables us to test whether the presence of huge inequalities in some regions matters for the design of optimal mitigation policy, depending on the distribution of the impacts of climate change and the distribution of abatement costs.

The first result we obtain is that the most aggressive mitigation policy would be warranted if the social objective was to maximize the total amount of consumption over all populations across space and time (no time preference, no inequality aversion). This is due to the importance of damages and the relatively modest abatement costs in the model.

The second result is that while the debate on the consumption discount rate has shown that this rate matters a lot for the pace of the optimal abatement policy, this discount rate is made of several components via the Ramsey formula:

discount rate = pure time preference + inequality aversion x growth rate,

and in this formula, a low inequality aversion does more for mitigation than a low rate of time preference, for the usual ranges of plausible values considered for these ethical parameters. This is due to the (relatively optimistic) assumptions in NICE (adopted from RICE) about the growth rate, which multiplies the former parameter in the Ramsey formula.

Our third result is that the role of these two ethical parameters is substantially muted when the damages are greater than in the standard damage functions of RICE, or when they affect the growth rate and not just the level of consumption. Such results echo earlier work by Dietz and Stern, Moore and Diaz.

Our last set of results is that the presence of inequalities within regions does not affect the optimal mitigation policy much when the damages and abatement costs are proportional to consumption. In contrast, if damages fall more than proportionally on the poor and less on the rich, the outlook of policy and of the role of ethical parameters changes dramatically. A strong mitigation policy may then be justified, and even more so with a strong inequality aversion, due to the implied value of protecting the future poor from strong damages. A progressive distribution of abatement costs also reinforces mitigation in the optimal path, and more so with strong inequality aversion.

The general conclusions of this paper are: 1) inequality aversion between and within generations is a crucial parameter in the design of the optimal mitigation policy (unless damages are much greater than usually assumed, in which case ethical parameters matter less); 2) the distribution of damages across income groups is equally important over the range of sensible assumptions; 3) in particular, distributions of damage that are less than proportional – poor bear larger burden than their share of income – will lead to stronger mitigation policy. The latter two points indicate that the distribution of damage with respect to income is an important field for future research.

P-3322-04

City Sustainability Risk under Climate Change: A Strategic Scan Methodology

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Revisiting the 2011 Climate Change and Cities First Assessment Report by UCCRN and the need to understand how climate risk relates to different cities and infrastructure sectors, the paper discusses transport system vulnerability in both car based and public transport based modes, bringing into play the vulnerability of different configurations of city transport networks and technologies when faced with climate change related hazards. Transport systems are designed to have an operational performance and are expected to contribute to a city's overall sustainability. However, under climate change related hazards, the transport system is at risk of being in a failed state, either below its expected operational performance level, or unavailable all together. The paper introduces the types of failed states for different modes and considers how the vulnerabilities can be better understood by first understanding the effect on reliability and availability of service. Climate change hazards can be viewed as an outcome of unsustainable practices in our built environment, infrastructure and use of resources. Sustainability itself is therefore a key contributor to mitigation of climate change hazards, but conversely climate change hazards put at risk the sustainability improvement we strive for in our cities. The paper explores measuring the vulnerability to climate change hazards, in terms of the change caused to sustainability performance when the transport system suffers loss in reliability or availability. A methodology which utilises accessibility as a useful measure in social and economic aspects of sustainability, generates visual sustainability metrics based on the concept of a sustainability goal in "environmental sustainability – accessibility space". A city's sustainability performance in relation to the goal is generated using plots of environmental sustainability & accessibility for each travel zone pair in the city. A collective plot of sustainability measures for individual zonal pairs creates a simple, but analytically rich visualisation, giving insight into the position, spread and internal distribution trends for a city's urban sustainability pillars of environmental stewardship, social equity and economic efficiency. For community and decision makers these visual differences give a simple snapshot of overall sustainability performance, for each scenario being considered. A feature of the methodology is its systems based drivers or levers. All visualisations have traceability back through the algorithms to the source inputs, allowing changes in system scenarios to be made. By including scenarios that include the transport system failed states, inclusive of the impacts of climate change hazards on travel time reliability and service availability, the paper explores the effect on the sustainability performance using the methodology. A particular strength is that the metrics are derived from data sets more likely to be found amongst transport and city planning departments. The paper presents Sydney case study visualisations to illustrate the type of high level outputs that can be built from this systems approach, to discern the merits of different resilience scenarios. With this methodology and the assistance of readily available GIS/T software, the sustainability metrics are able to be translated into spatial visualisations, to enable discernment of sustainability performance differences within the city. These metrics can also be applied in a way that expresses sustainability performance in terms of a sustainability risk ranking. High risk, where sustainability performance is poor, is indicated by low metric values. Low risk, where sustainability performance is satisfactory, is indicated by a higher metric value, above a community accepted minimum target. A grid concept likened to a risk matrix can be formulated allowing each zone pair to be assigned a sustainability risk rating. The sustainability risk boundaries are specific to each city, and influenced by the population's estimated resilience. The paper discusses this approach of sustainability risk rating, illustrating the technique of the translating this into a visual graphic in geographic space using geographic information system (GIS) thematic mapping. Visualisations of this type can be used to inform decision makers (community & government agencies) in the process of choosing climate change policies and programs for a city.The paper concludes with a discussion of next steps and need to further case study the work in conjunction with other researchers and with an initial selection of cities and their governments/agencies.

P-3322-05

A Research on the Multi-country-sector Economic Growth and Global Governance of Carbon Emissions under Global Carbon Taxes

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This paper focuses on the national/sectoral levels, using a climate-economic integrated assessment model named CIECIA to have a research on changes of the multi-country-sector economic growth and carbon emissions under different global carbon tax rates and tax distribution schemes. The results indicate that carbon tax policies have obvious promoting effects on the carbon

abatements of the developing countries. The accumulative carbon emissions of China and India from year 2016 to 2100 can be reduced by 69.27GtC and 57.78GtC separately, whereas the carbon emission reductions of the developed countries are smaller under carbon tax policies because of their low abatement potentials caused by higher initial low-carbon technologies, lower economic growth rates, etc. In the simulations of four international carbon tax distribution schemes, the equality principle which is based on the population benefits China mostly, while the carbon emission per capita principle and the payment ability principle benefit countries with large populations and low economic developments e.g. middle & low developing countries mostly. Specially, the carbon emission per capita principle is harmful to China because the population of China will decrease after 2030, whereas its carbon emission demand will still increase for its rapid economic development. Investing carbon tax returns to the knowledge capital for improving process technology progress will increase the carbon abatements, especially in developing countries. While the investing rate of knowledge capital from carbon tax return reaches up to 50%, the accumulative carbon emissions of China and India from 2016 to 2100 will be reduced by 69.27GtC and 57.78GtC separately. However, the developing countries have relatively lower emission reductions because of their higher initial capital knowledge levels, lower carbon tax returns, etc.

P-3322-06

A bottom-up approach to improve local-scale understanding and decision making in responding to climate change

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Integrated assessment models of global change require improvements to better quantify climate change impacts and to represent the effects of adaptation decisions at local scales. This is especially relevant for understanding the consequences of local decision making on land use change processes, which varies significantly across cases. Assessment of realistic adaptation options to climate change at local scales also requires recognition of relevant governance and behavioural aspects in any modelling and analysis rather than making over-simplified assumptions such as relying solely on profit maximization. Methodologically, there is also a challenge of studying these processes through the continuum between collecting (often qualitative) data on local stakeholders' decisions and tracing the cumulative impacts of those local decisions in simulation models (often quite formal and quantitative). This presentation provides an overview of model-based ways to contribute to incorporating essential human elements in decision making processes for modelling of complex socio-ecological systems, and hence improve understanding and communication about decision making in complex socio-ecological systems. The presentation then specifically tackles the challenge of bridging the qualitative and quantitative by presenting a step-wise methodology for integrating perceptions of stakeholders (qualitative) into formal simulation models (quantitative). The methodology integrates cognitive mapping and agent based modelling. It cascades through a sequence of qualitative/soft and numerical methods comprising: (1) Interviews to elicit mental models; (2) Cognitive maps to represent and analyse individual and group mental models; (3) Time-sequence diagrams to chronologically structure the decision making process; (4) Building an all-encompassing conceptual model of decision making, and (5) a computational, in this case agent- based, model. We apply the proposed methodology (labelled ICTAM) in a case study of viticulture irrigation in South Australia, which faces the potential of aggravated water scarcity under a changing climate. In particular, we focus on local decision-making of winery holders - both at individual and community [TF1] levels - with respect to their understanding of risk of water shortage and chosen adaptation strategies. Finally, we use the strengths-weakness-opportunities-threats (SWOT) analysis to reflect on the methodology. Results show that the methodology leverages the use of cognitive mapping to capture the richness of decision making and mental models, and provides a combination of divergent and convergent analysis methods, deepening the understanding of decision making during the construction of an Agent Based Model.

P-3322-07

Assessing future energy and climate pathways in an uncertain World: stochastic and parametric framework in TIMES models

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Uncertainty introduces a new dimension in the decision making environment that simply cannot be captured by scenario analysis. Hedging strategy is not necessarily a combination of deterministic solutions; new options may emerge dominant with explicit treatment of uncertainty. For example, perfect foresight of no emission abatement may favor coal, and that of severe emission abatement may favor renewable sources, for near term power sector investments. However, under a stochastic cumulative emission bound, gas may become the most appealing solution for decision-makers, as it is relatively short-lived, cheap and not as polluting as coal. We see several examples of this dynamic in the runs that we propose to present.

Further, it is not easy for decision makers to assign probabilities to long-term uncertainties like abatement levels imposed in a future changing climate. Analyzing a wide range of probabilities of key uncertainties would provide more useful insights to policy makers.

To demonstrate, stochastic programming with the TIAM-World model is used for a parametric analysis of hedging strategies, varying the probabilities associated with each of two contrasted technology outlooks. The parametric analysis constitutes an original supplement to the computation of hedging strategies by identifying technologies that are robust under a broad range of probabilities of the two technology outlooks. Natural gas appears to be one of the most appealing robust options in an uncertain technological context, especially in China, given its relatively low emissions and the low capital cost of associated technologies. Natural gas and some other options are in fact considered as «super-hedging» actions, penetrating more in the hedging solution than in any of the deterministic scenarios. Nuclear power and CCS use are less robust: they depend much more on either the level of the climate target or the probabilities of the technology outlooks. The analysis also shows that technological uncertainty has a greater impact under milder climate targets than under more severe ones.

The combination of stochastic programming and parametric analysis proves to be powerful for policy formulation as it delivers useful insights with minimal assumptions from the policy maker.

P-3322-08

2030 Climate Targets in Sweden: An Integrated BU and TD Approach

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The aim of this paper is to identify the role of biomass in meeting stringent Swedish climate targets in the year 2030. This is achieved by improving the existing soft-linking between TIMES-Sweden (national energy system model) and EMEC (national CGE model), with special emphasis on the representation of biomass in the two models. While the generation of electricity and heat is close to carbon-free, the Swedish industry sector and transportation has remained carbon-intensive. Biomass can play an important

role for CO2 reductions both in the industry sector (e.g. the iron and steel industry) and for transportation (e.g. biofuels). Some estimates indicate that the already high use of biomass for energy could double and still be ecologically sustainable (Börjesson et al., 2008), however, biomass will never be an unlimited resource.

The question is where, and to what extent, biomass can be used in an ecologically and economically sustainable way. The most cost-efficient allocation of this limited biomass can be assessed with a national energy system model covering the entire energy system, such as TIMES-Sweden. Moreover, the development of the industry sector (i.e. the demand for energy related goods and services) will both depend on future energy prices and on the remaining economy. Those are aspects that could be assessed by soft-linking TIMES with a national CGE model such as EMEC. A soft-link between the two models has been established (see Krook-Riekkola et al., 2013). A detailed soft-linking process, i.e. providing feed-back between the two models on a disaggregated level, was made possible by EMEC having a more detailed description of the energy use compared with many other CGE models. Nevertheless, CGE models are in general based on aggregated historical and current economic flows, which make it challenging to consider new fuels or technologies, such as different kinds of biofuels. In this present study, EMEC (the CGE model) have been modified to also capture the competition between conventional energy commodities and biofuels, which facilitate an improved feed-back between the two models and in the end an improved cost analysis of potential national Swedish climate targets. The soft-link now includes a disaggregated feed-back from TIMES-Sweden with different kinds of biomass use, including both energy intensities and cost figures, to the EMEC model. TIMES-Sweden has been improved accordingly. Preliminary results from when soft-linking the two models shows that biomass play an important role in meeting tough Swedish climate targets. Biomass, used efficiently, can reduce the cost of meeting a national climate target and still be within an ecologically sustainable level of biomass harvesting.

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P-3322-09

A household perspective on ecosystem services: a network approach

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Addressing global climate change (GCC) is one of the major social, political and economic challenges of humanity for the next decades. Scientific evidence suggests that this process already started a few years ago and will last for hundred and even thousands of years, with a scientific consensus on the changes this global phenomenon will imply in climate, ecosystems and human societies. However, there still is uncertainty about the magnitude of their impacts, especially in terms of ecosystem services and social welfare, as these depend ultimately on our social response at local-global scales. In Latin America and the Caribbean, millions of people depend, to one degree or another, on ecosystem services because much of their well-being and production system relate to live in diverse and healthy ecosystems. Therefore, it is important to understand the relationships between natural and social systems to be able to understand the eco-social impacts of global climate change. This project aims to map, using an approximation of complex networks, natural and social capital in rural populations. These eco-social networks will be built at the household level using trans-disciplinary tools such as application and analysis of socio- ecological surveys & interviews, development of conceptual eco-social models and the development and application of network models and metrics (quantitative analysis). The project is been developed in two watersheds in shouthern Chile, as a case study. We already have more than 370 surveys of use of ecosystem services in rural households. Our approach tries to use complex network theory to construct a "map" of the use or demand of ecosystem services (natural capital).

Our current approach is to develop quantitative, star-shaped networks of surveyed services (wood & water usage, water treatment, hopefully recreation) with households as the center node. We'll also try to map the social interactions that constitute "bridge" social capital (committees, associations, subsidies, etc.) trying to find relationship within these two forms of capital. In our social capital networks, the household is also the center node of a star shaped network composed of social capital "bridge" relationships -water committees, unions, neighborhood councils, government subsidies.

Our results show different patterns of natural capital depending on the level of urbanization of each watershed. Those localities located on more natural landscapes showed a higher diversity and uniqueness of patterns of use of ecosystem services. Our method provides an inexpensive, flexible tool to assess ecosystem services demand at household level.

Further developments could include coupling of these networks of natural capital to biophysical models to include the offer of services from ecosystems, thus modeling the whole dynamics of ecosystem services, from offer to demand. We need to improve our knowledge of the dependencies of our wellbeing with natural ecosystems to build resilient neighborhoods and prepare our societies to adapt for an increasingly 'uncomfortable' planet.

P-3322-10

The regional macroeconomic effects of delayed action in meeting a global 2 degree climate target

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The UN Framework Convention on Climate Change (UNFCCC) negotiations have previously sought to reach a global agreement on how to limit climate change to 2°C. Despite progress over the past decades, and whilst nearly all countries have signed up to this 2°C threshold, no such comprehensive framework has yet been agreed. Whilst there is renewed focus for the COP21 negotiations to be held in Paris in 2015, the possibility still remains that there will be further delays on how to limit climate change to 2°C will result in increased costs for different nations.

Part of the reason for these successive failures, and a key concern for each party at the international climate negotiations in 2015, is the anticipated national economic effects of implementing ambitious climate mitigation targets that are consistent with the pledged agreement to limit climate change to 2°C. However, further delays will tend to only exacerbate these issues. The aim of this work is to use hybrid modelling techniques to determine the economic effects on regional economies of limiting global warming to 2°C. We also aim to explore the macroeconomic implications of the delays that have already occurred in reaching and implementing a global agreement, and how these will be amplified if there is further delay.

We use the TIAM-UCL energy systems model developed at University College London which is a global bottom-up technology-rich cost optimisation model. The model is based upon the ETSAP-TIAM model (Loulou and Labriet, 2007) but with several significant additions in terms of a climate module, a separate UK region and significant regional resource data improvements. The model has recently been applied to explore distributional effects of unused fossil fuels in meeting a 2°C target (McGlade and Ekins, 2015). Here, we expand upon the model by considering the general equilibrium effects and potential regional GDP loss of limiting climate change to the agreed 2°C threshold.

We have added a simplified general equilibrium macroeconomic growth module developed by Kypreos and Lehtila (2013). Macro Stand-Alone (MSA) is a single agent; single sector, multi-regional, general equilibrium optimal growth model which maximises discounted utility of a single consumer-producer agent. GDP is comprised of consumption, investment and energy system costs. Total

economic production is determined by a combination of energy, capital and labour where energy substitutes with a capital-labour composite via an elasticity of substitution parameter. Quadratic cost functions and demand decoupling factors are estimated from the calibration routine are fed from TIAM-UCL to MSA. MSA is then solved and the new energy demands are given back into TIAM-UCL which is then solved again. The iteration continues until the model converges, defined by the change in energy service demand variation between interactions slowing to within a specified tolerance.

Initial results for the TIAM-UCL-MSA model show that the macroeconomic effects across the 16 regions of meeting the 2°C target differ significantly. The range of GDP loss in 2050 compared against a 'no emissions target' baseline scenario for European countries and the United States is between 1% and 2%. This suggests that the losses that would be incurred while achieving the ambitious emissions reductions required to limit global warming to 2°C are relatively modest in these regions. Losses are, however, much higher in the Middle East and Former Soviet Union regions, reaching up to 5.5% lower compared with growth in the baseline scenario. This results from the reduction in markets and prices for these regions' fossil fuel exports that can be expected under such a 'no emissions target' scenario.

If action is delayed beyond 2030 then it is highly unlikely that reaching a 2°C world is feasible at all, however further set of scenarios which delay action to 2025 and 2030, and which thus make the emissions reduction more difficult to achieve, will be examined in this work. By examining the additional losses in GDP that will result from delayed action on mitigating climate change, these results will have profound consequences for the climate negotiations to be in 2015.

P-3322-11

Forecast on China's Energy Consumption and Carbon Emissions Driven by Micro Innovation:an Agent-based Simulation

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To forecast the energy consumtion and carbon emissions in China, this paper established an input-output model with 17 sectors on the macroeconomy level, and an agent-based model on the microeconomy level simulating firms' innovations in each sector. Results show that due to the uncertainty of innovation, the peak years of energy and emission are also uncertain. The energy peak year will subject to a normal distribution from 2025 to 2036; while the distribution of emission peak year is also identified as a normal distribution from 2024 to 2033. The year with the maximum probability for energy peak will be 2031 with the probability of 23.57%; and 2029 will be the year with the maximum probality 33.51% for emission peak. Taking the average of 50 simulations, it is indicated that the energy peak will be 5146Mtce in 2029 with a decline by 2050 to 4086Mtce, and the emission peak will be 2.7GtC in 2029 with a decline by 2050 to 2.05GtC.

P-3322-12

The Simulation of China Regional Climate Trends

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In order to simulate the climate change in China, we adopt the regional climate model RegCM4, which is jointly researched and developed by NCAR/PSU (The National Center for Atmospheric Research/ the University of Pennsylvania). The model is widely used in the research of large range regional climate. Considering the CO2 emission strategy in the future process of climate change, A1B scenario simulation data produced by global circulation model EH5OM is chosen and used as the driver of regional climate model initial field and the lateral boundary conditions. Its change rate of annual average temperature is closed to observed value and the performance of the seasonal and interannual variability of precipitation is reasonable. Simulation period begins on 15 October 2040 and ends to 31 December 2060 and the period before 31 December 2040 is seen as simulation initialization phase. Sea surface temperature boundary field comes from SST_A1B data on RegCM4 website, interpolated on the grid simulation area.

The contemporary climate simulation results in 1981-2000 are subtracted form the A1B scenario simulation prediction results in 2041-2060 respectively. In this way, we reduce the uncertainty in climate predictions brought by the simulation error, and improve the reliability of prediction. Then we get the possible future climate change trend of China in the middle 21st century, under the A1B scenario. As results show, the multiyear average temperature increases more in the north region than it in the south, more in the east then it in the west. The increasement ranges from 1.5℃ in the southeast to 2.4℃ in the northwest, even reaches to 3℃ in some area. Different from mean temperature, the variation trend of multiyear averaged annual precipitation dose not shows an increasing trend in all reigons. The annual precipitation may have a decrease trend in the south of the Yangtze River, including the yangtze-huaihe region, which generally reduces about 100 mm. The average annual precipitation decrease rate is sharper in the southeast china and it decreases over 200 mm in some area. The precipitation may be lower in Guizhou and east Yunnan, as well as the east and north region of Taiwan. However, a increasing of annual average precipitation can be seen in the north region of China, especially in east Inner Mongolia and local area of Heilongjiang. In addition, there is a sharp increase in south Tibetan Plateau, which may exceed 200mm.

A lot of researches on climate change simulation are reported, and the simulation of RegCM4 under A1B scenario is accepted by most scholars now. While some details of this simulation results differ from others results, the error is acceptable.

P-3322-13

Modeling and Computation of Transboundary Industrial Pollution with Emission Permits Trading by Stochastic Differential Game

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The topic on how to deal with the transboundary industrial pollution is becoming more and more popular, and it requires international actions to control its formation and effects. In this paper, we present a stochastic differential game to model the transboundary industrial pollution problems with emission permits trading. More generally, the process of emission permits price is assumed to be stochastic and to follow a geometric Brownian motion (GBM). We make use of stochastic optimal control theory to derive the system of Hamilton-Jacobi-Bellman (HJB) equations satisfied by the value functions for the cooperative and noncooperative games, respectively, and then propose a so-called fitted finite volume method to solve it. The efficiency and usefulness of this method are illustrated by the numerical experiments. The two regions' cooperative and noncooperative optimal emission paths, which maximize the regions' discounted stream of net revenue, together with the value functions, are obtained. Additionally, we can also obtain the threshold conditions for the two regions to decide whether they cooperate or not in different cases. The effects of parameters on the results have been also examined. All the results demonstrate that the stochastic emission permits prices can motivate the players to make more flexible strategic decisions in the games.

ORAL PRESENTATIONS

O-3323-01

Human Dignity & the Future of International Environmental Governance in the light of ICJ Jurisprudence: A Normative Analysis

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More than being an attempt to suggest a direction for the further policy discourse, this paper presents a normative perspective which espouses and analyses Human Dignity as a School of Law with regards to International Environmental Governance.

The paper begins with an introduction of Human Dignity as the foundation of modern public international law and explains it further in the light of Elementary Consideration of Humanity doctrine as developed by the International Court of Justice (ICJ). This part explains the irreversible connection between the contemporary principles of international environmental governance and human dignity by relying upon various legal authorities and opinions.

The second part of the paper brings out the deficits of international environment law. It is argued that in the light of the conceptual trinity of sources of international law as enshrined in Article 38 (1)(c) of the ICJ Statute, one may observe that the deficit of international environment law is trilateral: treaty law, customary rules and the general principles of international law.

In the third part, this paper comprehensively analyses international environmental jurisprudence as developed by the International Court of Justice in order to address the deficits in the law as pointed out in the second part of the paper. It is argued that the ICJ's environmental jurisprudence reflects that progress in the international environment law can well be secured by the application of general principles of international law. Here, relying upon the ICJ jurisprudence, four such core principles are also identified which provide the basis for an environment specific legal application.

The objective of this paper is two-fold: firstly, to take forward the discourse on the future of global governance norms in the light of human dignity as the core principle, especially with regards to environmental governance; secondly, to propose the fundamental principles through a normative analysis which should form the cornerstones of the broader discussion taking place during the conference.

O-3323-02

Justice and equity in REDD+

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The UNFCCC adopted Reducing Emissions from Deforestation and Degradation, enhancement of carbon stocks, conservation, and sustainable management of forests in developing countries (REDD+) as a climate mitigation mechanism given the scale of CO2 emissions resulting from the conversion and degradation of tropical forests (ca. 12-15% of global anthropogenic greenhouse gas emissions (GHG)), and the early belief that avoiding deforestation would be a 'quick, cheap and easy' mitigation option. REDD+ was originally conceived as a system of Payment for Environmental Services which aimed to link sellers and buyers via voluntary, conditional agreements over a well-defined environmental service - or a land use presumed to produce that service. The majority of funding, it was anticipated, would come from carbon markets.

Despite the significant technical, methodological and policy challenges that still need to be met, it is likely that REDD+ will be a component of a new climate change agreement given the Copenhagen Accord, the outcomes of the work on REDD+ safeguards of the AWG-LCA in Cancun, the Warsaw REDD+ Framework, the ADP's continuing efforts to address Non-Carbon Benefits, non-market based approaches and joint mitigation and adaptation, and the emergence of a plethora of project-based and jurisdictional REDD+ standards. This despite the effective collapse of (forest) carbon markets, and an overall negative performance at a global scale (GHG emissions in 2012 were at 58% higher levels than they were in 1990 cf. Article 2 of the Convention). REDD+ activities are now financed predominantly as part of Official Development Assistance programmes. The added incentives promised by REDD+ are likely to heighten the existing struggles for access to, and control over land and forest resources. As new values are assigned to forests, contestation between statutory and customary systems of individual and communal property regimes are likely to be exacerbated.

This paper adopts a 'rights, responsibilities, revenues and relationships' framework to highlight the (relatively) limited attention accorded, to date, to develop appropriate legal frameworks for REDD+ often in contexts distinguished by legal pluralism and multiple framings and dimensions (procedural, distributive and contextual) of 'justice' and 'equity' at different scales of governance. It raises questions (again) about the limits of 'blueprint development' that often privileges external actors (and their knowledge systems) over local communities. Complex legal issues such as those related to land tenure, benefit sharing, constitutional compliance, conflict resolution and liabilities have not been adequately addressed to provide enabling legal frameworks for REDD+ implementation. The paper draws on collaborative research conducted by CIFOR and IDLO in Tanzania, Mozambique and Zambia.

O-3323-03

Law and Governance Instruments for Sustainable Landscapes in the Low-Carbon Economy

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Sustainable development of landscapes requires multi-sectoral and multi-level interventions, in order to deliver on the potential opportunities of the low-carbon green economy. What international law and governance instruments can assist land-use decision-makers, particularly in forest, agriculture, extractives and other sectors, to promote more sustainable trade and investments? New governance research and legal analysis is focusing on the innovative international economic instruments that global treaty processes, such as the UN Framework Convention on Climate Change, offer to provide incentives towards more sustainable landscapes. At the same time, while the Doha Development Agenda remains stalled in the WTO, emerging regional trade and investment treaty measures are seeking to encourage sustainable development of renewable energy, forests and other resources. These international regimes, and the financial flows that they govern, might serve to frustrate more sustainable development, requiring robust application of social and environmental safeguards. Or, if implemented in an effective and integrated manner, they may hold the potential to foster more sustainable development on the ground and across transnational value chains, providing levers for countries to ensure better governance of scarce natural resources in a way that supports global efforts to respond to climate change mitigation, resilience and financing challenges. Based on recent books and multi-country climate law and governance studies, this paper explores the key international, national and local policy and regulatory innovations, world-wide, and considers how can recent emerging treaty-based regimes and instruments contribute to sustainable landscapes governance.

O-3323-04

Migration, environment and climate change: legal frameworks and challenges

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The issue of a legal framework to address environmental migration is a widely debated topic. There is no internationally accepted legal definition or specific status for people on the move due to environmental factors, and no legal instrument dedicated specifically to this issue. As a result, ensuring the protection of affected individuals seems challenging in the absence of one instrument that identifies the applicable rights and corresponding States obligations tailored to the specificity of environmental migration. This has led to strong calls for international efforts to create a specific legal status for environmental migrants.

This presentation will provide an overview of the particular challenges environmental migrants may face in terms of human rights and justice; existing legal instruments, their applicability in the context of environmental migration, as well as their limitations; and discuss the prospects and challenges for creating a protection framework for those displaced or migrating in the context of climate change. As the leading migration agency, IOM will share its practical experience and emphasize the importance of a rights-based approach to the management of environmental migration.

O-3323-05

Hybrid Legal Approaches towards Climate Change: Concepts, Mechanisms and Implementation

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In the light of better understanding global risks, this paper will explore environmental risks from a climate change legal-related perspective, in particular human rights and migration, focusing on the core of the problem and not essentially on the form, drawing on and using regional level experiences, such as Pacific Islands. The paper will address climate change triggers, such as sea-level rise impact on national and regional law upscaling to international law, for considering a potential legal approach, not just in terms of mitigation, but also in terms of adaptation, risk reduction, transfer of technologies, climate finance and capacity building.

Hybrid approach is based on the (International) Hybrid Law, a legal research tool which concurrently, indivisibly and interrelated analyse a climate change case study from three perspectives: environmental law, human rights and refugee (migration) law. Hence, the research is simplified, using a single lens as a replacement for a three way analyse.

It was noted that having the main cause in breaching international environmental law, e.g. violation of the principles of international environmental law, the main legal effects are mostly to be found in the human rights law, due to its unavoidable first impact upon the targeted society. Secondary, as a subsidiary effect, there is refugee (migration) law, because of the same strong impact, regardless of the type of response: immediate, intermediate or long-term.

There are two methodologies the research will make use of in regards to address the issues mentioned above:

- Rights-based approach which will emphasise the bottom-up standpoint as imperative in the post-2015 climate agreement (human oriented analyses, loss and damage, etc.)

And

- The progressive interpretation of law methodology which will underline the need of hybrid approaches in addressing climate change from a legal perspective in particular in relation to human rights (direct effect) and migration (as subsidiary effect).

The paper applies international hybrid law methodology in its innovative endeavor to address the challenging questions of the existing legal gaps in international law, environmental (legal) risks and human security in an unprecedented global circumstance, when States, for the first time in the history of the humankind, are projected to disappear from the world map without war.

The expected outcomes of the paper are as follows:

- How rights and hybrid approaches apply to climate risks and lead to migration, as subsidiary effect at local, national and international level;

- How to use hybrid legal tools in climate change and migration related cases;

To address the questions of legitimacy and sovereignty under international law, of a State without a territory lost due to climate change triggers and provide preemptive legal solutions to potential risks associated with this unparalleled state of affairs.

O-3323-06

Exporting Harm

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In this paper I will discuss an aspect of the problem of how to divide the World's remaining 'carbon budget' - the amount of CO2-e that can be emitted if we are to avoid dangerous climate change. I will argue that there is a prima facie case for allocating responsibility for the harms caused by exported emissions such as those produced by coal, as well as those that are produced within a country's borders. This is not a complete determination of the carbon budget problem by any means, but a step towards its development.

My paper sets out some of the factors that determine a country's carbon budget and argues that the current methods for allocating emissions and responsibilities for their harms are inadequate and more complex than they appear.

The paper will consider several dimensions of the harm caused by unrestricted fossil fuel exports. First, what kind of harm is caused by such exports? Second, whether analogies exist between other harmful exports ¬ medical waste, tobacco, unsafe jobs, uranium ¬ and fossil fuels to examine how the kind of harm caused by global warming is different from standard cases of harm where only two parties are involved. Third, whether unrestricted export of fossil fuel exports satisfy a 'fair shares' criterion. Finally, what allocating responsibility for harms means in practice.

3323-POSTER PRESENTATIONS

P-3323-01

Environment Tribunals and Justice: The Indian Experience

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I inquire into practices and experiences with adjudication that emerge from a study of the cases filed before the newly formed National Green Tribunal in India and interviews with selected lawyers and appellants that focus on governance and justice. My endeavour is to show how the affected public's vulnerability to environmental and climate change intersects with the discourse and practice of governance, ethics and justice as well as resilience, mitigation and adaptation.

Taking a bird's eye-view, collective experiences of vulnerability have given rise to the organization of multiple environmental publics in India. Analyzing the cases filed before the National Green Tribunal by these publics enables me to demonstrate that by litigating the environmental public interest, the experience of vulnerabilities is often

transformed into events marked by resilience though not necessarily by success.

From a local perspective, issues of climate change and the environment cannot be easily disentangled since climate change hits the environment as base. It is a local climate-cum environmental violation that comes to threaten the life of an individual or household and is articulated as worthy of further action by gathering a public and acquiring a strategic local scale. The next step begins with the search for an environmental lawyer (and funds) for adjudication before the Tribunal. This step is the event's translation into the language of law and the state, which produces and views the violation from an altered scale and perspective. The transformation is experienced as a rupture that marks the distance from a local public to a public mediated by the environmental laws of the state.

New interactions then occur across scales such that the environmental/climate cause lawyer assumes a critical role - with one face turned to the local, as it were, and the other to the law as its representative interpreter. The environmental lawyer addresses the mismatches between the scale of law and the local apprehension of the problem and scale as he sifts the facts and frames them for presentation in a legal case. What comes into being at the local level, then, is a heightened awareness, friction and even a revelation, of the limits of legal processes (spatially, temporally and including their possibilities for justice). Simultaneously, therefore parallel channels of communication are activated and engaged to reach out to politicians and government officials at multiple sites in the quest for justice.

The Legal Bench of the Tribunal embodies the statutory perspective even more completely than the lawyer. Here the facts of the case are readily rendered as background and the legal order of argumentation and knowledge, into which the case must fit, takes precedence. From this perspective, the judge or Bench often reads the environmental violation as an issue that stems from the inadequacy of the executive which has failed to do its jobs and let the problem fester. As the legal judgment, in its corrective mode, travels back to the local, it is inevitably filtered through the visions of the executive, such that the local enforcement of a judgment on the ground is rendered uncertain and risky. The implementation of a sound legal judgment is contingent on the local bureaucracy and the local public attempts to adapt to this maladapted reality.

The global of environmental law and governance also emerges as a producer of new scales and perspectives from a different situated context. The transnational environmental climate sphere's scales and processes, too, journey downwards to nation-states where these are both ratified and refracted. The judge who embodies the statutory order of the nation state also appears as the arbiter of national difference from promulgated global principles of environmental-cum-climate regulation. International treaties are thus unable to trump national sovereignty in the present.

What you have, then, is an insubordination of scales, compelling us to move up, down and sideways to understand and address the legitimacies/ illegitimacies of governance and justice and the frictions of local and national difference in the context of environmental climate change.

P-3323-02

Governance of Local Disaster Management Committees in line with SOD in Bangladesh

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Due to its geographical location Bangladesh has always been prone to natural disasters such as tropical cyclones, floods, droughts, tidal surges, tornadoes, river-bank erosion and many more. Bangladesh has shown significant improvement in disaster management which is proven by its possession of Standing Orders on Disaster (SOD), Disaster Management Act, National Disaster Management Plan, Disaster Management Policy, Disaster Management Committees at the District, Upazila and Union levels. However, despite the government's commitment and effort given by many actors the room for improvement prevails in the disaster management system. A total of 51 DMCs in five districts that were vulnerable to flood, river-bank erosion, drought and cyclone were taken as sample to analyse the current situation of these committees. The study was conducted using both qualitative and quantitative methods. Both open-ended and close-ended questions were asked. Questionnaire and KII tools were used to collect information from respondents in both the government organizations and NGOs. The study has observed poor coordination between GO and NGOs at the sub-national and local level. Surprisingly, the study has found that only 38.9% DMC members are informed about Disaster Management Act and 36.76% are aware about their roles and responsibilities in the Standing Orders on Disaster (SOD). Although the selected districts are extremely prone to disasters, surprisingly it has been observed that 70% of DDMCs and 30% of UzDMCs are holding regular meetings and only 16.22% of UDMCs are holding regular meetings as per the SOD. The scenario mentioned above clearly states that the DMCs are not active as they should have been according to the SOD. Only 43.80% of DMCs have Risk Reduction Action Plan (RRAP) but perform very few activities according to the RRAP. It was found that only 23.3% of DMCs have developed volunteer groups and only 26% of DMCs have arranged community awareness building programmes. The study has also found that only 34% of Union Parishads have incorporated DRR into their Annual Development Plan. It is alarming that even though Bangladesh is one of the prime victims of climate change, encountering severe and frequent disasters like Sidr, Aila and Mahasen, 66% of the sample Union Parishads did not have DRR integrated into their ADPs. Based on the gaps recognized in the study, it can be concluded that the functionality of the DMCs needs to be improved through capacity building, training, and materials such as a guidebook to simplify the SOD etc. in order to levitate the current Disaster Management System. Empowering the DMC members by increasing their level of understanding in Information Technology and by linking them to the national level will ultimately lead to more and improved governance system of Disaster Management Committees.

3324 - Paradigms for Building Resilience from Cross-scale Integrated Risk Governance Perspectives

ORAL PRESENTATIONS

O-3324-01

Risk Culture: Implications for Risk Governance

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Deciding about the location of hazardous facilities, setting standards for chemicals, making decisions about clean-ups of contaminated land, regulating food and drugs, as well as designing and enforcing safety limits all have one element in common: these activities are collective endeavours to understand, assess and handle risks to human health and the environment. These attempts are based on two requirements. On the one hand, risk managers need sufficient knowledge about the potential impacts of the risk sources under investigation and the likely consequences of the different decision options to control these risks. On the other hand, they need criteria to judge the desirability or undesirability of these consequences for the people affected and the public at large. This second part is an integral aspect of risk culture, understood as the systems of norms, vales and visions that an organization shares among its members Within the portfolio of organizational culture, criteria on desirability are reflections of social values such as good health, equity,

or efficient use of scarce resources. Both components – knowledge and values – are necessary for any decision-making process independent of the issue and the problem context.

Anticipating consequences of human actions or events (knowledge) and evaluating the desirability and moral quality of these consequences (values) pose particular problems if the consequences are complex and uncertain and the values contested and controversial. Dealing with complex, uncertain and ambiguous outcomes often leads to the emergence of social conflict. This is particularly the case for emerging technologies where the risks are not yet known. Although everyone may agree on the overall goal of safety and environmental quality, precisely what that goal entails (how safe is safe enough?) and precisely how that goal will be obtained may evoke substantial disagreement. Major issues in this context are: what are the most suitable criteria for judging risks? Hoe can an organizational culture cope with uncertain outcomes and how can it develop an effective monitoring system. How should an organization manage risks that benefit one party at the expense of potential harm to another?

These crucial questions of how to deal with complex, uncertain and controversial risks demand procedures of decision-making that go beyond the conventional risk management routines. Numerous strategies to cope with this challenge have evolved over time. They include technocratic decision-making through the explicit involvement of technical experts, institutional arrangements for foresight and monitoring, direct stakeholder involvement, and external reviews. The main argument of the paper is that public and private institutions that assess and manage risks are in urgent need of revising their institutional routines and of designing procedures that enable them to integrate professional assessments (systematic knowledge), adequate institutional process (organizational culture), responsible handling of public resources (efficiency) and stakeholder knowledge and perceptions (reflection on public values and preferences). These various inputs require the inclusion of multiple procedures and the involvement of several actors in the risk assessment and risk management process. The structures that evolve from the cooperation of various actors in all phases of the risk handling process are subsumed under the term risk governance . Governing choices in modern societies is seen as interplay between governmental institutions, economic forces and civil society actors, such as non-governmental organizations (NGOs). 'Risk governance' involves the 'translation' of the substance and core principles of governance to the context of risk and risk-related decision-making. It includes, but also extends beyond, the three conventionally recognized elements of risk analysis (risk assessment, risk management, and risk communication). It requires consideration of the legal, institutional, social and economic contexts in which a risk is evaluated, and involvement of the actors and stakeholders who represent them. Risk governance looks at the complex web rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Such an approach links risk governance with risk culture.

O-3324-02

Disasters and Green Growth: An Exercise in Complexity

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It is by now common knowledge that air pollution is a huge disaster in Beijing as in other megacities of the present. It is less known that a century ago air pollution was at least as disastrous in Chicago and other large cities of those times. While efforts to reduce those historical pollution disasters started already in the 19th century, they became really successful only when economic growth had made far-reaching pollution control affordable. This option of "pollute first, clean-up later" is not open to countries like contemporary China. They need to switch to a path of green growth. This goal cannot be reached by simple top-down strategies. Rather, an approach fostering synergies between problem solving strategies by a myriad of actors is needed. Such an approach can be developed, but it requires a new view of the complex relations between economic growth and disaster management.

O-3324-03

World Regionalization of Climate Change [1961-2010]

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Existing climate regionalization aims to characterize the regional differences in climate based on years of the mean value of different climate indexes. However, with the accelerating climate change nowadays, existing climate regionalization cannot represent the regional difference of climate change, nor can it reflect the disasters and environmental risks incurred from climate changes. This paper utilizes the tendency value and fluctuation value of temperature and precipitation from 1961 to 2010 to identify the climate change quantitatively, and completes world regionalization of climate change (1961-2010) with state (province) administrative regionalization as the unit in combination with world's terrain feature. Level-I regionalization divides world's climate change (1961-2010) into thirteen tendency zones based on the tendency of temperature and precipitation; level-II regionalization refers to twenty-nine fluctuation regions based on level-I regionalization according to the fluctuation of temperature and precipitation.

O-3324-04

Everyday disasters, adaptation governance & resilience frameworks

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This paper introduces the concept and consequences of 'everyday disasters' – when regular oceanic processes such as tidal bores and high tides become more intense and catastrophic, destroying lives of those who live in low-lying coastal areas with striking regularity under the influence of climate change, sea level rise, coastline erosion and land subsidence. In the Indian Sundarbans, world's largest mangrove ecosystem situated at the mouth Bay of Bengal and a part of world's largest delta, these 'daily' weather hazards are egregiously affecting the socio-ecological system, leading to human crises of unprecedented proportions. Not classified and defined as 'disasters' and thus unattended by local, national and international disaster management authorities, these events engender a socioeconomic challenge to structured adaptive governance which is yet to be studied formally or understood.

Majority of the indicators of global warming are already higher than global averages in Sundarbans. Eventual outcomes in terms of actual environmental shifts as a product of complex interactions between anthropogenic and climate changes in this socio-ecological system are making the challenge of climate change adaptation further complex, along with increased intensity and frequency of cyclones, typhoons, flash floods, which have, however, received considerable attention from disaster risk reduction scholars.

On July 12, 13 and 14, 2014, a regular oceanic phenomenon of a tidal bore devastated island villages across Indian Sundarbans, destroyed human settlements, infrastructure, dwellings and displaced about 100,000 people, forcing them into near starvation for over three months. It also destroyed prospects of agriculture and aquaculture for an indefinite future. Using snowball sampling, extensive qualitative interviews, photographic and audio-visual evidence were collected from five of the affected villages between July and September 2014. The findings reveal narrow and limited framing of disasters and a disparate adaptation discourse that have failed to internalise these events. Through grounded narratives and evidences, this paper elaborate how threats from environment (climate change) domain were extending to social ones, exacerbating the existing crisis in the socio-ecological systems; underscoring specific needs for governance processes and systems to target newly

emerging socio-environment risks. The analysis also underscores epistemological weaknesses of existing resilience frameworks that are unable to address changing nature of vulnerabilities to livelihoods and human security. Also, imprint of the event on the adjoining areas, especially towns and cities in the region because of large human migration, argues for reconfiguring development paradigms in wake of altering environmental realities.

Thus, this work addresses two of the biggest gaps in resilience geography about how smaller, daily disasters were aggravating environment shifts and how they were jeopardising livelihoods, threatening human security and posing an unforeseen challenge to development in the South.

3325a - Overcoming barriers to transitions: knowledge to action and the importance of communication

ORAL PRESENTATIONS

K-3325a-01

Barriers to action and the role of communication

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Abstract not communicated

K-3325a-02

Experiences of co-production of evidence to support transitions

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Abstract not communicated

K-3325a-03

Impact, intention and inplementation - a hard talk toward COP-21

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Abstract not communicated

O-3325a-01

For richer or for poorer? Examining science-governance relations from a global perspective

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The application of research-based knowledge to national-scale action on important public issues such as climate change is necessarily shaped by each nation's socio-political stance toward the value and role of science in governance and decision-making (Jasanoff, 2010). Similarly, it is shaped by their capacities to enact those values by governing effectively for the public good. Yet although there has been considerable study and scholarship regarding the challenges of linking knowledge to action for science and research and associated institutional innovations, there has been relatively little that has sought to investigate the national-scale relationships between research and the public functions of governance. Examining these relationships helps us to understand the socio-political substrate from which other knowledge to action innovations must grow. There is extensive analysis showing that greater investment in R&D is related to higher economic growth, but none that has specifically sought to describe whether governance and R&D are related independent of national income via better public management, and how this might vary globally. To contribute to this understanding we sought to answer the questions of: whether there are quantitatively discernible relationships between science and governance at the macro (global) scale; how these relations might differ across countries; and how this diversity can be understood. This latter question is particularly important from the perspective of governing global environmental processes such as climate change.

To address these questions we investigated two hypotheses: first, that governance performance and research and development (R&D) are related independent of national income levels. Second, that these relations differ across high-income countries and lower-income countries, both quantitatively and qualitatively. We drew on publicly available country-level statistical data from the World Bank and UNESCO to investigate how national governance capacities are related to research and development investment (RDI). Using a sample of 209 countries we show that, while national income is an important factor, governance performance is independently related to RDI. Importantly, different domains of governance are relevant for high-income and lower-income countries. In terms of governance, in high-income countries, 'governance effectiveness' is the sole predictor of RDI while, in lower-income countries, it is predicted by greater 'rule of law' but less 'control of corruption'. These results show that the relationships between governance and R&D in lower-income countries are complex and substantially different from high-income countries. More detailed analysis is warranted if we are to understand how to address the diversity of science-governance relations and the challenges andopportunities they pose for linking knowledge with action on global issues.

Jasanoff, S. (2010). A New Climate for Society. Theory, Culture & Society, 27(2-3), 233-253.

O-3325a-02

Addressing migration in the context of global environmental change: an institutional perspective

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As the leading migration agency, the International Organization for Migration has been working on migration, environment and climate change for more than twenty years, promoting research, awareness and knowledge of the subject, contributing to mainstreaming migration and environment into policies, promoting migration as an adaptation strategy in the context of climate change, building the capacity of key stakeholders, and assisting migrants in need, by combining bottom-up and top-down approaches to the management of environmental migration.

Building on the Organization's global research, operational, and policy experience, this session will reflect on the pathway from knowledge to action in the area of climate-related migration governance. The presentation will explore the opportunities migration offers in the context of climate change, and discuss the challenges around addressing environmental and climate-related migration, including the difficulty of measuring and framing environmental migration and producing evidence to inform decision makers; the challenge of bridging the gap between empirical knowledge and political action, and of putting policies into practice; the difficulties behind attracting funding to enable action; legal challenges; operational and coordination challenges.

The session will also present some recommendations and possible avenues for improved action and governance of environmental migration, as a contribution to the preparatory work ahead of the COP21.

O-3325a-03

The smallholder farmers' adoption challenges on conservation agriculture practices in the southern highlands of Tanzania

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Conservation Agriculture (CA) used as a mitigation and adaptation options to address impacts of climate variability and an alternative practice for increasing food production while maintaining the soil resource base. It is promoted to address the problems of soil degradation resulting from the impacts of climate change and agricultural practices that deplete the organic matter and nutrient content of the soil. However, adoption of CA among smallholder farmers has been limited and features many challenges in the southern highlands of Tanzania. This paper assesses the challenges of adopting conservation agriculture practices in smallholder and subsistence farming in this region. It used the survey methods that include participatory rural appraisal (PRA), questionnaire survey, key informant interview and field observation to collect both qualitative and quantitative information. The qualitative methods established the knowledge and experience with livelihood activities, adoption of CA, spatial and temporal changes in agricultural production and response strategies while the quantitative method provided the percentages and statistical information. The qualitative data were processed and analyzed by using trend and content analysis while quantitative data were analyzed by using Microsoft Excel and SPSS software. The results indicate that about 95% of smallholder farmers tend to only adopt certain components, such as mulching, crop rotation and water management techniques. Factors such as the knowledge-intensive nature of implementing CA practices, long term crop yield benefits from CA, strong trade-offs posed adoption challenges. Poor functioning and access to the recommended inputs, markets and credit facilities and shortage of extension services increased adoption challenges at a local level. It was further revealed that climate variability, land exhaustion/ shortage, unreliable markets, and lack of product knowledge were reported to increase challenge in crop production. An enabling environment for farmers through appropriate policy, strategies and implementation plans at all levels provide an opportunity to increase adoption of CA and improve their livelihoods and productivity. This will need a policy and strategies that focus more on technical approaches to increase adoption rates with the consideration of social aspects such as perceptions that are equally important in conservation agriculture. Understanding what motivates farmers to try or reject specific CA practices is imperative in adoption of technology. In practice, farmers are able, or willing, to implement or partly adopt based on their perception of what is feasible in their particular circumstances. Issues such as the nature of the technology, affordability, time and resource invested, accessibility to appropriate tools and equipment, and competition for crop residue have influenced rate and extent of adoption among smallholder farmers.

3325b - Creating the climate change groundswell by communicating business, science and regional activity

ORAL PRESENTATIONS

K-3325b-01

Academic and Business Solutions for People and the Planet

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Abstract not communicated

K-3325b-02

Galvanizing climate action at all levels

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Abstract not communicated

K-3325b-03

Decision-Making under Climate Change: the challenge of linking science, policy and management

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Abstract not communicated

O-3325b-01

Graduated response from the stakeholders to the climate change impacts on water using a vulnerability index combining the uncertainties

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The Rhone Mediterranean Corsica water agency and the Regional Direction in charge of the environment - the DREAL - have been engaged since 2012 in a common project for climate change adaptation.

The work has developed a method to assure a solid "interface" between water policy makers and the scientific and technical fields conducting research on the impacts of climate change. Key information are provided to planners, water managers and policy makers, on the scientific knowledge that will have an impact on short- and long-term decision making for regional adaptation.

The work is organized in three interacting processes :

1. the production and gathering of scientific knowledge in order to identify climate change - related phenomena that will impact water management strategies.
2. the building of maps of the Rhone-Mediterranean basin showing regional vulnerabilities to climate change from five points of view : water resources, soil water balance, biodiversity, trophic level of rivers and snow. Each map presents a vulnerability index built for a large scale approach in order to deliver the key information to stakeholders.
3. a short-list of adaptation measures is presented face to each vulnerability map. The measures are graduated according to the level of uncertainties of the vulnerability index.

The exercise combines the exposition level to climate change with the sensitivity of the basin. The exposition level is delivered by climate projection results from 7 regionalization methods and 2 hydrological models. The sensitive index is built with technical characteristics of the basin linked to the issue.

This exercise is an original approach which combines the bottom-up and top-down approaches that are ordinarily used to build climate change adaptation strategies. The vulnerability index is inspired by the top-down approach and the graduated response by issue is the result of a bottom-up approach connected to the stakeholders. This will allow the project to result in stronger, more efficient messages.

This work has been lead under the authority of the Basin Committee, a governance structure that includes all stakeholder groups involved in water policies (State and local governments, urban, industrial and agricultural water users ...).

O-3325b-02

Sharing local and scientific knowledge for climate change modeling. A case study from an Andalusian olive-growing region (Spain)

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Under a research program focused on the adaptability of olive growing systems to climate change in the Sierra Mágina region of Andalusia and under the demand of a local action group, we combined an interdisciplinary approach, collaboration among climatologists, geographers and sociologists, and the participation of local farmers and stakeholders, all contributing their own knowledge. Sierra Mágina is a highly specialized Mediterranean agrarian territory: olive groves represent 85% of cultivated land (in 2006), half of them being irrigated. Our collaboration with stakeholders and farmers developed to the extent that we incorporated the "local knowledge system" in our scientific and modeling process. This incorporation had two objectives: on one hand, we expected that it would promote the buy-in of our projections by local stakeholders and farmers; on the other hand, we expected that local knowledge should help us understand the relationships between olive-growing, climate variability and climate change. This process is suitable for research incorporating complex issues and significant level of uncertainty, which is the case of olive growing adaptability to climate change.

Firstly, we analyzed projections of climate in Sierra Mágina, focusing on the parameters that 9 stakeholders considered as limiting olive growth. We assessed the evolution of rainfall and maximum temperature during the 21st century at the local scale using 17 regional climate models (RCMs) simulations. 15 to 30% rainfall reduction is expected in the fall combined with an 8% annual average reduction by 2030-2050 (verified for 16 and 14 models out of 17, respectively). The projections of the other parameters were more uncertain. Secondly, we observed during interviews with 15 farmers, that they expressed doubt about climate change since they are used to deal with inter-annual climate variability. Consequently, we verified and mapped which parameters of climate and water resources had changed over the last decades and to what extent. Indeed, rainfall decreased by 18% during the period 1955-2009, a more dramatic decrease than the one simulated for the 2030-2050 period (8%). Water resource availability has declined two or three times more than rainfall, in part because of the expansion of irrigation, which ameliorated the effects of droughts and increased profitability. Those farmers interviewed appeared to be less aware than stakeholders about the decline of water resources.

Thirdly, when we presented the results of the climatic study to local stakeholders, they asked us to determine the impacts of climate change specifically on olive production. These show that the cumulative rainfall of the two years preceding the harvest explains 41% of the variability of irrigated olive-tree yields and 46% of rain-fed yields. This result was unexpected for irrigated yields according to the literature, but some farmers have always known about the dependence of irrigated groves on rainfall. Contrary to local knowledge, biennial (and not seasonal) rainfall is the best yield predictor, due to the biennial fruit bearing of olive-tree. Fourthly, our model, although statistically significant, showed some discrepancies between observed and simulated yield values. We performed other 7 inquiries with olive-growing professionals and farmers to assess the validity of the model with local knowledge. Once verified the extent of the validity of our model, both statistically and using local knowledge, we projected yields for the future: they are expected to decrease by 7% and 3.5% by 2030-2050 for rain fed and irrigated olive groves. Although this moderate loss should be exacerbated by the expected shortage in water resources, it should allow sufficient time to elaborate a local strategy, particularly for irrigated olive-groves. Unfortunately, most stakeholders think that rainfed trees will better cope with future water shortage than irrigated trees.

The last step of this process consists in sharing our results in a seminar and in an engaging workshop, bringing together scientists, farmers and stakeholders, in order to elaborate jointly climate change adaptation strategies taking into consideration socio-economic challenges. These discussions also aim to build a mitigation strategy, by the recovery of pruning waste (currently burnt), in order to promote the transition to a low carbon territory (ongoing program Olizero).

O-3325b-03

The "Soil Carbon Network for sustainable agriculture in Africa": an open scientific group for a better consideration of CSA in Africa

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Since the food riots in 2008 and 2009 at the international level, some strategies are in place to tackle the problem of food security. As soils are the main support of agricultural activities, it is necessary to preserve them because of their non-renewable status at the scale of a generation, agricultural activities and forest sensu lato.

On the other hand, African agriculture has to face both climates changes which can be a source of many threats and demographic pressure which goes increasingly. Therefore, to feed people, it will be necessary to adopt agricultural practices which preserve soils and the ecosystem services they provide, such as food production and biomass, regulation and filtering of waters, the mitigation and adaptation to climate change, the conservation of biodiversity. Soil organic carbon is recognized as an indicator of fertility and productivity, two essential qualities for the autonomy and the food security of many African countries.

To meet these challenges, the implementation of agriculture that promotes alternative agricultural practices focused on optimal management of organic matter and thus the soil carbon are proposed and considered as an «agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals» according to the FAO.

Many of these practices are already implemented in Sub-

Saharan Africa (SSA) such as agroforestry, zai practices, and conservation agriculture. However, their extent and their efficiency to increase productivity, to be resilient and to mitigate GES need to be documented.

The "Soil Carbon Network for sustainable agriculture in Africa" or CaSA network was created in SSA in order to regroup the African soil scientists working on sustainable agriculture in link with soil organic carbon sequestration at SSA level. This network aimed to:

(1) replace the soil as the central support of production systems;

(2) show that the simple maintenance of soil carbon is essential, especially in arid and semi-arid areas;

(3) quantify the impact of the management practices on carbon sequestration in the soil for the different pedoclimatic African situations;

(4) promote research in connection with civil society and development agencies;

(5) facilitate access of the results of research to policy makers; improve the dissemination to civil society and farmers;

(6) strengthen the capacity of the teams and training expertise.

CasA network regroup more than 15 African and European research institutions distributed among 10 African countries (Benin, Burkina Faso, Cameroon, Ivory Coast, Mali, Senegal, Chad, Tunisia, Morocco and Madagascar) and 1 European country (France). An end-product of CaSA will be a book on combined research results of soil organic carbon storage/sequestration in sustainable agriculture at SSA level; it will be presented at the COP21 in Paris.

3325 - POSTER PRESENTATIONS

P-3325-01

Local beliefs and strategies of adaptation to climate change in Korhogo (Côte d'Ivoire)

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The precedent decades, the area of Korhogo, Côte d'Ivoire, has experienced climate variability which disturbs populations' agricultural activities. This survey has been conducted from March 2009 to February 2012 in order to identify the perceptible causes of change; be they climatic or environmental to the populations, and their endogenous strategies of adaptation. A qualitative approach based on semi-structured interviews, life stories and focus groups has been used for data collection. The historical and comprehensive method enabled to establish a relationship between populations' perceptions and beliefs and, the indicators of climate variability and environment changes but also, their endogenous strategies of adaptation. As indicators, the populations notice an extension of the dry season at the expenses of the rain season, advanced deterioration of vegetation, draining of sources of water supply (rivers, backwaters and wells) and disappearance of some animals like elephant and hyena and, some floristic species used by sculptors and traditional healers.

The survey also shows that the causes of the phenomenon are not only related to human activities but are mystical or metaphysical (non-compliance with customary practices, fetishes, totems (make love in the bush, commit blood crimes) and prohibitions related to nature; the multiplicity of religions, degradation of traditional values and the upheaval of society's rules (non-compliance of the elderly, liberalization of land working). Thus, the coping strategies of the populations based on two fundamental pillars: social capital of actors (contributions of NGOs and technicians, media and social networks) and occult practices related to beliefs. The study noted three types of strategies. The first is the survival strategy that is neither planned nor based on any knowledge of the phenomenon but obey of an instinct and the need of the population survival («climatic» migration and exodus rural, reconversion of populations and the development of certain sectors of activity).

The second type of strategy is the suggested coping strategies that are based on a scientific understanding of the causes and consequences of the phenomenon and developed and / or proposed by scientists (researchers), technicians and professionals (agriculture officers, NGOs). These strategies are related to the abandonment of long-cycle crops to new and more adapted varieties (integration cassava), the practice of crop against season, the use of improved planting materials, the reconversion of the population to income generating activities and the development of vegetable gardening.

The third strategy developed by the population is related to local knowledge, guided by the Traditional Environmental Knowledge (TEK) and beliefs guided by the metaphysical causes attributed to the phenomenon. Here, people are consulting «Fodonons» or rainmakers and also request the help of marabouts or charlatans for sacrifices in the direction of ancestors and gods' protectors, prayers are organized in mosques and churches asking God's mercy and return of the rains. Eventually, the survey shows that populations' adaptation strategies are mainly based on local traditional beliefs and knowledge which are at the same time a barrier and an opportunity for the adaptation to climate variability. This article shows in the same time the importance of taking into account local knowledge in order to develop efficient adaptation strategies.

P-3325-02

Dealing with integrated soil research and training to face climate change, overcome land degradation and ensure food securing in Madagascar

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Madagascar in a tropical country, hotspot of biodiversity, where people welfare greatly depends on natural resources, i.e., soil, water, forests, biodiversity. As a rural country, the need of agriculture and forest product is important inducing pressures on lands which have negative feedbacks on population such as soil erosion, loss of fertility, loss of biodiversity, vulnerability to climate change, deforestation, etc. Population livelihood and resource preservation together are therefore integrated in national development policies. These issues are also closely related with international objectives designed by three major conventions of the United Nations: Convention on Climate Change UNFCCC, Convention on Biological Biodiversity UNCBD, Convention to combat Desertification UNCCD. In this context, there is a great need and urgency to undertake research and capacity building. For 10 years, the Laboratoire des RadioIsotopes (LRI, University of Antananarivo) and IRD (French Institute of Research for Development, Research Unit Eco&Sols - Functional Ecology and Biogeochemistry of soils and agroecosystems) developed integrated research and educational activities on the understanding of soil ecosystem services and their responses to global change for a better decision-making on ecosystem and agrosystem management to improve livelihood and contribute to national development. LRI and IRD together undertook jointly research on Malagasy soil properties and cartography, soil and biomass carbon sequestration, greenhouse gas GHG emissions from eco- and agrosystems, nutrient recycling and crop production, and the role of soil biodiversity in these processes. Part of these studies is related to international frameworks such as REDD+ (Reducing Emissions from Deforestation and forest Degradation), REALU (Reducing Emissions from All Land Uses)and/or is shared with other African countries such as in the case of the CaSA framework (Soil Carbon for a sustainable agriculture in Africa, funded by the French Ministry of Foreign Affairs). Studies were undertaken at different levels: from plots to local and national levels. Different agroecosystems were also studied in order to cover the variety of existing systems and depending on

the ecosystem services measured. Carbon storage in vegetation and soil pools were measured or assessed using modern methodologies and technologies such as Medium InfraRed Spectroscopy MIRS, digital mapping/RS. Modelling (Ex-Act, Ex Ante Carbon-balance-Tool, FAO) was also used for upscaling and mapping for decision making on a sustainable development.

Some results showed that natural forests and agroecological systems were the agroecosystems which allow soil carbon sequestration and there could be as much as carbon in soil pool as in biomass pool, or even more (particularly in natural forests). Actually, they could store up to 100 Mg C.ha-1 in the first 30 cm depth, and more than 270 Mg C.ha-1 in 100 m depth[F2] , particularity in forest ecosystems.

Soil biodiversity has especially been studied in cropped fields from a functional point of view. The aim of theses studies is to understand which and how soil organisms are involved in different ecological functions, i.e., nutrient cycling, carbon dynamics and maintenance of soil structure. These studies are planned to be extended to forest systems.

The municipal solid waste (MSW) management studies showed that MSW composting reduced the amount of deposits in landfill (65% of initial mass of windrow) and creating product at relatively low-cost that is suitable for agricultural purposes. And after six years of organic fertilization the stock of SOM has increased by 48%, and the content of Olsen P and resin P, has increased respectively by 85% and 35%.

From a teaching point of view these issues are now integrated in different university courses such as the master of Agroecology (Higher School of Agriculture), the recent international master ABC (Agroecology, Biodiversity, Climate-Change, University of Antananarivo), the Doctoral School A2E (Agriculture, breeding, environment). The research conducted on soil ecosystem services for poverty alleviation and population development permitted the training of more than 15 PhDs. Efforts are also made by the team to train environment and agriculture stakeholders.

P-3325-03

The influence of stand-level attributes on wind damage probability of industrial tree plantation areas in Mindanao, Philippines

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In the past decade, the increased frequency and intensity of tropical typhoons brought by the changing climate had clearly brought severe damages to industrial tree plantations (ITP) in the Philippines. These damages resulted in loss of high-value timber and increased economic costs. The risk of wind damage from strong storms and typhoons should be an important component of plantation management plans. The problem, however, is that risks that were not conceived before may have become relevant in the present. Such is the case of an ITP in Mindanao, Philippines where the unprecedented increase in the frequency of storms and typhoons is now causing serious wind damages to plantations. In this consideration, the site's probability of risk to wind damage was estimated empirically using logistic regression analysis. Specifically, the influence of stand-level attributes such as average stand height, elevation and topographic exposure on damage probability were assessed. For the analysis, post-storm inventory data from 2012 Typhoon Bopha, in combination with previous stand inventory data, were used.□Results show that all three stand-level variables are influential and that damage probability has a direct relationship with the variables. By considering constant terrain conditions, the effect of average stand height was determined. Results indicate that there are critical average stand height levels which put each site at high risk of being damaged. Critical stand heights of 25 m, 20 m and 10-15 m were identified for low, medium and high-risk level sites. This information, when combined with site productivity, could be used as a basis for determining risk-sensitive rotation ages at which certain species can be grown while reducing wind damage to plantation. Moreover, topographic stand variables used were derived from DEM thereby addressing the high-cost issue associated with developing damage probability models. Amidst the issue of climate change and the projected increase in weather disturbances, these results can improve management plans and make them more relevant and responsive to changing times.

P-3325-04

We don't want that offer «development»! The reinvention of the territories in the semi-arid region of Brazil and Argentina: the case of the peasant community radios

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We speak from a epistemic place, from a locus of enunciation. In modernity, the actors and institutions of rational European thinking relate and proclaim themselves as if they were located in a higher stage of human knowledge (developed) and as such, they award themselves the right to invalidate, discard, (des)authorize, ticketing as lower all the other modes of knowledge. From a decolonizing epistemic turn, we seek visibilize and put in dialog two experiences of reinvention of the territories, carried forward by rural communities in arid regions of Latin America (Sergipe, Brazil and Santiago del Estero, Argentina), through its community radios. To propose and disseminate via radio the proposal of coexistence with the semi-arid and drought, the peasantry is proposing-living an alternative to development. In this way, resisting/re-exist in the public policies of rural development, who proclaim the 'fight to the drought', the peasantry reinvents its territories face/slowing the advance of the hegemonic model of rural development (agro-exporting mining extractive), collecting/spreading ancestral knowledge and technologies for collection and distribution of water from rain, which allows them to reduce the impacts of climate change. Look at that process demands geopolitics of knowledge, therefore the translation inter-cultural is the methodological tool necessary to achieve thinking with and together with the other.

P-3325-05

Exploring the links of artisanal fishery to climate change for developing a resilient livelihood for coastal communities in Ghana

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By nature, artisanal fishery operates on minimal investments and basic technology, and is therefore considered less adaptable and highly vulnerable. The paper argues that, though productive, it depends largely on natural marine productivity, which is closely linked to climatic elements. Studies conducted in the West African sub-region have not adequately demonstrated clearly the links between artisanal fishery and climate, due to the use of annual rather than intra-annual data and analyses. This impedes information generation suitable for informing fishery operational decisions, adaptive policy development and climate-resilient livelihood options. This study analyzed records of rainfall, atmospheric temperature, sea surface temperature (SST) and fish catch of three species with different sensitivities to temperature, on different time scales using time series techniques. Upwelling was derived from SST using the Bakun Model. It examines the interactions between the variables at different time scales to determine exposures and sensitivities. It also sought verifications from fisher perspectives, based on experiences and knowledge in respect of climate change dynamics and real impacts on fishery. The results depicted clear association in trends of sea surface and atmospheric temperatures; seasonality of rainfall and upwelling; fish catch and SST intensities, with round sardinella and anchovy showing clear sensitivities to temperature changes. Whereas the upwelling season period is typically three (3) months, in some cases it contributes some 60% of the total annual catch. Based on the evidence of high exposure and sensitivity of artisanal fishery to climate change, and overdependence of fishers on the artisanal fishery, the study proposes options of adaptive strategies for a climate change-resilient coastal fisher community livelihood.

P-3325-06

How can knowledge about health consequences promote acceptance of climate action?

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Health is currently not prominent in climate policy. It is regarded as one of many climate sensitive sectors. However, arguments deriving from health and physiology, if properly communicated to climate decision makers, could play a strong role as a driving force to motivate them (and citizens) to accept new policies and new behaviors for the transformation towards a low carbon society. This is based on three sets of arguments, which have recently been corroborated by new evidence (since IPCC AR5), which we present, and which highlight further the need to communicate the strong influence health arguments should have at the COP21 negotiations. These sets of arguments are as follows:

(i) There are huge health benefits from climate friendly policies and behaviors. Although the concept is not new, but new evidence points to the large scope of known health benefits accruing from physical activity from walking and biking, insulated housing, low meat diets. Two recently identified co-benefits generate considerable additional health gains:

1. Large health gains from reducing local pollutants, particularly in low and middle income countries. Fine particles and black carbon have recently been recognized as "climate active pollutants". Black carbon are of particular interest for climate policy, as reducing its emissions leads to a fast reduction of stocks in the atmosphere.

2. Recent population projections till 2100 significantly exceed previous UN estimates. Gerland et al. publishing their modeling results in Science 2014[1] project a 2100 population size of between 9.3 to 12.6 billions. This urgently call for even greater efforts for voluntary family planning, hence reaping even larger the linked health benefits accruing to mothers and their fewer children.

(ii) There are clear limits to society's capacity to adapt to the projected health impact of climate change. This holds to some extent in a 2°C world, but definitely in a 4°C warmer world. This holds even given maximal resource allocation to the task (e.g. 2).

(iii) Heat stress lead to reduced in work productivity in a warmer world, particularly in a 4° climate (e.g. 3). This concerns mainly the large populations in (sub-) tropical and arid areas and applies both to outdoor work, such as farming and construction and to indoor industrial production in non-air conditioned factories. Hence the physiological impossibility to work and generate further body heat is a health argument of significant bearing on economic output.

The above evidence-based health arguments provide a unique combination of positive news -reaping health gains from climate policy- and the reference to the ultimate driving force behind any climate policy and citizens behavior change: protecting our children's health form the adverse health impacts of climate change.

[1] Gerland P, Raftery AE, Sevcikova H, Li N, Gu D, Spoorenberg et al (2014) World population stabilization unlikely this century. Science 346(6206):234-237.

(2) Woodward A, Smith KR, Campbell-Lendrum D, Chadee DD, Honda Y, Liu Q, Olwoch J, Revich B, Sauerborn R, Chafe Z, Confalonieri U, Haines A (2014) Climate change and health: on the latest IPCC report. Lancet 5;383(9924):1185-9.

(3) Lucas RA, Epstein Y, Kjellstrom (2014) Excessive occupational healt exposure: a significant ergonomic challenge and health risk for current and future workers. Extreme Physiology & Medicine 3:14

3326 - The Mediterranean Basin in a warmer and drier world : challenges and opportunities

ORAL PRESENTATIONS

K-3326-01

Increased frequency of major heatwaves and droughts in the Mediterranean

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The last IPCC Assessment Reports (IPCC, 2007, 2013) identify the Mediterranean region as a climate change and biodiversity "hot spot" with an increasing likelihood of suffering in the future drought episodes and severe heat waves. In fact, most studies using global and regional climate model results suggest that the Mediterranean will experience a general trend towards drier conditions during the 21st century. Thus, the overall tendency towards a drier Mediterranean climate is not independent of the simultaneous increase of the heawaves frequency and magnitude in southern and central Europe. In fact, despite some contradictory results with state-of-the-art models, these combined tendencies towards a drier and more extreme Mediterranean climate fits particularly well into the expected changes predicted by most models for this climate change «hot spot» region (IPCC, 2007, 2013).

Summer heat waves are controlled by intense anticyclonic circulation, often associated with upper tropospheric blocking high. Heat waves have been shown to be responsible for excessive mortality, such as the 2003 heat wave in Western Europe that was associated with an excessive +50,000 fatalities (García-Herrera et al., 2010). Equally, heatwave events can be the main drivers of large wildfires occurrence, such as those that occurred in Portugal in 2003 with more than 430,000 ha burnt area (Trigo et al., 2006). Interestingly, this major heatweave was preceded by very dry conditions (winter and spring) in most of Western Europe, a factor that has been shown to play a crucial role in amplifying the heatwave magnitude (García-Herrera et al., 2010).

The summer of 2010 was exceptionally warm in Eastern Europe and large parts of Russia. In fact the anomalous 2010 warmth that caused adverse impacts exceeded the amplitude and spatial extent of the previous hottest summer of 2003 (Barriopedro et al., 2010). 'Mega-heatwaves' such as the 2003 and 2010 events displayed exceptional seasonal temperatures in a 500-yr long context over approximately 50% of Europe. According to regional multi-model experiments, the probability of a summer experiencing 'mega-heatwaves' will increase by a factor of 5 to 10 within the next 40 years. The results also indicate that the temperature maxima observed during these heatwave episodes were associated with the simultaneous occurrence of outstanding anticyclonic blocking patterns and were preceded by relatively dry soils resulting from the lack of precipitation in winter and spring and an earlier retreat of snow cover.

The western Mediterranean is recurrently affected by drought episodes and therefore by the adverse effects associated that range from severe water shortages to economic losses and related social impacts. During the hydrological years of 2004/2005 and 2011/2012, Iberia was hit by two of the worst drought episodes ever recording in this semi-arid region (Trigo et al., 2013). These two drought episodes were extreme in both its magnitude and spatial extent and appear to fit the tendency towards an increase in the frequency of drought events in the Mediterranean basin (Sousa et al., 2011) partially driven by anthropogenic greenhouse gases emissions (Hoerling et al., 2012; Trigo et al., 2013).

K-3326-02

The Medieval Climate Anomaly and Byzantium. A review of the evidence on economic performance, societal change and climatic fluctuations

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The study of the unusual climate patterns and their impact on ecosystems and societies during medieval times is of considerable interest for scholars of various disciplines such as past, current and future climate researchers, climate impacts scientists, historians, archaeologists, anthropologists, among others. The global, hemispheric and continental climate variability, the associated forcing factors and potential dynamic origin of the Medieval Climate Anomaly (in this work ca. 850 -1300 AD) have been the focus of many studies. Although the wealth of paleoclimate information for the last two millennia available in the Mediterranean basin and to a lesser extent in the Eastern Mediterranean, the character of paleoclimate records in combination with the inhomogeneous proxy records density and distribution during medieval times still restricts scientists from critically assessing the manifestation of the MCA on a regional scale and further to a high temporally and spatially resolved characterization of the climate patterns and associated societal and environmental impacts for specific areas as the Eastern Mediterranean.

During the Medieval Climate Anomaly, Byzantium, a medieval empire encompassing the northern part of the Eastern Mediterranean, had formed an expanding society with a thriving economy and complex political as well as cultural institutions. Byzantium as a medieval society left a considerable body of written evidence, enabling the use of detailed information to investigate potential connections between the societal impact of climate change in the period that spans from the moment when the Byzantine state and economy began to recover after the crisis of the so-called Dark Age, and until the period that followed the fall of Constantinople in AD 1204.

This study aims at assessing the manifestation of the MCA in the Eastern Mediterranean, and linking the existing knowledge about the character and extent of the climatic variability during medieval times in the Eastern Mediterranean, both historical (textual), palaeoenvironmental, and model-based, with what is known about the socio-economic processes taking place in the Byzantine Empire at that time.

K-3326-03

Rising concerns about ocean acidification and warming in the Mediterranean Sea

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The Mediterranean Sea is facing large biogeochemical changes driven by both climatic and non-climatic drivers. Unprecedented emission rates of CO2 into the atmosphere are responsible for two important drivers such as ocean acidification and warming that are rapidly altering the physico-chemical seawater properties with consequences for the marine ecosystems and ecosystem services.

There are rising concerns since this is one of the regions warming fastest under climate change and acidifying with a similar rate as subtropical regions. This marginal sea have a relatively short residence times and deep waters are likely to lag changes in surface waters by a few decades at most.

I will review here the state of knowledge on the combined effects of ocean acidification and ocean warming in the Mediterranean. Recent results demonstrated that some key organisms that are endemic to the Mediterranean, major contributors to habitat building, and/or ecological function, or species of economic value in the region, are largely affected by the rapid change in pH and/or increase in seawater temperature. The regional vulnerabilities alter the capacity of coastal and marine systems to provide ecosystem services and consequently affect economic activities.

O-3326-01

Climate Change Distress and Subjective Well Being in Urban coastal cities of India and French Mediterranean region

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Human-induced global climate change and associated sea level rise (SLR) can have major adverse consequences for coastal ecosystems and societies (Hinkel & Klein, 2003). The IPCC in its various reports has established a clear link among global warming, climate change, SLR and coastal livelihood security. There is growing concern in France of climate change and sea-level rise. There is enough information to identify coastal areas that may be affected. Lambeck and Bard (2000) examined the evidence for relative sea-level change along the French Mediterranean coast. Considerable evidence has been presented in the past two decades for the sea-level change along the French Mediterranean coast. Poumadère et al. (2008) have found that in spite of the stance taken by political figures, general attitudes in France regarding climatic hazards appear to lag behind scientific warnings. The established fact that anthropogenic factors account for one of the major contributors to climate change makes it necessary to probe into behavioral facets as in spite of the best possible efforts around the globe to combat climate change, it is felt that people are still not as seriously aware/ alarmed of the expected future risk as they should be. In view of this, the present study aims at gaining insight into issues of human-climate interaction through a comparative study between coastal cities of India and France. The study is intended at exploring how the coastal population of Indian and French metropolitan cities perceive climate change, how much aware and concerned they are, what guides their opinions, judgments, behaviours, and actions , how efficient they find themselves in adapting with the situation, what adaptive measures would be feasible for them, how competent do they find themselves in terms of coping strategies in relation to the current phenomenon of changing climate. The study enables comparison of data collected from 400 respondents of coastal population of metropolitan areas of Marseille (1,7 million inhabitants), Nice (a little less than 1 million inhabitants) with the researcher's existing data for Indian metropolitan coastal cities of Mumbai and Chennai (400 respondents), both highly vulnerable to climate change related accelerated sea level rise. A specially designed questionnaire called Climate Change Perception Inventory (CCPI) by Rishi et al. (2009) would be used to collect data from French population. The tool is based on Likert type format comprising of 48 items (in its original version) pertaining to perceptual and attitudinal components of climate change.A correlational research study design would be used to study the relation between different study variables which would be subject to regression analysis for making predictions in regard to climate change.

This study will provide an understanding of mindset of people in urban settlements on climate change. Not only this, it will also help to find out about the level of climate change distress of people with regard to climate change and also what are their actions and reactions in the changing climate scenario. Through Assessment of perceptions and attitudes of people in regard to Cognitive, Conative and Affective dimensions of Human-Climate Interface, one would better be able to determine the level of sharing responsibility regarding changing climate. By studying the pattern of behavioral adaptation to climate change, it would be possible to identify and compare what coping strategies people in coastal cities of India and France are using/ are required to deal with the phenomenon of climate change. The present study is directly in line with Article 6 of New Delhi Work Programme of UNFCCC (2007) in which special effort to foster psychological/behavioral change has been

stressed through public awareness. Hence, it fulfills a very strong requirement to conduct behavioral study in the area of climate change.

O-3326-02

Current and future Mediterranean Sea ecosystem functioning in relation with global change: The MERMEX/MISTRALS project

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The semi-enclosed nature of the Mediterranean Sea, together with its smaller inertia due to the relative short residence time of its water masses, make it highly reactive to external forcing, in particular variations of water, energy and matter fluxes at the interfaces. This region, which has been identified as a ''hotspot'' for climate change, is therefore expected to experience environmental impacts that are considerably greater than those in many other places around the world. These natural pressures interact with the increasing demographic and economic developments occurring heterogeneously in the coastal zone, making the Mediterranean even more sensitive. The current knowledge on and expected changes due to single forcing (hydrodynamics, solar radiation, temperature and acidification, chemical contaminants) and combined forcing (nutrient sources and stoichiometry, extreme events) affecting the biogeochemical fluxes and ecosystem functioning are explored within the project MERMEX in the framework of MISTRALS program. MERMEX project based on MERMEX group white book (*) is dedicated to the response of Mediterranean ecosystems and biodiversity to climate changes and anthropogenic pressure. MERMEX aims to deepen the current understanding of the Mediterranean marine ecosystems to better anticipate their upcoming evolution. It is focusing on the response of ecosystems to modifications of physico-chemical forcing at various scales, both in time and space, linked to changing environmental conditions and increasing human pressure. Four years MERMEX results clearly showed that several processes including winter dense surface water convection, surface water stratification, river water discharge and episodic desert dust inputs play a major role on marine productivity as well as on organism community structure. Slight modifications of such processes that will be very likely affected by global change in 21th century can induce significant changes in Mediterranean Sea ecosystems.

(*) The MERMEX group, (2011) Marine ecosystems' responses to climatic and anthropogenic forcings in the Mediterranean, Progress In Oceanography, 91: 593-594.

O-3326-03

Climate Change Impact on Mediterranean Forest Functioning

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The combination of significant past and current anthropogenic pressure and high level of biodiversity makes the Mediterranean one of the world's most threatened regions by current change, warranting its classification as a biome "in crisis". Mediterranean forests play major ecological, social and economic roles by providing goods and services and thereby represent a great asset and opportunity for the future of the Mediterranean. The functioning of Mediterranean forests is contingent on the existence of the dry summer period. Intensified and prolonged drought periods related to climate change are then of special concern in these ecosystems. Currently, our understanding of the response, in terms of biodiversity and functioning of Mediterranean forests to extreme drought conditions is limited. A wide variety of methodological approaches have been put into practice to examine the mechanisms by which climate change could alter the functioning of terrestrial ecosystems, such as the study of altitudinal climatic gradients, latitudinal transects, and the experimental modification of precipitation or warming. Controlled field experiments are however costly and difficult to operate on a large scale without introducing environmental modifications. Further, the investigations of ecosystem functioning in relation to climate change are very demanding, as they require multi-scale and interdisciplinary research maintained over long time-spans. We set up an experimental facility with a rain exclusion system and a network of various sensors at different levels of the forest situated in a French Mediterranean natural old-growth oak forest, the Oak Observatory at the OHP (O3HP).

This observatory allows investigating functional components of the ecosystem such as phenology, growth, litter decomposition and emission of biogenic volatile organic compounds by trees. Moreover, functional changes in biodiversity-related traits in the context of a drier climate are monitored, particularly the role of soil biodiversity in the biogeochemical cycle.

The first results show a significant effect of the experimental increase of the summer-drought period. For example, prolonged drought slows down litter decomposition and consequently nutrient availability, and initially increased to eventually decrease the emission rates of volatile organic compounds by trees in the course of the drought period. These results point-out the importance of addressing climate change on future management practices for the sustainable development of Mediterranean forest ecosystems.

O-3326-04

Lessons from the Past: Modeling past human adaptation to climatic change in the Mediterranean Basin

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The Mediterranean Basin has a well-documented history of climatic fluctuations throughout the span of its human occupation. Detailing past climatic changes and predicting those in the future is thought of as the task for sophisticated climate modeling, while investigating the human consequences of climate change remains a challenge for the social sciences. The AMENOPHYS Project combines the two and explores the limits of cultural adaptability to climatic shifts in the Mediterranean through a modeling approach, combining paleoclimatic data, GIS-based landscape evolution modeling, agroecosystem modeling, and agent-based modeling to ask how past climate change in the Mediterranean directly affected the lives of the region's inhabitants, and which factors were most salient in rendering climatic changes more or less survivable.

There is an abundance of literature - archaeological, historical, paleoclimatic, and paleoenvironmental - born out of the reasonable premise that past climatic shifts were of magnitudes that must have had cultural consequences. Such work, however, has struggled to move beyond correlation; we aim to articulate these links between paleoenvironmental and cultural change and to thereby tackle what has been a persistent challenge. This will improve our understanding of cultural trajectories, of human ecological footprints, and provide a strategy for untangling human and environmental histories in the long term. It will make past human experience directly relevant to current global realities and challenges.

Our models aim to provide explicit, well-formulated mechanisms linking humans and environments, thereby enabling the articulation of testable hypotheses that can be compared to empirical evidence. Questions of scale and resolution are fundamental. Environmental parameters are generally the purview of environmental modeling and paleoclimate studies - where spatial scales are regional and temporal scales are centennial, if not millennial. In

contrast, social scientific explanation relies fundamentally on anthropological models of behavior – i.e., human decision-making at local and annual or decadal scales.

Agent based modeling can contribute significantly to reducing this important interpretative gap. We model the human consequences of climatic change, with a view to exploring their variability across different geographies, production regimes (i.e., subsistence practice and technology, and available resources), demographic, sociopolitical and economic contexts, and environmental inheritances. This will provide a means of articulating linking mechanisms where they cannot be directly observed.

Using landscape evolution and agroecosystem models in a feedback system with agent-based models of small Mediterranean communities, and starting from a specific example of Provençal geography,this project explores the effects of climatic shifts, legacies of human activity, available subsistence options and technologies, and community size and organization on vulnerability and resilience.

3326-POSTER PRESENTATIONS

P-3326-01

Modelling blooms of comb jellyfish -Mnemiopsis leidyi -population under Mediterranean climate change

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The massive outburst of gelatinous plankton has important socio-economic impacts particularly affecting tourism, fishing, fish farming, and also impact on the structure of the pelagic ecosystem. Some species are opportunistic invaders that can cause permanent damage to the native fauna. This is particularly the case of comb jellyfish Mnemiopsis leidyi, a kind of gelatinous plankton that can form dense patches and, as a predator of fish larvae and other zooplankton, can have disastrous consequences on fish stocks and other aquatic resources. The potential for outbreaks of this species is based on its growth capacity and high tolerance to environmental conditions particularly considering salinity and temperature, allowing M. leidyi establishment in highly contrasting ecosystems (CIESM, 2014). High numbers of M. leidyi along the Mediterranean coastlines of Israel, Italy, and Spain and other Mediterranean countries (CIESM, 2014) were recorded during the last years. This fact strongly suggests that M. leidyi population is established in the Mediterranean coasts. However the specific causes and mechanisms of M. leidyi development are not well identified, and the lack of data makes any further investigation difficult (Boero, 2013).

Modelling can provide an additional understanding of mechanisms through the definition of the environmental characteristics that could support and/or favor M. leidyi and the description of the associated changes in the planktonic community structure. The aim of the present study is to understand the potential direct (temperature, salinity, nutrient enrichment) and indirect (through food chain changes) impacts of climate changes on M. leidyi blooms in the Gulf of Lions (NW Mediterranean Sea) using the biogeochemical model Eco3M-MED (Baklouti et al., 2006a,b, Alekseenko et al., 2014) coupled with the hydrodynamical model MARS3D (Lazure&Dumas, 2008). A M. leidyi compartment has been introduced in the Eco3M-MED model, in such a way that some of the physiological and demographic traits of this species are represented. A study on M. leidyi physiology and eating behavior has first been conducted with the biogeochemical model. Then, different scenarios have been simulated in order to analyze the role of several environmental parameters, namely, temperature, salinity and nutrient inputs of the Rhone River, on the seasonal variability of M. leidyi and the structure of the trophic web. The study is focused on the period 2009-2011 since the outputs of the model during this period have already been partially validated (Alekseenko et al., 2014).

Acknowledgements

The present research is a contribution to the Labex OT-Med (n° ANR-11-LABX-0061) funded by the French Government «Investissements d'Avenir» program of the French National Research Agency (ANR) through the A*MIDEX project (n° ANR-11-IDEX-0001-02).

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P-3326-02

Surface runoff evaluation watershed Tunisian-Algerian border modeling with software WEAP

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Tunisia is considered among the countries least endowed with water resources in the Mediterranean basin. The most significant changes in rainfall and making the periods of drought longer are the factors aggravating the imbalance between supply and demand water.

The main objective of this work is the hydrological study of the major trans-boundary watersheds Tunisian-Algerian. It is referred trans-boundary runoff modeling and assessment of surface water inflows to Tunisia of Algerian border regions.

The methodology used was based on the creation of a daily database (1 September 2009 – 31 August 2013) of rainfall in 43 stations, statistical analysis and spatial measurements. It also used for modeling the physical system of trans-boundary basins the software WEAP. The assessment of daily surface resources, demands and runoff were used to develop a daily dynamic management model.

The modeling results showed that Algeria's surface flows to Tunisia are mainly presented through the Oued Medjerda, Mellegue and El Kbir. The average annual intake is around 8204 million m3 which 22.41% are insured by the river of Medjerda , 63.51% from Mellegue and 14.08% from El Kbir one. The largest flows are carried by the Mellegue river which is valued at 2505 m3/s. The Medjerda and El Kbir river have recorded peak flows 806 and 732 m3/s, respectively, during the period of the study.

The simulation of climate scenarios and investment, showed that the change in the water flow follows the variation of rainfall. It is shown by simulation that if rainfall increases by 200% (very humid scenario), runoff can increase up to 265%. On the contrary, if rainfall decreases from 80% (very dry scenario), surface runoff would be reduced by about 85%.The first version of transboundary river basin management model developed Tunisian-Algerian proved useful for modeling of surface water resources for large hydrological catchments.

P-3326-03

Statistical and experimental approaches for demonstrating the effect of climate changes on the flowering dates as a road map for tree adaptations in the Mediterranean region

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In this study two approaches were used to highlight the effect of climate on the tree behavior. The statistical approach was carried out in three geographically contrasting countries of the Mediterranean region. It aims to understand the impact of climate change, particularly the temperature increases, on phonological stage of three taxonomically different species (early and late-spring-flowering species). Three species, namely olive, apple and almond were investigated to highlight the phenological behavior of one species at different locations (mild and cold regions) and different species at one location. Climate and phenological data were collected from Morocco, France and Italy over the last 40 years. The experimental approach was done in mild (Morocco) and temperate (France) areas in the Mediterranean in order to interpret the effect of the climate changes on the dormancy process of trees. In this goal, three cultivars of apple and almond were investigated. In each location, two experimental approaches were used during two successive seasons: one-single cutting test to assess the dormancy in vegetative buds and Tabuenca test for floral buds. The target of combining these approaches is to interpret the wholly tree dormancy behavior in vegetative and floral buds of one species in different regions and different species in the same site. Analysis of data on temperature showed a strong warming in the northern locations (coldest areas), particularly in Nîmes, compared to the southern ones (warmer locations) during the period October to May. The marked spring warming in all locations since the end of 1980s in France (the beginning of 1990s in Italy and Morocco) resulted in blooming earliness, with regional patterns in terms of impact. The late-spring-flowering species (olive and apple) showed a remarkable sensitivity to continuous warming in different areas. No flowering earliness was observed in early-spring-flowering species (almond), due to the stability of mean temperature during February. Thus, a strong control of mean temperature during the forcing period on flowering earliness of apple was found in all areas. Physiological processes (dormancy and dormancy release) of trees during the dormant and growth period explain, in part, the regional differences observed in flowering dates among sites and species. In terms of tree dormancy dynamics, deeper apple dormancy was evinced in the temperate area compared to the mild one, showing a strong correlation with winter temperature. In Morocco, the almond and low-chill apple cultivars seemed to behave similarly, showing low Mean Time of Budburst and permanently high Rate of Budburst. The dates of breaking dormancy approached by fresh and dry masses of floral buds showed the same time of dormancy release on almond cultivars in Morocco. However in apple, the significant increase of masses was earlier in fresh bud mass, while it was later in dry bud masses in both sites. The transition from the endodormant to the ecodormant phase of apple flower buds was distinct in both locations. Mechanisms of solutes importation and utilization by floral buds were different in almond and apple. Overall, the pronounced warming in the southern France reflects a relative trend toward aridity of climate at this site, and consequently some vulnerability of fruit trees. As result, the process of dormancy and flowering in a high latitude locations (northern areas) in the future can be represented by that in a low latitude locations at present (southern areas), particularly for apple. The agronomic consequences caused by global warming are already expressed in the southern areas (floral abortion, heterogeneity and delayed flowering time ...) where the apple cropping is limited only in the upland location (high altitude). In France, ominously, production irregularities related to climate change were frequent during the 2000s. This requires immediate intervention to find some ways of adaptation or improvement as part of a regional strategy to fight against this scourge in context of food security. Creation of new varieties with low chill requirement is a way of improvement and plant breeding while the change of vulnerable crop by others (such as almond well adapted in mild climate areas) is a way of adaptation.

P-3326-04

Modelling how climate change will impact growth and productivity of evergreen Mediterranean forests using a process-based model and multiproxy data

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Different physiological processes determine gross primary productivity (GPP) and carbon allocation in relation to environmental forcing. Climatic variability limits these two processes differently and this needs to be properly addressed in process-based forest models. Generally, empirical models have been preferentially used in dendrochronological studies. However, it is necessary to better address the interaction between climate and other factors such as CO2 to properly assess the instability in the climate-growth response expressed by trees and increase the accuracy of the modelled relationships both in forward and inverse models. In this study we developed an existing mechanistic model originally implemented with dendrochronological data. The model was calibrated to fit a combination of eddy covariance CO2 flux data, dendrochronological time series of secondary growth and forest inventory data at two Mediterranean evergreen forests. Among other differences with the original formulation, the model was modified to be climate explicit in the key processes addressing acclimation of photosynthesis and allocation. It succeeded to fit both the high- and the low-frequency response of stand GPP and carbon allocation to the stem as calculated from tree-rings. Simulations suggest a decrease in mean stomatal conductance in response to environmental changes and an increase in mean annual intrinsic water use efficiency in both species during the last 50 years. However, this was not translated on a parallel increase in simulated ecosystem water use efficiency. A long-term decrease in annual GPP matched the local trend in precipitation since the 1970s observed in one site. In contrast, GPP did not show a negative trend and the trees buffered the climatic variability observed at the site where long-term precipitation remained stable. Long-term trends in GPP did not match those in growth, in agreement with the C-sink hypothesis. There is a great potential to use the model with abundant dendrochronological data to analyse future forest performance under climate change and in dendroclimatic reconstructions. This would help to understand how different interfering factors produce divergence in the climatic signal expressed in tree-rings.

P-3326-05

Climate variability, ecosystem response and socio-environmental changes in the northern Aegean (Greece) during the last 1500 years

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The first high resolution paleoceanographic study of the last 1.5 Ka BP at the northeastern Mediterranean, using organic geochemical, micropaleontological and palynological proxy indices, allowed the recognition of recent climatic changes and ecosystem response during the Dark Ages (DA; 500-900 AD), Medieval Climate Anomaly (MCA; 900-1250 AD), Little Ice Age (LIA; 1250-1850 AD) and Instrumental Period (IP; 1850-2010 AD). Multicore M2, retrieved in 2011 from the north Aegean Sea

(40°05.15'N, 24°32.68'E, 1018m depth), was sectioned at 0.5 cm intervals, and analyzed for lipid biomarkers (Gogou et al., 2007), coccolithophores (Triantaphyllou et al., 2009), and pollen assemblages (Triantaphyllou et al., 2009; Kouli et al., 2012). Stratigraphic framework was based on 210Pb and radiocarbon dating. Past SSTs (mean annual) were reconstructed using the alkenone unsaturation index Uk'37 ((U= C37:2/(C37:2 + C37:3) and the global calibration by Conte et al. (2006). For the estimation of the net primary production (NPP), the equation of Incarbona et al. (2008), NPP = 885.864 + (-138.963 x ln (F. profunda %)), has been used. In addition, the use of the ratio between F. profunda (F) and E. huxleyi (E) abundances: S = F/F+E, is applied as stratification S-index (Triantaphyllou et al., 2009; Triantaphyllou, 2014). The ratio H=AP/St (AP: Arboreal taxa excluding Pinus; St: Artemisia, Chenopodiaceae, Asteraceae and Poaceae), has been used as a humidity index (H-index; Kouli et al., 2012).

The SST-record reveals significant variability with marked cool/warm intervals. SSTs increase from 650-1375 AD and then decrease till the late 1600s, except for a warm episode in early 1600s (LIA) with values as high as ~20°C. After a sharp decrease ending at ~1700 AD, SSTs rise at approximately 0.6°C/100 yrs till the present day. Towards the end of DA period, a drop in SST and decrement of terrestrial inputs suggest a tendency towards more arid conditions. The onset of MCA is characterized by an increase in SSTs and elevated terrestrial inputs along with high values for S index between ~1000-1200 AD, characteristic of humid climate conditions, that positively impact the photic zone productivity, due to enhanced nutrients supply from riverine inputs and continental runoffs. The onset of the LIA is marked by an increase in water column stratification between ~1350-1650 AD, and a transition from arid conditions between ~1250-1400 AD to humid conditions after ~1400 AD. Finally, the IP is characterized by a significant rise in SSTs along with enhanced terrestrial inputs and algal productivity in the euphotic zone.

Atmospheric modes of variability play an important role on surface water heat fluxes that in turn have consequences on the Mediterranean thermohaline circulation, in particular during winter when cold winds cause important heat loss and stratification breakdown. Because of the tight coupling with the atmospheric forcing, the sampling area has proven ideally situated to investigate the coupling of paleooceanographic conditions with major atmospheric circulation patterns. Finally, a historical approach has been applied, in order to explore the complex interactions between climate, environment and human activity in the north Aegean region.

P-3326-06

New forms of governance and collective action for agricultural irrigation canal management in southern France: what opportunities in the context of climate change?

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One of the socio-cultural specificities found on both the north and south shores of the Mediterranean is the ingenuity of local societies for managing water shortages and/or the unequal distribution of water in different areas. In European Mediterranean countries two main types of techniques have developed over the past centuries: either rainwater harvesting via terrace systems or gravity-fed canals supplied by springs and watercourses more broadly. The infrastructure designed and created by Arab societies-which is still used today, particularly in oases-is based for the most part on subsurface irrigation systems for recovering infiltration water; these systems are called quanat, foggara or khettara, depending on the country. Approaches to management in the North and South have created knowledge and know-how and forged what could be called a "culture of water" that can be useful in times of crisis, like that posed by the threat of climate change.

Farmers in the south of France-and in Provence more specifically-have created organisations (ASAs) since the late 19th century that manage issues related to the supply of water and its division; these have also allowed local agriculture to become extremely competitive on international markets, particularly for fruits and vegetables. At the scale of France's PACA region, there are over 600 ASAs that manage canals and their irrigated perimeter still extends over a very large part of the region's territory. These organisations are experienced in water resource management and their know-how has allowed them to adapt and evolve with changes in Mediterranean irrigation systems (e.g., gravity-fed, overhead and drip irrigation).

This presentation will analyse how maintaining canal-based hydraulic infrastructure is of central importance for perpetuating sustainable farming at the regional scale. For this to occur, ASAs must now accept that the canals they manage also have other uses; their management needs to take into account the multi-functionality of the canals and embrace new challenges which are both environmental and social (replenishing the water table, flood management, promoting the heritage value of the canals, etc.). We will take an historical approach to show how agricultural actors created types of organisations that were both unique and solidarity-based which allowed them to manage droughts and flooding (particularly in the Durance basin). Other forms of multi-actor governance are emerging today: e.g., canal contracts, the signing of bi- or multi-lateral partnership agreements and "Agora" assemblies for the operational governance of water. Such projects are proof of the dynamic thrust of the agricultural profession, but they also raise questions about the funding of such initiatives and therefore their long-term viability.

P-3326-07

Climate change impacts on water and local adaptation strategies in the Mediterranean: security versus sustainability

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Introduction
Climate change is predicted to lead to raising temperatures in the Mediterranean region and reduced rainfall, with possible worsening of water resource shortages that Mediterranean basin is already experiencing. Climate change is thus probably likely to generate tense situations among users. A conservative approach is to believe that changes correspond to situations that have already occurred in the past and that, with a successful management of these conflicts through appropriate integrated water management with local actors, there would be no new challenge in facing these situations. However, in the present state of knowledge on the impact of climate changes, it is now recognized that the chains of causes and effects will lead to different situations. Thus, tools and procedures previously developed, might become obsolete if they are not updated continuously with advances in knowledge about criteria explaining the chain of causes and effects between climate changes, water availability and water uses.

In this context, models undeniably represent an educational support for the dissemination of scientific results in the science-policy interface to develop. But this support needs to rely on the validity of databases, on the moderation of dissemination by experts as close as possible to local stakeholders and last but not least, for Europe, on the common implementation strategy of the water framework directive in coherence with the European and national adaptation strategies and plans.

Methods and Materials
The EU FP7 research program CLIMB, embedded in a cluster of three EU projects (the CLIWASEC cluster) about climate change-water-security, aimed to decrease uncertainties of hydrological modelling in the context of climate changes in the Mediterranean region. For this purpose, CLIMB defined an ensemble of 4 GCM-RCM-combinations to generate climate data to be used by a set of hydrological models implemented at catchment scale for 7 case studies. Two periods have been considered: 1971-1990 as the reference period, and 2041-2070 as the future period. To support the local dissemination of

scientific results of CLIMB, interactions with stakeholders have been engaged in the context of a study of water uses and water rivalries.

Results and Discussion
Impacts of climate change on temperatures, precipitations and flows have been described. They essentially affect the availability of water. According to interviewed stakeholders, it is notable that, for the Mediterranean region represented by CLIMB case studies, the main pressure on water resource during the last 20 years has been linked to the population growth and urbanization. The results have also underlined that the terms « climate change » have not been cited by stakeholders during both interviews and open questions in the questionnaires related to threat on water resource. In other words, and considering that climate change is not considered as an issue for the stakeholders, the evolution of rainfalls quantity over the next 20 years is overlooked by them. This confirms the need to continue efforts on disseminating facts and figures about climate change to local water managers.

Conclusion
In the Mediterranean region represented by 7 case studies within the CLIMB project, the main answer to the increase of water demand, without considering climate change as a driving force, has been a progressive transfer of water. It seems that there is no spatial limit to this transfer with respect to national borders.

It has also been spotlighted that all analyzed water management plans mention desalination as an option, both for European case studies and non-European ones. It seems that this represents the next step of water supplying in the Mediterranean region. While these adaptation provide water security, it is not coherent with climate change mitigation or adaptation strategies.

P-3326-08

Adaptive action pathways in rural and urban systems facing the challenges of Mediterranean changing climates: Comparative views of efforts and propositions for Europe and South America

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Four millions is the car fleet recently recorded in Chile, a South American country inhabited by only 17 million people. This ratio of 23 cars for every 100 persons is causing great circulation problems in Santiago, where one third of the population live but also in smaller towns. Big cities or European agglomerations suffer from similar problems. Concomitantly, our evaluations of social representation among car drivers about individual contribution to Green House Gases (GHG) indicate deep lack of basic knowledge on quantities emitted and on the ways to do effective compensation. This is probably due to our low human sensitive and visual appreciation of GHG and our lesser common knowledge of the effective modes of possible compensations.

In our study we show that in countries with high economic growth, like Chile during the last four decades, social representation of sustainable development in education systems is more associated to economic development than to social or environmental effects. Besides, critical visions on the development models are still much less present, although climate change towards desertification in countries like Chile is equal than that of south Sahel regions.

Finally we argue that connecting GHG compensation strategies to zero carbon agricultural practices could give impressing benefits to new urban and rural development strategies. More conscientiousness of climatic changes will result from strong government decisions, but our authorities must be well informed. The rural-urban connections could be based on existing taxation laws (like car circulation permits in Chile) and incentives to short-distance agro ecological production-consumption agreements (like AMAPSs in France). However further growth of such initiatives would need still stronger governance positions to limit growth of big cities, and to tax all carbon emitting production/consumption chains towards the promotion of changes of our ongoing agricultural and transportation paradigms. Conversely, the constraints to these changes could be counterbalanced by lower costs associated to improvement of poor public health-related parameters, another facet of modern globalization patterns. This statement is supported by the high nutritional value of some crops, like Andean quinoa, that respond well to agro ecological practices and can be cultivated worldwide under extreme climates. Our propositions could be implemented in all Mediterranean regions of the world, for which European and South American ones are good examples. These regions share strong urbanization, loss of biodiversity and migratory patterns among neighbouring countries so that education to have critical positions on these challenges should also be promoted.

Our hope with our vision is to contribute to:

1. More knowledge to take decisions on actions to reduce and to compensate GHG emissions, particularly those concerning agricultural practices and transport (that added are 25% of world emitted GHG).

2. To make this knowledge understandable to the most wide public

3. To link our propositions to sustainable health-care and food chains

4. To give examples of ongoing practices in the mentioned fields, from two distant Mediterranean regions (France and Chile) that are socially sustainable

5. To give education/formation to all publics a central role for making the changes a real possibility

6. To link urban and rural zones to give them hope of new opportunities for sustainable developpment

7. To make all public, from individuals to highest authorities, more sensible to accept the needed changes

We are the first generation (and the last one) that can make the changes. We cannot lose this opportunity. It is everybody's task and everybody's responsibility. We have all communication facilities for making COP21 a source of world's hope not only for future climate based visions but also for building new human societies, where interconnections can be much more acknowledged.

P-3326-09

Predicted climate change effects in a Mediterranean reservoir under different climate scenarios and management options

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In the Mediterranean area, water is a scarce resource, especially in the summer season. Good management of the resource is thus essential, not only regarding quantitative aspects, but also regarding ecological and water quality. Climate change in the region is expected to result in an increase in air temperature that will affect water temperatures.

Water temperature is an important variable in freshwater ecosystems. It can affect the biology of freshwater organisms in many ways; it can modify vital cycles, physiology, distribution areas, behaviour, etc. In addition, the vertical distribution of heat in a lake or reservoir determines its hydrodynamic behaviour and by extension water quality. The thermal and hydrodynamic behaviour of a reservoir depends on external driving factors (hydrology, meteorology) and internal characteristics of the water body (depth of the inlets and outlets, morphometry, reservoir management). Process-based hydrodynamic models allow investigating the effect of the alteration of these characteristics and are interesting tools to address the effects of climate change in Mediterranean reservoirs and testing possible adaptation actions. In this work, we used the model EOLE to simulate the hydrodynamic and thermal behaviour of the reservoir of Bimont (Provence region, France). To account for the hydrodynamic model uncertainty, we used two different calibrations: one based

on expert judgement, and the other based on the method of Generalized Likelihood Uncertainty Estimation.

To consider the effect of climate change on the reservoir we simulated the hydrodynamic behaviour of Bimont under the projections obtained during the project CORDEX of three different regional climate models (RCMs) for each of the two emission scenarios RCP4.5 and RCP8.5. The projections used were those issued by the models HIRHAM5 and RACMO22, applied to the output of the GCM ICHEC-EC-EARTH; and by the model RCA4, applied to the output of the GCMs ICHEC-EC-EARTH, CNRM-CERFACS-CNRM-CM5 and MOHC-HadGEM2-ES. We considered two time horizons: medium term (2036-2065) and long term (2066-2095).

We also considered different management options to see which the potentialities of adaptation to climate change are by varying water level, the temporal distribution and quantity of flow through the reservoir, and the outlet depth.

Water temperatures in the reservoir of Bimont are expected to increase during the present century, both in the epilimnion and the hypolimnion. The stratification period will likely become longer. The elevation of the water level results in similar surface water temperatures, and slightly lower hypolimnion temperatures. Some modifications of the reservoir management have potential effects that can be more important than those of climate change.

P-3326-10

Accounting for ecological processes changes niche modeling predictions: adaptation of Mediterranean forests to climate change as a model

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Bioclimatic niche models predict drastic changes in the geographical distribution of forest species habitats by the end of the 21st century. However, and despite recent advances, they are limited in their ability to account for ecological and demographic processes involved in forest dynamics. In this talk, based on recent interdisciplinary research results in Mediterranean Pinus halepensis – Quercus ilex and Abies alba – Fagus sylvatica mixed forests, we will show how taking into consideration these processes changes local forest structure and composition as compared to non process-based models. The key processes to be integrated are: migration (dispersal and recruitment), genetic adaptation and phenotypic plasticity. Migration, because it is constrained, limits the ability of species to track their optimal habitat. Phenotypic plasticity and genetic adaptation, on the other hand, facilitate local persistence when habitats become sub-optimal. However, in the Mediterranean, disturbances such as forest fire and insect outbreaks are expected to rise to more frequent and severe levels. These new disturbance regimes may result in demographic, evolutionary and functional tipping points where mortality becomes too massive and reproduction too limited for tree populations to adapt and survive.

P-3326-11

Impact of climate change on marine and coastal biodiversity: the case of Algeria

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Known for its arid and semi-arid climate, Algeria is highly prone to climate change. The last 50 years, an increase of events due to extreme weather was observed. Among the phenomena recorded in Climate Studies of the National Meteorology that reflect this change, we observe an increase in the frequency of torrential rains, especially in the highlands, which led to flooding for the first time. Other extreme events that have occurred: cyclogenesis, drought, heat wave and sand storms. Scientists have estimated that rainfall will decrease by about 20 percent in the coming years. They predict a shortening of the rainy season and higher temperatures of about 1° to 1.5° in 2020, which would have fatal consequences for 30 percent of animal species. They also feel that temperatures will rise by 3 ° C by 2050 more due to global warming.

The flora and fauna (terrestrial and marine) have been greatly affected by this increase: the changing environmental conditions are favorable and/or unfavorable to certain environmental factors compared to others, which causes a change of environments and species of flora and fauna that constitute them.

Thus, the coastal areas were severely affected by the climate change. Today, it is permissible, in the light of scientific data to associate with threats to marine biodiversity three important parameters and determinants of climate change: (i) the warming waters, (ii) the elevation the sea level, (iii) water acidification. These changes will surely have consequences in medium and long-term on living marine communities in various ways. Especially that the Algeria includes a rich faunistic and floristic diversity.

According to the fourth national report on the implementation of the Convention on national biodiversity of March 2009, the known marine biodiversity amounts to 3183 species of which 3080 were confirmed after 1980. The marine flora is estimated at 713 species grouped in 71 genera and 38 families. If we add the coastal and island vegetation, marine and coastal bird life, the known total biodiversity of the Algerian coastal marine ecosystem is 4150 species, of which 4014 are confirmed for a total of 950 genera and 761 families. But it should be noted that these numbers do not reflect actual biodiversity but rather the known.

Through this contribution we will present aspects of the consequences of global warming on marine ecosystems and particularly on marine and coastal biodiversity and actions taken by Algeria to remedy this situation.

P-3326-12

An epidemiological assessment of stomatal ozone fluxes-based Critical Levels for Southern European forests

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The Mediterranean Basin is expected to be more strongly affected by ongoing climate change than most other regions of the earth. The Southeastern France and Northwestern Italy can be considered as case study for assessing global change impacts on forests. Southern forests are at the highest O3 risk in Europe where ground-level O3 is a pressing sanitary problem for ecosystem health. Exposure-based standards for protecting vegetation are not representative of actual field conditions. A biologically-sound stomatal flux-based standard has been proposed, although critical levels for protection still need to be validated. This innovative epidemiological assessment of forest responses to O3 was carried out in 54 plots in Southeastern France and Northwestern Italy in 2012 and 2013. Three O3 indices, namely the accumulated exposure AOT40, and the accumulated stomatal flux with and without an hourly threshold of uptake (POD1 and POD0) were compared. Stomatal O3 fluxes were modelled (DO3SE) and correlated to measured forest-response indicators, i.e. crown defoliation, crown discoloration and visible foliar O3 injury. Soil water content, a key variable affecting the severity of visible foliar O3 injury, was included in DO3SE. Based on flux-effect relationships, we derived species-specific exposure-based (CLec) and flux-based critical levels (CLef) for forest protection, by joining data from all plots and years. As AOT40 was better correlated with defoliation than with discoloration and visible injury, we selected defoliation as effect parameter for defining AOT40-based CLec values. As a tree with defoliation above 25% is commonly rated as damaged, CLec was calculated on the basis of a threshold of 25% average stand defoliation. As POD0 was better correlated with visible foliar O3 injury than with defoliation and discoloration, we selected visible foliar O3 injury as effect parameter and POD0 as O3 metric for defining PODY-based CLef values. Unfortunately, a definition of damaged tree/stand based on visible foliar O3 injury is missing in

the literature. We thus based the selection of a visible foliar O3 injury threshold on a comparison of gas exchange of leaves with a range of visible O3 injury that was carried out in a 3-year-old O3-sensitive poplar plantation. CLef was derived from flux-effect functions for 15% of visible foliar O3 injury (stand level). We obtained CLec of 11.7 ppm.h AOT40 for P. cembra (high O3 sensitivity) and 24 ppm.h for P. halepensis (moderate O3 sensitivity). For broadleaved species, the average CLec was higher than for conifers (23.6 ppm.h AOT40) and similar in the two species with significant correlation between crown defoliation and AOT40, i.e. Fagus sylvatica (moderate O3 sensitivity) and Fraxinus excelsior (high O3 sensitivity). For conifers, CLef of 19 mmol.m-2 for P. cembra and 24 mmol.m-2 for P. halepensis were calculated. For broadleaved species, we obtained a CLef of 21 mmol.m-2 for Fagus sylvatica and of 19 mmol.m-2 for Fraxinus excelsior. To avoid an underestimation of the real O3 uptake, we recommend the use of POD0 calculated for hours with a non-null global radiation over the 24-h O3 accumulation window. We showed that an assessment based on PODY and on real plant symptoms is more appropriated than the concentration-based method. Indeed, POD0 was better correlated with visible foliar O3 injury than AOT40, whereas AOT40 was better correlated with crown discoloration and defoliation (aspecific indicators).

In the current climate change context, a deterioration of the crown conditions was observed likely due to a drier and warmer climate. Clearly, if such climatic and ecological changes are now being detected when the climate, in Southeastern France, has warmed in the last 20 years (+ 0.46-1.08°C), it can be expected that many more impacts on tree species will occur in response to predicted temperature changes by 2100 (+ 1.95-4.59°C). Climate change will create additional challenges for forest management.

P-3326-13

Sea-level changes in the western Mediterranean during the last 12,000 years: a tool to better constrain the future projection of sea-level rise

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Global sea-level rise is the result of an increase in the ocean volume, which evolves from changes in ocean mass due to melting of continental glaciers and ice sheets, and the expansion of ocean water as it warms. The elevation of the ocean surface relative to the ocean floor is defined as a relative sea level (RSL), and any shift in height of either of these two surfaces produces a RSL change. Present-day sea level variations in the Mediterranean depend on various factors, including recent climatic forcing, tectonic activity, anthropogenic effects, and glacio-isostatic adjustment. Our understanding of current rates of sea-level rise from tide gauge and satellite data, requires correction for glacial isostatic adjustment (GIA) effects that are both calibrated to, and independently tested by, observations of former sea levels. With this purpose, we created a database of Holocene (last 12.0 ka) geological and geo-archeological sea-level data across the Western Mediterranean. We reconsidered ~600 published and unpublished sea-level data along the western Mediterranean Sea and we proposed a standardized approach for the production of index and limiting points following the protocol described by the International Geoscience Programme (IGCP) projects 61, 200, 495 and 588. We then reconstructed the RSL histories in 21 regions located in Spain, France, Italy, Malta, Tunisia, Slovenia and Croatia. At the basin scale, RSL rose rapidly from 12.0 to 6.0 ka BP. Younger data showed a significant decrease in the rising rates in the last 6.0 ka. During the late Holocene (last 4.0 ka BP) GIA, sediment compaction and local neotectonic activity played a major role in controlling sea-level variability between regions. Data showed that sea-level was higher than today only in Tunisia.

Preliminary comparison with long-term tidal gauge data (>50 years) indicates an increase in rates of sea-level rise during the last 100 years.

Results of this study are relevant for understanding how GIA operates in the far field of late-Pleistocene ice sheets and to assess sea level rise hazards, which are particularly magnified in low-lying or subsiding coastal areas.

3327 - Adapting to Arctic Climate Change

ORAL PRESENTATIONS

K-3327-01

EU-PolarNet - Connecting Science with Society

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The rapid changes occurring in the Polar Regions are significantly influencing global climate with consequences for global society. European polar research has contributed critical knowledge to identifying the processes behind these rapid changes but, in contrast to lower latitudes, datasets from the Polar Regions are still insufficient to fully understand and more effectively predict the effects of change on our climate and society. This situation can only be improved by a more holistic integrated scientific approach, a higher degree of coordination of polar research and closer cooperation with all relevant actors on an international level.

The objectives of EU-PolarNet are to establish an ongoing dialogue between policymakers, business and industry leaders, local communities and scientists to increase mutual understanding and identify new ways of working that will deliver economic and societal benefits. The results of this dialogue will be brought together in a plan for an Integrated European Research Programme that will be co-designed with all relevant stakeholders and coordinated with the activities of many other polar research nations beyond Europe, including Canada and the United States, with which consortium partners already have productive links.

K-3327-02

Title not communicated

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Abstract not communicated

O-3327-01

The adaptation challenge in the Arctic

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We reviewed published research on climate change adaptation, vulnerability, and resilience, to identify and characterize the nature and magnitude of the adaptation challenge facing the Arctic. Framing the results using Adger and Barnett's (2009) 'reasons for concern about adaptation,' we demonstrate that: (i) even in the context of >3C warming already documented across the Arctic in the last 30 years, it is not the speed or magnitude of climate change per se that poses a challenge to adaptation, but how climate change interacts with non-climatic factors; (ii) significant barriers are likely to constrain adaptation in absence of concerted action on

broader human development deficits in northern regions. These barriers span multiple scales and are linked to long-term trajectories of disempowerment, colonization, and globalization; (iii) the potential for maladaptation is being increased by a weakening of key sources of adaptive capacity, compounded by limited anticipatory actions across scales to prepare for future impacts; and (vi) communities and Indigenous organizations have played leading roles in adaptation decision-making in the North American Arctic and to a lesser extent in the Nordic countries, but in Russia the very nature of climate change as a potential risk is not agreed upon. The challenge of adaptation in the Arctic is thus formidable, yet the review suggests that drivers of vulnerability can be overcome, avoided, or reduced by individual and collective efforts across scales.

O-3327-02

APECS France, a network of French early-career polar researchers involved in education and outreach activities

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APECS-France (www.apecs-france.org), the French national committee of the Association of Polar Early Career Scientists (APECS), is a young organization of volunteers created in 2013. Its objectives are to promote early-career polar scientists and to improve the dissemination of polar sciences towards the general public and school children in particular. APECS-France has developed several activities, projects and partnerships to better educate French students about the polar regions, better explaining their importance in the context of global climate change. For instance, the French polar week is organized twice a year, and thousands of pupils can exchange with polar scientists about their research and their life as young scientists. Every December 1st, APECS-France collaborates with OurSpaces, British foundation for the good governance of international spaces, to celebrate Antarctica Day, connecting young students to the French research polar station Dumont d'Urville in Antarctica. Schools are also involved to follow scientific expeditions: such long-term education and outreach projects imply resources for teachers, a blog, visits in classrooms, and/or oceanographic data analysis. APECS-France is now planning to edit a children's book using students' drawings as well as photographs taken during the Pax Arctica - On the Shoulders of Shackleton Expedition. More recently, APECS-France has developed a partnership with Wild-Touch (French non-profit organization created by Luc Jacquet, director of March of the Penguins) and CRI (the Centre for Research and Interdisciplinarity) to help students and teachers develop a scientific project about polar regions. In the frame of COP21, APECS-France aims at organizing a physical event in Paris to allow students from 15 to 18 to exchange with young polar researchers and representatives of the indigenous population from the Arctic about the impacts of climate change in the Arctic.

O-3327-03

The global economic implications of the melting of the Greenland ice sheet

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The Arctic has been changing at unprecedented rates over the past two decades, with the average rate of warming in the region roughly twice as high as the global average (IPCC, 2014). According to WGI of the 5th Assessment Report by IPCC (2013), there is growing evidence that Arctic change may have far-reaching consequences across the globe. Yet the potential global economic impacts from specific physical changes in the Arctic region are largely unstudied (Whiteman et al., 2013). This paper contributes to this emerging research agenda by assessing potential economic impacts from the Greenland ice sheet (GIS) using the PAGE integrated assessment model. PAGE is one of the top three IAMs used for climate change policy analysis and estimation of economic impacts related to climate change. While integrated assessment models (IAMs) have been previously used to estimate the net present value of economic impacts of climate change (Stern, 2007; Nordhaus, 2008; Hope, 2011; Hope, 2013), explicitly considering the potential economic impacts of Arctic change has thus far only been applied to potential methane release in the East Siberian Sea (Whiteman et al., 2013).

IAMs are simplified representations of key relevant systems such as "emissions and their socioeconomic determinants, the atmosphere-ocean-climate system, ecosystems, socioeconomic impacts, and policy and responses" (Parson and Fisher-Vanden, 1997). However, to date, IAMs (including PAGE), do not directly incorporate physical change into model configurations, but rather rely upon temperature estimates. Thus, large irreversibilities such as sea level rise from increased melt of the Greenland Ice Sheet (GIS) do not directly feed into the IAM structures. Current and future changes in GIS carry significant implications for the environment and for the global economy. To address this gap (and as part of the ICE- ARC project[1]), we adopt a transdisciplinary approach to adapt PAGE in order to evaluate the economic impact of different scenarios of GIS change.

More specifically, in this paper we (i) propose model modifications to integrate the physical changes in the GIS explicitly into the PAGE IAM, and ii) identify how best to assess economic impacts (costs and benefits) resulting from it. This includes looking into the potential drivers of the GIS melt - such as overall Arctic warming and black carbon pollution from the increasing wildfires (Benning et al., 2014; Doherty et al., 2013) as well as the main mechanisms by which the GIS melting will cause economic impacts globally. These include: sea level rise (which highlights the need to de-couple the GIS and Antarctic ice sheets in the PAGE sea level rise module), changing atmospheric and ocean circulations and its effect on weather patterns in Europe, North America and further afield. In order to achieve this, we develop distinct scenarios for the GIS melt under a given RCP (global emissions scenario) and work out the relevant economic costs globally using PAGE-ICE.References:Benning,L.G.A.M.Anesio,S.Lutz&M.Tranter(2014),Biological impact onGreenland's albedo,Nature Geoscience 7,691/ Doherty,S.J.,T.C.Grenfell,S.Forsström,D.L. Hegg,R.E.Brandt,S.G.Warren(2013),Observed vertical redistribution of black carbon and other insoluble light-absorbing particles in melting snow,J.Geophys.Res.Atmos.,118, 5553-5569/ Hope,C.(2011),The PAGE09 integrated assessment model:A technical description, Cambridge Judge Business School Working Paper, 4(11)/Hope, C. (2013), Critical issues for the calculation of the social cost of CO2:why the estimates from PAGE09 are higher than those from PAGE2002,Climatic Change,117,3,Page531-543/IPCC (2013). Climate change 2013: the physical science basis. Contribution of WG1 to the 5th Assessment Report of the IPCC/IPCC (2014). Climate change 2014: synthesis report. 5th Assessment Report. IPCC/Nordhaus,W.D.(2008),A question of balance- weighing the options on global warming policies,Yale University Press/Parson,E.,Fisher-Vanden,K.(1997),Integrated assessment models of global climate change, Annu. Rev. Energy Environ, 22:589-628/ Stern,N.et al.(2007),The Stern Review: The Economics of Climate Change, Cambridge University Press/ Whiteman,G.,HopeC.,Wadhams,P.(2013),Vast costs of Arctic change,Nature Comment,499: 401-403[1]This study is part of a programme of research funded by the European Union Framework 7 Programme, Grant Agreement 603887

3328 - Climate Change Challenges, Adaptation Barriers and Responses

ORAL PRESENTATIONS

K-3328-01

Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases

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To enhance understanding of the process of climate change adaptation and to facilitate the planning and implementation of sustainable adaptation strategies, deeper consideration of the factors that impede adaptation is required. Barriers to climate change adaptation are, consequently, being increasingly reported. But, despite this progress, knowledge of barriers that hamper adaptation in developing countries remains limited, especially in relation to underlying causes of vulnerability and low adaptive capacity. To further improve understanding of barriers to adaptation and identify gaps in the state-of-the-art knowledge, this paper presents a synthesis of empirical literature from sub-Saharan Africa focusing on vulnerable, natural resource dependent communities and livelihoods. Our review illustrates that: 1) local level studies that reveal barriers to adaptation are diverse, although there is a propensity for studies on small-holder farmers; 2) many of the studies identify several barriers to adaptation, but appreciation of their interactions and compounded impacts remains scarce; and 3) most of the barriers uncovered relate broadly to biophysical, knowledge and financial constraints on agricultural production and rural development. More hidden and under-acknowledged political, social and psychological barriers are rarely mentioned, unless captured in studies that specifically set out to investigate these. We argue that research on barriers needs to start asking why these barriers emerge, how they work together to shape adaptation processes, who they affect most, and what is needed to overcome them.

K-3328-02

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Background: Africa occupies a unique position when it comes to Climate Change challenges. It is one of the most vulnerable continents yet has very limited capacity for adaptation and recovery. Some of its challenges owe to its poor economic and social developmental states. A brief illustration of this:

According to the UN Office of The High Representative For The Least Developed Countries, Landlocked Developing Countries And Small Island Developing States (UN-OHRLLS), of the 48 Least Developed countries (LDCs), 34 are in Africa; of the 31 Landlocked developing countries (LLDCs), 15 are in Africa; and of the 39 Small Island Developing States (SIDS), 8 are in Africa. Africa

Climate Change challenges that accompany this situation include those associated with sea-level rise and changes in coastal and marine resources, which have very serious consequences particularly for SIDS; biodiversity and ecosystems changes, which have a negative impact on tourism, food security and other socio-ecosystems services; frequent and severe natural disasters like mudslides, floods, droughts and veld fires; poor infrastructure, leading to high transportation and communication costs.

The ultimate result of these challenges is a ripple effect on health and human well-being, availability of land and water resources, management of waste, renewable energy options, infrastructure choices as well as national finances. Resilience declines, mortality rates go up, life expectancies decline and ultimately sustainable socio-economic development is retarded. Needless to say, some countries in Africa have a fair level of development, but they are not immune to some of these regional impacts of climate change. The cost of adaptation rises by the day in a region already facing many challenges like poverty. The IPCC 2007 Report estimates that the cost of adaptation to climate change in Africa could amount to at least 5 to 10% of Gross Domestic Product (GDP), and other projected impacts like increased water stress, reduction in yields from rain-fed agriculture, as well as an increase in arid and semi-arid land could worsen in the next few years (Report. Summary for Policy Makers, IPCC, 2007). Considering the scale of poverty for most African populations, adaptation is costly, it's about survival.

Call for Concerted Action: Africa is generally reported as one of the least environmental polluters because of its low industrial development. However, it stands to suffer dire consequences from the effects of climate change. Information available points to evidence that all sectors will be generally affected. Why then, you may ask, is there no or poor concerted response to mitigate the impacts. We take a closer look at the key role players on the continent and how their collaborative efforts could positively impact Africa's climate change mitigation and adaptation attempts.

O-3328-01

African Climate Change Challenges : Innovative Climate Adaptation Practices in Ghana

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INTRODUCTION
Recent studies by IFPRI suggest crop yields across sub-Saharan Africa may decline 5-22% by 2050, pushing large numbers of people deeper into in hunger and poverty as both of Africa's staple crops, maize and sorghum, are expected to be badly hit by increasing severe weather.

Climate Change and its adverse impacts is been felt across many regions of Ghana and also in the majority of ACP states, this project has been under implementation since 2012 particularly as a solution to the visible effects and impacts of erratic climatic patterns affecting crop and animal production in catchment communities in Ghana whiles encouraging environmentally friendly practices by farmers, also this project seeks to promote innovative ICT Climate driven agricultural practices and policies which has successfully increased agricultural productivity and profits in catchment communities and have proved to be very resilient to climate change on agriculture for the targeted farming communities thereby improving food security in the project's catchment towns in Ghana and replication prospects in other African countries.

DESCRIPTION
ITU data suggest that mobile penetration reached 84.8 per cent in 2011, compared with fixed line penetration of 1.14 per cent, although the number of individual subscribers may be lower than that in practice, also mobile network coverage is not uniform across Ghana as areas that lack coverage are typically those with small population centers, which cannot economically support the installation of a base station. Ghana's mobile networks were in the past was predominantly second generation (2G) GSM technology which did not provide data connectivity however there has been major upgrade to faster third generation (3G) Technology which is enabling many citizens and businesses to enjoy the enormous benefits of faster mobile telephone and data services across Ghana.

BEST CLIMATE CHANGE ADAPTIONS PRACTICES INAGRICULURE
Setting up virtual online farmer association meetings - To enable farmers from different farming towns and communities to communicate and shear challenges and the problems they have been facing in their villages, access to financing, new agricultural practices and new innovative

systems and practices including market information and latest prices for agriculture produce and farm crops. Remote col-laboration and applications of ICT's for virtual interactions will significantly reduce greenhouse gas emissions caused by travel. 0.5 billion tonnes CO2e can be saved without any major investments .

Agriculture e-commerce - we have successfully assisted farmers to sell their farm produce through selected Messaging Applications on mobile devices of farmers and that of our project field teams assisted farmers to be in touch with buyers of their farm produce without the need for the farmers to travel long distances to sell their foods at nearby marketing centers , by this online transaction fuel usage and emission by vehicles have been saved and time and money have been saved for the farmers using this service depending on uptake, these solutions can avoid more than a billion tonnes of CO2e.

O-3328-02

Scaling up adaptation in Africa - barriers and enablers

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A critical question as the adaptation discourse and practice matures in Africa relates to how to scale up adaptation in a way that is sustainable, and promotes social justice goals. A relevant point concerns the types of transformations that are needed in structures and processes to support and scale up sustainable adaptation. There is no doubt that governance institutions at different levels have a decisive role to play in these transformations. Currently, we have incomplete, under-resourced and fragmented institutional frameworks and overall low levels of adaptive capacity, especially competency at local government level, to manage complex socio-ecological change. Structural poverty and inequity are common found many countries. Despite these commonalities, the local context for adaptation differs not only between countries, but between sub-national regions and indeed within localities, for different groupings of people. So how do we begin to identify the kind of steps needed on the transformation pathway? The IPCC 5th Assessment Report identified a number of key principles for building adaptive capacity and climate resilience, based on extensive assessment of the academic and grey literature, on adaptation in Africa. The principles point to necessary changes in policy and practice, and to the role of adaptive management and social and institutional learning in scaling up adaptation. This presentation will examine the potential of these principles to play a role in overcoming key barriers towards scaling up sustainable adaptation in Africa, and raise questions for discussion on the social and process dimensions of enabling scaling up.

3328-POSTER PRESENTATIONS

P-3328-01

Welfare impacts of climate shocks: evidence from Tanzania and Uganda

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Sub-Saharan Africa (SSA) remains the world's most food-insecure region characterized by high levels of child mortality and poverty and low levels of human&physical capital (FAO, 2009). SSA countries, including Tanzania and Uganda, heavily depend on a smallholder-based agricultural sector, which in turn makes them particularly vulnerable to climate change. An estimated 90% of the population depends on rain-fed crop production and pastoralism to meet its basic food needs (Patt and Winkler, 2007). Rising temperatures and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability, thus exacerbating the impacts of droughts, soil degradation and decline in biodiversity. The combination of these effects makes agriculture the most vulnerable sector affected by climate change.

There is an emerging economic literature on weather variations and their implications for a wide set of economic outcomes ranging from economic growth, to migration and agriculture (Dell et al., 2013). Most of this literature is concerned with establishing linkages between these outcomes of interest and weather using data at aggregated levels including cross-country studies. These studies establish a negative relationship between economic growth/income and hot climates in general, and a positive one between income and rainfall in SSA (Miguel et al., 2004; Barrios et al., 2010; Hsiang, 2010; Brueckner and Ciccone, 2011; Dell et al., 2012).

In countries where agricultural sector is largely based on small-holders and dominates the economy, the main linkages between weather and incomes go through agriculture, and when the latter is based on rain-fed subsistence agriculture, this link also has substantial implications for food security and welfare. Since climate/weather fluctuations translate into income shocks especially faced by small-holders, not only are the average incomes low but also they are highly volatile. In addition to the important policy implications that can be derived from the investigation of these issues, we focus on weather-related risk for two reasons. First, the growing availability of high-quality geo-referenced data on weather makes this important and exogenous component of environmental risk measurable along with the related households' response. Second, although it is not the only exogenous factor affecting income and consumption of rural households, it is spatially covariant. As pointed out by Binswanger (1993), this feature makes it an important determinant of income variability that is most likely to influence welfare.

The goal of this study is, therefore, to provide a comprehensive analysis of the impact of weather risk on rural households' welfare in two countries in SSA. We use nationally representative household data together with a set of novel weather variation indicators based on interpolated gridded and re-analysis weather data that capture the peculiar features of short term and long term variations in rainfall and temperature. In particular, we estimate the impact of weather shocks on a rich set of welfare indicators (including total income, total expenditure, food expenditure and its share in total expenditure and calorie intake) and investigate whether and how they vary by different definitions of shocks. Moreover, we also analyze the interactions of these climate risk-welfare relationships with a number of policy relevant variables such as access to extension information, access to credit and the use of sustainable land management (SLM) practices, which may help farmers to cope with risk and smooth income (Morduch, 1995).

Our results show that both rainfall and maximum temperature variability (defined for the last 25, 10, 5 and 3 years) exert a negative impact on welfare, even if results vary according to the reference period with respect to which the indicators are computed. Our estimates also show a significant income-smoothing for households that have adopted SLM practices, highlighting the role of SLM as a potential ex-ante risk coping strategy. We also find that the most vulnerable rural households are much more negatively affected by a rainfall deficit compared to the households in the top income quantile. We compare and contrast the results from Tanzania and Uganda to draw site-specific and evidence-based policy implications to improve welfare outcomes under increasingly unpredictable weather conditions in these countries.

P-3328-02

The African Safe Water Supply Challenges: Moringa Technology as an Alternative Approach

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Water is one of the most important indicator of climate change today. This is seen in the two extremes of water supply, either being short through erratic rain spills affecting consumption and agriculture or excessive supply through flooding. In traditional African rural settlement, water for human consumption during the rainy season in particular is highly turbid with the consequence of water-borne diseases. "In the developing world, more than 1 billion people cannot get clean drinking water... The United Nations says that dirty water causes 80 percent

of diseases in the developing world, and kills 10 million people annually." While similar water supply during same season in urban centres is difficult to treat by water works departments since they depend on the clarification by importing aluminium sulphate. However, the existence of a natural coagulant from Moringa seed holds promise as a substitute to the chemical coagulant of alum. The practice of using Moringa seed in water treatment has been scientifically proven both at small household and large community pilot scale. Local varieties of Moringa from Nigeria has been shown to contain 18-20% cationic protein (MOCP) that is active on coagulation and against common microbes in untreated water. MOCP act on microbe by fusing their inner and outer membranes affecting exchange within and outside their cellular component. This paper highlights role of the Moringa seed technology in water treatment as a substitute to aluminium sulphate with the aim of portable safe drinking provision in Africa and other developing nations.

P-3328-03

Harnessing the multidimensional climate and non-climate signals to livelihood vulnerability and adaptive capacity in Kaffrine, Sénégal

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The Increase of rainfall variability has since the beginning of the 1970s, one of the common threats of semi-arid countries with rapid and strong anomalies and extreme events. Kaffrine is one of those areas facing these rapidly dynamic climate challenges that affect both productive systems and populations income. The history of this site exhibits a long lasting domination of groundnut production for cash and high dependence to forest resources for income and mostly as a livelihood asset. Both groundnut cultivation as a rain fed crop and forest resources are impacted severely by climate variability, but the magnitude of the climate drivers has not been fully accounted systematically in assessing vulnerability and subsequently developing adaption strategies that are context specific.

With the increasing local empowerment through devolution of natural resources management, many policy decisions are undertaken for sustainable development and socio-economic resilience at community level. Accounting for the real weight of climatic factor on livelihood dynamics can help better understand the essential variables or derivatives of vulnerability to co-design proper options for improved resilience in Kaffrine. The research question is how to set a series of criteria and climate indicators that help understand the real climate impact and how population are responding to those. The central hypothesis is that climate may be important but not sufficient information to understand communities' vulnerability in poverty condition.

We combined data collection through the AMMA WP 3.2 (questionnaire and interview guide applied at 14 villages across Kaffrine), statistical national data and cartographic tool, we try 1) to show how rainfall variability in Kaffrine affect livelihood dynamics, 2) to assess adaptive capacities of Kaffrine communities.

This results show important indicators of climate variability that are affect ecosystems and society. The study did not allow us to conclude that climate variability was the only driving force of livelihood and land degradation in Kaffrine. We conclude that scenarios on adaptation should consider both climate and non-climate factors such as basic land management systems. Options, potentials and constraints of adaptive capacity, must be based on integrated assessment of local stressors.

P-3328-04

Demographic and Socioeconomic Determinants of Vulnerability and Adaptation to Climate Change in the Nigerian Savannah

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The paper examines the demographic and socioeconomic characteristics of rural farming communities as determinants of vulnerability and adaptation to climate change in the Nigerian Savannah. The Nigerian savannah has been seriously affected by human activities which have reduced its capacity to support the teaming rural farming communities and livelihood systems. The fact that livelihood systems in the region are closely tied to terrestrial ecosystems and changes in global climate further exacerbates the conditions of the rural farmers. The demographic and socioeconomic characteristics of selected agricultural communities in the Nigerian Savanna were examined with the view to assessing their vulnerability and adaption to climate change. The methodology for the study was based on multistage random sampling technique and Rural Rapid Appraisal (RPP) of 11 communities across 10 Local Government Areas (LGAs) in two states of the southwest and north central Nigeria. Site visits, Key Informant Interview of traditional rulers and Government officials were carried out while an intensive Focused Group Discussion among all the actors was done. The role of education, income from farm and other sources, ability to diversify, willingness to adapt, proportion of savings, and local adaptation mechanisms were identified and used to examine the relationship between indicators of vulnerability and adaptation of local farmers and communities to climate change in the region. By matching indicators of vulnerability and factors of local adaptation it help the understanding of local actions, barriers to adaption, present and future capacities.

The gender, age, marital status and size of households of the respondents reveal typical rural farming communities with large family sizes, low education and incomes from predominantly farming activities (65.8%). These conditions could perpetuate poverty and predispose rural farmers and their households to vulnerability to climate change impacts which could also limit adaptation. However, the paper analyse the opportunities to make money from other sources which shows that they could be protected from unexpected shocks from climate change and increase their resilience through the diversification of livelihoods. The poor culture of savings in these communities which cannot be divorced from their poor incomes from farm-based activities could limit adaptation. The results shows that the farming communities are facing the realities of climate change with 30% of the sampled population involved in adaptation while 21.9% are not. Some of the adaptation methods include use of fertilizer to boost production, shifting cultivation and irrigation while 17.2% do not know what to do. The farming communities deploy irrigation and organic farming, irrigation and rain harvesting and hiring of more labour as means of improving farming activities. The paper suggests that there should be a rural development policy to increase opportunities and prospects of non-farm activities and promote the culture of savings in these communities. The identified strategies for ameliorating climate change and improving farm activities must be developed sustainably to reduce vulnerability and ensure rural adaptation. This should engage the interest of policy makers if poverty eradication or at worst reduction is a sincere aspiration for the region.

P-3328-05

Climate Change Adaptation and Mitigation through Agro forestry systems in Wolaita Zone, Southern Highland of Ethiopia, East Africa

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Climate change is one of the most serious threats the world faces. It will affect all of us, but will have disproportionate impacts on millions of poor rural people in Ethiopia. For development work to be effective, we must not only help poor rural people emerge from poverty, we must also enable them to cope with and mitigate the impact of climate change. Agriculture is the human enterprise that is most vulnerable to climate change, because of the subsistence nature of the farming practices, and because communities have little resources to adapt to the impacts of climate change. Farmer's adaptive capacity is constrained by a lack of economic and technical resources, and they are vulnerable due to a heavy dependence on rain-fed crops. While agro forestry may play a significant role in mitigating the atmospheric accumulation of greenhouse gases (GHG), it also has a role to play in helping smallholder farmers

adapt to climate change. This paper presents data that examine the mitigation and adaptation potential of different agro forestry systems. Hence, the research questions those need to be answered concerning the role of agro forestry in both mitigation and adaptation to climate change. It is recommended that in low-income and food-deficit regions livelihoods including food security and climate change cannot be tackled in isolation.

P-3328-06

Responding to the Scares Skills Needs in the Renewable Energy Domain in South Africa

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According to the South African department of Energy, almost 90% of South Africa's electricity is generated in coal-fired power stations. One nuclear station near Cape Town produces about 5 % of the total capacity. The remaining 5% is provided by hydroelectric and pumped storage schemes, the sites available for this power being limited. The Tshwane University of Technology (TUT) in Pretoria, South Africa is responding to these needs in collaboration with French and European Institutions.

This is done through institutions within the Faculty of Engineering and the Built Environment:

- The French South-African Institute of Technology (F'SAT)
- The Centre for Energy and Electric Power (CEEP)

These institutions collaborate within the graduate programme of the Department of Electrical Engineering to provide courses and research in the energy domain and specifically in the renewable energy specialisation.

F'SATI is a National asset contributing to the creation of knowledge and the transfer of technology in South Africa through the establishment of collaboration between various higher education and research institutes, as well as industry. F'SATI's mission is to improve the quality and the quantity of the output at postgraduate level. This proposition is enhanced through the collaboration with other French partners. In the last four years F'SATI has highly increased its output at both postgraduate students and publication levels. The present stakeholders of this venture are the French Ministry of Foreign Affairs, the French Ministry of Education and Research, The Chamber of Commerce an Industry of the Parisian Region, the South African Department of Science and Industry and National Research Foundation.

The European partners of the CEEP include the Hogeschool Utrecht University of Applied Sciences, the University of Utrecht, the ECOFYS, the RWTH-Aachen University and the French ESIEE-Amiens.

The partners of the above programmes include companies such as ESKOM the main power company, Local Municipalities, the Council for Scientific and Industrial Research (CSIR) and other South African Universities.

The above programmes have contributed to the training and education at both the Masters and Doctorate levels. These programmes cover the following domains: smart networks, photovoltaic applications, wind energy production as well as hydropower. This collaborative effort has resulted in the training of postgraduate students as well as the production of many scientific publications in the domain of renewable energy.

The graduates of these programmes contribute to the development of renewable energy in South Africa. This adventure gives an example of a collaboration between European countries and an African country. It shows that such a venture may respond to scarce skills that are highly needed in Africa.

The authors will give more details of these activities in the full document and the oral presentation.

P-3328-07

The Nexus of Climate Downscaling Using RegCM4 and Hydrology dynamics in Ghana

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Climate Downscaling is a term adopted in climate science in recent years to describe a set of techniques that relate local to regional-scale climate variables in relation to the larger scale atmospheric forcing. Theoretically, the techniques are advancements of the known traditional techniques in synoptic climatology. Climate downscaling specifically addresses the detailed temporal and spatial information from Global Climate Models (GCMs) required by precise researches of today. The Regional Climate Model version 4 (RegCM4), with horizontal resolution of 55 km, was used to downscale the ECHAM5 simulations forced with observed SSTs over southern Ghana. For each of the ECHAM5 AGCM integrations a nested integration with the REGCM was done for the period January-June 1961-2000. Six-hour wind, temperature, humidity, and surface pressure data from ECHAM45 AGCM outputs were linearly interpolated in time and in space onto REGCM grids as base fields. The results of the comparison for the Densu catchment station showed a good correlation between the observed REGCM-simulated monthly rainfalls with significant statistics. Although no coherent trends were found in the basin, interannual rainfall variability was more pronounced as revealed by the REGCM 4 simulations. The northern part of the basin is most vulnerable to these variations because it has a monomodal rainfall pattern compared to the south which has relatively higher rainfall amounts due to its bi-modal rainfall pattern. The SPI analysis conducted on projected precipitation based on REGCM using IPCC's A1B and B1 scenarios against the base period of 1961-2000 showed both scenarios agreeing to a general drying trend for the future. Results show that precipitation will decrease by up to 70% in some areas and the duration of the rainy season will narrow, which may have extensive implications for agriculture and city water supply. In lieu of this, adaptation will be central to sustaining development and four response measures are discussed as being cardinal to this process. These include mainstreaming adaptation into policy planning processes at varied levels, enhancing water conservation for agriculture, promoting the cultivation of drought resistant and early maturing crop varieties, and promoting access to food through technical and economic infrastructure and services that facilitate food exchange. Climate Downscaling is a term adopted in climate science in recent years to describe a set of techniques that relate local to regional-scale climate variables in relation to the larger scale atmospheric forcing. Theoretically, the techniques are advancements of the known traditional techniques in synoptic climatology. Climate downscaling specifically addresses the detailed temporal and spatial information from Global Climate Models (GCMs) required by precise researches of today. The Regional Climate Model version 4 (RegCM4), with horizontal resolution of 55 km, was used to downscale the ECHAM5 simulations forced with observed SSTs over southern Ghana. For each of the ECHAM5 AGCM integrations a nested integration with the REGCM was done for the period January-June 1961-2000. The results of the comparison for the Densu catchment station showed a good correlation between the observed REGCM-simulated monthly rainfalls with significant statistics. Although no coherent trends were found in the basin, interannual rainfall variability was more pronounced as revealed by the REGCM 4 simulations. The northern part of the basin is most vulnerable to these variations because it has a monomodal rainfall pattern compared to the south which has relatively higher rainfall amounts due to its bi-modal rainfall pattern. The SPI analysis conducted on projected precipitation based on REGCM using IPCC's A1B and B1 scenarios against the base period of 1961-2000 showed both scenarios agreeing to a general drying trend for the future. Results show that precipitation will decrease by up to 70% in some areas and the duration of the rainy season will narrow, which may have extensive implications for agriculture and city water supply. In lieu of this, adaptation will be central to sustaining development and four response measures are discussed as being cardinal to this process. These include mainstreaming adaptation into policy planning processes at varied levels, enhancing water conservation for agriculture, promoting the cultivation of drought resistant and early maturing crop varieties, and promoting access to food through technical and economic infrastructure and services that facilitate food exchange.

P-3328-08

Risques Hydrométéorologiques dans les Villes Africaines RHYVA/PARRAF

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RHYVA Network: Risques Hydro-météorologiques dans le Villes Africaines

In synergy with the ECOWAS vision , the objective of RHYVA network is to develop a basic understanding of the risks in urban environments and to provide expertise to strengthen the resilience of African cities Capacities for hydrometeorological disasters.Specifically, RHYVA aims to:promote dialogue between the different actors that contribute to reducing the harmful effects of hydrometeorological disasters (scientists, emergency services and risk management, policy makers, NGOs, communities at risk) to share knowledge (results of the research, experience feedback, good governance practices, evaluation, coordination, communication and appropriate conduct).Make a plea and conduct training and awareness activities on reducing urban disaster risk to parliamentarians and local authorities, journalists and the target communities. ;to support research activities on risk Hydrometeorological in African cities and support the development and networking of national platforms in charge of disaster risk reduction at the subregional level

P-3328-09

The role of indigenous knowledge systems in climate change, prediction, adaptation and mitigation in sub Saharan Africa

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The recognition of the significance of indigenous knowledge systems (IKS) has only begun to emerge at the international level in the last few years. Understanding the nature and relevance of IKS for climate change adaptation and mitigation is a new and expanding area of collaborating research involving indigenous people, local communities and scientist. IKS is the basis of community based observations of climate impact and traditional practices and mechanisms that provide a robust basis for climate change response. IKS can be defined as ecological knowledge or accumulative board of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission about relationships of people with one another and their environment. For communities to adapt to climate change it is critical for them to perceive how climate is changing. Farmers have the following perception on climate change, shorting of growing season, changes in rainfall characteristics, increase in temperature, changes in wind characteristics and extreme events such as droughts, floods, dry spells, cyclones and increased incidence of pests and diseases. Farmers in Africa use indigenous knowledge systems for weather forecasting and prediction of season quality. They use a combination of tree phenology, animal behavior such as insects and birds and atmospheric phenomena such as the shape of the moon, type of clouds and wind direction. In most cases seasonal quality forecast and scientific forecast are identical. Scientific forecast may able to compliment indigenous forecast so as to mitigate the loss of traditional weather and climate indicators. Farmers use indigenous practices to adapt to climate change and mitigation.

P-3328-10

Responding to Sustainability Challenges in Irrigation Sector: Community-based Integrated ICT Solutions for Sub-Saharan Africa

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Irrigation is the most water intensive sector, consuming nearly three quarters of global fresh water resources. Significant number of countries in Sub-Saharan Africa (SSA) are emphasizing on expansion of land under irrigation to offset food insecurity brought about by climate change and other factors. This is happening amid increasing evidences on declining fresh water resources in the same region, therefore triggering options to their sustainable management. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector. The solutions were developed involving stakeholders in three SSA countries: Tanzania, Uganda and Rwanda. Testing focused on small scale but sensitive irrigation schemes around Trans-boundary Lake Victoria Basin in Tanzania's part. Among priority adaptation options for climate change is to develop, pilot implement and scale-up information systems. The paper describes integrated Information and Communication Technologies (ICTs) solutions that have been developed with and for communities to support coordination for sustainable water resources in the SSA. They provide tools and techniques that can create a common platform for sharing information at the bottom level. They provide many options through which community can engage in giving and receiving information regarding water resources. These solutions are believed to improve coordination, decision making and control on water resources for irrigation thereby contributing to sustainable water for agriculture, livestock and domestic uses.

P-3328-11

Impacts of climate change on water resources and relevant adaptation strategies in upper catchment of Pangani basin in Tanzania

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The climate change impact on water resources is the major challenge across the Pangani basin in Tanzania. In some areas, too little water leads to droughts and desertification, whereas in others too much water leads to increased flooding. The Tanzania Agriculture Policy advocates for improved water use efficiency as an adaptation strategy, which can help the nation to achieve in improvement of food security; increasing farmer's productivity and income. Following local peoples' perception, the major climate change impact is drought (78%) with high frequency of occurrence. Irrigated agriculture which depends on water resources is by far the largest water use sector in Tanzania, is affected by changes in water availability that is caused by climate change. Climate change also alters irrigation water demand. Higher temperatures and more variable rainfall tend to increase water demand per unit of irrigated area. The adverse effects of climate change is felt by poor communities because of their low adaptive capacity associated with limited financial resources, poor infrastructure, low level of education, dependence on natural resources and lesser access to technology. Traditional irrigated agriculture is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation measure for crop production is usually associated with significant water losses and low crop productivity. Traditional schemes are usually initiated and operated by farmers themselves, with no external intervention or support. They include schemes based on traditional furrows for production of paddy, maize and vegetables. Traditional schemes are usually characterized by locally improvised infrastructure which is poorly constructed and temporary in nature. They are often associated with low productivity due to poor farming and water management practices. Intake structures are made from locally available materials like stones, grass, earth, wooden poles and straw. Intake structures are usually built across the river, partially or wholly blocking the channel, and are thus prone to damage during high river flows. The majority of intakes do not have control gates to regulate the amount of water entering the furrow.

Conveyance canals are usually hand dug and not lined to minimize seepage. Because the canals are unlined, they quickly get clogged by vegetation growth which reduces their efficiency. The canals typically lack flow control devices for effective conveyance and distribution. This implies that, traditional irrigation has low efficiency due to wastage of water sources from the source to the field level. Promotion of efficient irrigation water use and adoption of good farming practices is, therefore, critical to ensuring sustainable use and management of the water resources for sustaining local peoples' livelihoods in Tanzania. Since water demands have intensified with the increase of economic activities such as irrigated agriculture, hydropower generation, livestock keeping, fisheries and wildlife activities, this paper recommends effective implementation of integrated water resources management as adaptation measure to be enhanced and implemented, to ensuring sustainable use and management of water resources for sustainable development.

P-3328-12

Complementing Local Indigenous Knowledge and Practices and scientific knowledge for better policy planning on climate change adaptation: the Case of Cameroon

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Climate change is a defining issue of our era, with its impacts reaching regional and global scales. The current magnitude and variability have critical implications for agriculture, fisheries, forestry, life histories, community compositions, and essential ecosystem functions. Warming, combined with the higher risk of extreme floods and droughts, shrinking water resources will lead to the rapidly lengthening list of potentially damaging impacts, from soaring food prices to famine and mass migration of species including humans and increase in conflicts over diminishing natural resources. Countries of the African continent are among the most vulnerable to climate variability and extremes, given that only 5% of their cultivated land is irrigated and food production is dependent mainly on rain-fed agriculture. How serious the repercussions will be, depends on how fast measures and strategies are adopted to facilitate coping with the extreme and inevitable conditions posed by climate change especially for grass root communities. Unfortunately, some of these agriculture-dependent areas that are most vulnerable to negative effects of climate change are quite remote with improper coverage by scientific forecasting stations. The farmers in these areas have been modifying their farm practices to adapt to inevitable changes in climate. Through on-farm management and post-harvest conservation practices, they have used their wealth of Local Indigenous Knowledge and Practices (LIKPs) in the food production chain to enhance their food security. It has been observed that although LIKPs have been recognised as a resource, they have however been given a tokenistic consideration through the addition of a small portion of traditional ecological knowledge in decision making processes related to climate change while business is still done as usual. These traditional practices and strategies that have been linked to changes in climate and long-term extreme weather conditions, transferred orally and through mutual and collective on-farm learning on-farm learning and practices, from one decade to another and from generation to generation, have been grossly neglected. This poster presentation shall highlight the conflict between traditional (indigenous) knowledge, which is contextual, localised and the western-scientific and bureaucratic (often top-down) method of management that finds it difficult to reconcile national planning with local action (bottom-up) within the framework of climate change adaptation. Focus shall be on Cameroon, one of main breadbaskets of the Central African Sub region. Over many decades, 70% of the 30 million inhabitants' livelihood is hinged on agriculture and these communities have learned to use their LIKPs to cushion themselves inevitable climate risks. Although acceptable levels of adaptation and resilience to climate change have not been defined across the board, this paper emphasises that reconciliations between LIKPs and 'western' science is essential for policy formulation and implementation processes. This places local communities as co-creators of knowledge and practices that cushions them against climate risks, ensuring ownership and sustainability of policies and implementattion strategies. Some examples of successful local indigenous knowledge practices gathered through evidence-based research and engagement with local agriculture dependent communities in Cameroon shall be highlighted to contribute to steer reflections on the subject.

P-3328-13

Influence of Madden-Julian Oscillation (MJO) on Rainfall Variability over West Africa at Intraseasonal Timescale

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Intraseasonal variability of rainfall over West Africa plays a significant role in the economy of the region and is highly linked to agriculture and water resources. This research study aims to investigate the relationship between Madden Julian Oscillation (MJO) and rainfall over West Africa during the boreal summer in the the state-of-the-art Atmospheric Model Intercomparison Project (AMIP) type simulations performed by Atmosphere General Circulation Models (GCMs) forced with prescribed Sea Surface Temperature (SST). It aims to determine the impact of MJO on rainfall and convection over West Africa and identify the dynamical processes which are involved. The simulations show in general good skills in capturing its main characteristics as well as its influence on rainfall over West Africa. On the global scale, most models simulated an eastward spatio-temporal propagation of enhanced and suppressed convection similar to the observed. However, over West Africa the MJO signal is weak in few of the models although there is a good coherence in the eastward propagation. In addition, the ensemble average of models give better performance in reproducing those features. The influence on rainfall is well captured in both Sahel and Guinea regions thereby adequately producing the transition between positive and negative rainfall anomalies through the different phases as seen in the observation. Few models overestimate the composite intensity in phases with strong MJO signal over the Sahel while the opposite is simulated over Guinea coast. Futhermore, the results show that strong active convective phase is clearly associated with the African Easterly Jet (AEJ) but the weak convective phase is associated with a much weaker AEJ particularly over coastal Ghana. In assessing the mechanisms which are involved in the above impacts the convectively equatorial coupled waves (CCEW) are analysed separately. The analysis of the longitudinal propagation of zonal wind at 850hPa and outgoing longwave radiation (OLR) shows that the CCEW are very weak and their extention are very limited beyong West African region. It was found that the westward coupled equatorial Rossby waves are needed to bring out the MJO-convection link over the region and this relationship is well reproduced by all the models. However, Kelvin waves do not account for the overall impact of MJO signal on convection over West Africa. Results also confirmed that it may be possible to predict the anomalous convection over West Africa with a time lead of 15-20 day with regard to Indian Ocean and AMIP simulations performed well in this regard.

P-3328-14

Adaptation and response to climate change, an opportunity for local development in Central Africa: case study of Cameroon western highlands

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Climate change offers opportunities for African countries to emerge. It calls the attention to a sustainable development in a century where African countries aspire to development, emergence and economic stability. According to observations made in different localities on the continents, African local communities are trying to assess and mitigate the impact of climatic change with their own means. This will help them to address particular issues concerning them. Indeed, general measures proposed by stakeholders and policy makers based on them are not always the best to resolve problems arising. Besides, some are living in remote or rural areas and

hence not aware of these mitigation measures and policies adopted. In Cameroon and especially in its western part, to ensure their productivity, farmers have ameliorated their production capacities by developing and mastering new production and commercialization tools. When talking about production we refer to the understanding of the new climatic patterns, the improvement of tilling and irrigation systems. Concerning commercialization, models have changed. Furthermore we see buyers going directly to purchase goods from farms while some years ago it was the producers who were going toward the buyers. Moreover, things have improved at the national level. Contrary to what was done during the last ten years, the publication of meteorological data through national televisions programs and newspapers shows a great progress in the African sub region. This meteorological data have a great impact on the daily lives of populations in the area. Also, state institutions such as ministries of environment and their respective departments, which control industrial production models and sanction those who pollute the environment helps in encouraging sustainable development. This paper shows how local communities in central African countries in general and in the western highlands of Cameroon in particular have adapted to climate change, showing how they respond to it in order to ensure their agricultural production in climatic variability circumstances and how this adaptation contributes to their development. The data presented in this paper are the result of a qualitative research based on in situ observations, interviews and literature review. These data reflect globally what is happening in most of central African countries.

P-3328-15

Biomass Economy in the Era of Politicization and Economization of Nature in Africa: A Case for Clean Energy Transition

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Over the next 25 years, 600 million people to over 700 million will rely on biomass energy in Africa. According to International Energy Agency 61.2% of the population of sub-Saharan Africa will depend on biomass and waste for total primary energy demand when you exclude South Africa, it is 81.2%. Yet, biomass economy as a vital sector of the economy is not integrated into the national development plan of most states. Traditional biomass is mostly unplanned heightening depletion of resources. Africa will witness increases in biomass consumption in 2035 whereas in other regions will witness decreases. With business as usual scenario Africa consumption will rise with exponential population explosion leading to between 51% - 57% higher demands for biomass in 2035. With greenhouse gases reaching 400ppm, man-made climate change will be a barrier to attainment of Sustainable Development Goals (SDGs) of this generation putting an end to poverty in 2030. However, ending global poverty is inextricably linked to energy consumption and production which will also exacerbate climate change. Resolving this complexity is critical in the years to come in that they are mutually reinforcing in Africa. In recognition, many countries made remarkable progress towards resolving this challenge by integrating renewable energy into the energy supply mix in the transition to zero society. However, carbon emission play vital role in clean economy as net zero emission and green growth are not just coterminous but axiomatic necessities. Yet, such necessity is also inter-related with our biospheric limits. Carbon-based growth for low income countries of Africa will ensure transition to middle income economy but such growth is based on resources depletion. For Africa, natural capital is still the large bowl for the transition to middle income country. I argue that though clean energy transition is the future to low carbon civilization. But for many countries in Africa biomass still holds more potential for improving economic wellbeing of the poor. Despite this beneficial attribute, biomass extraction will not only magnify existing inequalities within the continent but will result in reversal of growth. It is my contention there are still many gray areas in clean economy as unsustainable extraction and consumption will continue into the future reinforcing climate-related extreme events. This will require dramatic low carbon trajectory which aims at eco-efficient utilization of green infrastructure. And as such, it is a paradox of cohabiting extremes in the politicization and economization of nature in Africa.

In this paper, the above dilemma is closely examined in the light of its impediment to the food system and meeting SDGs. Finding an enduring energy policy solution to food insecurity will require an ecologically responsible food system that is not undermined by land grabs for biofuel production. This then prompts us to ask: Can Africa's biomass economy made eco-efficient? In what ways has Africa's energy policy mix changed with the politicization and economization of nature? Has Africa's clean energy complex imbibed principle of allocative justice? Can policy reforms rebalance growth towards net zero trajectories? The answers to these questions shall be uncovered through secondary data sources which will point us towards proffering adjustments for policy changes. We conclude by advocating a policy mix of materialization and dematerialization as solution to agro-ecological deteriorations. This will require dramatic changes in production or consumption critical in biomass economy as different phases of the economic process may cancel each other out when it comes to overall energy consumption. To achieve efficient use of energy will require a new roadmap called food sovereignty economy. This model advocates some form of dematerialization if we will not lock present generation into a fossil fuel dependent future. It combines eco-friendly policies of food sovereignty and sufficiency economy to set a pathway to net negative emissions in the attainment of SDGs.

P-3328-16

Ensemble Modeling using General Circulation Models from Global Producing Centres for Rainfall Forecasting over the Greater Horn of Africa

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Climate extremes like flood and drought have threatened the social-economic sustainability over the Greater Horn of Africa (GHA). Lack of accurate and reliable forecasts systems with correct time leads results to devastating impacts. Under the auspice of Global Framework for Climate Services (GFCS), World Meteorological Organization (WMO) in effort to address the challenges due to climate extremes designated global producing centres Models (GPCs) to provide accurate and timely climate services and information.

This study evaluated the skill of forecasting seasonal rainfall over the GHA using the GPCs models. The datasets used included; monthly rainfall model hindcasts, Climate Research Unit (CRU) blended with observed rainfall stations between 1983-2001. The methods employed in the study included Spearman Rank correlation, Composite Analysis, Weighted averages, Continuous Ranked Probability Skill Scores(CRPSS) and Taylor Diagrams.

The skill of the ensemble model was higher than that of the individual models in capturing the rainfall peaks during the ENSO phenomena. Correlation analysis showed higher values for ensemble model output than for the individual models mostly over the Equatorial region. The skill of the models was relatively higher during the onset of the ENSO event and became low towards the decaying phase of ENSO period.

It is clear from the study that ensemble seasonal forecasting significantly adds skill to the forecasts over the region. Blending dynamical ensemble forecasts with statistical forecast currently being produced during Regional Climate Outlook Forums (RCOFs) would add value to seasonal forecasts. This significantly reduces the impacts and damages associated with climate extremes over the region.

P-3328-17

Food security in African drylands: Learning from socio-ecological patterns of smallholder agriculture

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Food production is key to achieving food security in

African drylands. Agricultural productivity is however significantly constrained due to climate variability, low water supply, limited soil fertility and farmers' remoteness from decision-making centres. In addition, future climate change is projected to further undermine agricultural productivity. Vulnerability is employed as a concept to capture the relation between farming systems and climate stresses impacting upon these systems. To promote learning for a food secure future, we present a quantitative and spatially-explicit typology of smallholders' vulnerability in the drylands of Sub-Sahara Africa. This typology explicitly incorporates malnutrition as cause and consequence of vulnerability. We indicated the most relevant socio-ecological properties of dryland farming systems at a sub-national resolution including child malnutrition, water availability, soil erosion sensitivity, agropotential, income, population density, urban population share, distance to markets and governance. Cluster analysis revealed nine typical patterns of vulnerability showing distinct indicator combinations. For example, one pattern depicts high levels of child malnutrition, a poor resource base and poor governance and is indicated in the hyper-arid to semi-arid areas of eastern Africa. This typology enables the evaluation of key inter-linkages between smallholders' climate vulnerability and food security. Their evaluation facilitates the transfer of successful strategies for resilience building based on similarities among the farming systems and supports the identification of entry points for managing transitions towards a food secure future. The manageable number of socio-ecological patterns enable new insights into the prioritisation of interventions to improve and monitor food security.

P-3328-18

Barriers and enablers to climate change adaptation in four South African municipalities, and implications for Community Based Adaptation

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Despite the fact that municipalities have a vital role to play in planning and implementing climate change adaptation, numerous barriers are encountered when they do so, especially at the community level. A study was conducted to analyse these barriers and enablers, both via literature review and case study analysis of four South African municipalities. Comparison of barriers and enablers across the case studies revealed a number of key themes. Municipalities struggle to implement climate change adaptation and community based adaptation within contexts of significant social, economic and ecological challenges. These contextual barriers, when combined with certain cognitive barriers, lead to reactive responses. Existing municipal systems and structures make it difficult to enable climate change adaptation, which is inherently cross-sectoral and messy, and especially community based adaptation that is bottom-up and participatory. Lack of locally applicable knowledge, funding and human resources were found to be significant resource barriers, and were often underlain by social barriers relating to perceptions, norms, discourses and governance challenges. Enablers of engaged officials, operating within enabling organisational environments and drawing on partnerships and networks, were able to overcome or circumvent these barriers. When these enablers coincided with windows of opportunity that increased the prioritisation of climate change within the municipality, projects with ancillary benefits were often implemented.

P-3328-19

Predicting future climate for adaptation in northern Côte d'Ivoire: contribution of statistical downscaling model

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In the region of Korhogo in northern Côte d'Ivoire, recent climate variations are marked by a superposition of droughts and floods. These events contribute to weakening the wellbeing of populations, particularly the most vulnerable. To enhance the actual and future resilience and adaptation capacity of these people, it is necessary to have more information on present climatic parameters and their future evolution.

Temperature and rainfall of the white Bandama basin in the region of Korhogo from 1971 to 2000 were collected at the Société d'Exploitation et de Développement Aéroportuaire, Aéronautique et Météorologie (SODEXAM) and processed. Statistical downscaling method was used to project theses data at three horizons: 2020 (2011-2040), 2050 (2041-2070) and 2080 (2071-2099) base on IPCC A2 and B2 scenarios. Model calibration was done by multiple linear regression between four predictor variables derived from the general circulation model HadCM3 and local observation variables (temperatures and rainfall).

The results generally show that the model simulates well enough both temperatures and rainfall. Of the three horizons, the model predicts an average temperature increase of 0.43°C; 0.97°C and 1.63°C. In general, the A2 scenario provides greater increases than B2. Indeed according to A2 scenario, the current minimum temperature (20.87°C) could increase by 0.48°C, 1.16°C and 2.02°C respectively at the horizons 2020, 2050 and 2080. For current average temperatures (26.8°C), the increase could be 0.44°C, 1.13°C and 1.96°C, respectively for the three horizons. When actual maximum temperature (32.27) could increase by 0.31°C, 1.36°C and 1.17°C also for the same horizons. According to B2 scenario, minimum temperature could increase by 0.43°C, 0.82°C and 1.39°C for the three horizons. Current average temperatures could increase by 0.43°C, 1.13°C and 1.33°C according to B2 scenario. And for maximum temperature, increase could be 0.78°C, 1.11°C and 1.14°C. The months of september and october record the higher values of maximum temperatures.

For precipitation, A2 and B2 scenarios presented the same average annual increase of 34% at the 2020 horizon with a margin of error between 10% and 9% respectively. By 2050, the annual increase could be valued at 29% and 33% for A2 and B2. This increase could be 12% and 28% respectively for A2 and B2 by 2080 with lower margins of error of 4% (A2) and 7% (B2). The months of May and June could see the largest increases (149 mm and 109 mm respectively), which is twice the observed quantities. Such information's are useful for the planning and implementation of programs and plans for adaptation to reduce the potential risks associated with these climatic variations.

3329 - How Might East African Landscapes Respond to Future Climate Change?

ORAL PRESENTATIONS

0-3329-01

Understanding the past to develop a sustainable future: the value of the East African palaeoecological record

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Ecosystems are the primary resource for human well-being and provide key functions essential to the sustainable economic development, especially for African nations whose economies are heavily dependent on agriculture, rangeland pastoralism, forestry management and wildlife tourism. Planning for the long-term sustainable use of

Africa's ecosystem natural resource requires a longer-term historical perspective on human-ecosystem-environment interactions than is currently available. A synthetic overview of the palaeoecological records from East Africa will be presented and used to chart the interactions between people and their use of ecosystem resources during the transition into agriculture. The time period will draw on the palaeoecological record of the last 6000 years with a focus on the historical past. Zooming in on the past 500 years we will present how this has been used to build a foundation to construct informed climatic and socio-economic scenarios for the future. The presentation will focus on unpicking the temporal, spatial and complexity of interactions and interdependencies in the social-ecological systems in Eastern Africa to understand the interactions between people, their environment, wildlife, livelihoods, and provide a better potential future for the sustainable use of Africa's ecosystem. The presentation will unpick how societies, landscapes, ecosystems and Protected Areas have responded to climate change, so as to better understand how they may respond to future climate change and societal use.

0-3329-02

Landscape Resilience and Vulnerability in eastern Africa: an archaeological prospectus for the future

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The need to create and sustain resilient societies capable of facing the burgeoning challenges posed by accelerating global climate change has become a dominant mantra of our age. Both sustainability and resilience are inherently temporal concepts, but in planning for the future it is often difficult to identify which practices and systems are likely to enhance resilience and which may make communities and even whole societies more vulnerable to the detrimental effects of climate change. For this reason, examples from 'the past', and specifically tangible evidence for long-lasting socially and ecologically enabling practices are increasingly used as a source of information for planning the future. Using archaeological examples from East Africa spanning the last ca. 1000 years, this paper outlines some concrete instances of past strategies aimed at enhancing socio-ecological resilience during periods of extreme climatic pressures and critically discusses whether these can be used as models for the future.

0-3329-03

"Growing water" in Northern Kenya: Resilience of the Gabbra ecology and technology to adverse climate change

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Northern Kenya is frequently described as one of six areas directly impacted by the global climate change as well as a region having a low resilience to climate change. Yet the temporal and spatial dynamics of northern Kenyan socio-ecological systems have been relatively stable within a longer-term variability during the Holocene period. Driven by the Lower Omo Basin and the Lake Turkana basin, ecological conditions have only changed with the prolonged period of severe drought of the late-18th century and earliest 19th century and therefore started to challenge local incentives of pastoralist societies. The presentation discuss how severe climate variability and recent socio-ecological change is altering or modifying existing traditional resource governance, adaptation strategies and coping mechanisms in Northern Kenya by focusing on how Disaster Risk Reduction programs implemented to adverse effects of the climate change interact with the Gabbra ecology of the Chalbi desert. For long the local concept of "finn" was used to describe human-landscape interaction and to predict climate events and their relation to ecological conditions and adaptation mechanisms for pastures and water. Based on a complex predictive model, including memory of past climate events, moon calendar and local indicator of ecological condition, this traditional early warning system has probably collapsed with increasing "aid addiction" and the implementation of technological innovation to "grow water" in the desert. From an ethnographic survey done in 2011, the presentation will explore how the lost of local knowledge regarding climate, land and water resource reshape resilient capacities of socio-ecological system. From this situation of environmental acculturation, we expect to discuss how predictive model of climate and more widely the African Union "Policy framework for pastoralism in Africa" may help to build common responses to future climate change.

0-3329-04

Adopting landscape approach in enhancing resource governance, adaptation and resilience in arid and semi-arid lands of Kenya

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Efficient and balanced utilization of natural resources dispersed in spatial and temporal basis in vast landscapes of arid and semi-arid lands is the main survival strategy for pastoralist communities in Northern Kenya and horn of Africa for generations. Natural resource planning and management in pastoral communities is anchored on traditional regulations and institutions that facilitates mobility one of the cornerstone strategies that allows balanced use of the resource and survive harsh climatic conditions and stresses including drought. The traditional institutions plan and manage their resources in integrated manner at landscape level. External factors including formal government institutions and approaches have weakened these institutions and disrupted sustainable resource management hence making pastoral communities vulnerable to climate change.

Reviving and strengthening the landscape level approaches in resource management and governance that involve all the relevant stakeholders in participatory manner is paramount in facilitating resilience building and adaptation in pastoral areas of northern Kenya and horn of Africa. Towards entrenching and enhancing landscape level resource management and governance IUCN in collaboration with diverse stakeholders initiated natural resource governance projects in northern Kenya. This paper highlights the outcomes of the initiatives, opportunities and challenges that exist in adopting landscape level natural resource management interventions under the devolved system of governance in Kenya to enhance resilience and adaptation to climate change.

Integrated natural resource management anchored on participatory planning and management hold enormous potential in overcoming drought and climate extremes in pastoral areas of northern Kenya. One of the key approaches implemented to facilitate integration is adapted sub-catchment management planning approach. The approach is based on integration of the rangeland management and sub-catchment management plans to best serve the need of the pastoral communities. Landscape level planning and management was enhanced through this approach by bridging the gap between the formal and traditional resource management institutions that derive legitimacy from the national policies and local level governance structures. The formation of hybrid institution tasked with multiple resource planning and management operations were strengthened through formulation of integrated natural resource management bylaws anchored on traditional systems of resource planning and management which is formalized by county government through the devolved functions hence creating ownership and local control over resources. The bylaws formulation is informed by participatory resource mapping exercise which jointly facilitates tenure rights for resources at landscape level. The devolution process also offers inter-county collaboration on resource use and coordination which is critical aspect in implementation of landscape level interventions.

The key challenges in effective implementation of landscape level interventions in the northern Kenya are mainly related to low understanding of the value of the landscape approach in resources management which is intertwined with less appreciation of the pastoral livelihood among some government official. Although there are some challenges there are policies and laws that promote landscape approach at national level and opportunity exists for formulation of the further policies and laws at the County level.

0-3329-05

The Rusizi plain,an area proneto the challenges of climate change and subject to political contraints

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Statement of the problem: Is it possible to have a political ecology in a natural and human environment which is both subject to the global change and geopolitical tensions?

1. The starting point: The alarm was raised by the increase of natural physical challenges: frequent floods, erosion, fragile biodiversity, soil degradation, epidemics, etc. which reveal a serious ecological crisis which, nonetheless, is not the first one in the region.

- This crisis goes back into the past from the demographic pressure on the environment and its resources. It takes various aspects: settlement front in the plain, rapid urbanization, overpopulation, degradation of watersheds which undermine, beyond hill level, the upper slopes and the forests.

-This gap has been maintained by political instability over the last 30 years of civil wars accompanied by forced migrations, depopulation of one area and resettlement in another, the intensification of land disputes between herdsmen and farmers, which have been exacerbated by contrasting political styles of governance in different countries and, even more, by the effects of climate change (rainfalls, intensity of natural disasters-this needs to be better identified).

2. Short and mid-term projections :In the mid-term, the projections confirm this pattern and even exaggerate it: the Rusizi plain is a breathing space for the Great Lakes population, due to area development and agriculture projects. It is becoming an attractive economic frontier due to emerging economies, asymmetric national economies and their new sources of revenue (trade, tourism, etc.), an area for farming activities (rice- growing and processing project and cattle farms, etc.), an area with high demographic growth, both natural and due to migrations (refugee resettlement, long-term settlement in camps).

-Demographic policies, initiated in the three countries, although in an unequal manner, have had little or no effect in the short and mid-term, due to the inertia of the population movement.

-In addition to the above, you also have political, geopolitical, sub regional and bilateral challenges amid instability in some sub-regions of the Rusizi , conflicts between asymmetric political systems (strong/weak/failed state: Rwandan, Burundian and Congolese), fueled by outbreaks of rebellionin connection with the politicsin the three countries, and to which could be added territorial disputes. This situation does not help nascent public policies.

3. The way forward:In response to these challenges, sectoral approaches as well as technical-economic processes are possible, but they lack a comprehensive political framework. The best known are conservation policies for threatened areas (niches, protected areas, parks and nature reserves) ...., with local/ zonal public policies, with technical solutions for each type of soil (land use plan and landscape map). The aim is a sustainable agricultural and agro pastoral development, with a view to improving the population's living conditions. These require comprehensive policies that would lead to regional and international planning (diagram), with harmonized sectoralpolicies and investments (water, energy, town, mines agriculture, tourism).

- Everything will depend on the role of the states, the international and regional community, the provincial and municipal authorities and their cross-border cooperation, the national and international civil society, the means invested in such a scheme, focusing on the public good across the borders and in the region, with a view of creating 'peace lands'; hence, the relevance of a political ecology.

0-3329-06

Adapting to Climate- Bringing Back Traditional Grains to the Dinner table

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Climate change will have significant impact on crops yields. Adaptation to climate change will necessarily call for shifts in diets. This will require diversifying diets to reduce the risk for failure of one crop and shifting diets towards more draught resistant crops. In the Eastern part of Africa huge reliance on maize already make the regional vulnerable to famine as maize is a sensitive to shortage of water at critical period of growth. This vulnerability is going to be significantly magnified in the wake of climate change that will see reduction in precipitation and also increase in uncertainty on the timing of the rains.

The region can thus benefit greatly from shift towards diets that use traditional grains of millet and sorghum that are more resistant to draught and more suited to the region's agro-ecological conditions and importantly more nutritious than maize rice and wheat (the other grains whose consumption is growing fast). However the traditional grains have over the years lost their place in the dinner table, first to maize following introduction by the Portugese and more recently to wheat and rice. The loss to maize can be explained largely by resistance of maize to quelea birds attack and the rise of wheat and rice (which are largely imported) can be largely explained by ease of cooking and convenience offered by these garins, qualities which are important in urban areas where time is limited. The consumption by the more affluent urban dwellers has also conferred to wheat and rice a positive image of food of the successful. Conversely growing and consumption of millet and sorghum has remained confined to the poor and marginal and therefore poor areas, where they are really the only grains that can grow due to their hardiness, and the consequence is that the grain are now seen as the food for the poor an image that has made them very uncompetitive. They have been neglected by research and also food systems and as a results yields remain very low and farming system largely subsistence. The value chains remain highly fragmented with very low level of product development a factors that has further disadvantaged them in emerging dynamic urban food markets that call for convenience, good packaging and product variety.

Bringing the traditional grains back to the dinner table will therefore be problematic as it will require the upgrading of the value chains to meet the demands of modern food system. RAND and ACET are conducting an intervention to increase consumption of traditional grains. The intervention includes a millet and sorghum cooking competition by top chef to demonstrate the many ways millet can be used to cook nutritious foods and develop a millet and sorghum recipes book as an output of the competition. We are also working with food manufacturers and together with a supermarket chain to use the recipes to develop high value health millet and sorghum products under the supermarket brand. This intervention aims to position traditional grains as healthy foods and catalyse the development of healthy branded premium sorghum and millet products target at the emerging middle class while at the same time building a strong supply chain that can link small holder farmers to markets to processors and to the emerging regional supermarket chains.

The short term objective is to improve the image of the traditional grain by targeting high income consumers whose consumption is an important signal in conferring a positive image. The intervention will also support processors and farmers to tackle the pressing challenges including the quelea bird and mechanization for farmers and the upgrading of equipment and knowhow on product development for SME food processors.

In the medium term the objective is to increase general demand by leverage the improved image and upgraded value chains to target the low income urban poor with low cost and nutritious ready-To-Eat (RTE) sorghum and millet products.

The overall impact will be greater resilience through increase diversity in diets and also increased consumption of draught resistant grains. Nutrition will also be improved due to increased consumption of more nutritious food products and poverty as millets and sorghum replace imported rice and wheat products.

P-3329-01

Geothermal Development in Kenya, a Climate resilient strategy?

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Due to high vulnerability and lower adaptive capacity, Africa is predicted to contend with greater impacts resulting from climate change. This could potentially hamper past and future developments. 83% of Kenya, for example, consists of Arid and Semi Arid land inhabited by populations which are highly vulnerable. Moreover, there is indication that ASALs are increasing, one consequence of deforestation and climate change. According to the Stockholm Environment Institute (2009), major droughts occuring in 1998-2000, 2004/2005 and 2009 resulted in economic losses worth approximately $2.8 billion from water and energy deprivation. Declined water levels in dams for hydroelectric power production also caused widespread electric power rationing. In accordance with the Kyoto protocol, calling for countries to commit to decreasing green house gases, and the World Summit on sustainable Development (WSSD) specifically requiring countries to commit to producing 10% of their energy from renewables, the National climate Change Response strategy of 2010 aserts; that following a low carbon development path will result in significant economic and huge environmental and social benefits. The focus is to zero rate taxes on renewable energy technologies and promote alternative renewable energy such as solar, bio fuels, wind and geothermal. Currently, the government is focusing on electricity production from geothermal sources, most of which lie within the central rift valley. Here, geothermal development can be considered a climate change mitigation measure as well as an adaptation mechanism. Firstly, with completion of the targetted 5300MW by 2030, the geothermal power production is projected to save 906008 tones of CO2 /year and further reduce significantly, use of fossil fuels in electricity production. Secondly, Hydropower, on which Kenya depends for most of her electricity, is dependent upon climatic conditions and therefore highly vulnerable in the face of climate change. Thirdly, close to 80% or rural households and small businesses depend on biomass energy. Affordable electricity from alternative source - geothermal, seen as the most cost effective means of power production, could mean decreased dependence on biomass and subsequent deforestation. Fourthly, Non-annex 1 countries like Kenya; in undertaking mitigation projects can gain from 'carbon markets', which allows for trading in Certified emission Reduction (CER) credits. This contribution will explore the adoption and implementation of the geothermal industry in Kenya as a significant pathway to climate resilience.

P-3329-02

Nubians as Egyptian Indigenous people and Climate Change Mitigation

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Egypt and Sudan are the most populous countries in Africa and the Middle East. Nile River is considered as a very important artery that joins Sudan and Egypt. Nile was an important part of ancient Egyptian spiritual life.

Nubian peoples are an ethnic group; they considered as one of the most ancient people all over the world, their civilization started more than 8.000 years ago. Lake Nasser is the second largest man-made lake in the world; among the impacts that were anticipated were the resettlement of the Nubian population in the area inundated by the reservoir, saving of historic monuments, health impacts and coastal erosion.

The climate models all estimate a steady increase in temperatures for Egypt, with little intermeddle variance. Somewhat more warming is estimated for summer than for winter.

However, since Egypt is mainly a desert and relies primarily on irrigated agriculture, precipitation over the country itself matters very little. Much more important are precipitation changes at the water sources of the Nile, which affect the vulnerability of water resources.

The potential impacts of climate change on coastal resources are ranked as most serious. Climate change induced sea level rise only reinforces this trend. In addition to this high biophysical exposure to the risk of sea level rise, Egypt's social sensitivity to sea level rise is particularly high.

In general, although the models on average show an increase in precipitation, inter-model variation is so high that it is uncertain as to predict whether annual average precipitation will increase or decrease.

P-3329-03

A meta-analysis of long-term land management effect on Soil Organic Carbon (SOC) in Ethiopia

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The role of Soil Organic Carbon (SOC) in mitigating climate change, indicating soil quality and ecosystem function has created research interested to know the nature of SOC at landscape level. The objective of this study was to examine variation and distribution of SOC in a long-term land management at a watershed and plot level.

This study was based on meta-analysis of three case studies and 128 surface SOC data from Ethiopia. Three sites (Gununo, Anjeni and Maybar) were compared after considering two land management categories (LMC) and three types of land uses (LUT) in quasi-experiment design.

Shapiro-Wilk tests showed non-normal distribution ($p=0.002$, $\alpha=0.05$) of the data. SOC median value showed the effect of long-term land management with values of 2.29 and 2.38 (g/kg) for less and better-managed watersheds respectively. SOC values were 1.7, 2.8 and 2.6 (g/kg) for Crop (CLU), Grass (GLU) and Forest Land Use (FLU) respectively. The rank order for SOC variability was FLU>GLU>CLU. Mann-Whitney U and Kruskal-Wallis test showed a significant difference in the medians and distribution of SOC among the LUT, between soil profiles ($p<0.05$, confidence interval 95%, $\alpha=0.05$) while it is not significant ($p>0.05$) for LMC. The mean and sum rank of Mann Whitney U and Kruskal Wallis test also showed the difference at watershed and plot level. Using SOC as a predictor, cross-validated correct classification with discriminant analysis showed 46% and 49% for LUT and LMC respectively. The study showed how to categorize landscapes using SOC with respect to land management for decision-makers.

P-3329-04

Reconstructing 200 years of human-induced soil erosion in the Lake Baringo catchment (Kenya) based on sedimentology and geochemistry of lake sediments

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Summary. Land degradation due to loss of vegetation and fertile soils by strong erosion during the rainy season is one of the major environmental problems affecting the Lake Baringo catchment in Kenya's central Rift Valley. In this study we used magnetic susceptibility, X-ray fluorescence (XRF), and grain-size measurements on sediment cores from Lake Baringo to trace the variable influence of human activity on catchment soil erosion through time. The three studied sediment sequences, recovered from different offshore locations, display a similar stratigraphy of fine-grained and low-organic lacustrine clays deposited above stiff clays representing a desiccation horizon dated to the late 18th - early 19th century.

High-resolution magnetic susceptibility and XRF data reveal a cyclic pattern of peak values with apparently annual periodicity, particularly in sediments dated to the early to mid-20th century. It is interpreted as alternating seasonal spikes of sediment influx from rivers and direct run-off, linked to increased population and livestock pressure. Results of grain-size analysis indicate that the very fine-grained clay sediments dominating this particular zone are derived from old lacustrine sediments, originally deposited in offshore areas of the early Holocene 'mega-lake' Baringo, but which is now part of the gently-sloping Rift Valley plains surrounding the lake today. Sediment thickness above the desiccation horizon increases towards the southern end of the lake, due to high sediment influx from the Perkerra and Molo Rivers, which drain the largest catchment area. Lead-210 dating of these 200-year sequences shows that variation in the rate of sediment accumulation is strongly influenced by historical lake-level fluctuations, with accumulation maxima occurring during lowstands due to sediment being concentrated into smaller area of accumulation.

P-3329-05

Understanding the Vulnerability to Climate Change Effects in East Africa. Case Study of Rice Farmers in Bugesera District, Rwanda

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Located in the Eastern region of Africa, Rwanda has been faced with unusual irregularities in climate patterns including extreme temperatures, variability in rainfall frequencies and intensity over the last 30 years. In fact, the analysis of rainfall shows that, since 1992, Rwanda has been characterized by a declining trend with a remarkable variability in rainfall frequencies and intensity which resulted into serious floods in 1997-1998 and a prolonged drought in 1999-2000. This study has been conducted in Bugesera District to reveal the effects of climate change on rice farmers. According to the results, the rise in temperature and changes in the amount of rainfall and its distribution have altered the availability of water resources, consequently affecting the productivity of rice. The variability in the onset of the rainy season has led to variation in the start of the planting season which has negatively affected the production of rice. Assessment of people's perceptions on ongoing change on rainfall and temperature patterns, and their adaptation strategies has been made. The respondents accept that there is a change happening in their area and have already started to feel its impacts. The study revealed that yields of rice have been distorted by changes in precipitation, temperature, as well as soil moisture. Flooding in lower zones of altitude along river Akanyaru have been reported for many times in the study area as causing the submergence of rice fields thereby damaging the growth and reducing the productivity of rice. In adaptation to climatic change effects, rice farmers have started to take on some adaptation measures. These measures include constructing water reservoir to collect water for irrigation use in the dry season, switching to new varieties of rice that resist to drought and flooding, and application of pesticides to combat with pests.

3330a - Facing climate change in Sub-Saharan Africa

ORAL PRESENTATIONS

K-3330a-01

Observatories, a Key Tool to Tackle Climate Changes in Tropical Regions

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For both physical and socio-economic reasons, tropical regions are highly sensitive to the impacts of climate change. At the same time, the model projections are more uncertain than for many other regions of the world, especially regarding the hydrologic cycle that is the key driver for water resources, agriculture and food security. The various components of the continental water balance display a strong variability over a large range of space and time scales that are not properly documented by the operational meteorological and hydrological networks. This natural variability of the water cycle challenges our ability to detect significant trends potentially linked to the global warming and/or other factors, such as land use changes or ecosystem evolutions. While detecting changes in the annual mean of precipitation, runoff or deep infiltration is not always self-evident, it is still much more challenging to assess significant changes in the extreme values, because the less frequent are the phenomena to observe, the longer should be the period of observations to detect a statistically significant non stationarity. This set of issues applies in much the same way to other key components of our environment, such as for instance, erosion, dust transportation, soil resources.

Adequate observing systems allowing the documentation of both the climate evolution at regional scale and its impacts on the air quality, radiative budgets, hydrology and vegetation are thus a key tool for a fine characterization of climate change and for providing decision makers with the appropriate knowledge to be used for implementing and following ambitious public policies in order to mitigate its socio-environmental consequences. In the long run, observing systems are also crucial for improving climate models, especially when it comes to the simulation of variables -such as rainfall, river flows, dust transportation - that display the largest interannual variability.

This will be illustrated through the history and achievements of the AMMA-CACTH and other observing systems (IDAF, PHOTONS, Dust-Transect, GPS) providing the ground to debate the need for consolidating a collaborative strategy for tropical climate change observations and to discuss how to reinforce the science/policy interfaces in this area.

K-3330a-02

Climate Change Projections in the Sahel. The what and the why

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This talk will review the projected 21st century changes in temperature and precipitation at seasonal and sub seasonal scale in Subsaharan Africa, with particular emphasis on the Sahel and the West African Monsoon region.

Greenhouse-gas induced temperature increases are large compared to interannual variability and such forced seasonal temperature anomalies are decoupled from the occurrence of drought or pluvials; this results in a robust projection of unprecedented seasonal temperatures by mid-century.

Precipitation anomalies remain more uncertain. In the Sahel, although outlier models remain, the ensemble anomalies indicate lesser precipitation totals in the west and greater in the east, and a change in seasonality that is manifest in a delay in the beginning, peak, or demise of the rainy season.

Additionally, we present the projected changes in the characteristics of rainfall and in the occurrence of extreme events and we evaluate the robustness of such anomalies with respect to model uncertainty, natural variability, and the use of statistical downscaling to debias daily rainfall and temperature.

Finally, we interpret seasonal rainfall anomalies in terms of thermodynamic and dynamic forcings and in terms of regional and global modes of change. We emphasize the role of the large-scale circulation and the forcing from both the tropical and the midlatitude sea surface temperature anomalies.

K-3330a-03

External forcing and Sahelian African climate anomalies - A study from the WAMME project

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The Sub-Sahara Africa is a diverse climatic and economically fragile region and dramatic change over the Sahelian Africa from wet conditions in the 1950s to much drier conditions in the 1970s-1980s and then to partial recovery from the 1990s represents one of the strongest interdecadal climate variability and the longest drought on the planet in the twentieth century. A significant climate feature in the Sahelian Africa is the West African monsoon (WAM), which variability dominants the climate variability there. However, the CMIP5 coupled models underestimate the WAM decadal variability and the drought. Although encouraging progresses have been achieved, many systematic and robust biases of the coupled and atmospheric models have not improved from CMIP3 to CMIP5. It is necessary to have comprehensive understanding on the past Sub-Sahara decadal variability and predictability to provide reliable assessment of future climate change and adequate strategy for mitigation and adaptation under changing climate.

In past several decades, the West African climate community has recognized the importance of external forcings: oceans, land processes including land cover and land use change (LULCC), aerosols, and greenhouse gases, on WAM variability, especially their roles in the Sahel drought. However, most of these studies only focused on one external forcing with one single model. The West African Monsoon Modeling and Evaluation (WAMME) is a project comprised of both general circulation models (GCMs) and regional climate models (RCMs) with the objective to collectively provide best estimation of the relative importance of all those external forcing on WAM at seasonal to multi-decadal time scales. WAMME research activities are closely coordinated with those of AMMA, involving many African institutions. The observational and other relevant datasets acquired from AMMA provide important benchmark for assessing the role of external forcing in regional climate variability and anomalies.

In this paper, we mainly present the latest results from the WAMME-2, which is designed to test how seasonal and decadal variabilities of WAM precipitation are associated with external forcings, and assess their relative contributions in producing/amplifying the WAM seasonal and decadal climate variability. The sensitivity of the WAM variability to those external forcings is also examined. The WAMME-2 strategy is to apply observational data-based anomaly forcing of SST, land surface and aerosols, i.e., «idealized but realistic» forcing, in GCM and RCM simulations with the specific purpose of estimating the relative impacts of each forcing and feedback mechanisms.

In the SST experiment, in addition to the global SST effect, each ocean's role is also evaluated. The preliminary results from most GCMs consistently indicate that SST has a maximum impact on the WAM decadal variability compared with other forcings, and that the effect of the Pacific Ocean is most dominant. The models, however, differ in producing other oceans' contribution. Moreover, the models with specified maximum SST anomaly forcing are still unable to produce full Sahel drought (only slightly above 50% of the full drought). In the LULCC experiment, a newly available land use change map is applied. A consistent change in the vegetation maps is imposed for each modeling group. The simulated LULCC impact is also substantial, compatible to but less than the SST forcing (about 40% of the drought). In the dust experiment, the direct impact of dust on the radiation budget and its influence to the Sahel rainfall are evaluated using the GOCART dust data and its effect also contributes to the drought (less than 20% of the drought). In addition, some preliminary results for impact of the greenhouse and global warming on the Sub-Sahara climate decadal variability will also be presented.

WAMME is the first attempt to use multi-GCMs and RCMs to collectively explore the roles of multiple external forcing in WAM variability. WAMME2's achievement provide better understanding of relative importance of various forcing and possible feedback mechanisms, complementary to experiments under CMIP, which are focused more on impacts of emission scenarios, and CORDEX, which is focus on RCM downscaling ability. The results from WAMME should provide useful information to analyze and understand the CMIP results for future climate change and help design impacts scenarios and plan adaptation options.

O-3330a-01

Projected Climate Conditions over West Africa for the End of the 21st Century: Impact on Extreme Precipitation Events

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Global warming resulting from increased anthropogenic greenhouse gas (GHG) forcing will substantially alter West African regional climate conditions. 21st century projections from both Global Climate Models (GCMs) and Regional Climate Models (RCMs) indicate lower warming along the Gulf of Guinea and orographic zones and greater warming in the Sahel and the Sahara desert. In addition, mean precipitation changes and trends exhibit more complex, seasonally varying spatial patterns from the Gulf of Guinea to the Sahel and from the orographic areas to the flatter regions.

Investigating how these combined temperature and precipitation changes will affect the climate of West Africa requires a multivariate approach. Climate classifications integrate the influence of energy and moisture in order to define the climate of a region, and are thus well-suited tools for this purpose. As climate is the major influence on biological life, such classification is critical for the region, particularly at the time during which the loss of major ecosystems and croplands is a fact. Information on projected climate types over West Africa can thus enable the impact community to develop mitigation strategies and adaptation measures for the most vulnerable areas.

In this context, recent studies identified also substantial increases of very high monthly precipitation and an amplification of daily precipitation extremes by the end of the 21st Century. These increases in extremes are considerably spatially variable over West Africa and mostly driven by an intensification of the local hydrological cycle. However, key sectors and activities in West Africa may be more vulnerable to the seasonal timing of the occurrence of extremes than its yearly average. Estimating and understanding such seasonal and sub-seasonal changes is important for the formulation of adaptation and mitigation strategies. For example if an increase in high intensity rainfall events is concurrent to the peak of the rainy season, this may result in widespread flooding requiring strong responses. As another example, in the case of pre-monsoon high intensity rainfall events, early deployment of flood control measures may be required.

In this study, the revised Thornthwaite climate classification is employed to investigate the shift of West African climatic zones in response to future anthropogenic climate change under two Representative Concentration Pathways (RCP4.5 and RCP8.5) from multiple data sources: ensembles of GCMs from CMIP5, RCM projections from CORDEX and higher-resolution RegCM4 simulations over West Africa. The use of multiple ensembles enables us to assess the robustness of the response, and in particular the extent to which the higher resolution experiments offer added regional details. In addition, the study also examines how such a shift impacts on the timing of extreme events. In particular, we focus on the response to increasing GHG concentrations of the annual cycle of high intensity precipitation events, specifically during the pre-monsoon (April-June), mature monsoon (July-September)

and post-monsoon (October-December) seasons. This task is carried out through the analysis of a series of standard indices of precipitation extremes applied to the daily precipitation projections.

The results reveal that West Africa evolves towards increasingly arid and semi-arid regimes with the recession of moist and wet zones, thus adding another element of vulnerability to future anthropogenic climate change for the ecosystems and agricultural lands in the regions.

In addition, analysis of the changes in the annual of high intensity precipitation events indicate that the pre-monsoon season experiences the largest changes in daily precipitation statistics. These changes are particularly towards an increased risk of drought associated to a decrease in mean precipitation and frequency of wet days, and increased risk of flood associated with very wet events. Both these features can produce significant stresses on important sectors such as agriculture and water resources at a time of the year (e.g. the monsoon onset period) where such stresses can have stronger impacts.

O-3330a-02

Trends in West African floods: A comparative analysis with physiographic indices

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After the drought of the years 1970 In West Africa, the variability of rainfall and land use changes affected mostly flow, and recently, flooding is said to be an increasingly common occurrence throughout the whole of West Africa. These changes aroused many questions about the impact of climate change on the flood regimes in west african countries.

This paper investigates whether floods are becoming more frequent or more severe, and to what extend climate patterns have been responsible of these changes. We analyze the trends in floods of 14 catchments within the main climate zone of West Africa. The methodology includes two types of sampling flood events, namely the AM (Annual maximum) method and the POT (Peak over threshold), and two perspectives of analysis are presented, precisely long term analysis based on two long time series of flood, and regional perspective involving 14 catchments with shorter length of series.

Mann Kendall trend test and Pettitt break test are used to assess the stationarity of the time series. The trends detected in flood time series are compared to the trends of rainfall indices in one hand and vegetation indices in the second hand using contingency tables, in order to identify the main driver of change in flood magnitude and Flood frequency. The dependency between flood index and physiographic index is evaluated through a Success Criterion and the CramerV criterion calculated from the contengecy tables.

The results point out the existence of trends in flood magnitude and flood frequency time series with two main patterns. sahelian flood show increasing trends, and some sudanian catchments present decreasing trends. for the overall studied catchments, the maximum five consecutive days rainfall index (Rx5d) seems to follow the trend of floods, while NDVI indices do not show significant link between with the trends of floods, meaning that this index has no impact in the behaviour of flood in the region.

O-3330a-03

Evolution of surface temperature and heat waves over West Africa during the near and the far future

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The aim of this work is to study the spatio-temporal variability of the future evolution of surface temperature and heat waves over West Africa using regional climate models outputs engaged in COordinated Regional climate Downscaling EXperiment (CORDEX) project. CORDEX is an international project implemented by many research centers worldwide which aims to supply reliable climate change scenarios to the scientific community. These simulations are perfomed with the latest state of the art regional climate models over most emerged lands of the planet for environmental impact studies and also to characterize the associated uncertainties. The data analyzed within the framework of this work are the climate change projections performed with the latest greenhouse gaz emission scenarios: RCP4.5 and RCP8.5.

This work focuses on the near (2020-2050) and the far (2070-2100) future and analyzes the spatio-temporal variability of the surface temperature and heat waves episodes over West Africa; these heat waves remain under studied over this region despite their negative impacts on the populations and their socio-economic activities.

3330b - Facing climate change in Sub-Saharan Africa

ORAL PRESENTATIONS

K-3330b-01

Assessing climate impacts and adaptation options for cereal systems in West Africa

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Much has been learned in recent years about the nature of climate changes in the West African region, including robust projections of delayed monsoon onset and, in many locations, increased late-season rainfall. This talk will examine the implications of these changes for crop adaptation strategies. Two process-based crop models (APSIM and SARRAH-H) are used to explore climate change impacts under various management and cultivar scenarios for sorghum, the main crop in the region. Potential adaptation strategies we test include more conservative sowing rules (to reduce risks of early-season drought stress and crop failure), a switch to longer-season varieties (to avoid shortening of the growth period), increased fertilizer rates and planting density (to take advantage of increased late-season rainfall), switching from photo-sensitive to photo-insensitive varieties, and rainwater harvesting to provide supplemental irrigation. The results are analyzed in terms of effects on both average and variability of yields, with the goal being to identify strategies that will very likely reduce negative impacts of climate trends on average and/or variability of yields, while not sacrificing performance in the current climate. Such strategies could then be promoted as adaptation priorities in the region.

K-3330b-02

The challenge of water resource management in the Lake Victoria basin, East Africa

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The Lake Victoria basin, in the headwaters of the Nile in East Africa, is home to over 30M people. As the population continues to increase, demands for water for irrigation, hydropower, and domestic and industrial supply are growing rapidly. The significant drop in Lake Victoria water levels, beginning in 2000 and reaching the lowest recorded level since the 1940s six years later, inconvenienced those who depend on the lake for their livelihoods and generated not just a regional, but a global, debate. A number of conflicting narratives regarding the cause of the decline were advanced by the scientific community, the regional press and the citizens of the five riparian countries, namely Burundi, Kenya, Rwanda, Tanzania and Uganda.

Lake levels are a primarily a function of regional climate and resultant lake rainfall and evaporation; the impact of water releases for hydropower and other abstractions within the basin is still relatively minor. The Lake Victoria region is characterised by high intra- and inter-annual climatic variability, the consequence of which is significant uncertainty in future rainfall on, and inflows to, the lake. Long good quality hydrometeorological time series records have always been considered important for the assessment and management of water resources. However, many countries in sub-Saharan Africa, and elsewhere, have experienced a marked decline in hydrometeorological data collection and management in recent years.

An increasing need is emerging for long-term datasets to understand how national and basin-scale hydrological regimes are responding to climatic variations and anthropogenic influences. Predicting future water availability, for effective water resource planning under climate change and population growth, requires well-founded predictions of regional climate, hydrology and societal demands across the basin. Whilst climate and hydrological models can inform about expected impacts of change, validation of these models requires real data. In an interesting paradox which illustrates the current lack of capacity to predict the impacts of climate variability and change on water resources, the East African long rains are observed to be decreasing, whilst climate models predict an increase.

Initiatives to improve understanding of the climate and hydrology of the lake basin are welcomed e.g. GEWEX HyVic regional hydroclimate project, DFID-NERC FCFA (Future Climate for Africa) programme, and WMO data rescue activities which aim to identify and preserve records that capture natural variability.

K-3330b-03

Using climate information to build resilience agriculture for farmers in Kaffrine district in senegal

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Senegal, at the image of many sahelian countries, is one of the most affected area by climate variability. Climate is varying at decadal, inter-annual and sub-seasonal time scales. So population living in such environment are affected by climate shocks in their livelihood.

Funded by the CCAFS initiative there is a 5 years going on project with farmers demonstrating how to use climate information to help farmers in their decision making. This initiative is a pluri-disciplinary and multi-scale processes. In the course of this project many lessons were learnt and many good successful actions that lead to improve farmers decision system.

Downscaled climate and weather is produced for the district of Kaffrine. This information is then provided to a local pluri-disciplinary working group (GTP) which interpret it into actionable decision. In this GTP sit representative of farmer's organization, local decision makers, boundary organization and local department extensions working on agricultural related issues (agriculture, crop protection, forestry, water, seed producers, ...). Then the advices coming out of the GTP is broadcasted through rural radio, bulletin, text messaging as well as during social gathering (naming ceremony, funeral, ...). In this process indigenous knowledge is also used beside state of arts climate forecasting. During all the crop cycle, each ten days period, information is provided to farmers to help them to make the best decision. These decisions include choice of the planting dates, avoiding false start, applying fertilizer, removing the herb, harvesting and storage. In this project all initiatives are discussed with farmers representatives and evaluated after the cropping cycle.

A monitoring and evaluation study has shown that farmers in this project was able to cope with climate shock better than other farmers which lead to increase substantially their yields. Today this project in Kaffrine is owned by local government representative who calls and leads such meeting. Now the project is at its upscalling phase to other districts of Senegal using rural radio network. In the upscaling process community radio journalists are trained to understand climate information in order to disseminate such information at broader scale.

We will present lesson learnt and evidence in this project during these 5 years for a climate smart agriculture.

O-3330b-01

Yield Gap and the shares of climate and crop management in yield and yield variability of staple crops in West Africa

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« Yield gap » (Yg) is a key concept of agricultural science for identifying the room for improvement of yields through better management of the agroecosystem. In rainfed agriculture Yg is the difference between actual yield (Ya) and the theoretical water limited yield (Yw) that would be achieved if solar radiation, temperature and precipitations were the only factor limiting the crop's growth and yield. Changes in Yw over regions and years are due to climate-soil interactions that are not easily modified by crop management, whereas changes in Yg are due to limiting factors that are typically within the scope of crop management such as nutrient availability, weeds, and pests.

We provide an example of yield gap estimates in semi-arid Africa, using yield and other agronomic data collected in famers' fields of Senegal in 1990 and 1991 and from 2006 to 2012. It illustrates how contrarily to what most people would expect climate is not, on average, what most limits yields in that region: yet, actual yields are on average a quarter of water limited yield, and this is due to constraints whose reduction is technically possible albeit subject to the economic and environmental relevance of doing so.

Most studies dealing with the impact of climate change on agriculture in West Africa compare Yw under present and future climate as predicted by climate models. The magnitude of those predicted long term changes in Yw by 2050 is down to -20% in the worst scenario combining a +6°C change with a -20% rainfall change. Such changes in water limited yields are certainly concerning, but they are remarkably small compared to the potential +390% increase that would result from closing the current yield gap.

When considering yield variations observed across plots and years, and not anymore regional averages over a few years, what strikes is the stability of observed yields compared to variations of Yw. We used crop model simulations with historical series of 20 years of weather data to compare yield distributions over years of a crop grown using 3 contrasted levels of fertilisation and no incidence of weeds, pests or diseases. For each fertilisation level, the simulated yield reached a maximum value the 'best year' of the series. The three fertilisation levels were chosen so that the maximum simulated yield reached 0.25 Yw, 0.5 Yw, and 0.75 Yw respectively. The resulting simulated yield distributions show that even if management allows increasing the median yield, in many years the climate is the main limiting factor and fertilising has no or a slight impact only. In other words, the way the current climate limits crop production in this region is by making uncertain the output of investing for high yields. Buying fertilizers or working hard for manure collection, transport and distribution do not translate, a certain number of years, into more production. For farmers struggling for the daily subsistence of their family,

that kind of risk may not be justified while alternative use of family resources in cash and labour force provide less risky ways to produce subsistence means. Until recently, in many farming systems of West Africa, the growth in food needs due to population growth in rural areas was matched thanks to increases in cultivated or pasted areas rather than increases in crop yields or livestock pressure on land (i.e extension rather than intensification of crop or livestock activities). When rural families reached the limits of this strategy, migrations of many kinds of distance and duration became the adjustment variable to the gap between resources available from farming and population needs. This suggests that for many, it is less risky to leave home than to intensify cropping or livestock systems. Anyway, as job opportunities for migrants from the rural zones are currently low in West African cities and elsewhere, there are legitimate concerns about the way this strategy may soon reach its limit as well.

In terms of climate change, the worst scenario for farmers of that region would be if crop intensification became even more risky under future climate than at present. There is thus an urgent need for joint agronomic and climate research to go beyond the prediction of Yw or of yield under unchanged crop management and determine whether or not the future climate will increase the yield risks associated with crop intensification in that region. But this should not divert from designing and implementing policies incentive to such intensification under present climate, as this might be much easier now than later.

O-3330b-02

The re-greening Sahel: How green is green enough ?

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The Sahel region has long been the focus of a debate on its possible desertification, especially because of its sensitivity to climatic variations. This debate was fuelled following the extreme droughts that occurred and peaked in the mid 1970s and mid 1980s. Since the appearance of global and frequent satellite observations, a re-greening theory emerged in the 1990s, in total contradiction with a desertifying Sahel. This re-greening is simply defined as an increase in a vegetation index such as the Normalized Difference Vegetation Index (NDVI), widely used by the community as a proxy for aboveground Net Primary Production (ANPP).

The AVHRR instruments onboard the NOAA satellites provide daily NDVI data since 1981 at the global scale, and thus have been widely used for monitoring vegetation production over time. Their analysis regarding temporal trends over the Sahel since the 1980s clearly evidence the re-greening of the Sahelian belt. However, such data are subject to uncertainties, so that there is a real need for independent validation of this re-greening observed from space. However, this validation is very difficult to make since field measurements of vegetatio mass are scarce at a matching scale, especially in the Sahel, and especially over long time periods.

In the framework of an ILRI-ILCA project and afterwards thanks to the AMMA-CATCH observatory, we beneficiated from a long-term database of field measurements collected over the pastoral Gourma region in Mali (1984-2011) and over the agro-pastoral Fakara region in western Niger (1994-2011). These databases provide, among other variables, the aboveground herbaceous mass used at the end of the growing season as a proxy for ANPP. Data are available over a large number of sites covering the landscape heterogeneity.

The objective of this study was to evaluate the performance of NDVI products (especially the new GIMMS3g dataset) as compared with long-term field observations. Our analysis over the Gourma region showed that both datasets detected a strong re-greening over the 1984-2011 period, whereas a negative trend was found over the Fakara region in Niger. Moreover, we were able to show contrasted changes depending on the different soil types found in the Gourma: whereas the deep sandy soils show a clear recovery from the droughts, the trend is heterogeneous over the shallow soils with some sites showing a recovery and others not. The picture is also variable over the clayed soils usually located in small depressions. The negative trend found over the Fakara region could be attributed to changes in land use, since this region has experienced a large increase in agriculture since the 1950s. However, the landscape being fragmented and very dynamic, further studies have to be done to fully understand the changes observed in the vegetation cover.

In both cases, a very good agreement is found between remote sensing data and field observations, giving additional confidence to the satellite archive. The Sahelian re-greening observed over the past three decades therefore seems undisputable. However, this re-greening does not happen everywhere, and contrasted changes may have happened at a finer spatial scale, thus demanding caution in concluding about the resilience of the ecosystems. In any case, since the re-greening is mostly explained by a recovery in rainfall over the past decades, the future climatic conditions and especially the rainfall trend will have a tremendous impact on the evolution of the vegetation cover in the semi-arid Sahel. Of particular concern is the fate of areas already showing an absence of greening (eroded shallow soils, Fakara area for instance).

O-3330b-03

The probable impacts of climate change on malaria and Rift Valley fever in Africa

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Dynamical models of disease transmission between vectors and hosts and back to vectors have been developed for diseases including malaria and more recently Rift Valley fever. These models are driven by climatic and other environmental variables. This is a complex task, as the models require both accurate projections of the seasonally varying mean values of the climatic drivers and their correct variability across a range of time scales from days to multi-decades.

The relationship between finding parameter settings that represent the correct sensitivities to the climate drivers and the inherent spread of these drivers within an ensemble of climate models; develops the inherent uncertainties in the model outcomes. By using an ensemble of climate models then a signal to noise ratio can be used to display the outcomes of the model projections to decision makers.

Recent FP7 projects QWeCI in West and southern Africa and HEALTHY FUTURES in East Africa have run two dynamical malaria models, the Liverpool Malaria Model (LMM) and VECTRI (ICTP) across Africa with a range of bias corrected CMIP5 GCMs. Patterns of changes in malaria distribution in West Africa and East Africa have consistent signals seen into the future using climate model projections. The simulated malaria incidence is increasing over the tropical highlands and the uncertainties related to the disease models are generally larger than that from the climate models. The largest GCM related uncertainty is found at the arid fringes in areas, which have simulated epidemic malaria transmission. Generally the signal to noise ratios in the malaria outcomes improve with increasing projection time and also with higher RCPs.

Recently a new model the Liverpool Rift Valley fever model (LRVF) has been developed using the framework of the LMM but with much more complex structure. It has two dynamic vector models and a dynamic age stratified host model. One main task in its development was parameterising the two different behaviours of the two vectors correctly in the model whilst maintaining the correct sensitivity to the climate drivers.

For both diseases the main uncertainly lies with the future projections of seasonal rainfall patterns and the interannual and intraseasonal variations of this rainfall within the climate models. By using an ensemble of climate models to drive an ensemble of impact disease models, an improved assessment of the model-related uncertainty of the future projections of climate-driven health hazard can be obtained.

P-3330-01

Wind erosion flux and dune front dynamic at the Sahara-Sahel border: case of Kilakina (SE Niger)

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Sahelian sandy soils are more sensitive to wind erosion. In the south-east Niger, the population are essentially rural and their activities are dominated by traditional breeding and agriculture developed on sandyhill soils. The region is characterized by a continuous degradation of soil structure by wind erosion. This erosion is emphasized by an important human pressure and recurrent draught witch reactivated dunes. The most productive soils lost more than a quarter of their surface in recent decades because of wind erosion witch transformed cultivated area to moving dunes. This work conducted at Kilakina (SE Niger) aimed to characterize wind erosion dynamic of moving dunes. Thus, measurements of wind erosion horizontal flux by using BSNE (Big Spring Number Eight) sand catcher and dunes front dynamics have been done more than 2 years. It's appeared that on moving dune, wind erosion had a temporal and spatial variability. Thus, the foot was eroded particularly between April and Jun while at the top of dune, wind erosion and dune movement can occur all the year. At this place, the intensity of wind erosion reached close to the double of the intensity measured at the dune foot. In another way, the monsoon wind is the most agents of dunes front moving which attained a mean annual displacement near to half-meter.

P-3330-02

Precipitation and disturbance as main determinant of the spatial variability of carbon fluxes in 16 West African ecosystems

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This study reports carbon fluxes between sixteen different ecosystems and atmosphere in the West Africa region. Data were averaged at annual scale, but obtained by eddy-covariance and other indirect methods. Ecosystem types include forests, savannahs, grasslands and croplands under sudano-sahelian and guinean climates. Carbon fluxes data were recorded in the annual mean rainfall ranged between 350 (Agoufou site, Mali) and 1850 mm (Ankasa site, Ghana). The total ecosystem respiration (TER) were found very highly (R2 = 0.71) and Gross primary productivity (GPP) highly (R2 = 0.50) correlated with the annual mean rainfall. Both TER and GPP appeared to be saturated for sites receiving annually a mean of rainfall above 1000 mm.

No clear relationship was found between these two carbon fluxes (GPP and TER) and annual means temperature. Moreover, GPP and TER values ranged from (3.3 and 3.0) in the Sahelian fallow savannah to (27.0 and 20.5 t C ha-1 yr-1) in the sudanian Forest, respectively. Finally, the annual carbon sequestration varied spatially according to the degree of human disturbance and ecosystem management strategy.

P-3330-03

Study of CLOUDSAT products in semi-arid region of Cameroon

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Clouds play a major role in weather and climate processes. In this effect, a variety of satellites was put in orbit in the years 2002 to scrutinize them forming the «A-Train» providing raw data (digital data, images). This work aims to analyze and process these satellite images, preferably those in January and July 2009 in northern Cameroon from satellite data CLOUDSAT in order to explain why in this part of Cameroon, January was a very sunny month against July the raining month. From these data (base image), we applied algorithms (ECMWF-AUX, 2B-GEOPROF, FLXHR ...) to extract reflectivity coefficient and masks clouds that cover the region of the different types of clouds which appears and their water rates. We have found that the month of July is marked by a significant presence of clouds at low, middle and vertical development (clouds rushing) against January which is marked by a very light cloud cover at higher floor. Therefore, the results of the profile vertical clouds predict the weather and climate; which equate January to July in the dry season and the rainy season respectively. These results can affecting ecosystems and societal functioning, water resources, agro-pastoral and economic activities over the northern Cameroon.

P-3330-04

Impacts of climate variability on crop yield: how do local farmers adapt in Nigeria?

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The recent impacts of climate variability on crop yield raise the question as to whether there will be enough food in Nigeria in the next century. Various studies on the impacts of climate variability on crop yield have been carried out in different parts of the world and well established through decades of field experiments, statistical analyses of observed yields and monitoring of agricultural production by IPCC and other scholars. The majority of these studies assess inter-annual variability in the climate of West African countries, particularly the magnitude of rainfall variability impact on human activities, including crop production. Surprisingly, little systematic research has focused on the distribution patterns of the impacts of climate variability on crop production, in terms of mapping its spatiotemporal impact using the modern GIS techniques such as Kriging interpolation technique. Thus, the present study uses both Geographical Information techniques (GIS), social and demographic survey to assess the impacts and how local farmers (of different demographic characteristics) adapt to climate variability in Nigeria. The study aimed at using GIS Kriging interpolation technique together with questionnaires methods to examine and map the spatiotemporal impact of rainfall variability on crop yields in the Guinea Savanna Ecological Zone of Nigeria. Both parametric and non-parametric techniques are used for testing whether there have been significant impacts and how farmers adapt to climate change/variability. The result show that modelling with a GIS offers a better mechanism to integrate many scales of data developed for agricultural research. Also the results also show that the zonal variability of rainfall is observed to bring about not only the differences in the types of crops cultivated but also the rate of yield of such crops and deferent adaptation methods. The major finding is that climate change/variability has two major effects on crops. First, during the latter part of the growing season, insufficient soil moisture may restrict transpiration to well below the potential rate, with corresponding reduction in growth and yield. Second, after harvesting the crop, there will be a deep layer of soil which must be recharged to something approaching field capacity early in the following rains before satisfactory growth of the next crop can occur. The results from demographic survey using questionnaires show that local farmers have different adaptation strategies and that the variability climate implies that crop yield is exceedingly variable over space and time.

P-3330-05

Climate and climate variability: case study of the traditional lowland rice cultivation in the middle and upper Casamance Region

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The Casamance Region is an enclave territory in southern Senegal that has suffered from the sociopolitical instability caused by the separatist movement for the independence of the region in the 1990s and 2000. This has led to a significant delay in infrastructure development to support the economy of the region. Nowadays, it has an unexploited potential due to a series of structural limits for the creation of an efficient supply chain for local agricultural production. The change in the security context of the region and the new Senegal rural development policies provide new opportunities for agricultural production in Casamance.

Among the various food crops, the traditional lowland rice cultivation by woman in the secondary valleys along the Casamance River is a peculiarity of the region. This crop is mainly grown to cover the food needs of the farmer's family, therefore within a strategy of food security. There are many limits to rice production in the region. The lack of mechanization, the absence of a regular distribution of improved cultivars, poor labor quality and quantity and conflicts with the livestock rearing in the valley make the system very fragile and strongly dependent on seasonal weather patterns. For these reasons, the traditional rice cultivation is becoming marginalized, with a gradual abandonment of the valleys.

In order to preserve lowland rice production and make it sustainable, an analysis of meteorological factors that most influence the crop yield aims to provide useful information for the identification of alternative cultivation strategies and implementation of direct and indirect mitigation practices on crops. The study therefore aims to assess recent climate change recorded in the region with particular attention to the parameters determining a bad or good rice crop.

Weather data from rain gauges are quite scarce in the region, often limited only to the registration of the total daily rainfall in the major towns. It was therefore chosen to use the CHIRPS daily rainfall estimate dataset that covers the period from 1981 to 2013 at 0.05° resolution. Attention has focused on assessing the fundamental parameters of the growing season such as total rainfall, number of rainy days, average daily rainfall, onset and the cessation of the growing season. In addition, we evaluated the incidence of dry periods and heavy rains during the germination and flowering period of rice, as these are the most vulnerable stages of the crop. The relationship of these parameters with large scale oceanic and atmospheric forcing was also evaluated.

The variability of these climatic parameters over time are a source of uncertainty for local farmers decision-making process and their ability to adapt to new climatic forcing. Describing the climate, identifying observed trends and overlapping the future predictions derived from atmospheric General Circulation Models has allowed us to define a set of future scenarios that should guide local farmers and policy makers in the orientation of agricultural development policies for the middle and upper Casamance Region.

P-3330-06

Using multi-agent simulation to assess the impact of adaptation scenario on agricultural land use change and household food availability in northern Ghana

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The impact of climate change and variability on the growth and development of sub-Sahara Africa (SSA) is severe. Farmers are already changing their agricultural land-use to adapt to the impacts of changing climate. In Ghana, agriculture contributes to food availability and accessibility of some food commodities consumed annually. The capability of agriculture to ensure food availability has been affected by low production, and climate change also plays a significant impact. National policies and strategies to sustain food security at a high level have concentrated on increasing domestic production. Some of the policies aimed at improving farm household resilience to the impacts of climate change may have implication on land-use change. Hence, adequate understanding on the impact of these policies in a temporal manner is vital. This study therefore applied multi-agent simulation (MAS) model to assess the impact of adaptation scenario on agricultural land use change and farm household food availability in northern Ghana. MAS model is able to simulate the impact of human decision processes explicitly. Few studies applied MAS model to relate adaptation with changing climate in West Africa. Application of MAS model for land-use change studies is still at embryonic phase in Africa

We applied the Land Use Dynamic Simulator (LUDAS) as a MAS model to investigate the impact of farm credit as adaptation strategy to climate variability on agricultural land-use change and farm households' food availability in Vea catchment, Upper East Region of Ghana. The model was parameterised using 186 surveyed farm households. From these households, we identified the determinants of their crop choices grouped into household characteristics (e.g., age of head, household size, dependency ratio) and farm plots characteristics (e.g., soil type, wetness index, elevation, upslope area, plot size and proximity features). The crop choice sub-model is directly linked to an agricultural yield sub-model to determine the yields of selected crops. To adapt to climate variability in the study area, household choice of maize adoption with respect to maize cultivation credit (maize credit scenario) was integrated in the decision making and simulated for a 20-year period, and compare with the business-as-usual scenario.

Findings show that under maize credit scenario, maize adopters increased from about 20 % to about 50 % and the area allocated for maize cultivation significantly increased by about 266% at the expense of traditional crops. Average annual aggregated household crop yield was 6.3 % higher under the maize credit scenario as compared to business-as-usual scenario. In conclusion, this study shows that access to credit can significantly influence agricultural land-use change and food availability in the study area. However, food may be available as a result of access to farm credit, but sustaining it is a big question.

P-3330-07

Comparative study of five statistical methods of climate change analysis in the Niger River basin (West Africa)

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Climate change is characterized by a significant change in the mean values of climate variables. However, detection of trends in climate variables depends on the methods applied. In this study, 4 commonly used statistical methods, Pettitt's test, Lee and Heghinian's bayesian method, Hubert's segmentation and Mann-Kendall's test at 5% significance level are compared to the cross entropy method. The latter is a stochastic optimization technique initially developed for assessing the number and the position of breakpoints in continuous biological data. From a theoretical view point, the approaches of Pettitt as well as Lee and Heghinian provide only one breakpoint. The Hubert's segmentation gives multiple breakpoints but within a series even just one extreme value could result as a break. The Mann-Kendall's test detects trend in series for a given level of significance. As for the cross entropy method, it provides multiple breakpoints and offers the possibility for the user to choose the number of breakpoints desired. The five methods were applied to 17 rain gauges of the Beninese part of the Niger River basin whose data cover the periods 1981-2010

(5 gauges) and 1970-2010 (12 gauges). There was 16% of chance of obtaining a trend with the Mann-Kendall's test. The likelihood of detecting a breakpoint with the Pettitt's test, the Hubert's segmentation, the Lee and Heghinian's method and the cross entropy method was 16 %, 28%, 72% and 100% respectively. We also noticed that the cross entropy method was 100% and 89% of the times able to replicate a breakpoint detected by the Pettitt and Hubert's approaches and the Lee and Heghinian's method respectively. On the other hand, there was 60% of chance for the Lee and Heghinian's method to reproduce a breakpoint indicated by the cross entropy method. These results suggest that the cross entropy method outperforms the 4 others and should be considered in statistical climate change studies. However, further studies are necessary to confirm the performance of the novel method in comparison to the 4 others.

P-3330-08

Latitudinal ITCZ sensitivity to the width and depth of the convective activity in WAM

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The onset of the West Africa monsoon (WAM) occurs in 2nd half of June, with a week uncertainty on the date. The onset date is defined by the date of the suddenly migration of the intertropical convergence zone (ITCZ) from the Guinea Gulf to an inland position placed at about 10° North of the equator. Prior to this latitudinal jump the ITCZ stays in an almost stationary position at 5° North for two months; during this period, the convective activity widens and deepens. This increase of convective activity is observed by satellites as an ORL minimum and as a rainfall maximum over the Guinea Gulf. Towards the end of June, the convective activity weakens over the Guinea Gulf, to crop out few days 5° further inland.

The mechanisms which accompany the development of WAM are rather complex, thus a simple model for the ITCZ behavior is not yet available. One cause reported in the literature of this peculiar behavior of the ITCZ in WAM is the positive feedback between the deepening of Saharan low at the time of the onset and the confining action of the inland orography to the ITCZ inland penetration. An other confining action can exerted by the presence of inland critical lines for propagating easterly wave.

We propose a mechanism which can concur to this sudden latitudinal jump of the ITCZ. Following results found in the literature of a latitudinal ITCZ sensitivity to the shape of the forcing, using a Matsuno-Gill model, we show that a widening of convective activity is accompanied by a temporary weakening of the convergence 5° North, followed by a strengthening of convergence at 10° North, when the width of the convective activity exceeds one equatorial Rossby radius. When this width is exceeded, the ITCZ transition is rather rapid, this is when the convergence maximum settles at at one Rossby radius North of the equator. This mechanism the ITCZ migration is complementary to other mechanisms; the feedback between different mechanisms might be difficult to model in terms of simple theory.

P-3330-09

Climate change in a tropical region: the case of LAMTO reserve in Côte d'Ivoire

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LAMTO reserve is located on the center of Côte d'Ivoire in West Africa. Climate variability of LAMTO reserve was studied over the period from 1962 to 2010 (49 years). This study uses climate data (precipitation and temperature) measured on LAMTO geophysical station. In general, rainfall decreased in the reserve. Compared to the average of the 49 years, the region recorded a rainfall deficit over thirty years (1971 to 2000). This deficit was more pronounced during the 90s. On the over side, during the period 2000 to 2010, the rainfall increased.

The region recorded an increase of the mean temperature (+1.4°C) compared to 1960s. This is a sign of global warming. In contrast, from 2001 to 2010, the average minimum temperature decreased (-2.43°C). In fact, this fall causes the decrease of the average mean temperature (-1.25°C) of this decade.

P-3330-10

Recent rainfall variability and vegetation activity in the experimental site of the Upper Ouémé basin (Benin)

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From the late 1990s, the Sudano-Sahelian zone is, a priori, wetter than during the two previous decades, which were marked by the development of persistent droughts. This recent evolution is likely to influence local to regional climate and, thus the vegetation cover, the biomass and seasonal phenology in the forest and savannah belt. Contrasted results in simulating the future regional climate trends, however, leaves the future of West African environments widely open and uncertain. Accurate in-situ monitoring is therefore needed to increase knowledge and understanding of West African regional climatic contrasts and, thus, and to exceed diagnostics, which are limited to the semi-continental scales. In this context, an instrumental period was launched in 1997 on the Upper Ouémé meso-scale site (Benin) under the AMMA-CATCH (African Monsoon Multidisciplinary Analysis - Coupling the Tropical Atmosphere and the Hydrological Cycle) observation initiative. This experimental catchment basin of approximately 14 366 km², which is influenced by a Sudanian climate, present different hydroclimatic conditions to those studied in the Sahelian regions. This catchment basin show a lower decrease in streamflow during dry periods, and unclear relationships between land degradation, vegetation cover, surface hydrological and climatic fluctuations. By comparing the satellite images during different time-periods, continuously deforestation and clearing land processes is identified since the 1970s, while anthropized fallow land and savannah are increasing by 24% and 22%, respectively.

This study thus aims to a better regional understanding of the recent rainfall variability and of vegetation phenology through the photosynthetic activity. We compare observed bioclimatic patterns among the four main defined as "non-climatic or climatic degradation" versus "climatic or non-climatic greening" by the current conceptual modelling studies. We focus on the 2001-2013 period using in-situ rain-gauges from AMMA-CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS-MODIS; 0.5×0.5 km). Although monthly rainfall amounts are underestimed in the RFE data, the interpolated rainfall field from AMMA-CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year-to-year variability.

The recent period (2001-2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2003, respectively, is significantly wetter than during the earlier decades (1970s and 1980s) showing regional rainfall amounts rarely above 900 mm. The start of the growing season is significantly correlated with January-May rainfall amounts over the Upper Ouémé catchment and the length of this season is positively correlated with mid-May rainfall amounts. The length of the vegetation activity could therefore be especially sensitive to rainfall at the beginning of the growing phase. Meanwhile, the end of the growing season could be explained by late September to late December rainfall amounts. The end of the growing season is thus delayed by 10 days per decades, e.g., 68th pentad (early December) in 2002 to 70th pentad (late December) in 2010. This could indicate that bioclimatic conditions are more favourable and, thus, lead to a longer duration of photosynthetic activity. This could, however, indicates that green vegetation, which can originate from agricultural land and, thus almost independent from the regional rainfall variability, remain a bit longer in the year. A multivariate statistical analysis of the NDVI thus clearly shows regional contrasts and response specifics over certain areas and in different forms of vegetation in the Upper Ouémé Basin. The contrast between protected

native forest (forest reserves) areas and those undergoing a transformation into farmland (crop-growing and fallow land) is very clear. More accurate spatio-temporal analyses (at daily and 250m spatial resolution), such as multi-criteria regional analysis (e.g., dynamic factor analysis), could provide a better understanding of environmental processes involved and the contribution of associated agrosystems.

P-3330-11

HORIZONTAL VISIBILITY as witness of ENVIRONMENTAL DEGRADATIONS in CENTRAL SAHEL (NIGER) SINCE 1950

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Environmental degradation is one of the most important consequencesof persistent drought occurringin the Sahel between the late1960s and the 1980s. Although central Sahel experiences a partial rainfall recovery since the 1990s, environmental responses to the recent climate trends are still contrasted mainly due to increasing anthropogenic pressure. Analyses of long-term proxy of Sahelian land surface conditions, such as horizontal visibility, and their response to regional climatic variability, such as regional to local rainfall and wind dynamics, are therefore of major importance in understanding the relationship between climatic and environmental processes.

Time-evolution of the relationship between horizontal visibility (and associated weather types: blowing sand, sandy haze and dust haze) and regional rainfall and wind speed variability have been examined. Over a NE-SW transect from southern Sahara to central Sahel, 3-times daily measurements (i.e., 6am, 12pm and 6pm) of horizontal visibility and wind, and daily rainfall amounts from 4 weather stations have been selected (Bilma: 18.68N-12.92E; Nguigmi:14.25N-13.12E ; Maine-Soroa:13.23N-11.98E; Niamey: 13.48N-2.17E) and, then, analyzed between 1950 and 2009.

The horizontal visibilities and Sahel rainfall show similar seasonal cycles. Horizontal visibility is increasing during the rainy season (June to September), while horizontal visibility is decreasing during the dry season (October to April). While increasingsuspended dust in the atmosphere, e.g.,due to increasing soil erosion and particle transport, is likely to reduce horizontal visibility during the dry,the rainy season actsto reverse this trend by moistening the soil and by blocking dynamically a part of the dust transport. This is thus not true at the southern limit of the Sahara (i.e., in Bilma), where horizontal visibility is lowest between February and August.

At the interannual timescale, decreasing horizontal visibility over the Sahel is linked to increasing occurrence of specific weather types, such as blowingsand, sandy haze and dust haze. During the dry season, we note an increase in wind speedsbetween the wet period (1950-1969) and the dry period (1970-2009), which is associated with a decrease in horizontal visibility. The dry period (1970-2009) is also marked by an increase in daily occurrences of weather types associated to low visibilities (sandy haze). However horizontal visibility decreased in Bilma by sandy haze increase particularly since 1967.

One could think that the mechanisms of the climate change are earlier than what is generally admittedonrainfall evolution only. These mechanisms would first affect zones that are most sensitive to wind erosion. In Bilma, it is also observed that the increase of the blowing sand, originating particles in suspension is significant before the drought of 1973., Is it thus also possible that increasing dust in the Sahelian region was caused bythe particles mobilized in another source area, which could bemore fragile andlocated northward (e.g., central Sahara)?

Furthermore, it is observed that sandy haze increased in Niameysince the 2000s, even if this region experiences a partial rainfall recovery. That tried to the consequence of a supplement of the environment degradation in relation to the demographic explosion of this area and the overexploitation of the natural environments which was followed from there.

P-3330-12

Weather related income shocks and the child's health in Burkina Faso

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We combine health data originating from the 2008 national household survey with meteorological data to test the ability of rural households in Burkina Faso to smooth investment in child health over agricultural income fluctuations. An in-depth econometric analysis of shock transmission mechanisms shows that children are vulnerable to a rainfall shock occurring in the prenatal period or during the first months of life. Results also shed light on the risk-coping strategy set up by households. Households smooth part of positive weather shock but are unable to dampen large negative shocks. Livestock is an effective buffer asset only for a minority of large livestock owners whose children are spared. By contrast, children living in poorly endowed households are severely affected by a weather related income shock. The implementation of weather insurance mechanisms appears to be desirable to fight against moderate malnutrition but would be ineffective in reducing severe malnutrition which depends above all on the health and educational status of mothers.

P-3330-13

Rainfall in the Sahel and global temperature: lessons from a 1500-year long paleoclimate record

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As climate model uncertainties remain very large for future Sahel rainfall, it is necessary to look for a long-term perspective in the past climate to better understand the relationship between global warming and the centennial trend of increasing aridity observed in the 20th century in the Sahel. We present here a new record of aridity conditions over the past 1500 years in Senegal, obtained from stable oxygen isotope analyses in archaeological shell middens in the Saloum Delta. Our dataset shows that the actual aridity in western Sahel is unprecedented in the past 1500 years. We observe significantly more humid conditions during the medieval warm period, a transition into the little ice age that was the most humid period in the past 1500 years, and a sharp increase of aridity in the past 200 years. While the recent aridity may be partly due to anthropogenic changes in the local vegetation feedback, a clear link between global temperature and Sahel aridity is revealed in the multi-centennial climate variability. Although this relationship may change in the future with increased greenhouse gases, the climate history supports the scenario of decreasing rainfall in the Sahel in response to future temperature rise.

P-3330-14

Assessing Impact of Climate Change on Vegetative Species Diversity Using the Normalised Difference Water Index: The Case of Mutirikwi Sub-catchment, Masvingo Zimbabwe

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Vegetative species diversity is essential for human well-being because it provides services, such as food, medicines, clean water and soil stabilization within a catchment or sub-catchment. However, it is under threat from climate change which poses a challenge by exacerbating the impacts of other pressures. Climate change affects

different ecosystems in different ways, depending on the complexity and original characteristics of the system, geographical location and presence of factors that may regulate the extent of the changes. In southern Africa in general and Zimbabwe in particular, there is still paucity of scientific understanding of climate change's impact on vegetative species diversity specifically species richness and evenness. A plethora of studies have claimed that climate change affects biodiversity but without focusing on specific diversity indices. This poses challenges when designing adaptive and mitigative strategies that are ecosystem and species specific. This study assesses the effects of climate change on vegetative species diversity in Mutirikwi sub-catchment using the Normalised Difference Water Index (NDWI).

To achieve the research objective, the relationship between vegetative diversity indices (richness and evenness) and climatic variables (rainfall and temperature) was explored based on species data directly collected from the field over a 3 year period and climate data collected from three local stations (Makoholi, Masvingo airport and Buffalo range). Relationship between NDWI and species diversity indices was examined to confirm the utility of remote sensing in predicting vegetative diversity. NDWI was calculated using the formula:

NDWI=(□NIR-□SWIR)/(□NIR+□SWIR).

Where □NIR and □SWIR are the reflectances of the near-infrared (NIR, 0.78-0.89 m) and shortwave-infrared (SWIR, 1.58-1.75 m) regions, respectively.

The species diversity indices were calculated using the Shannon Weaver Index which usually combines aspects of richness and evenness. This index was calculated using the formula:

H = -∑ (Pi In (P) Where the summation is over all species and P1 is the relative abundance of species in the quadrat. This index measures the average degree of uncertainty in predicting to what species chosen at random from a collection of S species and N individuals will belong. Species evenness (E) was calculated using the formula:

E= H/In (S) Where H is the Shannon Weaver index and S is species richness observed within the quadrat.

The resultant predictive model was used to estimate changes in species diversity over a 40 year period (1974-2014). The species diversity data was then regressed with climatic data for the same period. These data were also modelled to project future changes in vegetative diversity in the face of climate change.

Preliminary findings reflect a significant ($P<0.05$) correlation between species diversity and climatic variables. The results also indicate that there is a significant ($P=0.003$; $\alpha=0.05$) relationship between species richness and NDWI. Species evenness was also significantly correlated ($P=0.04$, $\alpha=0.05$) with NDWI. This implies that we can use NDWI to assess changes in species diversity over time. The Mann Kendall test revealed a significant decrease in the rainfall received within the catchment over the 40 year period (1974-2014). The minimum and maximum temperatures over the period were significantly increasing. These changes in climatic variables were matched with a decrease in species richness and evenness. Some species tend to be succumbing to the environmental changes influenced by climate change resulting in their changes in phenology, abundance and distribution.

The study concludes that climate change in Mutirikwi sub-catchment is influencing species diversity through changing species phenological features, abundance and distribution. Besides being a good indicator of water content in leaves, NDWI has proved to be a useful indicator of species diversity. The study leads to the understanding of the relationship between vegetative species diversity and climate change and this provides a platform for nations to devise strategies to enhance the resilience of ecosystems to climatic changes through the adoption of species based adaptive and mitigative strategies.

P-3330-15

Responding to Climate Change Challenges in Sub Saharan Africa - A case for Water Supply

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Change is a permanent phenomenom in all spheres of life. Many a time changes present both opportunities and threats on diffent facets. For sustainability, we need to constantly anticipate changes and their impact. Some changes come with heavy impact. Climate change is one of them. It has spiral effect on several frontiers of human existence. It is one phenomenom that derseves urgent attention. Based on risk assement, we need to take proactive steps to either eliminate adverse impacts or mitigate them or compensate for the perceived impacts. Sometimes changes present beneficial opportunities. In dealing with changes, time of reaction and availability resources are vital.

Sub Saharan Africa Countries are presently existing on fragile economy. Population is increasing while social infrastructures are dwindling. This presentation outlines the challenges of dealing with climate change in Sub Saharan Africa. It analysis the following issues as it relates to climate change

- Threats of climate change
- Opportunities occassioned by climate change
- Capacity to respond to climate changes
- Effect of climate change
- Consequence of climate changes in Sub Saharan Africa
- Strategy to coping with climate change challenges
- Risk identification
- Stakeholders communication strategy

The paper asserts that Sub-Saharan Africa remains the most vulnerable region in Africa due to inherent poverty and lack of clear policies on dealing with climate change. Climate change will have adverse impacts leading to decreased food production, displacement, increased poverty, conflicts and reduction in production capacity in the region. Although, some parts of Sub Saharan Africa will experience increased agricultural production as a result of increased rainfall but there exist little capacity to take maximum advantage of the opportunity or mitigate the adverse impact of excessive rainfall. Generally, climate change portends a bleak future for Sub Saharan Africa. The paper posits that Sub Saharan Africa countries need to take urgent actions towards tackling the threats of climate change and plan on take advantage of emerging opportunities.

The paper elicites that climate change challenges in Sub Saharan Africa will adversely affect other regions of the world in one way or the other.

P-3330-16

The impact of global changes on agriculture: the case of Ivorian Basin of Comoe River

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Since some decades, the Ivorian Comoe river Basin faced environmental and climatic changes. As one of rainfed agriculture leading forces, climate conditions display (here) a major role in agriculture transformations. The simulation of water need requirements, coupled with farming systems, shows that actual global changes mainly benefit to annual crops such as corn (Zea mays), and allows the upgrading of the trees crop as cashew (Anacardium occidentale), rubber tree (Hevea brasiliensis), etc. However, the precariousness of the production systems, whose practices have not deeply changed, has to be linked with the combined effects of land saturation, agricultural policies and need of cash faced by farming communities. Therefore, the diversification and reconversion toward rubber plantation, are to be considered as farmers' strategies aiming at finding alternatives for old speculations such as coffee

(Coffea L.) and cocoa (Theobroma cacao L.). For instance, the countryside has been gripped by a frenzy of agricultural development of Chromolaena Odorata and wetlands, which were previously not cultivated. These changes go with intense competition for land that benefits some urban elite who, in example, seeks to cope with retirement by investing in rubber plantation (Hevea brasiliensis). We are witnessing social and spatial reconstructions that, in view of the uncertainty of present conditions, leave small room for environmental protection. The present survey analyzes the ongoing processes, speculates on their future development, and suggests some ways for sustainable agriculture.

P-3330-17

Impacts of climate variability and agricultural intensification on the origin of runoff: the case study of the watershed Kolondieba in the south of Mali

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As part of the international research program RIPIECSA (Interdisciplinary and Participatory Research on Interactions between Ecosystems, Climate and Society in Africa), watershed Kolondieba (under Sudanese climate) was selected to understand the mechanism of runoff process in order to improve hydrological model in a context of strong climate variability and agricultural intensification (cotton culture is the main economic activity in the basin). The method used is based on rainfall, hydrometric, geochemical and piezometric data monitoring over the period 2009-2011. The results showed that 2009 and 2010 were normal rainfall years (1300 mm, in average), compared to the average of chronic 1960-1969 (wet period), while 2011 has emerged as a dry year compared to the chronic 1970-1992 (dry period). During the last contrasted two years, the runoff coefficient has decreased by half from 2010 to 2011 occasioned groundwater discharge deficit estimated at 33%. Monitoring the mineralization of targeted water compartments: rainfall, surface water, and groundwater with the integrator chemical parameter (Electrical Conductivity), showed a very little mineralization of rainfall with an average of 16.99 ± 8.53 µScm-1. Mineralization of surface water is closer to the rainfall's, but it's far from the groundwater's consist of shallow aquifers and deep ones with respectively 120.58 ± 90.07µScm-1 and 133.57 ± 85.68 µScm-1 in average. This chemical relationship between water compartments showed that deep aquifers don't contribute enough to the runoff. This allowed to deduct a double origin of the runoff on the watershed consists of stormflow and subsurface flow. The separation of the hydrograph in a normal year (2010) gave a contribution of stormflow about 77%. This contribution has increased by 3% in dry year (2011). In these conditions runoff doesn't depend only on rainfall variability, it can be assigned to the land use because cotton culture area is increasing on the basin since 1960.

P-3330-18

Climate projections in West Africa: evidence and uncertainties?

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The Subsaharan Africa response to global warming was uncertain in the models of the third phase of the Coupled Model Intercomparison Project (CMIP3) used for the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), which even disagree on the sign of future rainfall anomalies over this region. This disagreement remains even among models that correctly simulate the twentieth-century West African climate. Our study investigates results from a new ensemble of state-of-the-art climate modelswhich participated of the fifth phase of CMIP (CMIP5) and raises several questions. Do the models agree more on Subsaharan Africa rainfall projections ? Do they well simulate the partial rainfall recovery observed over the last decades ? How well are models able to reproduce the main features of the West African Monsoon (WAM) ?

Preliminary results of twelve CMIP5 models have shown, in despite of great progress in the representation of MAO characteristics, little changement on their climate projections on West Africa compared to CMIP3. Robust tendancy to warming over the Sahel, larger by 15 to 50% compared to global warming is noticed. The spread of models projections remains very large for both temperature and precipitations. But the dispersion in surface air temperature is large over the Sahel and Sahara and seems to be linked to the radiative aerosols properties and surface albedo in this region. Most of CMIP5 models project increasing temperature with 1.8-4.2°C amplitude in a rcp4.5 scenario (3.5-8.5°C in a rcp8.5) in Western Sahel (15°W-5°W) ; these values being slightly higher in Eastern Sahel (10°E-35°E). The uncertainty temperature changes will have dramatic consequences as those associated with precipitation. An opposite response between the western and eastern Sahel for rainfall projections seems to be robust. However, some « outliers models » predict rainfall increase which cancels part of the Sahel warming during the summer monsoon. This finding on the western Sahel gathers more and more models as we advance into the 21st century: 40% for the period 2011-2040, 60% for the 2041-2070 period and more 80% in the last period. In contrast, the eastern Sahel, although the consensus model is relatively high, it decreases by 80% in the first period to 70% in the last period. The rcp4.5 scenario shows precipitation oscillations around a mean value (positive for the first zone/negative for the second) as well in the East and the West of Sahel, indicating a high interannual variability ; while rcp85 scenario gives a tendency net increase of abnormal rainfall in the eastern reaches 100 mm at the end of the 21st century. A particular domain (5°W-10°E), encompassing western Mali, Burkina Faso, northern Nigeria and eastern Niger, where consensus between the models is low on changing rainfall for two scenarios have been charachterized.

Finally, our study indicates that further investigations on the rainfall response mechanisms in these outliers models should help to assess their credibility and need to be explored.

P-3330-19

Why is the « Sahelian paradox » recently exacerbated?

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During the Great Drought that West Africa suffered at the end of the 20th century, hydrological observations highlighted an increase in runoff only in the Sahel, although this was the area where the rainfall deficit was the highest. From the small experimental plot to the major tributaries basins of the main rivers, runoff coefficients and discharges values increased significantly during the dry period. This was named the «Sahelian Hydrological Paradox». From the very end of the century, after 1995, rainfall generally increased again in the whole West Africa. Therefore, an increase in runoff afetr 1995 is easy to explain. However the increase in runoff and discharges valuesbegan in 1970, at the very beginning of the Great Drought; the hydrological behavior of Sahelian surfaces remains thus paradoxical at least from 1970 to 1995. Thus its recent exacerbation is not such paradoxical, yet needs to be explained.

The more commonly cited Sahelian paradox explanation is the widespread soil crusting through the Sahel. It is considered as a consequence of the extension of crops, leading to a quasi-disappearance of natural bushes. This trend was accompanied by a decrease in fallowing, the main fertility restoration practice used in the Sahel. After 3-4 years of cropping, a 8-10 years fallowing was traditionally practiced. The population increase and subsequent food needs progressively led to the

abandonment of this practice, and then to e decrease in crop yields and a general soil degradation (structure, water holding capacity, fertility, OM content, etc). This was for long way considered as the main cause of soil crusting. Soil crusting and its consequence the runoff coefficient rise was general, within in exorheic areas as well as within endorheic ones. In the latter, it caused an extension of ponds, which are the main groudwater recharge sites, and then it led to a rise in water table levels. The rise in local runoff due to soil crusting was sufficient to provoke the change of someendorheic areas into exorheic ones: the overflowing of some ponds effectively transformed closed valleys into tributaries of the Niger River. In the sole Niamey area, 1700 km² of supplementary catchments were added to the known previous basin; this is close to 50% of the direct catchment of the Niger River in this region (small basins directly supplying the Niger River, without considering the main tributaries). Locally, urbanisation should also explain an increase in runoff, because it leads to a decrease in soil permeability (buildings, roads, etc..). Otherwise gutters are not always maintained and in many cases they are blocked, their overflowing aggravating then the flood. Recent flooding of capital cities without rivers (Ouagadougou in 2009; Dakar in 2012 amogst others) proved that a purely urban cause of increasing runoff is possible.

A recent observation of an increase in frequency of extreme rainy events cannot be considered as a factor of increase in runoff coefficient and flooding. So far, neither the number of rainy events above certain high thresholds of daily amount, nor the amount of rain fallen during these events have (until 2014) exceeded those observed during the 1950s and 1960s decades, before the beginning of the observed increase in runoff coefficients. An intensification of rainfall is observed, however it is evidenced only by the increase in the proportion of rainfall amount observed during high daily rainfall amount events (commonly named extreme events).

The annual flood does not always provoke inundations; however, floods can evolve in inundation owing to at least two series of factors: the silting up of river beds led to the reduction of hydraulic sections, and thus overflow must occur for discharges values which did not cause overflowing in past years. Otherwise, urbanisation again is the cause of severe damages of flooding, because it applies in floodable areas occupied by spontaneous settlements (areas not flooded since the beginning of the Drought, more than 40 years ago), anciently secondary river beds of the main stream flows, or current floodplains.

Soil crusting and then land use changes seem to be the main explaining factors of increase in runoff. Therefore it is important for policy makers to be sensitized about the effects of consequent land use changes on the hydrological regimes of Sahelian rivers.

P-3330-20

Impact of climate changes in the last thirty years on the second generation of Cocoa in Ivory Coast

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The Ivorian cocoa sector is facing in the recent three decades with difficulties to plant a new generation of cocoa due to changes in the annual cumulative rainfall and the inadequacy of the current crop calendar in the present climatic context. This study, conducted in the center-west of Côte d'Ivoire aims to assess climate risks for cocoa and determine the suitable period to establish new cocoa farm and to ensure the survival of young trees during replanting. Agro-climatic data were collected at the agronomic research stations of Divo and Gagnoa. The comparison between climatic parameters and the water needs of cocoa shows that the favorable period of implementation of cocoa in the current climate context of the study area is between March and April and not between May to June as recommended since the 1960s, to enable young trees to take advantage of the long rainy season that occurs earlier. A strategy of implementation the second generation of cocoa taking into account the climate change observed over the region is proposed.

P-3330-21

Determination of malaria parameters using meteorological data sets of Senegal stations and reanalyses products

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Climate behavior is an important factor for malaria development, a vector-borne disease which is a really public health problem, particularly in Sub-Saharan part of Africa. High temperatures are favorable for the quick growth of mosquitoes and the shortening of the reproductive cycle of the pathogen known as plasmodium, while the proliferation of vectors in breeding sites is driven by precipitations. Due to difficult access of observations datasets, this study has a huge component of simulations of malaria parameters using the Liverpool Malaria Model (LMM) developed by Hoshen et al (2004). The inputs of the model are meteorological data of stations and different reanalyses products. The results of this study show that a two-month lag is often observed between the maximum of precipitations and the peak of malaria incidence in Senegal. Malaria occurrence period is centered on the September-October-November period corresponding to the end of the rainy season warm and humid. These findings are highlighted both with stations datasets and reanalyses.

Otherwise, this study attempts to assess the impact of past, present and future climate features on vector-borne diseases such as malaria. Our findings about malaria changes under climate change will be useful in order to prevent malaria outbreaks due to high probability of climate change.

These results taking account the main climate and environmental behaviors could be useful in the prevention of malaria in Senegal and elsewhere.

P-3330-22

Climate variability and its role in accessibility to and use of water: social and health issues in informal settlements in Ouagadougou (Burkina Faso)

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Expected changes to the global environment have led to a burgeoning literature on climate change vulnerability and adaptation. A part of this literature focuses on developing higher-resolution climate models to better characterize uncertainty in the regional climate projections offered to decision-makers - the "top-down" methods. Another part of the literature addresses past and present climate variability and aims to reduce vulnerability, in a "bottom-up" approach. As social scientists, we want to contribute to this second part of the literature, as we agree with the geographer Richard Washington and his colleagues that coping with present climate variability is in itself enough of a challenge. In this communication, we wanted to document the diversity and the variability of access to water depending on the variability of the climate (across seasons) in an African capital-city characterized by both population and spatial expansions.

Indeed, better access to water is as much a factor conducive to development as its result. Improved water

access has many effects on human health. This effect is mediated by both the quality and the quantity of water available in a household. Greater quantities of water and a reduction in the risk of water contamination are two principal means of preventing the diseases transmitted through the faecal-oral route, such as diarrhea, which are a leading cause of death among children in sub-Saharan Africa. Nevertheless, in terms of water access, sub-Saharan African cities are some of the worst off in the world, with 20 % of their populations supplied by an unimproved water source. Urban growth of African cities is leading to the development of informal settlements that do not have access to basic services, including access to water. Changes in both water supply (because of climatic variability) and demand (because of the increase of urban populations and economic growth) have caused many African urban dwellers to experience difficulties in meeting daily water needs. In light of climate change and the continued growth of urban population, there is concern that the gap between the supply and demand for clean water will widen.

We use original data on access to water from a survey implemented in 2012 in the three informal neighborhoods of the Ouagadougou Health and Demographic Surveillance System. The aim was to monitor the diversity and the variability of access and use of water in households, across seasons. Four times per year, a questionnaire was administrated to the same representative sample of households (n=1496). It was composed by seven modules addressing issues as varied as the types of water supply, the conditions of collection and storage of water, and the cost of water, as well as various domestic water uses and a health section on water-related diseases for each child under the age of 10 living in the household. To complete the dataset, water samplings was analyzed to test the microbiological quality of the water consumed by these households.

Results show that population's adaptation to seasonal variability is high in terms of diversity and changes in the choice of water sources. This choice implies variability in the distance and in the price paid for water. To a certain extent, in some period of the year, people have not the possibility to choice between different sources: the scarcity lead to pay a high price and/or to travel long distances to a water fountain and, to limit the quantity for each domestic use or to alter the quality of water used. Results also highlight that a number of factors related to water access are associated with higher occurrence of childhood diarrhea, and specifically the use of rainwater. The use of hand pumps is as well interesting owing to its impact on higher childhood diarrhea due to microbiological quality issues.

From these results, we have a broad picture and we can make first hypothesis on the future adaptation to consequences on climate changes in those informal parts of the city, and more generally in African irregular settlements.

P-3330-23

Rainy extreme events and phenomenon of flood in the city of Cotonou (Benin): Measure of protection and adaptation of the population

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More and more, because of the climate change, the populations have to resist frequent and extreme meteorological phenomena, greater climatic variability and changes of the climatic standards. In Benin and more exactly city of Cotonou, occurrence of the extreme rain events associated to a lack of adequate politics of the urban development contributed these last two decades to the degradation of the living environments of the urban population.

To appreciate the impacts of the extreme phenomena on the physical and socioeconomic environment of the population, the pluviometric and infrastructural data are used. The statistical analysis was used to determine the extreme rains. The socio-anthropological inquiries will allow to determine the perceptions of the population on their states of vulnerabilities to the phenomenon of floods and to see that they are the strategies of possible adaptation.

The results of this study show that the populations with average income, the socio-urban equipment's and houses are the most exposed to the phenomena of floods. This vulnerability is often understandable by the collapse of certain houses, the break of ways and bridges under the influence of the phenomenon of the érodibilité provoked by runoff water. Today, it is about develop or to make developments which are capable of adapting itself to the current climatic evolution of the context and future.

P-3330-24

Diffusion and scaling of Soil and Water Conservation measures to manage Climate Change in Nigeria

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Throughout Nigeria, small holder farmers are increasingly affected by extreme climate and environmental change events. Worsening droughts in particular is ruining the lives and livelihood of many small holder farmers as it continued to hamper farming activities. Their albatross includes water mismanagement, inappropriate land use, as well as poor knowledge of anti-drought measures and this has led to land degradation such as soil erosion and loss of the soil's productive capacity to produce food.

Also the limited potential for dry season farming through soil and water conservation, the non-employment of rain water harvesting technology, as well as conflicts over limited water resources have not helped the situation. Consequently, local livelihoods are being jeopardized while increasing poverty for thousands of these farmers expands.

The paper therefore reviews the adoption and scaling of the World Overview on Conservation Approaches and Technologies (WOCAT) technologies and measures based on the fact that it offers a basket full of Soil and Water Conservation measures that work under specific or under a range of conditions. Soil and Water Conservation (SWC) in this context include the prevention or reduction of soil erosion, compaction and salinity; conservation or drainage of soil water; maintenance or improvement of soil fertility, etc.

The paper also documents, evaluates, compares, monitors and analyses the performance of these WOCAT technologies and approaches such as agronomic, vegetative, and structural and management measures that have proven capable of controlling soil degradation and enhance productivity in the field under existing environmental and climatic variations.

It recognizes and acknowledges the challenge and importance of adapting to climate change. Thus, standardized documentation and evaluation of approved as well as innovative land management technologies and approaches, taking into consideration their adaptation potentials and tolerance towards possible scenarios of climate change, builds the basis to get prepared for the future.

Using the WOCAT methodology, this paper discusses how small holder farmers in eastern Nigeria; whose livelihoods are based on small-scale cropping and livestock agriculture sustainably harvest and use rain water through agronomic, vegetative, and structural measures. It underscores the sheer grit, courage and the determination this vulnerable group and many others bring to the endless challenge of survival. It further underscores that -individuals, households and communities are not passive in the face climate change, and even economic change.

P-3330-25

Managing water and nitrogen fertilizers in maize production for smallholder farmers' resilience to climate change impacts

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Water scarcity is one of the most limiting factor for maize production in Malawi, especially the areas that are vulnerable to climate change. Irrigation alone without proper soil nutrient management fails to enhance maize yield. Participatory embracement of efficient water and nutrient management strategies from on – station to on – farm would help farmers build resilience to the impacts of climate change. This paper discusses how development and dissemination of efficient water management strategies in maize can adapt smallholder farmers to climate change. Irrigation scheduling techniques combined with nitrogen rates and the use of maize varieties efficient in water use were participatory assessed from on–station to on–farm in comparison with farmers' practices. Alternate furrow irrigation technique was evaluated at on – station in a randomized complete block design experiment with four replicates with three irrigation scheduling treatments: (1) Alternate Furrow Irrigation (AFI); (2) Fixed Furrow Irrigation (FFI) and Convention Furrow Irrigation or farmer practice (CFI). Following on–station successful results, AFI was participatory evaluated at on – farm against, crop stage – based irrigation, daily water budget irrigation scheduling and farmers' practice combined with nitrogen rates using OFD mother – baby approach at five different irrigation schemes. It was RCBD Split – Plot Experiment with above four irrigation scheduling as main treatments. Three nitrogen rates of 100, 125 and 150 kgN ha–1 were mini–treatments. Maize was planted at 0.25m apart with one seed per station on a 37.5m2 plot. Results for both On–station and On–farm indicated that farmers' irrigation scheduling practice uses more water than the AFI. Alternate furrow irrigation reduced irrigation amount and labour by 38 – 45% compared to farmer practice. Water use efficiency (kg m–3) determined as total grain yield (kg ha–1) per crop water use (m3 ha–1) for each irrigation scheduling, differed with irrigation strategy ($P<0.0001$), location ($P<0.05$), nitrogen rates and maize varieties. Application of 125kgN ha–1 increased yield. Water use efficiency was highest in AFI and lowest in farmer's practice. Both the on–station and On–farm results suggested that AFI strategy and use of maize varieties efficient in water use can definitely adapt farmers to water scarcity by conserving water without affecting economic maize yield.

P-3330-26

Recurrent climate disasters in Cameroon: an indicator of inadequate adaptation to climate change

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Cameroon is a central african country with a variety of climates determined by its location on the Atlantic ocean, its extension in latitude from 02 ° to 13 ° N, and its varied landscape. As a young country with low–middle income, Cameroon is highly vulnerable to natural hazards, particularly to those related to climate variability and change (World Risk Report, 2014). This results in a variety of climatic disasters which unfortunately recur every years, usually at the same places and during the same periods of the year despite responses from the State and its partners. Therefore, the efficiency of strategies and adaptation approaches in place ought to be questioned. This paper aims at making a comprehensive assessment of the government's approach to adapt to recurring impacts of climate variability and change in Cameroon. At first, we list climate disasters recorded in the archives between 1960 and 2012 in Cameroon while highlighting recurrent events at specific locations and time of the year. Following this historical review, we analyse recurrent disasters for each decade and the rate of change of the occurrence of climate disasters between the first decade of the study period and the others. Finally, through content analysis, we review the types of responses implemented by the State to address these impacts and the consideration given to long–term solutions, or planned and anticipated adaptation in the country's key strategic planning documents since independence in 1960. As a result of our work, we have highlighted 450 climate disasters that occurred in Cameroon between 1960 and 2012. They are of various natures: floods, storms, droughts, landslides, hazes, wildfires, disruptions of seasons, sea level rise and others. All the 58 administrative divisions of the country experienced at least one climate disaster during the above period, which is enough to show that the scale of the problem is national. These unfortunate events occurred each year, with an average of 9 per year and a maximum of 55 in 2010. Similarly, a high increase of these events is noticeable over the years and decades, with a higher occurrence during the 2000s (30% of climate disasters of the period).The number of disasters increases by an average of 28 between two decades. This foreshadows an amplification of climate disasters for the current decade and those to come as projected by some recent publications (Mc Sweeney, C. et al, 2010; Climate Service Center, 2013;...). The ten–year rate of change is generally between 161.11% and 616.67%. Thus, compared to the first decade (1960–1969), weather–related disasters are multiplied by at least 2 during other decades and even more during the 2000s (by about 6 for all climate disasters and 7 for floods specifically). In some areas (large cities like Douala and Yaounde, the Sudano–Sahelian plains of the Logone and Benue), recurrent climate disasters were recorded at the same periods of the year with rising intensity and higher damages each time. The government is aware and concern is shown at the highest level. In August 1988 and August 2012, the president of Cameroon, Paul Biya, visited the same places hit by floods in the Sahelian part of the country. Relief type responses like evacuation of populations, accomodation in camps, comfort visits, donations in materials and money are the type of measures found in the literature after these disasters. Anticipated and planned adaptation strategies are rare (10% of observations). The government scheme for civil protection is still deficient. More so, an overview of the main strategic planning documents in the medium and long terms indicates low consideration for climate hazards by the government. Cameroon still lacks a National Adaptation Programme of Action (NAPA) and a National Adaptation Plan (NAP). A process to develop a NAP started in 2012 but is still not finalized because of the weaknesses of the legal and institutional frameworks as well as inappropriate methodology. Meanwhile, disasters and other climate change impacts are increasing and the government is taken unawares most of the time! The recurrence of climate disasters in Cameroon is thus a consequence of poor adaptation to climate change, the strategy in place being more oriented to measures after blows instead of anticipated or planned medium and long term strategies at national level.

P-3330-27

Trends of Heat Exposure in Northern Ghana

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Farmers are largely exposed to heat in the performance of their outdoor activities especially in developing countries. As global climate change is intesified, farmers occupational health and productivity need to be safequarded to ensure food security in the developing world where mechanized farming is at the bearst minimum This study present results of yearly trend of heat exposure in northerast Ghana where temperature could reach sa high as 45 degrees celcius with WBGT in the of 29 to 37 degrees celcius. Farmers work with minimal rest which can be injarious to their health, productivity and food security. The study uses Lascar El USB temperature and humidity sensor which can record temperature and humidity for longer period of time. The results are expressed in terms of heat stress to show the yearly pattern in the north east part of Ghana.

P-3330-28

Development and Assessment of Non-Linear and Non-Stationary Seasonal Rainfall Forecast Models for the Sirba Watershed, West Africa

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Water Resources Management in the Sahel region, West Africa, is extremely difficult because of high inter-annual rainfall variability. Unexpected floods and droughts often compromise economic activities and sometime lead to severe humanitarian crises. This is exacerbated by endemic poverty, poor preparedness to disaster response, the inadequacy of climate information, and weak institutional capacity. All these factors worsen the vulnerability of sub-Saharan Africa countries to climate changes and make them to be the regions which are highly impacted worldwide. Seasonal rainfall forecasting is one possible way to increase resilience to climate change/variability by providing information in advance about the amount of rainfall expected in each upcoming rainy season. Rainfall forecasting models often arbitrarily assume that rainfall is linked to predictors by a multiple linear regression with parameters that are independent of time and of predictor magnitude. Two probabilistic methods based on change point detection that allow the relationship to change according to time or rainfall magnitude were developed in this paper using Normalized Bayes Factors. Each method uses one of the following predictors: Sea Level Pressure (SLP), Air Temperature (AirTemp) and Relative Humidity (RHUM). Method M1 allows for change in model parameters according to annual rainfall magnitude, while model M2 allows for changes in model parameters with time. M1 and M2 were compared to the classical linear model with constant parameters (M3) and to the climatology (M4). Results showed that model that allows a change in the predictor-predictand relationship according to rainfall amplitude (M1) and using AirTemp as predictor is the best model for seasonal rainfall forecasting in the study area.

P-3330-29

The competitive impacts of global SST warming and CO2 increase on Sahelian rainfall: results from CMIP5 idealized simulations

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The West African Monsoon (WAM) is affected by large climate variability at different timescales, from interannual to multidecadal, with strong environmental and socio-economic impacts associated to climate-related rainfall variability, especially in Sahelian countries. State-of-the-art coupled climate models still show poor ability in correctly simulating the WAM historical variability and also a large spread is observed in future climate projections.

In this work, climate simulations from a set of 10 CMIP5 atmospheric global climate models are used to study the July-to-September WAM variability in the period 1979-2008. The individual roles of global SST warming and CO2 concentration increase are investigated through idealized experiments simulating a 4K warmer SST and a 4x CO2 concentration, respectively.

Results show a dry response in Sahel to 4K SST warming, with dryer conditions over western Sahel. On the contrary, wet conditions are observed when CO2 is 4x increased, with the strongest response over central-eastern Sahel. The precipitation changes are associated to coherent modifications in the regional atmospheric circulation: dry (wet) conditions are associated with reduced (increased) convergence in the lower troposphere, a southward (northward) shift of the African Easterly Jet (AEJ), a weaker (stronger) Tropical Easterly Jet (TEJ). The analysis of the changes in the regional and global connections of WAM dynamics reveals that in the 4K experiment the observed relationships with the global SST and the regional dynamics patterns are weaker, while in the 4xCO2 simulation the connections are more robust. Specifically, a strong coupling between WAM precipitation and Equatorial Pacific and Atlantic SST is observed, along with a reinforcement of the regional connections with the Saharan heat low, the AEJ and the TEJ.

The above results suggest a competitive action of global SST warming and CO2 increase on the WAM climate variability, with opposite effects on precipitation. The global SST warming affects Sahelian precipitation by weakening the global Tropical convection, while the CO2 increase results in a strengthening of the regional dynamics features associated to wet conditions in the Sahel. It is argued that the large spread in CMIP5 future rainfall projections may be related to the weight given to SST warming and direct CO2 effect by individual models.

P-3330-30

AMMA-CATCH a hydrological, meteorological and ecological long term observatory on West Africa

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AMMA-CATCH is a multi-scale observation system dedicated to long-term monitoring of the water cycle, the vegetation dynamics and their interaction with climate and water resources in West Africa. In the context of the global change, long-term observations are required to i) gain understanding in eco-hydrological processes over this highly contrasted region, ii) help their representation in Earth System Models, and iii) detect trends and infer their impacts on water resources and living conditions.

It is made of three meso-scale sites (~ 1°x1°) in Mali, Niger and Benin, extending along the West African eco-climatic gradient. Within this regional window (5° by 9°), each of the three sites comprises a multi-scale set-up which helps documenting the components of the hydrologic budget and the evolutions of the surface conditions over a range of time scales: raingages, piezometers, river discharge stations, soil moisture and temperature profiles, turbulent fluxes measurements, LAI/biomass monitoring.

This observation system has been continuously generating coherent datasets for 10 to 25 years depending on the datasets. It is jointly operated by French and African (Mali, Niger and Benin) research institutions. The data-base is available to the community through the website (www.amma-catch.org). AMMA-CATH participates to several global or regional observation networks, such as FluxNet, CarboAfrica, International Soil Moisture Networks (ISMN) and to calibration/validation campaigns for satellite missions such as SMOS (Europe/France/Spain), MEGHA-TROPIQUES (France/India) or SWAP(NASA). AMMA-CATCH fills a gap over a region, West Africa, where environmental data are largely lacking, and thus, it can usefully contribute to the international networking effort for environmental monitoring and research.

P-3330-31

Preparing for El Nino: a starting point for climate change adaptation for malaria

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Background on impact of El Nino on malaria in Ethiopia

Malaria outbreaks in East Africa and Ethiopia overlapped with El Nino events, which has been documented since the beginning of the 1950s until 2003/2004.

Response of the malaria community based on 2014 early warning

An El Nino was predicted to develop late in 2014 and was expected to last through at least spring 2015. This translates to a period of heightened likelihood that extreme weather conditions can occur with associated malaria outbreaks in East Africa. The International Research Institute for Climate and Society (IRI) issued a Bulletin "Emerging El Nino conditions: Guidance for the East African Malaria Community following series of consultations.

Difficulties associated with uncertainty of forecast

Forecasting malaria risk remained a series challenge due to focal nature of malaria transmission in Ethiopia.

Analysis of historical events using Ethiopia ENACTS products

The National Meteorology Agency (NMA) and the IRI have been collaborating on improving climate service since 2008. The most prominent of these activities has been the implementation of the ENACTS (Enhancing National Climate Service) initiative, which was first started in Ethiopia. In order to accurately assess the influence of climate variables and malaria morbidity data at district level. In order to accurately assess the influence of climate variables and phenomenon on malaria data, charts and maps from Ethiopian climate series, epidemics at the district levels, and the IRI Data Library, NMA Ethiopian Map Room were used in this analysis. Thus, mean annual rainfall and temperature across Ethiopia displays a normal interannual decadal fluctuation but overall shows a slightly positive trend. The region has been receiving more rainfall and becoming 'wetter' but temperature has been warming and becoming 'hotter'.

An El Nino event in Ethiopia is typically associated with enhanced and increased probabilities of above normal rainfall during the secondary Belg rain season (March-May). However, El Nino rainfall during the primary Kiremt rain season (June-September/October) is more varied and subject to other climatological factors.

To determine whether an El Nino event, subsequent rainfall and temperatures were associated with the below malaria epidemics of the district "hotspots" we assessed these climatic factors in certain three month groups prior to and during the actual epidemic.

Temperatures and relative humidity within the districts were usually already at an acceptable level to encourage malaria transmission. From our prior research, we found that El Nino events in Ethiopia were typically associated with enhanced and increased probabilities of above average rainfall during the secondary Belg rain season. However, this was not substantial in our analysis. Probabilities of a wet El Nino (rainfall) or a hot El Nino (temperatures) deviated from the actual observations. Although the sections in these tools were very insightful in the study of climatic conditions that encourage the probability of malaria transmission, it fails to properly demonstrate the probability of transmission based on ENSO state without a high level of uncertainty. It also does not indicate the strength of the ENSO state, which could be helpful in the future analysis. Monitoring and use of climate information for public health decision requires strong collaboration and sustainable collaboration between the health sector and climate community. In the last decades, both MOH and NMA have moved towards preparing capacity building and strategic documents. The health sector should benefit better through the recent advancement of climate information services from NMA's ENACTS.

P-3330-32

Policies to favour crop intensification and farm income under climatic risk in West Africa

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In West African countries, agricultural production per capita has decreased over the past half century. With continued population growth and the diminishing availability of marginal arable land, pressure on land is rapidly increasing and there is now a common view that crop yield must be increased in this region, especially as there is a wide gap between actual and potential yields. Although there are several factors which may explain this yield gap, the fact that agricultural production takes place in resource-constrained farm households exposed to risk is widely recognized as being important. Indeed, risk discourages the adoption of high-risk, high-return agricultural technologies, which in turn impedes the improvement of yields.

In order to assess how climatic risk constrains intensification strategy in West Africa, we built and calibrated a bioeconomic farm simulation model predicting the choice to intensify crops or livestock as depending on the availability of key policies in the economic environment of farms, for typical cases in the groundnut basin of Senegal. These cases include two regions contrasted in terms of rainfall (Sine and Saloum) and in each region two typical farms, representing poor and less poor farmers. The model features uncertainty in weather (hence yields) and crop prices, farmer's risk aversion, nine cropping systems representing millet, maize and groundnut with various intensification levels, and the main interactions between crop and livestock: draught animal power, the feeding of animals with suitable crop products (groundnut haulms, cereal straw) and the production of farm manure. Farmers are constraint by land, labour, cash and credit availability. 180 households were surveyed to build the socio-demographic and economic dataset used by the model, and agronomic data were collected from 206 fields.

These key policies analysed are (i) weather index insurances against drought impact on crop yields, either subsidised or not, (ii) subsidies to short term credit for purchasing farm inputs, (iii) subsidies to fertilizer, and (iv) direct payments to farmers. In our simulations, under the current climate and prices of agricultural products and inputs, all these policies appear favourable to the increase of farmers' expected utility for typical farms representing the vast majority of farms in the groundnut basin. Apart for insurance, all of them appear also favourable to intensification of coupled crop and livestock activities for those typical farms. Insurance appears favourable to this intensification strategy only for farms located in the northern part of the region studied, where climatic risk is higher. Among the scenario tested, for most typical farms, combining unsubsidized insurance with subsidized credit appeared as the best use of a given amount of public funds in support of crop intensification: subsidized credit allows the farmers to buy costly inputs while insurance reduces the risk that a drought prevents them from reimbursing the credit. Direct payments also rank high in this respect, because they efficiently mitigate the cash constraint. The amount of subsidies required to obtain a given increase of the value of farm production varies across farm types and subzones in the region, but is relatively reasonable. These results suggest that crop intensification is currently relatively close to becoming a relevant option for farmers and that public policies may favour it by improving the economic environment of farms.

P-3330-33

A study of flood intensification in Niamey based on satellite, gauge data and hydrological modeling

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One anticipated impact of climate change is a possible enhancement of the hydrological cycle and an intensification of extreme hydrological events, such as floods. Observing the present and past changes in hydro-systems is helpful to understand the causalities - and the respective roles of climate variability and land use changes, in the increase of floods. In many tropical basins, and notably in sub-saharian Africa there is a deficit of in situ observations. In these regions satellite data and modeling can help analyzing the hydrological behavior and the recent evolution.

Since the beginning of flows observations, in 1920's, Niamey (Niger) has suffered drastic hydrological changes. Several studies highlighted the hydrograph modification from one to two floods (around 1970's). This hydrological change has been attributed to increased runoff in the basins of the local tributaries (Gorouol, Dargol, Sirba), resulting from land clearing and soil crusting,;. In the last decade (2000's) a dramatic increase in the frequency and intensity of the first flood as been observed. Years 2010, 2012 and 2013 recorded the three highest water levels and peak discharge since the beginning of observations;

and lead to severe material losses and several casualties.

Recent studies have raised the issue of a possible increase in extreme rainfall in the Sahel, which may had an important role in the last extreme floods. This study explores the possible impact of this rainfall change in the Niger flood in Niamey. It focuses on the 125000km2 basin between Ansongo and Niamey, corresponding to the drainage area contributing to the first flood. Several long series of satellite and gauge based rainfall estimations, from 1950 to present, are analyzed and used as input to a hydrological model to analyze the possible role of rainfall in the observed evolution of the flood regime and compare with the effect of land use on the basin. These results should provide a basis to anticipate future changes.

P-3330-34

Towards innovative solutions for monitoring climate changes in observation poor regions : Rain Measurement based on cellular phone networks in Africa

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The observed anthropogenic global warming over the last century is well documented but the effect on rainfall is less clear, particularly at small scales. Confidence in future precipitation scenarios is currently subject to large uncertainties and can only be assured if there is a comprehensive understanding of the processes controlling rainfall variability, made possible through reliable rainfall records. In many part of the Tropics the ground based gauge networks are sparse, often degrading and accessing this data for process studies, climatological analysis or for validating satellite products is sometime difficult.

Here a novel approach is presented. It is based on using commercial microwave links from cellular telephone networks to detect and quantify rainfall.

Rainfall monitoring based on commercial terrestrial microwave links has been tested for the first time in Burkina Faso, in Sahelian West-Africa. In collaboration with one national cellular phone operator, Telecel Faso, the attenuation on a 29 km long microwave link operating at 7 GHz was monitored at 1s time rate for the monsoon season 2012. The time series of attenuation is transformed into rain rates and compared with rain gauge data. The method is successful in quantifying rainfall: 95% of the rainy days are detected. The correlation with the daily raingauge series is 0.8 and the season bias is 5%. The correlation at the 5 min time step within each event is also high. These results demonstrate the potential interest of exploiting national and regional wireless telecommunication networks for monitoring rainfall in the Tropics, where operational rain gauge networks are degrading and the hydro-meteorological risk increasing.

P-3330-35

Less rain but more surface water: paradoxical evolution of ponds and runoff in pastoral Sahel

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The Sahelian region has experienced a dramatic rainfall deficit over the second half of the last century with severe droughts in the early seventies and eighties which had dramatic consequences on the ecosystems and the population living in these areas. In parallel and paradoxically an increase in surface runoff has been observed over the same period of time in different areas of the Sahel, particularly in Niger where the increase in areas cleared for cropping was suggested as a possible explanation for this phenomenon.

This presentation focuses on the evolution of ponds and surface runoff in pastoral areas in central and northern Sahel, where agricultural activities are very limited. It addresses in particular the Gourma area, in Mali, over which in-situ data on vegetation, meteorological variables and pond water levels are available via the AMMA-CATCH observatory.

The analysis of different satellite data and aerial photographs revealed a spectacular increase in the surface of ponds in the Gourma region over the last 60 years (Gardelle et al. 2010) as well as over other similar zones in Mauritania and Niger. A water balance equation, which includes water volume changes derived by in-situ water level coupled to pond's surfaces, water input by rainfall and water losses by evaporation and infiltration, has been derived for the Agoufou pond. This allowed to quantify changes in the water amount supplying the pond over time, with annual runoff coefficient (estimated as the ratio of water supply over rainfall) going from 0.005 - 0.05 in the 60s-70s, 0.5-1 in the 90s and ranging from 3.5 to 10 in the last ten years.

These results prove that the Sahelian paradox is also taking place in non-cultivated areas. Analysis of land cover changes over the Agoufou and Tin Adjar watersheds indicates that vegetation degradation and soil erosion occurring over the shallow soils that generate most of the runoff ending up in ponds, play an important role on the evolution of the hydrological system in these areas.

A first analysis on the capability of general land surface models to represent runoff in this region has been carried out in the framework of the ALMIP2 project (AMMA Land Surface Model Intercomparison exercise, Boone et al. 2009). It was found that the representation of shallow soils has to be taken into better account to correctly represent surface hydrology and runoff in endoheric Sahel. More generally, better understanding and modeling the eco-hydrological mechanisms operating in this regions and particular the co-evolution of vegetation and runoff systems is necessary to correctly reproduce past changes and predict the future evolution of these ponds.

P-3330-36

Temperature in the Sahel: mean climate and multidecadal warming in observations and climate simulations CMIP5

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In a companion study (Leauthaud et al.), we show with observations that the Sahel experienced a strong warming since 1950; it is stronger in Spring, which is already climatologically very hot, and more pronounced in nighttime than daytime temperature. This warming is more pronounced that further South in the tropical Soudanian region and increases with latitude from the Gulf of Guinea to the Sahara. Observations also indicate a decrease of the diurnal temperature range (DTR) which is more pronounced outside of the rainy monsoon season.

In this study, we address the ability of climate models to simulate these salient observed features. We use outputs from the CMIP5 archive, and in particular amip, control and historical simulations. We also use amip-type cfSites ouptuts, that allows a more in depth understanding of the physics underlying the simulation of temperature with high-frequency energy budgets (when available). Here, we evaluate the simulation of the annual and diurnal cycles, of the distribution of temperature, and their multi-decadal fluctuations and changes.

The observations used for evaluation include CRU, GHCN and BEST monthly-mean gridded datasets, but also results from several SYNOP stations located across the Sahel and providing daily minimum and maximum temperature, plus, for some of them, 3-h sampled data. The later are used to compare temperature distributions and distribution shifts in the last decades.

First, it appears that the simulation of the annual cycle of

temperature is very challenging, especially outside of the monsoon season (cf. also Roehrig et al. J. Climate 2013). Simulations often display phase shifts of several weeks to a few months in their extrema (Spring and Autumn maxima and Summer and Winter minima). Biases typically reach a few to several degrees in their monthly-mean values. In numerous models, compensating errors arising from sub-diurnal to seasonal scales are involved in the representation of the annual cycle. In general, differences among models are also found to dominate over differences among scenarios (amip, historical...).

High-frequency observations of the surface meteorology and radiative budget, available over the last decade, point to strong physical couplings between radiative fluxes and thermodynamics, for instance between longwave fluxes, DTR, water vapour, clouds and precipitation. Strong couplings are also found in simulations, but they are quantitatively distinct.

The causes and implications of these simulation biases for the study of the Sahelian climate and its future evolution are discussed.

P-3330-37

Characterization of seasons with the wind profiles observed by VHF radar in West Africa

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The variability of the West African monsoon had socio-economic and environmental impacts on populations. This variability is closely linked to atmospheric circulation, which also plays a dominant role in the organization of the monsoon. These experimental results provide information on the dynamics of winds through the features of the jets. Data are provided by a VHF wind profiler radar installed in North-Benin, precisely Nangatchori (9°6472N, 1°7411E) during the measurement campaign AMMA program (2006-2007). This study shows the presence of the African Easterly Jet (AEJ) in the middle troposphere (2-4km) . It shows also the presence of the Subtropical Jet (STJ) and the Tropical Easterly Jet (TEJ) in the upper troposphere (10 km) . The patterns obtained let distinguish two great seasons characterizing the Hydrometeorological Observatory of Oueme Upper Valley. The Hierarchical Agglomerative Clustering (HAC) applied to the wind mean velocity and frequency of direction at 10 km associated to the monthly rain confirms the two great seasons existence: one dry season (November to March) and wet season (April to October). The wet season is characterized by three phases: the pre-wet phase (April, May, June), the heart of the wet season (July, August, September) and the post-wet phase (October).

P-3330-38

Description of the agro-climatological characteristics of the rainy season in southwestern Burkina Faso for the 1970-2013 period

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The rain-fed agricultural system of West Africa is very vulnerable to climate variability. The different drought phases during the last four decades (1970-2010) revealed the weakness of the agriculture system with a high decrease in crop production, and a significant deficit in food availability. Many studies have identified the seasonal pattern of the rain events during the rainy season as a key driver of agricultural production failure during these drought phases. In this study, rainy season potentialities with regard to crop growth (maize, millet, and sorghum) are described for southwestern Burkina Faso through seven key climate characteristics: annual rainfall amount, rainy season onset and offset, dry spell duration, seasonal maximum rain event, maximum temperature, and wind speed. These characteristics are calculated from daily climate data recorded by a local network of 16 stations from 1970 to 2013. A computation of the intensity and occurrence of these characteristics during the rainy seasons help to draw a description of the drought phases. The rainy seasons during the drought phases are characterized by a low annual rainfall amount, a late rainy season onset, and a more frequent long dry spells (>7days). Unfortunately, the long dry spells mostly occurred during the most sensitive crop phases: leaf initiation, flowering and grain filling. Moreover, the dry spells are accompanied by high daytime temperature. The intensity and the probability of occurrence of the other extremes events (hot spell and strong wing) in the rainy season are very high in the study area mainly during the sowing and the harvest periods.

The adaptation strategies to these worst climate conditions in the region should include a selection of crop varieties with short cycle and the implementation of a supplementary irrigation system and an agricultural insurance scheme.

P-3330-39

Project ACASIS : A early warning system on Sahelian heat waves and their impacts on health

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While the heat wave impacts on public health have been widely addressed in developed countries especially after the intense event over West Europe during summer 2003, no effort has been made to detect them and evaluate their impacts in least developed countries, and especially Africa, where climate is warmer and adaptation capacities are low. Over West Africa preliminary interviews, climate and epidemiologic analyses show however that this problem is emerging and climate projections indicate that such events should increase in frequency and intensity in the coming decades. However these climate models display important temperature and radiative biases over this region, which must be reduced to provide robust information on the future evolution of heat waves.

Starting from this context, the main objective of ACASIS is to set-up a pre-operational heat wave warning system over West Africa tailored to health risks of the population living in this region. This is a demonstration project focused on Senegal and Burkina where national weather services have already started developing products dedicated to weather/climate and health relationships, and where several health and demographic observatories have been operating for up to several decades. Based on qualified meteorological, climate and demographic data bases, firstly, the dynamics of the heat wave events and their atmospheric patterns will be determined, as well as their evolution over the last decades. Their predictability at short and medium ranges will be evaluated on ensembles of multi-models forecasts outputs. On a longer time scale, control simulations and climate scenarios of the CMIP5/AR5 (5th phase of the Coupled Model Intercomparison Project the results of which are synthesised in the IPCC Assessment Report) database will be analysed and the simulated future evolution and associated uncertainty of these events will be evaluated. More precisely the processes at the origin of model radiative biases will be examined and reduced as much as possible. In parallel, epidemiologic studies associated with interviews will be conducted in the health and demographic sites in Senegal and Burkina in order to evaluate the physiologic and social vulnerability of the African population to high temperature extremes. It will allow to define tailored bio-meteorological indicators to be used in the warning system. From these outcomes and by implementing downscaling to link the synoptic scale of the heat waves to local bio-meteorological indicators, we will set-up a demonstration warning system on a "testbed" platform named MISVA, already implemented as the result of a prior collaboration between Meteo-France, OMP and ANACIM, the meteorological agency of Senegal. Based on the interviews, and with the setting of several workshops with stakeholders and public institutions, we will be able to provide specific recommendations associated to these warnings. An implementation in the Meteo-France operational system at the end of the project or after might be possible.

To carry on this project, a pluri-disciplinary consortium has been set-up gathering climatologists, physical processes specialists, meteorologists, biostatisticians, demographers, socio-economists, epidemiologists, geographers, and operational meteorological agencies. It

will work through a close collaboration between French and African teams where young African researchers will be highly involved.

P-3330-40

Estimation of the West African Monsoon variability through the analyses of the induced wave parameters

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Using local (rainfall data) and global satellite observations (atmospheric fields reanalysis, OLR data, satellite-observed brightness temperature data and cloud cluster data), the activity of convective equatorial waves revealed to be strongly coupled with the West African Monsoon (WAM) variability.

A previous study of wave activity in the West African area (Kafando et al., 2008), revealed that the signature of the monsoon is clearly observed on total energy density in the lower stratosphere (19-23km). The annual cycle and the climatology of wave total energy density showed that peaks of activity match the period of intense convection. In the present study, wave activity in relation with monsoon proxies (convection and precipitations) has been used to analyze the WAM interannual variability using nine years radiosonde observations, Tropical Rainfall Measuring Mission (TRMM) data and Outgoing Longwave Radiation (OLR) data over several West African meteorological stations located in the latitudinal belt 4°N-20°N.

P-3330-41

Impact of climate variability on the water balance of the anthropized Agneby watershed in the southeast of Côte d'Ivoire: application of nTopAmma hydrological model

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Agneby Watershed (8490 km2) is located in the southeast of Côte d'Ivoire. It is subject to a monsoon (1500 mm annual rainfall) with four contrasted climatic seasons. This basin is also subject to strong human impact that contributes to a change in water balance due to intense agriculture (cocoa, coffee, rubber and food crops).

This work is part of a general framework for understanding the impact of climate variability and agricultural intensification on water resources in the watershed of the Agneby. The main objective of this study is to evaluate by modeling the different terms of the water balance and their evolution over the period 1970-2000. We use a modified version of nTopAmma model developed from observations in the upper basin of Ouémé (wet site AMMA-Catch observatory). The nTopAmma model favours the shallow groundwater efflux as the origin of the flow. The amended taking into account changes in land use and the seasonal cycle of vegetation in the calculation of evapotranspiration can address the impact on the water balance of the plant cover changes.

P-3330-42

Climate impact studies in the Sahel: A word of caution

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One can easily understand why climate impact studies are increasingly solicited for regions such as Subsaharan Africa in general and the Sahel in particular. Past climate fluctuations like the multidecadal drought that started in the 70ies had a very strong impact on people, societies, natural resources, and ecosystems. The Sahel drought is the strongest multidecadal drought recorded so far, and this drought combined with a high vulnerability to result in dramatic consequences.

Therefore, it seems meaningful to address the consequences of future climate changes in the Sahel. However, I would argue that a number of limitations and misunderstandings considerably reduce the conclusions one can reach with climate impact studies.

Managers, resources planners, stakeholders, NGOs and scientists in non-climate domain like ecology, hydrology or health, often look for climate projections which have horizons of 20, 30 or 50 years, and in many cases, which are local or regional, from the size of a city to one or a couple of countries. Again, the logic behind these scales is rather straightforward: A couple of decades is seen as the proper timescale for many infrastructures planning (buildings, dams), and for public policies also (laws on resource use and preservation for instance) . The spatial scale, from local to regional, obey the same logics. Of course, there are also interests in larger spatial scales (global, continental) and longer time scale (century), but this is not the most common design of climate impact studies.

Based on a review of recent studies, I will argue that caution is needed for impact studies in the Sahel because of two rather simple facts of far-reaching consequences:

- 1) The Sahelian climate at these time-scale is dominated by multidecadal variability. A few climate parameters may escape this statement, like surface temperature just before and after the monsoon season (Guichard et al. this session, Léauthaud et al. this session), and more global parameters like sea level and CO2 atmospheric concentration. However, most parameters related to the monsoon season are dominated by the multidecadal variability: this notably includes rain, temperature during the rain season, and less immediate factors like dust emission in the dry season and ecosystem dynamics that also depend on rain. Of course, these parameters have huge impacts on many systems and activities. I will show examples of effect of climate variability on ecosystems and hydrosystems.

- 2) Present climate models do not have the skills to produce reliable projections of future multidecadal variability. This is true for global and regional climate models, coupled with oceans which multidecadal variability has still to be fully understood. This is a well known issue in the climate community, which is probably not that well recognized in the 'impact' community and by the funding agencies. To make things worse, even the longer term trend is prone to marked differences in climate scenarios for the Sahel.

For these reason, I would call for cautious in impact studies. Multidecadal variability has to be considered, and its understanding is, in my opinion, a prerequisite to most impact studies. Extensive dialog between communities is needed to clarify this issue as much as possible.

P-3330-43

Improving the incomes of producers on family farms in the context of climate change in Burkina Faso

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Climate change in the context of Burkina Faso results in recurrent pockets of droughts, heat waves, reduction in the number of rain days and a high variability of rainfall. The consequences of this claimate hazards on family farming are inter-alia, the drop of productions and yields. One of the major challenges of the agricultural sector is improving yields and incomes. Our research aims at presenting the initiatives developed in connection with the improvement of yields and incomes of the producers of family agriculture covering more than 90% of farmers in Burkina Faso. Climate information associated with proven practices and the market information system used could inspire other stakeholders of family farming in similar contexts.

P-3330-44

Impact of climate on groundwater recharge in the crystalline basement rocks aquifer of Northern Ghana

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Water is the cornerstone of human life and for all economic developments. West Africa and specifically Ghana are no exception to this reality.

Northern Ghana is characterized by a semi-arid climate, with prolonged dry season (7 months of very few rainfall) leading to the drying up of many rivers and streams. In addition, rainfall is highly variable in space and time. Therefore, surface water is unreliable and insufficient to meet the water demands for socio-economic development in this area. As a result, the area is heavily dependent on groundwater for domestic water supply as well as for dry season irrigation of vegetables (cash crops).

However, aquifers in northern Ghana are dominantly the hard rock type (Crystalline basement rock). This aquifer has no primary porosity and may not be able to sustain the increasing demand on the resource. Further, climate change may worsen the situation as recharge is dependent on rainfall in northern Ghana. Therefore, it is important to understand exactly how climate change will impact on recharge to the groundwater for sustainable development and management of the resource.

Previous groundwater studies in Northern Ghana barely analyzed the impact of Climate change on the recharge to the groundwater. This research is aimed at determining the current relationship between groundwater recharge and rainfall and to use the relationships to determine the impacts of changes in climate on the groundwater recharge. The results will inform plans and strategies for sustainably managing groundwater resources in Ghana and the Volta basin.

P-3330-45

From Artisans to Entrepreneurs: Understanding the role of small business for sustainable energy access

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The «Developing Energy Enterprises Project - East Africa» (DEEP EA), which ran from 2008 to 2013, was funded by the European Union (EU) and the Dutch Ministry of Foreign Affairs (DGIS). The Global Village Energy Partnership - International (GVEP-I) coordniated the partnership programme responsible for implementing the project. DEEP EA aimed to increase clean energy access among the rural and peri-urban poor in East Africa by assisting entrepreneurs to grow their businesses through enterprise training, mentorship and possible linkages to finance. The project was implemented in Kennya, Tanzania and Uganda, and included three principle technologies and services: improved cook stoves (ICS), briquettes and solar PV (solar lanterns, solar home systems, and PV-based mobile phone charging). During March 2013, Restio Energy conducted an independent terminal evaluation of DEEP EA. This presentation is aimed at capturing and articulating many of the lessons learned - with the purpose of strengthening majority market climate change mitigation enterprises in the future. DEEP EA provides a number of crucial lessons on the nature of support needed to stimulate private sector-led energy access initiatives in Africa. Ther project has discovered how to develop people from artisans to entrepreneurs; from someone merely involved in producing a piece of low-tech, low-carbon energy technology to someone who takes ownership of the entire business aspect. Throughout the project, there has been an effective non-technical shift in business performance, which (along with the technical abilities) has raised the performance of a significant number of these DEEP EA supported businesses. Overall, the project has developed a deeper and more textured undertanding of the challenges of entrepreneurship in East Africa. The small and micro-business model that emerges presents a blend between certain defining features of the formal economy and other features with a distinct «informal economy» nature. The outcome is a blend that is more in-tune with the socio-economic realities of not only the entrepreneurs themselves, but the market they service. This is where a great deal of support should be aimed if the private sector is to play its indispensable role in meeting the Sustainable Energy for All targets by 2030.

P-3330-46

Recent climatological trend of the Saharan Heat Low and its impact in West Africa

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The Saharan Heat Low (SHL) plays a crucial role in the West African Monsoon in spring and summer. The recent trend in SHL activity has been analysed using two sets of numerical weather prediction reanalysis. A local increase during the 90's has been found in the two sets of temperature. This increase is stronger within the heat low region than the surrounding areas. This change is accompanied by a modification of the large scale and slow increase of temperature, but we do not observe a change in the filtered signal under 25 days. Despite a large variability of the temporal trends between 15 climate models from the CMIP5 project, the trend is observed using the ensemble mean. Nevertheless, the spatial and temporal evolutions of the HL activities display a large difference between the reanalysis and climate models. The impacts and atmospheric variabilities have been compared in reanalysis and climate models and reveals different behaviours of the climate models to represent the west african monsoon interactions with HL pulsations.

P-3330-47

Changes in temperature and precipitation patterns in Benin Republic between 2000 and 2050

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Climate change is considered as a worldwide concern. The consequences include changes in temperature and precipitation patterns, with more and more extreme weather events, and shifting seasons. It will disproportionately affect the poor who depend mainly on agriculture for their livelihoods and have a lower capacity to adapt. Benin republic's economy is based essentially on agriculture and its population is projected to at least double (to 18 million) or possibly more than triple (to 25 million) by 2050. Food security is therefore a great challenge for policy makers.

This work focused on analyzing climate changes in temperature and precipitation trends between 2000 and 2050 in Benin. Four downscaled climate models (i.e CNRM-CM3, ECHAM5, CSIRO-MK3 and MIROC3.2 GCMs) and 2 climate scenarios (A1B and B1) were used to assess changes.

We found that all four GCMs show an increase in the normal annual maximum temperature for the whole country, ranging from slight (1°-1.5°C for MIROC 3.2) to substantial (2.5°-3.0°C). The climate models show different outcomes for precipitation levels for the country in 2050. CNRM-CM3 and ECHAM 5 showed increased precipitation, while the two other models (CSIRO Mark 3 and MIROC 3.2) showed areas of precipitation decrease, mainly in the south. These changes in climate may affect in varying ways crop production and food security.

P-3330-48

Observed multidecadal changes in air temperature from 1950 to 2010 in the Sahel

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The Sahel experienced in the last decades the strongest climatic signal ever recorded. Alongside the well documented changes in precipitation amount and frequency of extreme events, modifications of air temperature stronger than the global increase in mean annual temperature in the past 60 years is evidenced. However, little is known about the changes in the seasonal and diurnal cycles in temperature and the underlying processes. Furthermore, most studies addressing this subject rely on satellite products or gridded datasets and not directly on observational data, thus limiting their temporal depth and accuracy.

The objective of this study was to address this shortcoming by analyzing observational air temperature data obtained from the various synoptic and daily datasets available for the Sahel region (roughly defined here by the box 11-17°N ; 18°W-20°E) and its surroundings during the period 1950-2010. To do so, all available synoptic and daily temperature data were collected. Only stations retaining less than 20 % missing data were retained for analysis. This final database was constituted of over several tens of stations spread over the Sahel region. Analysis focused more specifically on (i) characterizong the seasonal and daily cycles of daily minimum and maximum temperatures, and (ii) comparing them with available gridded datasets for specific localities.

Preliminary results show that temperature characteristics have indeed evolved, with an increase of mean daily air temperature of over 1°C over all the Sahel. Increases are most important at the onset of the rainy season. The observed decrease in diurnal temperature ranges is mostly explained by strong increases in minimum air temperature. Finally, the evolution of temperature characteristics differed geographically, with stronger variations in the Northern part of the Sahel. It is now important to compare these observational data with meteorological reanalysis and with historical simulations of Global Climate Models. This is undertaken in a companion presentation by Guichard et al.. These modifications of daily temperature, diurnal temperature range and minimum and maximum air temperature can have serious consequences on agriculture, but also human health, even the more as increases have occurred in periods of the year during which temperatures are already critically high.

P-3330-49

Innovating low carbon waste management models in developing countries: a case of local community based artisanal entrepreneurship in Sub Saharan Africa countries

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The prospect of global economic growth in the next decades will depend on the performance of emerging and developing economies given their rapid population growth and accelerated urbanisation and industrialisation. Growth in emerging markets will not sustain without the inseparable concern for ecological sustainability of their economies and the global environmental challenges such as climate change. The global sustainability targets can only be achieved when actions are taken at both global and local levels. It entails decoupling the global economy of pollution, shaping autonomous and endogenous local development, organizing productive social inclusion while enabling decentralized governance of a multipolar global economy at the local level, driven by local solidarity initiatives and culture-specific entrepreneurship in developing nations. This paper aims to shed light on how local entrepreneurship innovations may contribute to sustainable and inclusive growth, enhanced human capital and global equity in sub-Sahara Africa from the perspective of a specific sector—namely waste, in which multidimensional challenges of poverty reduction, cultural diversity conservation, community solidarity and climate change governance are intertwined. One key element of sustainable development and climate governance in SSA is the waste. Today waste is a thorny issue in many SSA countries and has resulted in significant resources loss, income deficiency and poverty concentration, greenhouse gases emissions, and disastrous environmental impacts including public health degradation. The widespread practice of dumping waste into water bodies and scattered dumps prompted by fast-growing urbanization contribute to aggravate the problem. In effect, investments from FDI and aid programmes led by international institutions such as UNEP, World Bank, European Commission have indeed brought capitals and technologies necessary for the socioeconomic development programmes in SSA countries. It is not yet clear how these parachuted aids and investments are accommodated locally and how they impact traditional artisanals in waste treatment from the perspective of poverty reduction and local governance for climate change mitigation and adaptation. It would be inappropriate to transplant directly the top-down waste management model developed in industrialised countries to SSA without adaptation to local community-based solidarity culture and inclusion of bottom-up entrepreneurship innovations, particularly in the domain of utilisation of agricultural residues for generating renewable energy. This study attempts to answer a key climate policy question: how can low-income SSA countries develop a climate friendly waste-based circular economic growth model incorporating bottom-up entrepreneurship innovations? The model takes into account traditional artisanal know-how and communal solidarity as well as sustainability ethics within an intercultural environment, which is pertaining to Africa in the context of growing urbanization and socioeconomic transition. Our study focuses on several low income countries in SSA: namely Cameroon, Ivory Coast, Burkina Faso, Guinea, Senegal, Niger and Ghana. To render our research results replicable to a broader development perspective, we draw lessons from the experiences in the projects implemented by APREIS in Burkina Faso and Cameroon over the past years, and also from some Latin American countries such as Brazil and Argentina in particular where waste management is characterised by bottom-up civil organisation model with limited state intervention. Community economy experiences learnt from our fieldwork suggest that pro-development policy encouraging 'inclusive innovations in climate friendly waste management entrepreneurship' has to incorporate four building blocks: economic, social, environmental and cultural dimensions within a coherent climate governance framework in SSA countries.

P-3330-50

Multi-Agent System for simulating the change pattern of agricultural land-use under changing climate in the semi-arid region of Ghana

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One of the operationalised tools of human-environment system (HES) approach is Multi-Agent System (MAS) which has been used in a number of areas to study the dynamics and management of human and natural systems especially when facing unexpected disturbance. Therefore, increasing studies are interested in using MAS approach for the understanding of agricultural adaptation to environmental change. However, when it comes to the use of MAS for the operationalization of adaptation decision making in agricultural land-use based on the implications of climate variability, only very few studies empirically operationalise the concept in their simulations. In this research, Land Use Dynamic Simulator (SKY-LUDAS as referred to the communities where it was implemented: Sirigu-Sumbrungu-Kandiga-Yuwa) framework was applied by integrating the two step-decision making sub-models. Therefore, three scenarios have been designed and tested: baseline (Baseline), perception of climate change (PCC) and No perception of climate change (NO-PCC). Simulation results of SKY-LUDAS suggested that the

land-use behaviour in the study area reflects a tendency of subsistence farming. In terms of farm-households' livelihood strategy, especially the structure of the farm income, there was a growing contribution of rice and groundnuts. Accordingly, SKY-LUDAS has revealed a gradual shift among land-use types from traditional cereals farming to the cultivation of groundnuts and rice. As a result, this study has a merit of contributing to answer the critical question on whether certain adaptation decisions are stimulated by climate change. Therefore, farmers in the study area have adapted their land-use to climate change based on their income source and gradual change in the cultivated land-use in the purpose of being less dependent on the vulnerable farming systems.

P-3330-51

A Bayesian Trend analysis of annual maximum stream flows of the Oti River Basin (West Africa)

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Non-stationary analysis of hydrological extremes is crucial for characterizing hydrologic phenomena, planning and management of hydraulic and water resources systems. Moreover, Bayesian analysis appears to be a consistent framework for deriving complex statistical models and implementing uncertainties into induction problems. For this study which is conducted in the Oti River Basin, West Africa (75,859 km²), a set of discharge data from two gauging stations in Benin (upstream at Porga) and Ghana (downstream at Saboba) were obtained from the national hydrological services. These records were quality checked and preprocessed in order to derive long term annual maximum stream flows (AMSF) time series between 1952 and 2008. The Generalized Extreme Value (GEV) distribution was fitted to AMSF under stationary and non-stationary conditions. The non-stationary condition tested here is the variation of AMSF over time. To this end a time covariate was introduced in the location parameter of GEV distribution using a Bayesian approach. The results showed better non-stationary fitting for the upstream site (Porga) which exhibits significant decreasing trend in AMSF. The reservoir between the two gauging stations strongly controls the flows at the downstream gauging station which in turn affected the detection of no significant trend in AMSF while annual maximum rainfall are changing over the basin. The estimated return levels under non-stationary conditions showed a decreasing trend over time. This study provides good baseline information for climate change and flood frequency research within the basin. However, further investigations are required to understand the impact of the reservoir on the downstream discharge in general, but also on extremes and the occurrence of floods.

P-3330-52

Impact of deforestation on surface water and energy feedbacks in sudanian region of West Africa

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In West Africa, surface atmosphere exchanges have been found to impact both regional and local features of the Monsoon. At local scale the spatial patterns of evaporative fraction can drive the trajectories of mesoscale convective systems. Within Sudanian climate, ~80% of the precipitation returns to atmosphere through evapotranspiration. However, this amount and its seasonal dynamic may vary with the vegetation cover. Consequently, one might expect that any land use or climate changes could lead to the modification of the surface water and energy feedbacks, and, thus both the atmospheric and the regional water cycle. Finally, the sudanian region of West Africa is submitted to a 3% demographical increase per year, which induces a drastic expansion of crops areas. This study aims at quantifying the changes in evapotranspiration and sensible heat flux regimes caused by such a land use change under sudanian climate.

The AMMA-CATCH observatory documents evapotranspiration flux in West Africa since 2007. A pluri-annual energy budget term of a clear forest and a cropland area are analysed. It is shown that sudanian forest evapo-transpirated always more than crop areas because of agricultural practice, which cleaned to bare the crops areas with bush fires and water availability for trees. Thus, during the dry season, the cultivated areas remain bare. At the same time, more than 1mm per day of evapotranspiration rate is measured above the forest area despite the lack of precipitations. Deep rooting systems allow the clear forest to get access to water from deep soil layers for transpiration throughout the dry season. During the rainy season, low but significant differences in evaporative fraction are also observed. These differences will lead to a large deficit of the water vapour that returns to the atmosphere, and, thus, will change significantly the continental water cycle when forests will be replaced by crops. In the future, agroforestry that combines local crops (yam, manioc, millet, etc.) and sparse trees could mitigate surface feedbacks. Finally, the selected trees could provide extra agricultural products taking benefit from deep water availability, but also strengthen social equilibrium between men and women.

P-3330-53

Impact of Climate, Agriculture and Vegetation in the Sahel in the recent past : the CAVIARS Projet

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The semi-arid regions of the Earth are particularly vulnerable to wind erosion. The Sahelian region experienced contrasted climatic conditions during the last decades, with severe drought in the 70's and 80's and a relative re-greening in the recent years. Over the same period, changes in land use have occurred with an increase of the cultivated surfaces leading to a decrease of fallows and rangelands. As a result, a significant proportion of the land is bare or sparsely vegetated, and thus is not efficiently protected from the erosive action of wind. In this region, wind erosion tends to decrease the productive capacity of the soils whose fertility is already very low. In addition, the impact of wind erosion is expected to increase significantly in the near future (1) in relation with the expected changes in climate (in particular the modifications of precipitation and surface wind) and (2) in response to the increasing land use due to population increase and the related food needs.

The aims of the CAVIARS project (Climate, Agriculture and Vegetation: Impacts on Aeolian ERosion in the Sahel) are to develop an integrated modeling tool to describe the evolution of wind erosion in the Sahel in connection with climatic and land use changes, to validate this tool in the current period by making the best possible use of the numerous data sets acquired in recent years over West Africa, and to test its ability to reproduce specific events (such as the drought in the Sahel) of the recent past (about the last 50 years). This project is based on a modeling approach of this recent past (hindcasts) that is justified by the need to ensure the robustness of the simulations with different forcings prior to any simulation of future scenarios.

The proposed strategy is (1) to develop or optimize reliable modeling tools for quantifying the various terms (land use, changes in aridity...) responsible for changes in the intensity of wind erosion (2) to synthesize quality-checked observations, that can be used as direct or indirect indicators of wind erosion (precipitation time series, changes in vegetation cover, atmospheric dust load,...) (3) to implement a validation strategy based on the quantification of wind erosion both locally, measured on grazed and cultivated plots, and at the regional and continental scales.

P-3330-54

Using longterm rainfall and streamflow trends to inform local level agricultural water management in Benin

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Due to lack of irrigation and water storage facilities rice production is mostly practiced under rainfed conditions across most of Benin. Farmers use temporary water control structures to divert water from streams to rice fields in valley bottoms. This type of production system is dependent on rainfall and streamflow. It is vulnerable to natural variability of rainfall and streamflow. Analysis of rainfall and streamflow observed in the Ouémé River basin between 1951 and 2012 was carried out to understand rainfall and streamflow trends at local level to identify relevant climate indicators and data that best serve the needs of farmers for water management at local level as a way to improve water management and productivity under a changing climate. The Mann-Kendall test was used for the analysis. Significant rainfall trend was confirmed at 3 of the 19 rainfall stations in the basin. The 3 stations showed increasing rainfall at 95% confidence level. An increasing trend was evident at 13 stations but not significant at 95% confidence level while a decreasing trend was evident at 3 stations. Increasing streamflow trend (95% confidence) was confirmed at 3 of the 13 streamflow gauging stations in the basin. Further analysis of streamflow for the non-perennial rivers in the basin showed increasing number of days with zero flow at 2 of 8 streamflow gauging stations and decreasing number of days with zero flow at 1 station (95% confidence). Long term trend of monthly rainfall for June, July, August and September (the rice growing season) provided additional insight into variability at local level. This research highlights the relevance of considering indicators that may be relevant for local level water management in support of rainfed agricultural production in the Ouémé River basin in Benin.

P-3330-55

Assessment of climate change impact on water resources in the senegal river basin

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In this study we assess the impact of climate change on water resources by using uncorrected and bias corrected data of the regional climate model REMO simulations over the Senegal River Basin (SRB). Both simulations were used as input of the Max Planck Institute for Meteorology - Hydrological Model (MPI-HM) over the Upper Senegal Basin (USB).

Applying the bias correction simulations of present day climate (1971-2000) substantially improved for both temporal and spatial variations of the analyzed climate parameters (precipitation, temperature) when compared to observations and independent station data. Additionally, the bias corrected input give better representation of the mean river flow regimes and the 10th (low) and 90th (high) flows at the outlet of the USB.

For the future, the regional climate model projections for precipitation show a general decrease by the end of 21st century (2071-2100) for both scenarios (RCP4.5 and RCP8.5 Representative Concentration Pathways) and datasets in the majority of the basin, except the Guinean highlands where slight increase is found. In case of the potential changes of the maximum number of dry days and wet days, the northern basin is likely to face the most pronounced increase of dry days and decrease of wet days, although slight increase of heavy rainfall is found with similar spatial patterns in both data. Higher decadal variability of the maximum 5-day precipitation with the uncorrected in RCP8.5 is projected, while uncorrected and bias corrected data depict similar temporal variability for extremely wet days. Furthermore, a general temperature increase is projected over the entire basin for both scenarios, but more pronounced under the RCP8.5 scenario. Warm night's percent is found to be higher than warm day's percent. As for the potential changes of the basin's hydrology, a general decrease of river discharge, runoff, actual evapotranspiration, soil moisture is found under RCP4.5 and RCP8.5 in all simulations. The decrease is higher under RCP8.5 with uncorrected data in the northern basin. However, there are some localized increases in some parts of the basin (e.g Guinean Highlands). Furthermore, the available water resources are projected to substantially decrease by more than -50% in the majority of the basin for all data, except the Guinean highlands where no change is projected.

The impact of the bias correction on the projected climate change signal, affects mainly the magnitude of the signal rather than its direction of change although some alteration may occur in particular months and localities.

P-3330-56

The main projections of the West African monsoon : mean climate, seasonal cycle, extreme rainfall events

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The main responses of the climate change effect on the West African Monsoon is evaluated in terms of mean climate and intense rainfall events with CMIP5 models under the rcp8.5 emission scenario. We examine the projections and how they are related to the mean biases of the historical model simulations. The projections range from an increase to a decrease of rainfall amounts, exhibiting a large spread. These differences are due to radiative forcing ranging from 4 to 6°C in the Saharan desert and to feeding (export) of moisture at low-level (mid-level). A majority of models exhibits a decrease (increase) of rainfall over the western (central) Sahel along with more subsidence (air ascent) and a southward location of the AEJ (more moisture flux convergence). The extreme indices change exhibit a more extreme Sahelian climate, but the results remain strongly model-dependant. This study draw up a catalogue of the model projections in order to allow a selection of models for impact studies.

P-3330-57

The impacts of environmental variability and model uncertainty in disease prediction

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Modelling vector-borne diseases using dynamical models driven by climate and environmental variables is a complex task. The models require both accurate predictions of the seasonally varying values of environmental drivers and their correct variability across a range of time scales from days to decades. Whereas, the model's internal structures and the parameter settings for key processes have to develop the correct sensitivities to the external driving variables. The relationship between these two areas develops the inherent uncertainties in the model outcomes especially when driven with an ensemble of outputs from climate models.

Most of these detailed diagnosis runs and investigations are undertaken within the initial development phases of the models. Detailed diagnoses are perhaps even more challenging than the initial model development and construction. Once the model becomes established, in its use, the pace and quantity of model runs required in large collaborative projects make it difficult to find time and resource to allow detailed in depth diagnosis. Development of partially automated diagnosis methods and visualisation needs to be supported with the ever increasing loading of climate model runs that are being undertaken by disease modelling groups.

This paper will discuss two models the established Liverpool Malaria Model (LMM) and the recently developed Liverpool Rift Valley fever model (LRVF). Using the LMM we explore the relationship between seasonal average climate and malaria risk, which remains largely unquantified.

We also investigate key uncertainties in the malaria model, by introducing variability in parts of the model formulation. Results are visualized as location specific impact surfaces: easily integrated with ensemble seasonal climate forecasts. Using the LRVF, which is based on but much more complex than LMM, having two dynamic vector models and a dynamic age stratified host model. One main task in its development was parameterising the two different behaviours of the two vectors correctly in the model. In that, Culex spp. mosquitoes are the amplifying vector that, in the model, and only show significant spikes in population dynamics and EIR following flooding and a sizable Culex spp. population. The Culex spp. were infected from a substantial number of infectious hosts in the model simulation. These host infections came from Aedes spp. mosquitoes whose relationship with rainfall is more complex and gain infection through vertical transmission.

P-3330-58

How farmers permanently adapt to climate evolution by testing new options and caring for food security: case of long-cycle sanyo millet comeback in Serer area in Senegal

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During the last decade, Serer farmers of the Sine region in the central and western part of Senegal have started to grow again the sanyo millet (Pennisetum glaucum), a long-cycle (110-140 days) and photoperiodic traditional variety that had disappeared for 30 years from this region due to the rainfall decrease which has affected the Sahelian and Sudano-Sahelian zones starting from 1970, leaving only the short-cycle (90 days) souna millet in the fields. We made the assumption that the reintroduction of the sanyo millet could be an agronomic "marker" of the increase in rainfall observed in Senegal since the mid-1990s (Salack and al., 2011) attesting to the capacity of farmers to adapt to the evolution of their environment. We wanted to check, however, whether this necessary climatic opportunity was sufficient to explain farmers choices.

We investigated how important was the sanyo comeback in local farming systems, its geographical diffusion, and its biophysical, economic, social and cultural drivers. We carried out (a) simulations of souna and sanyo annual development during the 1950-2013 period using the SarraH©Cirad model; (b) several Focus Group Discussions with farmers; (c) a large survey by questionnaire on farming systems among 1,061 farms in the 30 villages of the IRD human and health observatory zone of Niakhar (monitored since 50 years); and (d) a rapid survey in 240 villages of the region located between Bambey and Diourbel in the North and Fatick in the South (about 1000 km2) on whether the sanyo millet was grown and its date of reintroduction. The SarraH©Cirad crop model was parametered according to previous works. Survey data were carefully analysed using relevant statistics to assess the factors underlying sanyo reintroduction.

Crop model simulations confirmed that sanyo reappearance is due to the recent rainfall improvement which now allows getting again grains with this variety whereas since 1970 grains production was only possible with souna. But simulations also show that sanyo yields remain very risky due to the rainfall interannual variability whereas souna yields are higher and surer. They also show that sanyo provides important biomass (stalks and straw). Farmers comments and surveys data analysis complement and confirm the results of the simulations. First, peasants report that they prefer the taste of sanyo and above all the quality of its stems rather than those of souna. In addition, adopting sanyo does not require any specific know-how or investment as it is grown like souna. Its qualities explain why it has quickly spread throughout the area. Sanyo was present in 61% of the sites surveyed in 2013 compared with 23% in 2000. But farmers stress that it is a risky cultivation and that they will not endanger their food security by substituting souna with sanyo. Souna and groundnuts still remain their main staple and cash crops, respectively. They also deplore that sanyo (similarly to souna) cannot provide cash, unlike groundnuts or watermelon that has also expanded in recent years. Statistical analyses highlight some social and family influences since farmers belonging to the "warrior caste" and those whose fathers formerly cultivated sanyo are more likely to cultivate it. But "land resources" appear to be the key factor. Yet, farmers explain they would plant fields dedicated to sanyo only if they were sure to produce enough souna. This is why sanyo is mainly cropped in association with souna, in an average proportion of 1 line of sanyo for 4-5 lines of souna. Moreover farmers point out that they would easily stop sanyo if they had other opportunities, particularly if they provide cash. Thus, despite its spectacular diffusion, sanyo cover very little surfaces: in the zone of Niakhar it was present in 2013 on 2.8% of the cropped areas and on 7.3% of millet areas.

Sanyo reappearance and its important and rapid diffusion is clearly an agronomic "marker" of the recent climate evolution (rainfall increase) observed in Senegal. It attests to the adaptive capacity of farmers to quickly and autonomously adapt to the evolution of their environment by permanently looking and trying new options, but underlines how cautious they are to not endanger their food security, and confirms that a climatic opportunity is not sufficient to account for farmers' choices. Comparisons can be made with recent watermelon emergence in the same area and developments of maize and rainfed rice areas in the southern areas of Senegal, which have been enabled by the rainfall evolution but benefit of solid economical drivers.

P-3330-59

Economic futures of African family farms in the face of climate change: addressing three big questions through integrated assessment with a Tanzanian case

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Family farms have sustained the livelihood and development of most Sub-Saharan African countries and will continue to do so for a foreseeable future. Much of the development literature has widely addressed the economic futures of African family farms in the perspective of regional and global economic trends and trajectories -with limited attempts of scoping these futures in the context of climate change. Where such attempts have been made, the assessments overly fall short of an integrated approach that utilizes recent advances of interfaced biophysical and economic modeling. Based on a sample of 168 family farms in the semi-arid and sub-humid farming systems of Wami-Ruvu Basin in Tanzania, the paper applies an integrated climate change assessment to address the following three big questions: How the African family farms will be impacted by climate change if they continue with business as usual? What will be the impacts with foreseen development pathways without adaptation? What will be the impacts with foreseen development pathways with adaptation?

P-3330-60

Trends in daily extreme precipitation and temperature indices over Ghana from 1980 to 2011

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In this study, the spatial and temporal patterns of the variabilities in the indices of precipitation extremes, on the basis of daily data and it association with climate change at twenty synoptic stations in Ghana over the period 1980-2011 were analyzed. Daily temperature (maximum and minimum) and precipitation data over the period of 1980 to 2011 were used. Data were quality controlled, and processed into indices of climate extremes, and the indices were calculated using RClimDex which is based on R software and is developed and maintained by the Climate Research Branch of Meteorological Service of Canada. From 1980 to 2011 hot days and nights have increased, leading to a decrease in cold days and nights. Except simple daily intensity (SDII) index station, other precipitation indices

do not illustrate statistically significant trends across the whole region. The precipitation indices show a general increasing trend in annual rainfall (PRCPTOT), heavy precipitation days (R10mm) and very heavy precipitation days (R20mm) with an increasing trend also in the simple daily intensity observed. However, the results of other precipitation indices indicate an unstable trend in the intensity of rainfall. In spite of the results of the precipitation indices it is noticed that more intense rainfall is observed over short periods although the temperature trends increase sharply and dramatically. Therewith, the climate of the region is becoming warmer.

P-3330-61

Revivifying a 13th Century Craft to Enhance Community-based Adaptation through Ecosystems and Farm-lands Resilience enhancement in Uganda

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Bark-cloth making is a 13th Century craftsmanship steeped in ancient culture and tradition where it played significant cultural, financial, social and conservation roles. Uganda's bark-cloth, a unique fabric proclaimed by UNESCO as 'a masterpiece of the world's intangible heritage' and indigenous textile production craft, is produced from Ficus natalensis. The F. natalensis trees are cultivated on the farm in an agro-forestry system intercropped with other crops. The bark of the tree is harvested, without harming the tree, to make an environmentally-friendly, renewable material. Where the trees have been cultivated it has been found that crops like coffee, bananas and others are able to withstand dry spells better than where it is not cultivated. Beyond this F. natalensis branches are harvested to provide a sustainable supply of firewood making households energy-secure and reducing on deforestation - cooking energy being one of the major causes of deforestation and environmental degradation; leaves of the trees provide fodder for domestic animals; and, the sale of bark-cloth provides a passive income that is always accessed by households even if the weather conditions are not favorable for seasonal crops. The presentation discusses the potential of bark-cloth making as a stimulus to long-term community-based adaptation.

P-3330-62

Climate change and surface water resource mobilization for agricultural purposes in the okpara basin (west africa)

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This research aims at evaluating the ongoing impacts of climate change on water resources availability in the Okpara basin. It seeks to identify water resources vulnerability in the basin in regard to the ongoing climate changes. These changes are characterized by variability in climate indicators.

To identify current climate change impacts, climate data of the normal (1941-1970) and (1971-2000) are assessed and compared. The rainfall averages have been used to determine differences (gaps) between the two above-mentioned normal. The data generated at different levels have been translated into relative values. As for temperatures, warming indicators are identified on the basis of calculation of the differences (° C) between the said normal (1941-1970 and 1971-2000). Besides, considering the evolution of climate parameters on the target period, 1971-2000, their future trend has been estimated.

Comparative analysis of the rainfall data between normal 1971-2000 and 1941-1970, shows overall that rainfall has decreased by 16 and 28 % in the Okpara basin. During this very period of time, temperatures have increased overall by +1° C in the basin.

This has led to a degradation of water resources in the basin, which has resulted in the Okpara River's flows downfall. In fact, analysis of the hydrological flow rate over the period 1965-2000 shows an overall downward trend of about 20-25 % during July, August, September and October, which consequently reduces water resources availability in the basin.

On the basis of projections and events considering the period 1971-2000, temperatures will be rising between 1.5 and 2° C in the basin by 2050. The fall in rainfall would be between 11 and 30 %. As for river flow, during the same period, the decline will increase up to 30% by 2025 and beyond 40 % by 2050. If this trend is not reversed, we will be experiencing a decrease of water availability in the basin.

In this increasingly climate dryness context, potential reduction of surface water resources disrupts the performance of ecological and socioeconomic systems. Facing this situation, efforts to mobilize surface water for agricultural purposes are the main measures for adapting to climate impact hazards in the basin. These efforts should be continued and backed up for a sustainable economic production.

P-3330-63

Challenges of climate change in Southeastern, Nigeria: Sustainable containment measures

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Climate change, a global phenomenon has recorded great significant in sub-Sahara Africa and Nigeria in particular. The total environment of land, water and air are under the severe threat of climate change challenges (CCC). The ecological hazards of gully erosion and landslide ravaging Southeastern, Nigeria though geogenic/anthropogenic in origin have been exacerbated by increasing impacts of climate change. The well established variation in the onset and cessation of rainfall attributed to climate change has significant implication on water availability, water quality, ecological hazards, vegetation cover, food security and public health. The torrential rainfall with attendant huge runoff results in flooding. The impacts of climate change induced flooding is significant in rural, semi urban and urban areas of southeastern, Nigeria. Loss of farmland and water supply sources with impact on food and water security respectively has been recorded. Standard of living and sustainable socioeconomic developments are hindered due to climate change challenges (CCC) in Southeastern, Nigeria. Outbreak of water borne diseases especially in the river rein areas is a recurrent trend affecting poverty alleviation and capacity building. Siltation of rivers, lakes and streams is commonplace exacerbating water scarcity and sustainable development. Heavy rainfall that initiates the development of new gully erosion and landslide sites and widening of existing ones is a consequence of climate change challenge (CCC) in the area. Over 750 active gully erosion and landslide sites have been recorded in Southeastern, Nigeria with depth ranging from 2 m to > 300 m and length from 25 m to 2.9 km. Removal of sediments from gully and landslide sites and deposition of same in surface water sources has resulted in the siltation of most rivers and lakes in the area. This is complimented by the excessive heat and temperature of above 400C during the dry season to cause total loss of some surface water bodies. The impact of desert encroachment also abounds with the rate of southwards advancement of desert increasing seasonally. The degradation of the rainforest vegetation to savanna grassland with remnant of rainforest vegetation only around water courses has generated serious concern to all stakeholders in recent time. The rainforest vegetation of southeastern, Nigeria has been severely degraded exposing the arable lands to the scourging effects of climate change. These climate change challenges (CCC) disproportionally affect women and children in the developing economies such as Southeastern, Nigeria. There is need for the creation of awareness on the adverse effects of climate change on the environment in terms of water scarcity, gully development, vegetation degradation and food security. Tree planting campaign of planting two trees at the removal of one should be promoted and given the wide publicity it deserves. Laws prohibiting illegal tree cutting and building along flood plains should be constituted with the political will to punish defaulters. Establishment of research centers for researches on climate change related issues is also recommended.

P-3330-64

Use of the CORDEX simulations to with ORCHIDEE crop to assess the impact of +2/4 K climate change on crop yields in Subsaharan Africa

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The population of Subsaharan Africa is projected to increase during the 21st century. This population increase needs to be matched with an increase in the amount of food available.

The IPCC AR5 used the CMIP5 models to assess future climate impacts on a regional and global scales. Alongside the development of AR5 recent publications have changed approach to a «not if, but when» approach to passing certain climate thresholds. The +2/4/6 K global temperature changes are examples of these thresholds. The Representative Concentration Pathways (RCPs) used in AR5 were simulated using different inputs and models and therefore reach temperature thresholds at different times. Here we present the projected change in crop yields in Subsaharan Africa for global average temperature changes of +2/4 K.

In tropical regions the ability of Global Climate Models (GCMs) to reproduce realistic weather patterns is known to be poor, this is largely due to the low resolution of climate models being unable to simulate the weather conditions accurately. To counteract the low resolution issues, the Coordinated Regional Climate Downscaling Experiment (CORDEX) used several Regional Climate Models (RCMs) to focus on specific geographical regions, including Africa, South East Asia and Europe. The higher resolution RCMs are better at simulating accurate weather and can be bias corrected to remove any large inconsistencies. Models which represent the range of the CORDEX simulations have been used to drive the ORCHIDEE-Crop model. The ORCHIDEE-Crop model is the crop specific version of the ORCHIDEE land surface model. The crop specific version has been tuned to produce accurate yields with various crops including maize, wheat and rice.

In this work we investigate how maize yields will change in Subsaharan Africa at +2/4 K using data from the CORDEX experiments. The changes in yields and the responses to different stresses will be used to assess how the future climate will affect the populations in Subsaharan Africa.

P-3330-65

Observed long-term land cover vs climate impacts on the West African hydrological cycle: lessons for the future ?

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West Africa has experienced a long lasting, severe drought as from 1970, which seems to be attenuating since 2000. It has induced major changes in living conditions and resources over the region. In the same period, marked changes of land use and land cover have been observed: land clearing for agriculture, driven by high demographic growth rates, and ecosystem evolutions driven by the rainfall deficit. Depending on the region, the combined effects of these climate and environmental changes have induced contrasted impacts on the hydrological cycle. In the Sahel, runoff and river discharges have increased despite the rainfall reduction ("less rain, more water", the so-called «Sahelian paradox »). Soil crusting and erosion have increased the runoff capacity of the watersheds so that it outperformed the rainfall deficit. Conversely, in the more humid Guinean and Sudanian regions to the South, the opposite (and expected) "less rain, less water" behavior is observed, but the signature of land cover changes can hardly be detected in the hydrological records.

These observations over the past 50 years suggest that the hydrological response to climate change can not be analyzed irrespective of other concurrent changes, and primarily ecosystem dynamics and land cover changes.

There is no consensus on future rainfall trend over West Africa in IPCC projections, although a higher occurrence of extreme events (rainstorms, dry spells) is expected. An increase in the need for arable land and water resources is expected as well, driven by economic development and demographic growth. Based on past long-term observations on the AMMA-CATCH observatory, we explore in this work various future combinations of climate vs environmental drivers, and we infer the expected resulting trends on water resources, along the west African eco-climatic gradient.

P-3330-66

Regional climate modelling of the West African Monsoon regime and its use for impacts and adaptation studies in Sahelian countries

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In the context of climate change, increasingly applications are asked to better adjust adaptation and mitigation policies at regional and local levels. Regional Climate Models (RCMs) appear as useful tools to downscale meteorological and climate information and make it more meaningful to fulfill end-user needs. In the framework of the International Research Initiative on Adaptation to Climate Change (IRIACC) - Faire face aux Changements Ensemble (FACE), a joint effort has been carried out to investigate different aspects and repercussions of climate change on health and agriculture over the Sahelian region in view of various RCM projections. The presentation will focus on the ability of RCMs to improve the climate information at different time and space scales, with respect to large-scale boundary conditions, in particular their performance regarding the intraseasonal variability of the monsoon regime. Precipitation onset, which significantly affects the agricultural activities, meteorological-scale rainy systems as well as daily precipitation indices (related to occurrence, intensity, and duration of daily events) are compared with the recent past observations showing a better agreement compared to global reanalyses and global climate models simulations. However, to be really helpful and oriented to specific applications, some aspects of RCMs, namely their physical parameterizations and/or simulated processes at the scale of meteorological systems, need improvements.

P-3330-67

Defining genotypic adaptation targets via crop-climate modelling

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Recent literature indicates that, in the absence of adaptation, on average, climate change would reduce agricultural yields globally by 2-10 % per degree of warming. Crop breeding will likely play a critical role in

agricultural system adaptation to climate change by enhancing productivity and improving crop quality traits. Here, we explore the role of crop-climate models in informing breeding, and identify research gaps. We focus in particular on simulation of genotypic adaptation options with crop models, and on assessing the robustness of crop-climate information, with particular focus on Sub-Saharan African maize. First we present an extensive review and meta-analysis of recently published literature with regards to genotypic adaptation. Second, we develop a numerical analysis of climate information using Sub-Saharan African maize as a case study. Our review of modelling literature suggests that yield gains of up to 50 % can be achieved by breeding improved varieties. However, we find that critical knowledge gaps remain if climate model information and/or model-based projections of genotypic adaptation are to be used in the development of breeding agendas. First, certain key processes and their interactions (e.g. ozone damage, CO2 stimulation, CO2 x temperature) are still poorly represented in models, largely due to a lack of understanding, thus stressing a need for further experimentation and model evaluation. Secondly, crop model parameters are often not adequately linked to the effect of alleles on given loci or genes controlling key traits. Finally, model scale mismatches and/or model misuse accompanied with poor sampling of the model and parameter space is likely to underestimate the importance of uncertainty. Assessments of robustness are therefore a critical modelling need to underpin decision-making.

For maize in Sub-Saharan Africa, we used bias-corrected CMIP5 data to demonstrate that climate model information is robust at a range of scales, from sub-national (i.e. ~200x200 km) to the mega-environment scale. With the former being the scale at which national breeding programs set their targets and the latter being the scale at which long-term international breeding goals are set, this means that climate model information can be useful to both processes. We find early and robust changes in crop duration in all mega-environments but weak changes in drought and heat stress. These results suggest that crop-climate models can provide information regarding lead times at which some (though not all) processes become important under climate change, as well as on the rates at which certain crop traits need to change. For some breeding programmes this might enable priority setting for breeding in a changing climate. However, if the full potential of model-based information for breeding is to be realised, we stress that more work is needed on the coupling between genetic and crop growth models, as this will ultimately result in modelled traits that are better grounded in genetic and physiological knowledge. Given the complex nature of the models needed for this endeavour, it is critical that (1) understanding of driving processes under future climates continues is improved (so that traits can be prioritised in target areas), and (2) individual model component testing against observational data is performed.

P-3330-68

Reconciling Past and Future Rainfall Trends over East Africa

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It is well known that rainfall during the East African Long Rains season has declined over recent decades, whereas the majority of climate models predict an increase due to anthropogenic carbon emissions. This raises questions about either the reliability of the model projections, or when we might expect this drought to turn to more abundant rainfall and perhaps more frequent flooding.

We first list all hypotheses that may conceivably explain this paradox, our aim being to include all possibilities regardless of preconceptions as to their likelihood:

- A: The recent observed trend is due to poor quality data.
- B: The projected trend arises from poor modelling of key processes.
- C: Trends are due to natural variability.• D: The balance between competing forcings is changing, with the past trend driven by aerosol emissions and the future trend driven by carbon emissions.
- E: The past trend has been driven by land-use changes.
- F: The mechanistic response to CO2 emissions is non-linear
- Some combination of the above.

Regarding A, there is good observational evidence for a recent downward trend in rainfall. Regarding B, careful and substantial further research is essential to confidently refute or accept this idea.

The possibility that the observed trend is due to natural variability (C) is assessed using two approaches. Both suggest that the recent Long Rains droughts are either due to a very unusual natural event of the climate system, or (more likely) are at least partly due to anthropogenic forcing. Hypothesis D, that the recent observed rainfall trend may be due to anthropogenic aerosol emissions, eg. from Asia, is investigated using CMIP5 sensitivity experiments. These reveal a sometimes significant, but highly model-dependent, impact on SST trends over the Indian and Pacific Oceans, which are thought to have caused the recent Long Rains droughts. Other CMIP5 experiments suggest that land-use changes are unlikely to have caused the recent droughts, and that the response to CO2 forcing over East Africa is not substantially non-linear (Hypotheses E and F).

Further work should therefore focus on improving the modelling of aerosol impacts on regional rainfall changes, on providing a well-considered 'expert judgement' of the reliability of the model's projections for the coming century, and better understanding the relevant natural variability.

P-3330-69

Crop-Climate ensemble scenarios to reduce uncertainty in agroclimatic risks estimation under 2°C regional warming

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The estimation of the response of rainfed crops to heat stress and water stress requires adequate accounting for the uncertainty in climatic and non-climatic factors that affect impact assessments. The objective of this research is to narrow the range of values characterizing the limits within which estimates are expected to fall in the diagnostics of agroclimatic risks. Assessments are made by analyzing historical observations and evaluating the influence of heat stress and rainfall variability on crop water demand, on biomass and on grain yields of short-cycle cultivars of pearl millet and maize. We use a wide range of consistent and practical sets of crop model ensemble analyses (based on crop management practices: seedling densities, fertilization levels, early/late sowing dates and soil types), and climate model ensembles from two climate change hypothesis (A1b & RCP8.5) over the West African Sudan-Sahel (WASS). Recent rainfall developments shows that hazardous sub-seasonal rainfall distribution affects crop productivity with increased frequency and intensity of daily rainfall, false start, early cessation of the rainy season and decreasing diurnal temperature range. In 2011-2050 perspectives, relative to the 1981-2010 baseline, a slight increase in temperature (i.e. +0.6 to +0.8 ° C) combined with a stationary-to-moderate decrease in precipitation leads to a 10-15% (8-15%) decrease in above-ground biomass production (grain yield). When the warming is moderate (i.e. +1.4 to 1.8°C), the decline in grain yield worsens (10-20%) despite a slight increase in rainfall projections. At these rates of loss in crop production, resilience can be re-enforced. However, it will require that climate-smart crop management practices are embedded in sub-seasonal and interannual monitoring and early warning systems.

P-3330-70

An observatory for farmers adaptation to climate change in Thies district

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In 2011, the Centre de Suivi Ecologique and Senegalese partners have developed an innovative participatory observatory. Through exchanges between researchers, policy makers, farmers organizations and NGOs in the Thies district, the observatory plays a crucial role by sharing useful information for vulnerable communities to adapt to climate variability and change. For example farmers selected millet varieties more resilient to increase yields and fodder reserves.

P-3330-71

Assessment of water availability and demand in lake Guiers, Senegal

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Water resources are critical to economic growth and social development. In most African countries, supply of drinking water to satisfy population needs is a key issue because of population growth and climate and land use change. During the last three decades, increasing population, changing patterns of water demand, and concentration of population and economic activities in urban areas has pressurize Senegal's freshwater resources. To overcome this deficit, Senegal turned, to the exploitation of the Lake Guiers. It is the sole water reservoir which can be used extensively as a stable freshwater source throughout the dry season, which lasts 9 -10 months a year. Its water is use for irrigating crops and sugar refinery and as a drinking water resource for urban centres, including Dakar, the capital city of Senegal, as well as for the local population and animal herds.

To ensure sustainability, a greater understanding of Lake Guiers's water resources and effective management of its use will be required. In this study we will investigate future water situation (water availability and water demand) in Lake Guiers under scenarios of population growth until 2050 for an efficient long-term planning of water management.

Scenarios of future water availability and water demand will be developed and quantified using the the water management model WEAP (Water Evaluation And Planning system).

P-3330-72

A systemic approach to evaluate shea parklands as possible climate smart agriculture to be intensified in Sudanese Africa : the multidisciplinary RAMSES Project

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We have set up a project on the « Roles of shea parklands in Reduction of vulnerability of AgrosysteMs and SociEties in Sub-Saharian Africa » (RAMSES) that has been submitted to several potential funders. This project ambitions to evaluate possible regeneration, extension and ecological intensification of shea production in Sudanese Africa, which is the only area supplying the international market with shea nuts (chocolate industriy) and butter (cosmestic industry). By this agroforestry practices, sub-Saharan societies seem to respond spontaneously to the MEA, diversifying their production while minimizing environmental degradation and deforestation impacts linked to extension of the cultivated areas. However, ecosystem services provided by shea trees are neither known nor quantified. Interactions between shea parklands and their associated socioeconomic systems is also currently in tension between the increasing demand at the international level and local degradations of shea stands with increasingly limited regeneration. This results in a worrying decrease in shea production capacity while enhancing competition between farmers, between genders (shea producers are women, trees and plots belong to men), or between private buyers on which the project propose a diagnosis. The project is based on multi-disciplinary investigations in two countries that are representative of the diversity of biophysical and socio-economic situations of the shea parklands, Benin and Burkina Faso. It ambitions to provide 1) a classification, with a geographic mapping support, of ecological combined to socio-economic conditions in which parklands are still viable from a past half- century diachronic and spatial analysis of their trajectory drivers; 2) under conditions where viability is proven, an assessment of increasing trees density impacts (i) on ecosystem services (ii) on the farms income, by using quantification of the processes underlying services provided by trees, and a bio-economic model to simulate different trees density.

P-3330-73

The ESCAPE project: an inter-disciplinary study on vulnerability, resilience and adaptation of rural societies to environmental changes in Africa

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Sub-Saharan Africa (SSA) is known to be particularly vulnerable to climate change due to a combination of naturally high levels of climate variability, high reliance on climate sensitive activities such as rain-fed agriculture and limited economic and institutional capacity to cope with and adapt to climate variability and change. Urgent actions are required to tackle the issues raised by climate change in SSA and these actions need to be supported by the best knowledge available. ESCAPE is a 5-year research project started in 2011 funded by the National Research Agency which aims to revitalize research in SSA in this field through an integrated interdisciplinary framework for increasing our understanding of the problem and support decision making for the future. ESCAPE addresses the vulnerability of rural societies in SSA to climate and environmental changes and explores adaptation pathways to reduce this vulnerability. The project fosters interdisciplinary research, through both retrospective and prospective studies, in Senegal, Niger, Benin and Mali, on the evolution of different agricultural, ecological and social systems interacting together under the global environmental changes.

P-3330-74

The easterly water vapour transport from Indian monsoon and its role in the variability of west african monsoon

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West Africa region is one of the poorest in the world and most of its economic activities depend on the rainy season. In Sahel region and in many other regions of the tropics rainfall is largely related to the intensity of convection. But since the 70s strong of observed variations in rainfall marked by a decrease in rainfall in this area. This work is focused on study of water vapour fluxes at high altitude from Indian monsoon and contributing to the supply of convective systems in Sahel.Squall lines are responsible for a large portion of the rain observed in this area. They are defined as a thick cloud system moving from east to west at a speed of about 14 m / s. Consist of a convective part at the sharp edge of a stratiform part, they have a life cycle left in four (4) phases: training, increased maturity and dissipation (Leary and Houze 1979). Several researchers have studied the advection of water vapour on Squall-lines (Peugeot et al 2011, Meynadier et al 2010, Cadet et Nnoli 1989, De Felice et al. 1982), which plays an essential role in their life. Cadet and Nnoli showed that easterly waves strongly contribute to water vapour transport to West Africa. De Felice et al. think that the amount of water vapour present in the medium and high layers of atmosphere in Sahel could come from the Indian monsoon and neighboring regions and transported by prevailing easterly flux during this period.

For this work we used ECMWF datasets, daily averages wind and humidity measured at 200hPa-1000hPa levels pressure and daily average OLR (Outgoing Longwave Radiation) NCEP / NCAR grid 2.5x2.5 the rainy season June-July-August-September during the period 2001-2010.The study focused on 20°W-90°E Longitude 0°-30°N Latitude area covering West Africa to India. The water

vapour column available in West Africa is the result of a contribution from the south-westerly monsoon (1000-850hPa) on one hand and easterly fluxes (850-300hPa) on other hand (R. Meynadier 2010 Dème A. 2002, De Felice et al 1982). To detect and study the fluxes supposed to come from the Indian monsoon we consider the top (500-300hPa) of the high layer knowing that the middle layer (850-500hPa) brings water vapour through the African Easterly Jet.

We have calculated the fluxes from qV (When q: Specific Humidity, V = u + v zonal and Meridian wind).

We performed Hövmoeller diagrams of fluxes computed on 500-300hPa layers and it appears very clear so water vapor advection in the upper layers of the altitude to Africa from joining the column available water.

These water vapour movements have an intra-seasonal and inter-annual variability during the 2001-2003 and 2006-2010 summers.Water vapour fluxes calculated on the 45oE-70oE area longitude and latitude 10oN-20oN are oriented towards Africa and reach a maximum of about 25 kg/m/s during the summers from 2001 to 2003 and a maximum of 36 kg/m/s observed in 2010 August.

To follow these fluxes up to the Sahel we considered the 40oE-50oE and 15oE-35oE areas further west, on 5oN-20oN latitude.It was noted an increasing of the quantities of westward water vapour advected in this part of the troposphere during the years studied.In June 2010 low values of olr (cloudiness) in Chad appear between 3 to 5 days after initiatiation in India of a westerly flow. The lowest values of olr observed in Chad in late August 2010 follow relatively large amounts (33; 36 kg/m/s) of water vapour flux from India.

P-3330-75

Impact of Climate Change on Freshwater availability for Senegal: Modeling Future Changes in Hydro-climatology of Lake of Guiers

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The future climate change could have a major impact on the hydrological systems. The hydroclimatology of the northern Senegal, especially over the basin of the lake Guiers' (north Senegal) for the present and the late 21st century has been analyzed; based on simulation from the Regional Climate Model (RCM) RegCM4. RegCM4 simulations have been performed with a horizontal resolution of 25 km (0.22 X 0.22°) for the 1985-2004 period and 2080-2099 period under both the RCP4.5 and RCP8.5 emission scenario over the West African domain. Initial and Lateral boundary conditions are taken from the ECHAM6 Earth System Model. Overall RegCM4 reproduces reasonably the spatial distribution of precipitations and temperatures as well as its month-to-month variations over both the northern Senegal and the basin of the Guiers' lake area. RegCM4 projects with both emission scenarios a rising of temperatures and a decrease of the rainfall in the late 21st century. Therefore the rising of temperature as well as the weakening of rainfall is more intense in the scenario RCP8.5. On the other hands, RegCM4 projects an evaporation decrease over the lake basin reaching up to 40% under the RCP8.5 emission scenario followed by an enhancement of runoff over the lake basin and the north of Senegal. This increase of runoff would resulted probably from the either the enhancement of the aridity by the end of 21stcentury or and from probably an increase of extreme events such as heavy rains.

P-3330-76

Effect of seasonal variability on the incidence and transmission patterns of malaria in urban, peri-urban and rural communities around Kumasi, Ghana

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Changes in temperature, rainfall and relative humidity are expected to influence malaria directly, by modifying the behaviour and geographical distribution of malaria vectors and by increasing or decreasing the length of the life cycle of the parasite. This study was aimed at investigating the impact of these changes on malaria incidence in the Kumasi metropolis and a rural district in the Ashanti region, Ghana. Data on climatic variables from December 2009- November 2011 were obtained from the Owabi, Emena and Airport weather stations. Data on malaria cases from December 2009- November 2011 were obtained from Nkawie hospital (near Owabi weather station), Aninwaa Medical Centre (near the KNUST Weather station) and Manhyia hospital (near Airport weather station) from December 2009- November 2011. Based on malaria morbidity data, three communities were selected and sprayed for mosquitoes using the pyrethrum spray catch method. Data analysis was conducted with Microsoft Excel and Statistical Software Package, SPSS version (16.0). Pearson's correlation analysis was done to establish the relationship between climatic variables and malaria transmission. In all the communities, Anopheles gambiae was the highest mosquito vector caught with few or no Anopheles funestus over 60% of which were fed with the dry season recording the highest percentage of fed mosquitoes. Over 90% of the fed mosquitoes had fed on human blood. Sporozoite rates for Nkawie were 6% between April and July 2011, 5.6% between August and November 2011 and 2.6% between December 2010 and March 2011. In Emena, the rates were 4.0%, 5.0% and 3.0% between April and July 2011, August and November 2011 and December 2010 and March 2011 respectively while Asawasi had 6.6%, 4.8% and 5% April and July 2011, August and November 2011 and December 2010 and March 2011 respectively. The annual Entomological inoculation rates (EIR) for Nkawie were 245.6, 203.6 and 52.4ib/p/yr April and July, August and November and December 2010 and March 2011. In Emena, August to November recorded the highest annual EIR of 182.5ib/p/yr, followed by April to July with a value of 175.2ib/p/yr and then December 2010 to March 2011with 94.9ib/p/yr. In Asawasi, April to July recorded the highest annual EIR of 245.4ib/p/yr followed by August to November and December 2010 and March 2011with 229.9ib/p/yr and 109.5ib/p/yr respectively. There were direct relationships between minimum temperature and human bite rate, maximum temperature and sporozoite rates, rainfall and number of mosquitoes caught during the study period and between malaria incidence and the entomological inoculation rate. There were also indirect relationship between maximum temperature and the number of mosquitoes caught. This research shows that malaria transmission is caused by a multiplicity of factors including climatic, environmental and socioeconomic factors. These factors play diverse roles on malaria vector biology as well as on the parasite.

P-3330-77

Multi-decadal variability of Sahel Rainfall and African Easterly Waves in CMIP5 Models: Mechanisms, Model Fidelity and Implications for Future Climate Change Projections

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This study uses models from phase 5 of the Coupled Model Intercomparison Project (CMIP5) to evaluate and investigate multidecadal variability of Sahel rainfall and teleconnections with global sea surface temperatures (SSTs). The simulation of African easterly waves (AEWs) in the CMIP5 models is also evaluated as part of this work.

Multidecadal variability of Sahel rainfall is lower than observed in all historical simulations evaluated. Focus is on teleconnections with North Atlantic SST [Atlantic multidecadal variability (AMV)] as it is more successfully simulated than the Indian Ocean teleconnection. To investigate why some models successfully simulated this teleconnection and others did not, despite having similarly

large AMV, two groups of models were selected. Models with large AMV were highlighted as good (or poor) by their ability to simulate relatively high (low) Sahel multidecadal variability and have significant (not significant) correlation between multidecadal Sahel rainfall and an AMV index. Poor models fail to capture the teleconnection between the AMV and Sahel rainfall because the spatial distribution of SST multidecadal variability across the North Atlantic is incorrect. A lack of SST signal in the tropical North Atlantic and Mediterranean reduces the interhemispheric SST gradient and, through circulation changes, the rainfall variability in the Sahel. This pattern was also evident in the control simulations, where SST and Sahel rainfall variability were significantly weaker than historical simulations. The reasons for these errors will be discussed.

African easterly waves are the major synoptic weather producer in the Sahelian region and the extent to which CMIP5 models represent them is important to know. Changes in AEW-activity may be expected to impact the frequency of extreme rainfall occurrence for example. Large biases exist in the simulations of low-level (850 hPa) eddy kinetic energy (EKE, a proxy for AEW activity) in AMIP and historical simulations. CMIP5 models simulate excessive EKE and deficient rainfall south of 17N. The same biases exist in historical and AMIP models and are not a consequence of errors in sea surface temperatures. The models also struggle to accurately couple AEWs and rainfall, with little improvement from CMIP3 models. Future projections of the annual cycle of AEW activity show a reduction in late spring and early summer and a large increase between July and October that is consistent with rainfall projections in the Sahel but large differences exist in future projections between high and low resolution models. The simulation of AEWs is challenging for CMIP5 models and must be further explored in order to provide appropriate confidence levels of rainfall projections in the Sahel.

P-3330-78

Recent trends in the regime of extreme rainfall in the Central Sahel

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Ongoing global warming raises the hypothesis of an intensification of the hydrologic cycle, extreme rainfall events becoming more frequent. However, the strong time-space variability of extreme rainfall makes it difficult to detect meaningful trends in the regime of their occurrence for recent years. Using an integrated regional approach, it is shown here that over the last ten years, the Sahelian rainfall regime is characterized by a lasting deficit of the number of rainy days, while at the same time the extreme rainfall occurrence is on the rise. As a consequence the proportion of annual rainfall associated with extreme rainfall has increased from 17% in the 1970-1990 years to 19% in the 1991-2000 years and to 21% in the 2001-2010 years. This tends to support the idea that a more extreme climate has been observed over 2001-2010: this climate is drier in the sense of a persisting deficit of rainfall occurrence compared to 1950-1969, while at the same time there is an increased probability of extreme daily rainfall.

P-3330-79

Climate Change and Agricultural Production: capitalisation of the farming techniques for the food security in Benin

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The capitalization of the farming techniques for food security in Benin has been studied. The effects of climate change have impacted the farming techniques of the populations in order to adapt to the new conditions imposed by climate. Throughout the country, the rainfall changeablenesses have modified not only the dates of seedling but also the abandonment of some speculations. In order to ensure their food security, the populations have proceeded to a revision of their farming techniques. The situation in Benin can be summarized as follows three zones (North, Centre and South). As a matter of fact, in the north 40% of the yielded speculations today can be considered as introduced twenty years ago. In this area in the years 60s there are crops such as yam, voandzou, maize, peanuts, and garden pea. The current crops are yam, maize, and sorghum. Crops such as peanuts, voandzou are more and more withdrawn from the speculation ranges. Furthermore, the situation in the centre of Benin is enough animated. In effect, about 65% yielded speculations in the past were abandoned at the profit of new estimated ones more adapted to the current climatic conditions. To ensure their food security, the populations of this zone have spared the speculations such as maize, yam, and peanut. Crops such as sorghum, millet, voandzou and garden peas are almost given up and replaced by soya which represents now the speculation that occupies 45% of the farmed surfaces. In the south of the country, about 30% only of the farming techniques have undergone changes. The climatic changeableness has provoked for instance the introduction of cotton crop which in the past was quasi impossible. But one must understand that in majority the south depends much more on the centre and north as regard food crops.

P-3330-80

Role of groundwater in buffering changes in climatic and anthropogenic conditions: experiences from Sub-Saharan Africa

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Currently, more than 300 million people in Africa do not have access to safe drinking water. Expanding irrigation to enhance food security is also a growing necessity. Moreover, most countries where population is expected to grow rapidly in the future are the same countries that have high levels of malnourishment and also limited access to drinking water. The proportion of the population that depends on groundwater for its daily water supply is estimated at about 75%. In the future, the ability to increase reliable access to water supplies will also depend on the development of groundwater, which is generally the only perennial water source in arid and semi-arid regions. One of the most important advantages of groundwater as compared to surface water is its much slower response to climate and anthropogenic changes. Indeed, the amount of water stored in the rock reservoir buffers the transient response of the system to conditions that vary over time. Thus, increasing appropriate groundwater supplies in Africa can significantly increase the resilience of communities to climate variability.

One of the most important difficulties in assessing groundwater resources is that groundwater is underground and hence hidden from our eyes. Reliable quantification of groundwater storage and recharge is not straightforward. Moreover, the projected impacts of climate change on groundwater recharge obtained from large-scale models are uncertain, and the scale of models is not appropriate to groundwater systems which are highly spatially heterogeneous over about 40% of Africa surface area where hard rock aquifers occur.

To illustrate the role groundwater can play in buffering changes, we present the results of a study carried out in Benin in a widespread environment of Sub-Saharan Africa (i.e. hard rock aquifers). Thanks to a novel approach, we determined the groundwater storage of our study area (27,200km²) to be 440mm+/-70mm. To assess the buffer capacity of aquifers, we compared groundwater storage to groundwater discharge. Groundwater discharge is the sum of natural discharge plus human abstraction. We evaluated human abstraction at less than 1% of total groundwater discharge. We conclude that increased abstraction due to population growth will probably have a small impact on storage. We calculated buffering capacity as the ratio of current storage to total discharge, and obtained a result of 6years+/-47months. This buffer capacity confirms groundwater's ability to buffer changes. Finally, our study is intended to promote a more quantitative approach to assessing groundwater resources and to support our ability to adapt to future changes.

P-3330-81

Heat effects of ambient apparent temperature on total non-accidental mortality in Cape Town, Durban and Johannesburg, South Africa: 2006-2010

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INTRODUCTION
Although many studies of temperature have been conducted in other disciplines such as climatology, they have only received greater attention in public health and epidemiology in the past decade. However, very few studies have been conducted in Africa and none which also controlled for possible confounding by air pollution. Epidemiological studies are crucial to understand possible local human health impacts due to climate change, and to the development of adaptation strategies to mitigate such impacts.

METHODS
The objective of this study was to investigate the influence of heat effects of ambient apparent temperature (Tapp) on total non-accidental mortality in Cape Town, Durban and Johannesburg, South Africa (2006-2010) using the time-series and case-crossover epidemiological study designs. The heat effect was investigated for apparent temperature above the city threshold, 15°C, 20°C and 13°C for Cape Town, Durban and Johannesburg, respectively. The three cities are classified in different Köppen-Geiger climatic zones: Cape Town has a Mediterranean climate (Csb). Durban has a humid subtropical climate (Cfa), that closely borders a tropical wet and dry climate (Aw). Johannesburg has a subtropical highland climate (Cwb).

RESULTS
In Cape Town, total non-accidental mortality significantly increased by 1.1% and 2.1% for all ages (60228 deaths) and >=60 year olds (28383 deaths), respectively per °C increase in Tapp above 15°C (lag0-1). No heat effect was observed for 0-4 year olds (4649 deaths). The maximum Tapp (lag0-1) observed was 27°C.

In Durban, total non-accidental mortality significantly increased by 1.0%, 1.4% and 1.9% for all ages (95269 deaths), >=60 year olds (28801 deaths) and 0-4 year olds (8628 deaths), respectively per °C increase in Tapp above 20°C (lag0-1). The maximum Tapp (lag0-1) observed was 31°C.

In Johannesburg, total non-accidental mortality significantly increased by 0.5% and 1.2% for all ages (94900 deaths) and >=60 year olds (31859 deaths), respectively per °C increase in Tapp above 13°C (lag0-1). No heat effect was observed for 0-4 year olds (10080 deaths). The maximum Tapp (lag0-1) observed was 24°C.

CONCLUSION
These results indicate that the health of the South African population living in Cape Town, Durban and Johannesburg is at risk with increases in Tapp. The study will be expanded to include four other South African cities located in different Köppen-Geiger climatic zones. Cause-specific mortality, such as respiratory and cardiovascular mortality, will also be investigated.

P-3330-82

Participatory approach for the integrated management of a wet ecosystem in a context of climate change: Inner Niger Delta (Mali)

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Long about 4100 km, the Niger River in its central part in Mali, extends an area which can reach 40.000km2 called the Inner Niger Delta. Largest wetland in West Africa, delta's hydrosystem is constituted by main branches, effluents and distributaries of the river, ponds rosaries, large lakes and channels. Right in the Sahel, the delta is an important productive ecosystem with a rich biodiversity. One million person derive their livelihood from this ecosystem through key activities such as fishing, livestock and agriculture mainly rice farming. With the climate crisis of the 70s, the Niger River Basin and its tributaries are subjected to high rainfall deficit causing a flood decrease in the delta. This resulted in a reduction of 50% of inundated areas. The climate crisis affects the socio-economic activities because the productivity is related to the hydrological regime and maximum areas inundated. There is also a demographic pressure leading to overexploitation and degradation of the delta ecosystem. This situation is not without creating tension in the management of resources, including use conflicts such as agricultural encroachment on pastoral areas; the non respect of transhumance calendar, use of prohibited fishing gear. The delta resources dwindle and production systems degrade and populations have to adapt.

Thus in this study we have developed with local stakeholders, sustainable management strategies of delta resources to deal with the marked variability of climate and demographic pressure. Strategies are a combination of technical options and economic instruments. Technical options include options locally developed complemented by a literature review covering WOCAT (World Overview of Conservation Approaches and Technologies) technicals. Economic instruments have been selected with tools like the DST and DESS developed in the frame of AFROMAISON project. The approach adopted is participative, mainly based on focus groups and workshops with stakeholders. Strategies contribute to the following goals: securing water in the delta, the assurance of integrated resource management; and strengthening the capacity of actors to the mastery of biodiversity conservation techniques and sustainable use of the resources.

P-3330-83

Interaction between moist Kelvin waves and synoptic variability of precipitation over Congo basin

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The synoptic structure and variability of moist synoptic Kelvin waves over the Congo basin during March to June(1979-2010) are explored using satellite-observed brightness temperature (Tb), outgoing longwave radiation (OLR) and National Centers for Environmental Prediction-National Center for Atmospheric Research (NCEP-NCAR) reanalysisdata.We found that synoptic Kelvin waves (SKWs) activity is most predominant during March-May and it is centered at the equator where the convective active phase of these waves favors formation of convective synoptic systems. A brief analysis of an intense Kelvin wave in March-May 1999 (active year) shows a clear impact of the wave on convective development and daily rainfall over Congo basin. Convection is found to be less frequent immediately prior to the passage of the convectively active phase of the convectively coupled atmospheric equatorial Kelvin wave(CCKW), more frequent during the passage, and most frequent just after the passage. Otherwise, Results show marked interannual variability of Kelvin wave activity over Congo basin. The large synoptic variability of precipitation are observed from March-May which clearly denotes synoptic activity in this region. Interannual variability in thefluctuation strength of the wavelet power spectrum as well as in its distribution amount different periods. Strong signalis clearly found at period between 4-6 day and 7-9 day. The location of peak SWKs convection are consistent with high rainfall location and clearly impacted crops yield over this region.

P-3330-84

Extreme condition and climate change in northern Africa during the last century

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Four homogenous climatic zones are detected in northern Africa (20°W-40°E, 0-30°N) by applying the Cluster Analysis (CA) method on the rainfall anomalies data from the Climatic Research Unit (CRU).The four climatic zoneswere distributed into Saharan, Sahelian, wet tropical and equatorial climate types. The application of a segment of 15 years with overlap going from 1901-1940 (P0) , and 1961 to2000 (P4) throughout the periods 1916-1955 (P1), 1931-1970 (P2) and 1946-1985 (P3),shows important spatio-temporal modifications of rainfall zones south of 15°N. The semi-aridlands (sahelian) which govern the dynamics of this zone doubled at the end of thetwentieth century, while the wet tropical and equatorial zones decreased at the half.

Temperature trends have a magnitude of up to 1.5 K per century in all the four climaticzones. This warming was mainly observed during the last three decades. During these samethree decades, regional precipitation trends were less significant.For the four climatic zones, the wavelet power spectrum for the time series of yearly average precipitation anomaliesshows the timescale of variability which is governed by 3 main periodicity bands: less than 5 years, from 5 to 30 years and above 30 years.

The extreme conditions in temperature and the precipitation were analysed in terms oftheir persistence. The sporadic long-lasting extreme conditions appear for several years toover 10 years during the last century.

3331 - Forest landscape management to create resilience in the face of climate change in West and Central Africa

ORAL PRESENTATIONS

K-3331-01

Forest landscape management to create resilience in the face of climate change in West and Central Africa

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Deforestation in West and Central Africa is driven by economic concerns, primarily associated with the expansion of agriculture. Recent suggestions that deforestation is increasing in Africa are drawing attention for the associated emissions. There has been a lot of discussion and many documents written about the importance of forests in these regions for carbon sequestration. The potential role of forests in adapting to the stresses associated with climate variability and change are less well considered. For example, none of the Congo Basin countries highlighted potential impacts of climate change on forests as a source of national vulnerability in their first national communications to the UNFCCC. Yet evidence is accumulating that climate change has begun to affect the growth and condition of the Congo Basin forests and this will affect communities that depend on these forests for goods and services. A large number of stakeholders believe that climate change and climate variability do not threaten the forest ecosystems in the humid parts of the region. Threats are more readily recognized in the sub-humid and semi-arid regions. Other stakeholders contend that climate change adaptation needs to pay attention to the role forests play in landscapes and there are different opinions about whether adaptation and mitigation need to be considered separately or together. However, when we talk about forests, mitigation and adaptation concerns often go hand in hand. This talk will look at the changing nature of climate and climate variability in the region and posit a number of climate associated risks for local livelihoods and economic development. We will then look at the goods and services provided by forests and examine the evidence that forests have an important role to play in resilience to climate variability and change. Finally we will look at how adaptation interests can be served by increasing tree plantations in rural African landscapes.

K-3331-02

The Great Green Wall for the Sahara and the Sahel within the context of Climate Change

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Common perception of desertification is the advancement of the desert through sand encroachment on fertile lands. Many images of the desert invading its surrounding lands are widespread in the general public. The idea of halting the desert by planting linear barriers of trees, shrubs and grass, is based on many historical or recent successful examples of shelter belts and greenbelts protecting towns, infrastructures, oases and other fertile lands from shifting sands. In this context, why successful techniques at very local level could not be applied at large scale to halt the desert expansion? Large scale linear barriers have been proposed to control the northern and southern rims of the Sahara. The Algerian Green Barrier is an example of this approach.

However, desertification is defined by the UNCCD as "land degradation in arid, semiarid and dry sub humid areas resulting from various factors, including climatic variations and human activities". Consequently, desertification is not an advance of existing deserts but rather the effect of localized degradation of the land. It follows deforestation, overgrazing or soil exhaustion due to the over exploitation of natural resources. Thus, desertification cannot be controlled by planting tree lines to stop desert progression. China launched in 1978 a large scale integrated management programme in an area of over 4 000 km long by almost 1 000 km wide named "The Three North Shelter Belt Project". In 1989, President Deng Xiaoping called this the "Green Great Wall" in reference to the ancient "Great Wall" of China, to highlight the scope of the work. But it is by no way a bulwark against the desert despite what this nickname suggests.

The Great Green Wall for the Sahara and the Sahel (GGW) launched by the African Union builds on these past experiences and aims at the implementation "of multisectoral initiatives and interventions to ensure natural resource conservation and protection with the aim of fighting poverty". This initiative has been much welcomed since the political mobilization of African countries around this concept is a clear sign of adoption and involvement. However, the scope of the programme is limited to a 15 km wide transcontinental belt running from Dakar to Djibouti. Within this belt some areas need actions while others have a stable environment where no action is needed. The continuity of the belt is not required. On the other side, areas outside the belt may need urgent action and the belt represents a small portion of the affected area of Sahelian countries. The effects of GGW will be limited to the areas under management. Thus, regarding the adaptation of the Sahelian countries to climate change and the mitigation of its effects, the Great Green Wall for the Sahara and the Sahel should be a driving example for the extension of the activities to all the degraded or endangered areas of the whole Sahel.

O-3331-01

Adaptive capacity and tree-based livelihood diversification strategies of smallholders in Central Burkina Faso

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Ecosystem-based adaptation strategies are increasingly gaining attention, among researchers and development practitioners, as a diversification option to address climate change. Informed decision on the adequacy of ecosystem-based strategies requires an understanding of the adaptive capacity they confer to households who seek to build resilience toward climate's adverse impacts. This paper analyzes how different trees and forest-based diversification strategies affect household's adaptive capacity in Central Burkina Faso. It uses an integrated approach to select indicators at a household scale, and calculates an aggregate adaptive capacity index (ACI) derived from a combination of both sub-aggregate and sub-composite indexes. Existing ecosystem-based strategies were first identified, and the analyses are done on a sample of 129 representative households who use four different forest and tree-based diversification strategies. Households were interviewed on their assets endowment as well as on the different livelihood outcomes achieved while implementing the strategy. The perceived sensitivity of the strategies to climate risks is also assessed. A cross-comparison of ACI of households under each strategy indicates that while households who engage in eucalyptus plantations benefit a low adaptive capacity index (3.23), those who engage in restored lands and fruit tree plantations have a high adaptive capacity index. The calculated ACI is 4.78 for households who implement restored lands strategy, 4.58 for those using mango plantations strategy, and 4.35 for households who engage in cashew plantations strategy. However, it is important to put on perspective the adaptive capacity index of households using fruit tree plantations, considering the overall situation of environment and biodiversity lost. Restored land shows a better diversity in terms of products harvested, which are available at different times during the year while fruit tree plantations produce a higher economic gain but their role as a safety net in a case of crisis is low and their sensitivity is higher. The integration adaptive capacity analysis to implement ecosystem based interventions could enhance the climate resilience of livelihoods by increasing the adaptive capacity of communities and individuals.

O-3331-02

The Great Green Wall : a potential driver of transformation and increased resilience in Sahalian landscapes

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The African Sahel is one of the most vulnerable regions on Earth. Although it is comprised of highly diverse landscapes, the increasing ecological and social vulnerability is clearly the common denominator of the entire zone, translating into an urgent call for action. The currently situation is characterized by a downward spiral: vulnerability has been caused by a combination of climatic and human factors resulting in land degradation, which in turn further accentuates human vulnerability. In order to create resilience for the growing populations of the Sahel, innovative, multi-scale strategies must be implemented. The adoption of the Great Green Wall for the Sahara and the Sahel Initiative (GGW) in 2007 is a step in the right direction. For the first time, the African continent stands united to confront the socio-ecological challenges of the Sahel and Sahara. Since its political adoption, the main objective of human and ecological well-being has remained unchanged. From its original configuration of eleven founding member countries across the Sahel, it has gradually begun merging with other ongoing, sustainable development initiatives throughout the African continent, thereby creating even greater potential force. Importantly, it has evolved from its original raison d'être as primarily a reforestation project into a series of multi-sectorial actions that takes into account the diversity of the mosaic landscape it crosses.

The success of the GGW will depend on its capacity to intelligently gather, generate, integrate, and use knowledge derived from a wide range of disciplines, taking into account the nature and complexity of socio-ecological systems. How can scientific research in the GGW context nudge the GGW into an appropriate trajectory for transformation of the Sahel? To respond to this demand, the GGW Human Environment Observatory was created by the French National Centre for Scientific Research (CNRS) in 2009 and groups together international researchers from a wide range of scientific disciplines, all working on a common social ecological system located in the Senegalese Sahel. Research is carried out in close collaboration with natural resource decision makers for the GGW in Senegal (The Senegalese National Green Wall Agency), and in conjunction with local populations. In this presentation, several examples of interdisciplinary research outputs including ecological restoration and monitoring, as well as health and social impacts of the GGW will be presented by observatory researchers. We will provide examples as to how science is already contributing to ecological and human well-being in the region and how scientific data are directly translating into action on the ground and aid in the land use management decisions with the aim of enhancing the resilience of local populations by attempting to provide the appropriate suites of ecosystem services in an equitable manner.

O-3331-03

Implementing REDD+ and adaptation to climate change in the Congo Basin: Review of projects, initiatives and opportunities for synergies

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In the face of the climate change, two main types of strategies have emerged. While mitigation aims to reduce the sources or to enhance the sinks of greenhouse gases, adaptation addresses the impacts of climate change on societies and ecosystems. Even if adaptation is gaining importance in the international arena, national policies and projects have difficulties to emerge in developing countries. Moreover, forests and forest communities are rarely taken into consideration in debates and policies on adaptation. In addition, Congo Basin countries have limited experiences on reduced emissions through avoided deforestation and degradation (REDD+). Although the forestry sector presents opportunities for synergy between adaptation and mitigation, very few life-size experiments can confirm it.

We explored the state of progress of projects and initiatives to promote adaptation and REDD+ in the Congo Basin region and analyzed opportunities for synergies or trade-off between the two strategies. Between 2008 and 2013, 94 national programs and activities related to REDD+ and 11 on adaptation have been identified in six countries of the Congo Basin. Most projects are at an early stage with more emphasize on REDD+ than on adaptation, due to uncertainties about spatiotemporal patterns of risk occurrence, lack of clear adaptation solutions, insufficient political support or lack of national structuring framework as REDD+ does.

Two main tendencies emerged from REDD+ initiatives: 1) local demonstration activities directly aim to reduce carbon emission from deforestation, forest degradation, and sustainable forest management and increase carbon stocks; 2) readiness activities aiming at creating enabling framework for countries to participate in REDD+ deals and develop strategies accordingly. Adaptation to climate change and REDD+ evolves as two parallel and similar processes. Potential for synergies among the two processes exists but are not fully recognized yet.

To be noted is the emergence of hybrid approach, where most of REDD+ and adaptation projects intend to combine the integrated conservation and development

project (ICDP) approach with payments for ecosystem services (PES). This bears the advantaged of repackaging the on-going efforts, reducing uncertainties and risks of maladaptation and offering some responses to the fragmentation of finance opportunities. In sum, the hybrid approaches present potentials for synergies between adaptation and mitigation.

However, transformational changes are needed to increase the synergy between adaptation and mitigation in the current climate portfolio. In particular, there is a need for tools, information and knowledge to support decision makers to harmonizing climate policies.

3331-POSTER PRESENTATIONS

P-3331-01

Could IFM REDD+ projects incentivize forest concessionaires to reduce greenhouse gases emissions in Central Africa? A lesson from the FORAFAMA project

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Improved Forest Management (IFM) is an activity eligible to the mechanism of Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+). In this context, IFM refers to activities that increase carbon stock on managed forest lands by changing forest management practices. As nearly 20 millions of hectares are now managed in the Congo Basin forests, it is a strategy of prime importance in climate policies of Central African states. However, the carbon benefit is generally based on a decrease of felling intensity that means severe income shortfalls for the logger. The extent to which carbon storage could compensate losses of timber income is a decisive factor in the feasibility of REDD+ projects. Given the few number of scientific studies on this subject, and the even fewer number of pilot projects that have been implemented, this issue is still highly in debate.

To assess the potentialities for emissions reductions of IFM REDD+ projects, and to evaluate their financial feasibility, we explored a broad range of scenarios for reducing logging intensity in a typical export-oriented forest concession in Central Africa. For each scenario and for several carbon accounting approaches, we calculated timber income shortfalls and carbon benefit to estimate internal rates of return and break-even prices of carbon credits. As part of the project of «Support for the sustainable management of forests in the Congo Basin and the Brazilian AmazonBasin» (FORAFAMA), a partnership with several forest concessionaires has allowed us to incorporate forest, industrial and economic factors. Parameters uncertainties are explicitly taken into account through a Monte-Carlo method.

We predicted that current voluntary markets conditions do not permit the implementation of IFM REDD+ projects in Central African concessions. Notable exceptions to this statement are Logged to Protected Forest (LTPF) projects, that correspond to an extreme case of a complete cessation of logging. In this case, the non-building of road networks results in substantial savings. The feasibility of other IFM REDD+ projects is particularly constrained by the current approach to addressing the risk of non-permanence. As an example, under Verified Carbon Standard (VCS), the maximum number of Voluntary Certified Units (VCU) available to projects including harvesting, cannot exceed the long-term average carbon benefit. In the Clean Development Mechanism (CDM), an other approach to deal with non-permanency had been proposed with temporary Certified Emission Reductions (tCER). A tCER expires at the end of the commitment period following its issue. Such an approach, that can allow to value the storage of carbon even on short time periods, is much more flexible and adapted to permanent timber production tropical forests. However, even under this accounting method, IFM REDD+ projects prove to be unattractive for Central African timber companies as their feasibility remains conditioned to a major reduction of logging intensity. Otherwise, projects are severely penalized by transaction costs and low carbon differentials.

Our work suggests that current methodologies of voluntary standards are not well appropriate to include IFM within REDD+. Instead of incentivizing to conciliate timber production and carbon sequestration, IFM REDD+ projects rather encourages forest concessionaires to value either carbon or timber exclusively, hence acceptability and additionality issues. To promote the deployment of a truly climate-smart forest management, the incentive system should focus more on practice changes than only on the result expressed in permanently avoided emissions.

P-3331-02

An Economic Impact Assessment of Community-Based Conservation Associations (CBCAs) in the Nzoia River Basin, Kenya: Taking stock of ecosystem services and welfare trends under Climate Change

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Community-based conservation associations seek to address the trade-offs in conservation and development objectives through participatory approaches to sustainable ecosystem management. Some empirical research has been carried out in the past two decades do evaluate the impact of community-based conservation associations. The findings on outcomes are mixed and still a subject of intense debate in the forest economics literature in developing countries. The issue of nonlinearity comes up with the outcomes of these assessments and management institutions hence further research and methods needed to understand these complex conservation problems in developing countries context, especially in Africa which has few impact studies globally. Past assessments of associations in conservation are faced with numerous limitations such as complexities in implementing communities-number of members, social capital, institutional context and programme attributes. Most of these assessments have several problems: methodological limitations, baseline data access, and selection of indicators of outcomes for evaluation, leakages and timescale measurements. Despite the growing literature in community forestry, there are still lack of empirical local studies that can substantiate and quantify the impact on forest ecosystem services and welfare of community-based conservation association members in the Nzoia Basin in Western Kenya. Our economic impact study seeks to address some of these limitations raised above through the integration of ecosystem services and household livelihood outcomes. Field interviews are undertaken with key stakeholders in two forest ecological conservancies out of ten in Kenya (North Rift Conservancy-Trans-Nzoia Zone and Western Conservancy-Kakamega Zone). Sample of three different community-based conservation associations in different communities are considered for the economic impact assessment based on advice from Kenyan Forest Services and Kenyan Wildlife Services. These associations are (1) Kipsaina Crane and Wetlands Conservation Group (Saiwa Swamp National Park-North Rift), (2) Community Forest Associations(Kiptogot CFA, Kimothon CFA, Malava CFA, Muileshi CFA) (3)Kakamega Forest Reserve Conservation Arm(Kakamega Community Wildlife Association) and (4) Non-Members of community-based conservation associations in sampled research area. The study anticipates to (1)Quantify and explain drivers of CBCAs participation that fully capture the significant theoretical expectation, (2) Quantify the impact of community-based conservation association membership and non-membership on forest ecosystem services supply and household welfare based on sets of selected criteria from the household survey, (3)Assess the three (3) CBCAs and evaluate which one is doing the best in the supply of ecosystem services in the Nzoia River Basin and

(4) recommended approach to ''avoid the tragedy of the commons'' in community forestry in the Nzoia Basin under current climate change conditions in Kenya.

P-3331-03

Risks and opportunities of Eucalyptus planting (Case study in the framework of the GIZ-German-Madagascan Environmental program)

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Growing biomass for rural (energy) purposes in highly productive planted forests can contribute to the preservation of natural forests, the mitigation of climate change and the rehabilitation of degraded land and biodiversity - provided that they are appropriately planned and managed. Since 1996 in North-Madagascar ~7.000ha of former degraded savannah have been afforested with Eucalyptus within the "German Madagascan environmental program" of the "Deutsche Gesellschaft für Internationale Zusammenarbeit" (GIZ) GmbH to supply the Diana Region with sustainable wood energy (charcoal). The GIZ-community-based afforestation approach aims to develop a sustainable charcoal value chain in Madagascar.

Despite the manifold opportunities, cultivating Eucalyptus has often been associated with environmental and ecological impacts that negatively affect environmental sustainability of afforestation projects. Little research in this context was done in Madagascar. Based on a case study the present study aims to analyse ecological risks and opportunities of planting Eucalyptus in projects to promote renewable energy resources in rural areas. Floristic diversity and soil properties of 21 different-aged and -managed Eucalyptus camaldulensis (EC) plantations and adjacent savannah sites around three different villages in the Diana Region were analysed and compared. Research on biodiversity was based on the parameters species richness (number of species, "spR"), plant frequency (plants/hectare), Shannon Diversity (H') and the species composition of predominating plants of woody and ground cover (GV) species. Soil samples of plantation and savannah sites were analysed for their pH value and carbon to nitrogen ratio. Special regard was given to spatial, temporal and management intervention effects. This was achieved by sampling EC-stands with different stand characteristics (e.g. stand age) and through the design of the chosen transect-sample unit.

Soil properties did not vary significantly between savannah and plantation sites although stand volume per hectare and partly stand age negatively affected both soil properties.

In all villages absolute recorded number of woody species was higher in the savannahs than in the plantations whereas GV-species richness was relatively even. Mean woody spR and H' were further elevated in the savannah-units while mean plant frequency was partly higher in the plantation-units. Differences were not significant. Species composition was similar between savannah and EC-stands. Stand density and/or -volume positively affected diversity while plant frequency decreased with higher stand density in some cases. No spatial and temporal effects could further be observed in the study region. This low response is likely due to human interventions and cattle grazing that reduced plant regeneration. Differences in terms of diversity conditions were, however, apparent between the investigated villages. Variations in the distance to remnants of natural forests and site conditions (e.g. soil) of plantations are likely to play a key role in this context.

Plantations established on degraded land in North-Madagascar indirectly preserve natural forests and its biodiversity, thereby help to mitigate climate change and increase the value of degraded land. Results indicate that impacts of EC-stands on biodiversity and soils are small and that the plantations are further able to provide habitat for many (including the predominating) species of the savannah. Nevertheless, a trend towards a reduced diversity in the plantation was observed. In order to reduce the risk of diversity loss further research should focus on the potential of mixed-species stands in the project region including native species with a high relevance for the local population. In this context, also the role of remnants of natural forests and seed dispersal methods should be assessed.

Recent developments have shown that programs that avoid deforestation by supplying local needs such as the presented approach of the GIZ will gain further importance in the future. Considering the expanding land area covered with eucalypts, the objective of enhancing biodiversity and other (ecosystem) services should therefore be incorporated in the land-use planning of programs to promote renewable energy resources in rural areas.

P-3331-04

Forest Ecosystem as Strategies to Face Climate change in Sub-Saharan Africa: Mangrove for Carbon Sequestration in Benin (West Africa)

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The increase of carbon dioxide (CO2) in atmosphere and global warming are becoming a global challenge especially in Africa where adaptation capacity is low. Natural ecosystems as the green forests are known to contribute in controlling of the greenhouse gas through carbon sequestration. Across the world, mangrove forest interested many studies which reveal the potential role of this ecosystem on climate change strategies. This study aims to strength how to use the mangrove ecosystem to face climate change through its capacity of carbon sequestration in Benin.

The study is based on existing literature, mangrove cover estimation from 1980 to 2040 in Benin, assessment of mangrove ecosystem capacity to sequester carbon in Benin based on critical, intermediate and optimist scenarios. On the over hand, climate data such as temperature over the period 1961 to 2014 are analysed to correlate its trend in Benin to the global warming.

In Benin projections show an increase in air temperatures in all regions of Benin around 2100, with the largest increase in temperature, compared to the reference period 1971-2000, of around 3.27°C. In the same time, total greenhouse gas increased from 4797.74 Gg CO2-e to 6251.03 Gg CO2-e representing a growth of 30.29 % over the period 1995-2000. With regard to the principle of the Clean Development Mechanism and to adapt efficiently to this climate change in Benin, mangrove ecosystem can be useful. So carbon sequestration by mangrove in Benin is approximately estimated average of 24 169 t/yr in 2010 and 3580 t/yr in the critical scenario, 17 004 t/yr in the intermediate scenario and 35 423 t/yr in the optimism scenario at the horizon 2040.

Promote mangrove ecosystem protection and development will help increase carbon sequestration in West Africa. So the great need is to enhance local community's capacity on climate change adaptation using mangrove forest to control CO2 emissions based on reforestation, reinforcement of traditional law used for natural resources protection, implementation of Clean Development Mechanism (CDM) projects in Sub-Saharan Africa.

ORAL PRESENTATIONS

K-3332-01

Projected Climate Change Impacts on Terrestrial Ecosystems of the Asian Highlands

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Rapidly accelerating climate change in the mountains of Asia, notably the Himalaya, Hindu Kush, Tien Shan, and the Tibetan Plateau, is projected to have major implications for montane species, ecosystems, and mountain farming and pastoral systems. A geospatial modeling approach based on a global environmental stratification and a simple in-situ water balance model has been used to explore potential impacts of projected climate change on the hydrology and spatial distribution of bioclimatic strata, across the Asian highlands. Projected climate change impacts on terrrestrial ecosystems, including agricultural and pastoral systems, were modeled based upon an ensemble of 19 Earth System Models (CIMP5) across four Representative Concentration Pathways (RCP). Large and substantial shifts in bioclimatic conditions can be expected throughout the region by the year 2050, across all bioclimatic zones and ecoregions. Potential impacts include upward shift in mean elevation of bioclimatic zones, decreases in area of the highest elevation biomes and ecoregions, large expansion of the lower tropical and sub-tropical zones and ecoregions, and the shifitng or disappearance of specific sets of bioclimatic conditions, threats to agricultural crop species, cropping systems, and genetic resources, the effectiveness of protected areas, and the rapid onset of potentially high levels of biotic perturbance by 2050, with a high likelihood of major consequences for biodiversity, ecosystems, ecosystem services, conservation efforts and sustainable development policies across the region. The importance of improved understanding of the direction and magnitude of climatic change for strategic pand, adaptation, and disaster response, is illustrated with case studies of landscape analsyses and participatory community based approaches from Nepal, Pakistan, and southwest China.

K-3332-02

Response to Climatic Hazard: Vulnerability Measurement of the Coastal People Matters

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In recent years, climatic hazards - extreme weather conditions and rising sea-level - have impacted seriously on economies and daily life in many coastal regions. The present study measures the vulnerability of frontline coastal regions in order to find path-ways for speedy recovery from the socio-economic devastation associated with climatic disasters, and to recommend potential protection measures for coastal people. The study focuses on two vulnerable regions of the Bay of Bengal delta. The outcome of this research will help understand the responses required after a climatic disaster. Governments, NGOs and international communities including Asian vulnerable regions need micro level studies, such as this, on which to develop effective sustainable development policies. The study uses survey data to investigate vulnerability following a recent climatic hazard (cyclone) that have affected Bay of Bengal delta in 2009. More specifically the aims are: 1. to investigate the impacts on socio-economic vulnerability due to climatic hazards in selected regions; 2. to find path-ways for speedy recovery from the socio-economic devastation; and, 3. to recommend protection measures for the coastal people frequently hit by global warming induced climatic hazards.

It is not only a lack of knowledge on the risks from climatic hazards in developing Asia, in other OECD nations policy makers suffer from this knowledge gap. Being a closest neighbour of Asia, it is needed to know how much, for example, Australia spends on climate response aid other than the immediate disaster aid to the victims? Does Australia take climate refugees? Immediate relief while is important, it is also needed to know how were the affected regions cope from a natural calamity? There is, therefore, a serious need for showing results from small-scale micro studies that can develop a theoretical, methodological and empirical foundation to inform climate change adaptation/recovery options for households, governments and communities in front line regions.

The present research has been focused on assessing local level socioeconomic vulnerability of communities living in vulnerable locations of Asia. Vulnerability to climate disasters is a complex concept which has major socioeconomic and political implications. Public policies, including adaptation strategies, disaster risk reduction (DRR), and migration policies have the potential to play a determining role in addressing vulnerability.This paper is based on two villages surveyed from two sides of the Sundarbans on the Bay of Bengal delta and estimates the vulnerability of the coastal people from a category 5 Cyclone called 'Aila' hit in 2009. The villages are located in Bangladesh and Indian (West Bengal) territories. A census of the entire households of the two villages has been carried out in 2011 and 2012. Vulnerability due to natural hazard has been investigated based on econometric models. The vulnerability estimates at local level is essential with a view to develop relevant adaptation policies for the Sundarbans region.

O-3332-01

Climatic Change and Indian Agriculture - A Case Study of West Bengal

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The recent IPCC report (IPCC 2007) and a few other global studies indicate a probability of 10 to 40% loss in crop production in India with increase in temperature by 2080 - 2100. A few Indian studies on this theme generally confirm an agricultural decline with climate change. Recent studies done at the Indian Agricultural Research Institute indicate the possibility of a loss of 4 to 5 million tons in wheat production in future with every 10C rise in temperature.

In this paper we have focused on the impacts of climatic change on agriculture faced by West Bengal. West Bengal is a state of India, which extends from Himalayas in the north and Bay of Bengal in the south. In 1981-82, West Bengal was amongst the lowest in the country with its per capita net agricultural product being 18 per cent lower than the national average. By 1994-95, it was above the national average by about 10 per cent.

Like all natural system, agriculture is linked to climate and there is some observed and projected climatic change in West Bengal also. During1969-2005, a net warming trend has been established in the annual average temperature.

This paper studies whether the relationship between the long term Agricultural Production of India and West Bengal is trend stationary or not. This has been done by using Unit Root technique. It also studies the relationship between temperature and agricultural production. The paper then derives the relation between the GDP and Indian Agriculture Production on one hand and the SDP and West Bengal Agriculture Production on the other hand. This has been compared by using the Co-integration equations.

An in-depth survey has been conducted in six districts of West Bengal and the production of staple crops, rice and potato have been considered. We have carried out mean tests to compare amongst the districts and also with a north Indian state. On the basis of the data long term projection has been made. Finally, the paper hints at considerable policy implications towards adaptation to climate change in the state.

O-3332-02

Mountains and the Anthropocene

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Mountains change due to volcanic activity or rising tectonic plates; human activity, too, has changed mountains since the beginning of days. The extent and pace of anthropogenic changes to the mountain's climate, cryosphere and biosphere are now so great that ecosystems and societies become unbounded, while the changes themselves become harder to predict and harder to live with.

In the mountains, geography promotes cultural diversity in languages, belief systems, architecture, settlement patterns, and livelihood practices. Mountains are the cradles of many civilizations. People have adapted in ways that demonstrate their intimate relationship with the environment and knowledge about not only plants, wildlife, vegetation, and ecosystems, but also the risks and natural hazards such as earthquake, landslides, droughts and flash floods.

The seeds of "good Anthropocene" – positive visions of futures that are socially and ecologically desirable, just, and sustainable – can be observed in many cultural communities in mountainous regions. We use both participatory approaches and local visualization to solicit, explore and develop a suite of alternative pathways for conservation and sustainable development in southwest China's mountain regions.

O-3332-03

Farmer's perceptions of and adaptations to changing climate in the Melamchi River Valley of Nepal

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Climate change is a global challenge that has a particularly strong effect on developing countries such as Nepal, where adaptive capacity is low and where agriculture, which is highly dependent on climatic factors, is the main source of total income and food consumption at household level. Among the biggest challenges to farming communities in future will be adaptation to climate change. As climate impacts are often locally specific, it is essential that large-scale initiatives to support farmers consider local priorities and integrate lessons from local adaptation efforts. But there is very limited knowledge and information available on how specific climate hazards impact livelihoods, and how farmer communities in the mountains of Nepal are responding to climate change. In addition most of the climate change projections using empirical models are unable to capture the local level specification of climate change. Therefore, knowledge of farmers' perceptions of climate change and of their adaptation measure is important to enhance policies addressing the threat of climate change to farmers.

This case study examined farmers' perceptions of and adaptations to changing climate in the Melamchi River Valley of Nepal. We surveyed 365 farmer households and held six focus group discussions using a Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) to understand local perceptions of and current adaptation practices to climate changes. Climate trends in the study area were analyzed for the period 1979-2009. Results show that while mean annual temperatures had risen by 0.18° and 0.9°C per decade during the 1980s and 1990s, respectively, the rise in temperature had accelerated to 1.56°C per decade after 2000. The frequency of drought had also increased measurably after 2003. With this change in climatic factors farmers observed increases in crop pests, hailstorms, landslides, floods, as well as thunderstorms and erratic precipitation as climate-related hazards affecting agriculture. Changing farming practices, selling livestock and livestock products, engaging in daily wage labor and seasonal migration were common practices in response to climate and other changes. Diversification of agriculture, improvement of current agroforestry practices, and investment in water-based income-generating opportunities were identified as means of adapting to climate changes.

O-3332-04

Coastal Adaptation to Climate Change in Bangladesh: Challenges and Opportunities for Integrated Legal and Policy Responses

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The coastal area of Bangladesh comprises the second largest delta of the world. This coastal area comprises distinctive development opportunities which can be instrumental in reducing poverty and contributing significantly to the development of Bangladesh. Over the past few decades, however, the region has come under threat from climate change, and the effects are now starting to be felt. Moreover, unplanned and disorganized coastal adaptation programmes and the absence of climate change considerations in the coastal planning are deteriorating the whole scenario. In response to the challenges posed by the effects of climate change, Bangladesh has adopted several plans and policies including the Bangladesh Climate Change Strategy and Action Plan 2009, the National Adaptation Programme of Action 2005 and the Country Framework to Mainstream Climate Risk Management and Adaptation 2006. However, no laws and policies have been developed to-date targeting specifically the development of coastal areas in the context of climate change. Moreover, the people living in coastal areas of Bangladesh are not adequately consulted and integrated both in policy making and implementation of disaster risk management plans and adaptation strategies. Bangladesh can enhance its coastal management by strategically integrating climate change adaptation, disaster risk management and development into its laws and policies.

In this context, this paper provides an assessment of impacts of climate change in the coastal zones of Bangladesh. It also examines the existing adaptation strategies and policies of the government. With a critical analysis of the provisions for adaptation strategies in international climate change regime, it outlines the necessity for new adaptation strategies and policies in the context of the daunting challenges posed by climate change to the prospects of development in Bangladesh. This paper emphasises the importance of an integrated approach combining both disaster risk management and climate change adaptation in policy making in order to ensure climate resilient and climate compatible development in the coastal areas of Bangladesh. It further advocates for developing community-based adaption arguing that the empowerment of coastal communities who are mostly at risk is essential so that they themselves can identify and prioritise their risks, plan for mitigation and treat their risk factors. Ultimately communities should have direct access to and control over the public resources allocated for them and establish their rights to reduce their risks, be it social, cultural or political, and policy development process.

3332-POSTER PRESENTATIONS

P-3332-01

Adaptation Measures in Dryland Eco-system: Management of Scarce Water Resources for Rehabilitation of Degraded Lands in Arid and Semi-arid Region of Southern Pakistan

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Drylands in southern Pakistan are home to communities living in poverty and depending on livestock rearing for their livelihood. The subsistence agriculture is losing its importance under the effects of climate change i.e. uncertain rainfall and very low productivity. Due to increasing population of livestock, the pressure on silvo-pastures is increasing resulting in degradation of natural resources and loss of soil fertility, a fact that adversely affects the livelihood of communities. The Farm Forestry Support Project (FFSP) of the Intercooperation (IC) and Swiss Agency for Development & Cooperation (SDC), initiated

rehabilitation work in 2003 in extreme dry region of Karak using the silvo-pastoral system with hillside ditches and sand dune stabilization techniques. The objective was to recover vegetation and increase productivity of the area with minimum cost and hence support livelihoods. The activity was carried out with participation of civil society organizations and farmers' associations.

The results recorded in 2008 showed a profuse plant growth in terms of trees, shrubs and grasses with a potential to provide timber, fuel wood and fodder for livestock. Maximum harvesting of rainwater and conservation of moisture also resulted in growth of natural grasses and shrubs. Within a short period of 5 years, plant growth in height and diameter of 6 meters and 20 centimeters respectively was recorded. The average vegetation cover of 45% and increase in soil organic mater and nitrogen content was also recorded. All this happened with a minimum cost of US$ 82 per hectare. The rejuvenation of wells in few cases was an additional positive affect of the activity. On the other hand, an annual income of US$ 735 per hectare from Saccharum spontaneum planted in sand dunes was a real benefit to farmers against the other land-uses in dry sand dunes.

P-3332-02

Mitigation & Adaptation experiences of farmers to drought in Semi-arid region of India

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Climate change is predicted to have severe consequences on agriculture and the rural poor in South Asia and Africa. Given that approximately three-fifths of the cultivated area in South Asia is rain-fed, the onset, duration, spatial extent, and total precipitation of the monsoon are critical factors in determining the livelihoods of large majority of people in rural areas. The arid regions of India cover an area of 317,090 km and is exclusively depend on rain-fed crops, even modest alteration in the intensity, frequency and timing of rainfall should cause consternation to large section of farming community. Karnataka state in south India ranks second, next only to Rajstahan in India, in terms of total geographical area prone to drought. Among its 30 districts, 18 are drought prone. During 2001-02 and 2002-03 the state faced consecutive droughts; this severally affected the farmer's livelihood. The present study has been visualized to assess the vulnerability and adaptations experiences of poor farmers to repeated droughts in semi-arid regions of Karnataka.

The drought affected regions of Karnataka recorded lower crop yields and consequent increased povertylevels in the region. The repeated droughts have lead to over exploitation of ground water besides increased in fire incidences in arid and semi-arid regions. The two districts of Karnataka (Raichur and Koppal) each belonging to severely affected categories and representing arid climatic condition. The drought affected regions of Karnataka recorded lower crop yields and consequent increased poverty levels in the region. The repeated droughts have lead to over exploitation of ground water besides increased in fire incidences in semi-arid regions. The annual income of the households reduced to half in drought years. The reduction was more in case of the crops followed by labour. In this regard Karnataka state established disaster management authority to undertake mitigation and adoption measures in the region.

The case studies in semi-arid region of Karnataka offer a valuable complement to the macro profile by revealing insights on the determinants of vulnerability at the individual or community levels. Numerous physical and socio-economic factors come into play in enhancing or constraining the current capacity of farmers to cope with adverse changes. Prominent among the physical factors are cropping patterns, crop diversification, and shifts to drought-/salt-resistant varieties. The most important socio-economic factors include ownership of assets (like land, cattle, pump-sets, and agricultural implements), access to services (like banking, health, and education), and infrastructural support (like irrigation, markets, and transport/communication networks). From the last few decades, a growing incidence of seasonal migration is occurring in northern part of Karnataka due to the lack of livelihoods and fodder availability.

The climate change adaptation (CCA) policy approach has also been fragmented, with climate change strategies and plans not strongly linked with existing agricultural policies in the region. The present study documented traditional knowledge of the farmers on climate change mitigation and adaptation, which will help to evolve a policy and shape future research on climate resilient agriculture in semi-arid region of South India. The National Mission for Sustainable Agriculture speaks of attaining "ecologically Sustainable Agricultural Growth through progressive Adaptation and Mitigation. While the noises are sound, the mission still emphasizes the role of bio-technology. The Policy concern is that Growth is linked to extracting a monetary value out of the system, whereas the principle of sustainable practices, means that the outputs, inputs into the system, which is the principle of ecological farming. Whereas bio-technology options tends to be patented means of extracting rents out of discovery. The complex and multidimensional nature of drought in India requires a long term, well organized and coordinated research plan and action involving all the stakeholders. The present study aims to highlight the ongoing efforts of farmers groups, government and Non-government organization in evolving ecosystem-based mitigation and adaptations strategies for the region.

P-3332-03

Measuring Vulnerability of a region in Indonesia

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For many rural households in Indonesia, yields from subsistence production are the main source of food to maintain their health and livelihoods. The livelihoods of households in dryland West Timor are expected to be affected by climate change due to their dependence on rainwater for their subsistence production. Due to the subsequent poor rainfall and low crop yield, some of the households have begun to adapt to broader modern employment and modified their income sources with males taking up external cash-employment; such as temporary labour in the construction or plantation fields at local cities or overseas. Is this pathway of income adaptation sustainable, compared to the subsistence-based corn farming and traditional forms of livelihood?

This paper investigates factors that contribute to the livelihood vulnerability of the subsistence households to drought. The five major factors include EDU (Education), SCP (Social-Cultural Participation), FS (Food Store), IA (Income through management of agricultural production) and ACC (Access). Primary data are collected through a household survey conducted in three villages of West Timor (total sample 627). Data gathered are then used to produce a vulnerability index, using the following equation:

LVI_v=WEDU EDUv + WSCP SCPv + WFS FSv + WIA IAv + WACC ACCv

WEDU+ WSCP+ WFS+WIA+WACC

LVIv= Livelihood Vulnerability Index for village v

WMi= weight of each major components (e.g. WEDU is the weight of Education)

Mci = average value of major component (e.g. EDUv is the average value of Education)

The Probit analysis is then performed to investigate the relationship between «perceptions of households about causes of drought" and "their readiness to better equip themselves for the future drought or other disasters".

Where Cause_1i is type of cause: 'It has been like this all the time' = 1; otherwise = 0

Cause_2i is type of cause: 'I don't know why' = 1; otherwise = 0

Cause_3i is type of cause: 'God's Plan' =1; otherwise = 0

Cause_4i is type of cause: 'Manmade' = 1; otherwise = 0

Statistical reliability and validity, and factor analysis are conducted using SPSS 22.

The results show that ACC (access to water, local market and health centre), SCP (social and cultural activities), and IA (income through management of agricultural production) are all significantly correlated with a household's vulnerability to drought. Households are less vulnerable when they have better access, agricultural incomes, and when they and their children are actively involved in local agricultural and ritual activities. A poorer access to market and schools may also contribute to increasing household's vulnerability as the youth have to leave the village and stay at urban area for employment or education purposes. Combining all five factors, the overall vulnerability index for individual village shows that the further the village is to urban area (Kupang or Soe) the more vulnerability it is. The furthest village has the highest score (0.503), while the closest village scores 0.234.

Furthermore, the results of Probit analysis show that the tendency to take precautionary measures to anticipate drought and other disasters is related to the perception about the cause of disasters. Households tend to have no planned alternatives such as saving money or preparing water storage in the house when they believe that Gold's plan or manmade are the cause of drought and other disasters.

The paper concludes that the temporary participation in broader modern employment may be an alternative for the households to cope with short-term impacts of drought and low crop yield. However, the social-cultural participation, which maintains local ritual and belief, provides long-term sustainable pathway for dryland ecosystem as it helps to regenerate local knowledge system and conserve the use of natural resources. Future adaption should aim to increase household awareness of the importance of proactive saving (water and money), and to improve infrastructures that help sustain both existing economic and social-cultural activities.

P-3332-04

Local practices of reducing vulnerability, and securing livelihoods in the age of climate change: Lesson learned from the analysis of community adaptation plans and practices in Nepal

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About 25% of the total populations in Nepal live under the poverty line (less than 1.25USD/day) and the country is ranked one of the 5th climate vulnerable countries around the world. Flash floods and landslides, loss of biodiversity, decline in agricultural productivity, increase of invasive species and depletion of fresh water resources are some major vulnerability resulted from the climate change and pushing the lives and livelihoods of over 1.9 million households at risk. Responding to these climates induced adversities, the local communities have started making their adaptation plans (more than 1500) in partnership with growing development institutions at local level. The paper is based on the studies of more than 1000 local adaptation plans, field observation and interaction with more than 500 communities in between 2011 to 2015. The paper analyses of the major vulnerabilities identified in different adaptation plans, local practices of responding these vulnerabilities, tradeoff between growing vulnerabilities, and securing livelihoods challenges through the analysis of the 1000 community adaptation plans in Nepal.

3333 - China's climate policies and low-carbon innovation

ORAL PRESENTATIONS

K-3333-01

China's emissions trading schemes

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China's government has established seven pilot emissions trading systems. Pilots differ in the extent of sectoral coverage, the size threshold for qualifying installations, and other design features that reflect diverse settings and priorities. We identify issues that have emerged in the design process and the operation of the pilot trading schemes, and outline important next steps for the development of a national emissions trading schemes.

K-3333-02

The Economic Benefits of Decarbonization for China

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China needs to reduce its carbon emissions if global climate change mitigation is to succeed. Conventional economic analysis views cutting emissions as a cost, creating a collective action problem. However, decarbonization can improve productivity and provide co-benefits that accord with multiple national policy objectives. Investment in greater energy productivity and economic restructuring away from heavy industries can bring productivity gains, and decarbonization of energy supply has important co-benefits for air pollution and energy security. To properly identify the true costs and benefits of climate change action requires new thinking in economic analysis. This presentation draws on recent academic papers as well as research contributions to the New Climate Economy report and the global Deep Decarbonization Pathways project.

K-3333-03

Challenges and opportunities for renewable energy development in China

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China's rapid renewable energy deployment is increasingly well known. The country has set out ambitious targets for wind and solar and is well on track to deliver them. However, this robust development should not be taken for granted over the next few years. As more renewable energy enters into China's power system, energy integration is emerging as the biggest headache faced by the industry. Already over the past few years, while China was busy adding new installations, its existing renewable power plants were curtailed severely. The root cause is China's electricity market design which favors strongly baseload capacity and gives little incentive to clean but fluctuating generation sources. The degree to which China could further reform its aging power market will therefore largely determine whether the country can continue to unleash its immense renewable energy potential.

O-3333-01

Lessons from climate change and energy policy in Western countries

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China is planning a national emissions trading scheme and to expand and reform other policy approaches to curb greenhouse gas emissions. Valuable lessons have been learned in Western countries about the design of emissions trading schemes, as well as other policy approaches such as feed-in tariffs for renewable energy and mechanisms to support energy efficiency. Some of the lessons are universal, allowing China to avoid costly mistakes made in

Europe and elsewhere. Others are specific to the context, and effective climate policy instruments for China may look quite different from what works in market economies. In this session we point out key lessons for China from Europe, the United States and Australia. We draw on our own research bridging Europe/Australia and China, and on a recent special issue of Energy Policy journal on emissions trading in China, edited by Loeschel and Jotzo.

O-3333-02

Low-carbon innovation in China: prospects, politics and practices

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This paper explores innovation in China and its potential to contribute to global transitions to low-carbon patterns of development. Building on earlier studies bringing alternative forms of low(er)-technology, 'below-the-radar', 'disruptive' and social aspects into innovation, and drawing on empirical research on electric mobility, solar-generated energy and food systems in China, the paper also pays particular attention to issues of changing power relations and social practices. Taken together, this shift in perspective allows neglected questions in low-carbon innovation to be introduced and points to both opportunities and challenges to low-carbon system transition that are overlooked by an orthodox focus on technological innovations alone.

O-3333-03

Intersections of China's Energy Technology Innovation, S&T Policies and Ongoing Reform

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China's energy technology innovation, with a strong focus on clean energy technologies, is central to a strategy that faces head-on the dual challenge of satisfying energy demands while safeguarding the environment as part of China's self-proclaimed "Energy Revolution". Combining with the global concern on addressing climate change, China's policies and actions in energy field have been focused on industrial transformation, energy system optimisation, energy efficiency promotion and the environmental protection. Recent energy technology innovation, S&T policies and reforms seek to capture opportunities for economic advantage from the transition to a cleaner, more sustainable and increasingly market-oriented system.

China has demonstrated some progress in its low-carbon and energy sector development. The remarkable progress could be tracked in the development of its Strategic Emerging Industries (SEIs), encouraged by the convergence of energy and S&T policies.

State R&D fund acts as one of the most important financing channels for energy technology innovation. China's funding for research and technology (R&D) as a proportion of GDP (R&D intensity) is increasing, but unprecedented co-ordination among government and institutional actors will be needed to sustain innovation over the long term. Existing gaps create opportunities for institutional reform to promote innovation. A new round of S&T reform is being proceeded in China in aims of offering greater information disclosure and transparency and promoting the efficiency of resource allocation.

The commercialization of technology is another key issue requiring efforts to enhance China's innovation competitiveness. Enforcing IP governance and encouraging the development of public-private partnerships (PPPs) to support innovative approaches to new market have been emphasized by the government.

Monitoring and evaluating innovation measures against energy sector and environmental benefits can help to improve policy implementation over time and lead to more effective innovation systems designed to meet the main public objectives. The effects of China's ongoing reform in the field of energy and S&T are worth a further observation.

O-3333-04

The transportation sector as a lever for reducing long-term Chinese mitigation costs

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** Rationale and Objective: Chinese economic development goes hand in hand with (i) a growth of the production that is accompanied with an increase of the freight transport, and (ii) an enriched population and fast-growing urbanization that induce increasing demand for passenger transport (notably an increase of the motorization rate). Given the high reliance of transport on oil products, its increasing energy demand and CO2 emissions, the transportation sector is a crucial sector for China, particularly regarding energy security and climate change issues. In its attempts to have a sustainable development, the transportation sector is indeed particularly challenging for China. To avoid important "lock-ins" in carbon-intensive pathways, especially given the high coal availability and the important life span of infrastructures, China has to redouble its efforts with voluntary schemes promoting mobility growth control.

This paper investigates the role of passenger and freight transportation activities in the transition to a low carbon Chinese society. A particular attention is given to specific measures designed to control the growth of mobility. It is an attempt to quantify the impact of urban voluntary policies on Chinese mitigation costs.

** Modeling approach and Methodology: This article revisits the role of the transportation sector in low-carbon pathways by using the Energy-Economy-Environment (E3) model IMACLIM-R. It is a hybrid multi-region, multi-sector CGE model, which embarks a detailed description of passenger and freight transportation. The standard representation of transport technologies is supplemented by an explicit representation of the "behavioral" determinants of mobility. The model relies on hybrid matrices ensuring consistency between money flows and physical quantities and allows an explicit representation of the interplay between transportation, energy and growth patterns. It accounts for the rebound effect of energy efficiency improvements on mobility, endogenous mode choices in relation with infrastructure availability, the impact of investments in infrastructure capacity on the amount of travel, and the constraints imposed on mobility needs by firms' and households' location.

Moreover, IMACLIM-R represents the second best nature of economic interactions and the inertias on technical systems that limit the flexibility of adjustments, a crucial dimension for emerging economies when envisaging large structural change over the course of the century.

Complementarily to carbon pricing to reach a stringent climate objective (3.4W/m2 in 2100), we consider actions to control the "behavioral" determinants of transportation in the course of the low-carbon transition, and assess their effects on the Chinese economy. More specifically, we consider (i) urban reorganization lowering the constrained mobility (i.e. mobility for commuting and shopping), (ii) reallocation of investments in favor of public modes at constant total amount for transportation infrastructure and (iii) adjustments of the logistics organization to decrease the transport intensity of production/distribution processes.

** Results: This analysis demonstrates the risk of high losses if using carbon price as the sole instrument of mitigation. Transport proves to be the sector for which carbon emissions are the more difficult to reduce. It thus represents a dominant share of remaining emissions in the long-term when ambitious mitigation objectives are set. Because of its weak reactivity to price increases, very high levels of carbon prices are needed in the second half of the century to reach low mitigation targets. We find indeed that they can reach 1400$/tCO2 by the end of the century.

But we find that controlling mobility growth allows limiting these effects by offering mitigation potentials independent of carbon prices. The considered measures allow significant reductions of carbon price levels (on average 25% lower over 2050-2100) and hence help limiting the macroeconomic costs of the mitigation policies (e.g. long-term mitigation costs are reduced by 5 points in 2050 and

by 10 points in 2100).

** Conclusion: This study highlights the role of transport in the mitigation process. Given a climate target, the implementation of measures fostering a modal shift towards low-carbon modes and a decoupling of mobility needs from economic activity prove to modify the sectoral distribution of mitigation efforts and to significantly reduce the mitigation macro-economic costs relatively to a "carbon price only" policy.

3335 - Climate Change Mitigation in Latin America

ORAL PRESENTATIONS

K-3335-01

Energy Technology Roll-Out for Climate Change Mitigation: A Multi-Model Study for Latin America

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In this paper we investigate energy technology deployment under climate change mitigation efforts in Latin America. Through several carbon tax and CO2 abatement scenarios we analyse what technologies in the energy sector, and particularly electricity generation, could best be used until 2050 to significantly reduce CO2 emissions in the region. By way of sensitivity test we perform a cross-model comparison analysis and inspect whether robust conclusions can be drawn across results from not only different models but also different types of models (that is, bottom-up versus top-down, and general equilibrium versus partial equilibrium models). Given the abundance of biomass resources in Latin America, they are likely to play a large role in energy supply in all the scenarios we inspect, especially in the climate policy scenarios since some use of biomass can be combined with CCS. We find that hydropower, which today already contributes about 800 TWh to overall power production in the region, could be significantly expanded to meet the climate policies we investigate, on average by 50% but perhaps by as much as 75%. According to all models, electricity generation increases exponentially with a two- to three-fold expansion between 2010 and 2050. We find that renewables such as wind and solar power typically expand at double-digit growth rates, but the robustness of our findings differs substantially between these two options: the climate policies represented in our models raise wind power in 2050 on average to half the production level that hydropower provides today, while they raise solar power to either a substantially higher or a much lower level than hydropower supplies at present, depending on which model is used. For CCS we also observe a large diversity in model outcomes, which reflects the uncertainties with regard to its future implementation potential given the challenges this CO2 abatement technology currently faces. The extent to which different mitigation options can be used in practice varies a lot between countries within Latin America, depending on factors such as resource potentials, economic performance, environmental impacts, and availability of technical expertise. We provide concise assessments of possible deployment opportunities for some low-carbon energy options, mostly for the region at large but with some country-level detail in specific cases. A similar climate scenario study of technology diffusion in Latin America has not yet been made, so we contribute a new piece of work to the existing literature. This study possesses particular relevance for the ongoing climate negotiations leading up to COP-21 in Paris, as was demonstrated by the attention we received by the presentation of this work during COP-20 in Lima in December 2014. Given the theme of this paper, our work, if accepted, could best be presented in session.

K-3335-02

Climate Change Mitigation in Latin America

T. Kober (1) ; B. Van Der Zwaan (2)
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In this keynote speech we present an overview of today's structure of the energy sector of Latin America and provide a long-term outlook of possible future developments associated to different levels of climate change mitigation ambition in the region. This conference contribution largely builds on the CLIMACAP-LAMP research project (see www.CLIMACAP.org) and highlights its main outcomes. Key findings of the project have already been presented at COP 20 in Lima, and a compilation of the major results scoping on selected regional and topic 'deep-dives' is forthcoming in a dedicated special issue in Energy Economics expected in spring 2015. Almost 20 research teams are involved in this project delivering new energy and climate policy analysis, which is derived from a broad application of model-based assessment tools.

Before highlighting climate change mitigation in Latin America, we discuss the baseline projections for the set of models participating in the CLIMACAP-LAMP project and identify key differences between model projections including how these projections compare to historic trends. We find that population and GDP projections across models span a broad range, comparable to the range represented by the set of Shared Socioeconomic Pathways. Kaya-factor decomposition indicates that the set of baseline scenarios mirrors trends experienced over the past decades. Emissions in Latin America are projected to rise as result of GDP and population growth and a minor shift in the energy mix towards fossil fuels. For the future most models assume a somewhat higher GDP growth than historically observed and continued decline of population growth. We observe minor changes in energy intensity or energy mix are projected over the next few decades.

The climate policy scenarios perform around three main clusters of policy measures: carbon taxes, greenhouse gas emission caps applied to Latin American countries and a globally harmonized scheme for cap and trade of emission certificates to attain different levels of temperature stabilization. Regarding the latter, we explicitly investigate pathways reach a stabilization of the mean temperature increase at 2°C compared to pre-industrial level. We find that an overall energy emissions reduction of roughly 50% across Latin America is consistent with meeting a 2°C goal at lowest cost. However, a range of other mitigation levels will also be consistent with meeting this goal. Our study confirms the results of previous research that the variation in mitigation costs across models may vary by as much as an order of magnitude. For Latin America as a whole, currently discussed country level policies lower 2030 emissions to a level that are not inconsistent with a 3°C long-term target, but may be inconsistent with a 2°C target. Besides greenhouse gas emission reduction potential related to energy conversion, avoidance of land use and land use change emissions will play an pivotal role, particularly for Colombia and Brazil. These emissions may be alternatively affected by efforts to store more carbon in land and those aimed at producing more bioenergy for low-carbon energy

One of the major economies in Latin America is Brazil for which our results show an increase over time in emissions in baseline scenarios due, largely, to higher penetration of natural gas and coal. Climate policy scenarios, however, indicate that such a pathway can be avoided. While carbon taxes up to 32 US$/tCO2e do not significantly reduce emissions, higher taxes (from 50 US$/tCO2e in 2020 to 162 US$/tCO2e in 2050) induce average emissions reductions around 60% when compared to baseline. Emission constraint scenarios yield even lower reductions in most models. Emission reductions are mostly based on lower energy consumption, increased penetration of renewable energy (especially biomass and wind) and of carbon capture and storage technologies for fossil and/or biomass fuels. The range of mitigation options resulting from the model runs generally fall within the limits found for specific energy sources in the country, although infrastructure investments and technology improvements are needed for the projected mitigation scenarios to achieve actual feasibility.

O-3335-01

The macroeconomic impact of climate mitigation action in Latin America: a model comparison

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In this paper we investigate economic impacts under climate change mitigation efforts in Latin America. Through several carbon tax scenarios we analyse the impact that climate change mitigation policy might have on income, trade and investment in the region. By way of sensitivity test we perform a cross-model comparison analysis and inspect whether robust conclusions can be drawn across results from not only different models but also different types of modelling approach (that is, a hybrid modelling approach that links an energy system model, TIAM-ECN, with a macro-simulation modelling, E3ME, compared to the mainstream general equilibrium modelling approach).

The paper presents the first detailed multi-model comparison of the macroeconomic consequences of carbon pricing action in Latin America. In the short term at carbon prices reaching around $15/tCO2 by 2030 the models agree that the reduction in consumer spending, as a proxy for welfare, is expected to be limited in all countries modelled and across the continent. However, by 2050 and at carbon prices of $165/tCO2, there is much more divergence in the estimated impact on GDP and consumer spending across models and across countries in Latin America reflecting the uncertainty about the cost of technology and substitution between technology options. The insight of the hybrid modelling approach comes through in the comparison of increasingly higher carbon prices in each model. The negative impact of reduced consumer spending and GDP are linear in the CGE models and increase as the carbon price increases; but divergent and non-linear in E3ME-TIAM-ECN reflecting step-changes in technology substitution in TIAM-ECN and the non-linear impact of each technology (its cost, cost composition and supply chain implications) on the economy as represented in E3ME.

A similar mulit-model scenario analysis of economic impacts of mitigation policy in Latin America has not yet been made, so we contribute a new piece of work to the existing literature. This study possesses particular relevance for the ongoing climate negotiations leading up to COP-21 in Paris, as was demonstrated by the attention we received by the presentation of this work during COP-20 in Lima in December 2014. Given the theme of this paper, our work, if accepted, could best be presented in session N° 3335 - Latin America pathways. This has been a multiauthored exercise, led by Philip Summerton, with contributions from Hector Pollitt (Cambridge Econometrics), Unnada Chewpreecha (Cambridge Econometrics), Xiaolin Ren (National Centre for Atmospheric Research), William Wills (Energy Planning Program, Federal University of Rio de Janeiro), Claudia Octaviano (MIT Joint Program on the Science and Policy of Global Change), James McFarland (US Environmental Protection Agency), Robert Beach (RTI International), Andres Camilo Alvare Espinosa (National Planning Department, Colombia), Silvia Calderon (National Planning Department, Colombia), Karen Fisher-Vanden (Penn State University), Katie Daenzer (Penn State University), and Ana Maria Loboguerro Rodriguez (CIAT-CCAFS).

O-3335-02

Scenario building and macroeconomic modeling in response to climate change challenges: an overview of the modeling results from MAPS Latin America

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The Mitigation Action Plans and Scenarios (MAPS) programme is a collaboration amongst developing countries to establish the evidence base for long-term transition to robust economies that are carbon efficient and climate resilient. The programme aims to contribute to ambitious climate change mitigation aligned with economic development. Central to MAPS is the way it combines research and stakeholder interest with policy and planning, through providing robust research to underpin national policy processes. This paper focuses on the scenario building and macro-modelling experiences in each of the four MAPS Latin America countries: Brazil, Chile, Colombia and Peru.

The paper starts with a description of the results on national feasible GHG abatement options and mitigation options that were identified in each case. We then evaluate cross-cutting assumptions, most recurrent/common actions in the four countries and mitigation scenarios packaging criteria. Later, we compare Required by Science and Required Equity scenarios to the mitigation scenarios to assess ambition and equity levels in the four countries.

Next, the paper explains the economy-wide impacts associated to these mitigation options and scenarios. This section includes a summary of the macroeconomic modelling approaches key features and cross-cutting assumptions of each country model (closure rules, exogenous drivers, world prices and sectoral rigidities). This is followed by an analysis of the related impacts of these assumptions on the socio-economic indicators such as GDP, welfare and employment.

Through out the paper, benchmarks and indicators are calculated to evaluate the results.

This analysis draws on four unique Latin American country experiences that could inform and support policy makers in other Latin American countries when examining policy interventions to transition a low carbon economy.

O-3335-03

Energy Supply Investments in Latin America under Climate Control Policy

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In this conference contribution we present our findings on energy supply investment requirements in Latin America until 2050 investigated through a multi-model approach as jointly applied in the CLIMACAP-LAMP research project. Key findings of the project have already been presented at COP 20 in Lima and are forthcoming in a dedicated special issue in Energy Economics expected in spring 2015. In our analysis we compare a business-as-usual scenario needed to satisfy anticipated future energy demand with a set of scenarios that significantly reduce CO2 emissions in the region. We find that more than a doubling of investments, in absolute terms, occurs in the business-as-usual scenario between 2010 and 2050, while investments may be multiplied by up to three over the same time horizon when climate policies are introduced. However, investment costs as share of GDP decline over time in the business-as-usual scenario, and even under the most ambitious climate policy scenario, due to the rapid economic growth in the region. For the electricity supply sub-sector business-as-usual cumulative investments of 1.4 trillion US$ are anticipated between 2010 and 2050, and become increasingly important when additional climate policies are introduced: under a carbon tax of 50 $/tCO2e in 2020 increasing with a rate of 4% per year, an additional 0.6 trillion US$ (+45%) investment is needed. Further, our analysis suggests that compared to the business-as-usual case an additional 21 billion US$ per year of electricity supply investments is required in Latin America until 2050 under a climate policy aiming at 2°C climate stabilization, which, when compared to the 100 billion US$2020 targeted to be mobilized globally under the Copenhagen accord by 2020, is substantial. In terms of specific low carbon electricity technologies, model results reveal that wind, solar, and CCS applied to fossil fuels and biomass will play an important role under climate policy scenarios, while nuclear power does not. Significant investment opportunities in renewable energy exist in the short- to medium-term, even in the absence of climate policy measures. If climate change mitigation is envisaged policy frameworks with ambitious long-term goals provide

stronger signals to investors than a policy mix with weak goals and fragmented instruments.

These findings have clear implications for policy makers. Moving forward, increased absolute investment in energy supply, even in the absence of climate control policies, is needed to underpin economic and energy demand growth in the region. Mobilizing necessary additional investment capital, in particular for low-carbon technologies, will be a challenge, and suitable frameworks and enabling environments for a scale-up in public and private investment will be critical to help reach required levels.

3335-POSTER PRESENTATIONS

P-3335-01

Quantifying the impact of non-conventional renewable energy sources in reducing greenhouse gas emissions: Chilean experience

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The countries are interested in quantifying the impact of mitigation actions that they have implemented in order to know how far or near they are from their voluntary and non-voluntary pledges. During COP19 in 2009, Chile proposed a voluntary commitment to reduce its GHG emission by 20% by 2020 with respect it 2007 baseline scenario. This commitment was confirmed in the Climate Summit in New York (2014) and during the COP21 in Lima, Peru (2014). In the case of Chile, the reason to select the year 2007 as a reference is because the country wants that the mitigation actions implemented before 2009 are recognized as a national mitigation effort. In Chile, one the main environment policies is the non-conventional renewable energy (NCRE) law implemented before 2009. The first non-conventional renewable energy law was launched in 2008 and it stated that 10% of the total sales would be provided by NCRE sources in 2024. This quota system was updated recently (2013) and the new law states that 20% of the total sales would be provided by NCRE sources in 2025. This paper aims to propose a methodological approach to quantify the impact of the non-conventional renewable energy law in reducing greenhouse gases emissions in Chile. The effectiveness of this policy is analyzed.

In order to quantify the impact of this mitigation action by 2020, this exercise requires projecting at least two scenarios: the baseline scenario, i.e. the GHG emission trajectory considering the implementation of the NCRE law, and the counterfactual scenario. This is an estimate of what would have occurred in the absence of the NCRE law. The methodology used an optimization model in order to project the planning in new power plants in the power sector. This model also projects the electricity generation by power plants and the GHG emissions. The steps of methodology are the following:

1) A gathering information process is done for those NCRE projects installed between 2007 and 2014. The first step of the proposed methodology is to estimate how many of these projects were installed due to the NCRE policy launched in 2008.

2) Construction of periodical baseline scenarios between 2007 and 2013: The model to project the baseline scenario is run activating and not activating the NCRE constraint. The resulted investment plants of these cases (with and without NCRE constraints) are compared in order to estimate the installed capacity in NCRE projects between 2007 and 2013. This projection is compared to the real projects installed in the same period.

3) In order to project the emission reduction by 2020, a Baseline 2014 scenario is projected. The Baseline 2014 is the scenario which considers the current situation and trends of the electricity generation sector: current investment cost projection, fuel price projection, projection of demand, etc. This model is run activating the NCRE constraint (20% of sales will be provided by NCRE sources by 2025).

4) Projection of the counterfactual scenario since 2014: This scenario has two main differences in comparison to Baseline 2014 scenario. The first, this model is run non-activating the NCRE energy law, and the second, is to suppose that only x% of the installed capacity in NCRE project would be installed in 2014. This percentage is calculated from step 2 of the methodology. The Chilean voluntary pledge refers to a Baseline 2007 scenario; however, we propose that a more realistic quantification of the emission reduction of the policy is done using the current trends of the sector.

5) A sensitivity analysis is done in order to capture the uncertainties.

The results of this methodology show that the emission reduction of this policy would be between 1.1 and 6.1 million tCO2 in 2020. This emission reduction is compared to other policies implemented in Chile. The results show that the NCRE law has been the most important policy to mitigate the climate change. However, it has not been enough due to the building of thermoelectric power plants has not stopped in Chile. In effect, between 2009 and 2013, 2263 MW of coal power plants were installed. In addition, there are 611 MW of coal plant under construction. Therefore, by 2016 will be 2874 MW additional in coal plant with respect 2006 installed capacity. It means that at least additional 28 million tCO2 will be launched to the atmosphere by the electricity generation sector.

P-3335-02

The territorialization of climate change in southern rural Chile: linking local knowledge to global environmental change

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This paper presents findings of a five-year research programme called the Sociology of Climate Change (SCC) carried out in southern Chile by an interdisciplinary team. By means of ethnographic work and extended case methods, the research aims to unravel the processes by which national and international public policies on climate change are territorialized in rural regions of southern Chile by farmers, rural dwellers, scientist, and other local agents. From a social sciences perspective, climate change can be seen as an elusive techno-political object needing complex methods to be represented. However, it has gradually become a transforming driver of rural practices and everyday life in rural territories worldwide.

Therefore, the main focus of the case studies is to present evidence about how local actors internalized the socio-technical object called climate change creating new practices and meaningful representations of an otherwise distant global phenomenon. Most institutional actions by government, universities, and international organizations are loaded with a highly normative approach placing mitigation and adaptation at the centre of their strategies. However, little attention has been paid to understand if and how climate change becomes a local category for farmers and rural dwellers; how are they framing the phenomenon and engaging in new sustainable and/or transformative options.

The results show that local actors are concerned with climate related problems but a process of understanding and translation to local epistemologies and ontologies is needed, a process that we have conceptualized as territorialization. To illustrate this point we present specific findings on the associations between climate change and peasant agriculture on Chiloé Island, in southern Chile. Drawing from Actor-Network and Social Practice Theories, we track interesting changes in the use of local peasant knowledge as it relates to weather and the organization of farming activities. Furthermore, we find evidence concerning the configuration of new territorial assemblages devised to explore the means of facing the negative consequences of this phenomenon, in terms of both production, and the fragmentation of local knowledge.

The conclusions highlight the importance of empowering networks where mentioned responses are produced and diversified, and in which local knowledge can be updated and applied to the organization of rural practices in order to face growing climate variability.

P-3335-03

Guatemalan Advances to climate change adaptation and Mitigation

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The goal of this essay is to present a comparative review of the advances of Guatemalan national and municipal initiatives to climate change adaptation and mitigation, which includes public policy, private sector strategies, and indigenous communities' practices to make resilient communities. The author of this essay analyzes the limitations and contributions to climate change adaptation derived from the national and local planning policies to address sustainable development with the complexity of poverty and climate change impacts. The author also describes private sector experiences in managing natural resources with environmental social responsibility. In addition, the author identifies the local indigenous community strategies and other local practices and principles to manage local natural resources and biodiversity with an effective climate change adaptation and mitigation and prevention of natural disasters. For instance, in Guatemalan indigenous highlands there are recently introduced a few forested communal parks which are managed by indigenous organizations; interestingly, they aim to increase local economic development, prevent landslides, conserve cultural and natural values, and contribute to reduction of climate change impacts; it is the case of "hearth Municipal Park" located in Atitlan lake's watershed.Because climate change has shown strong effects in Central American countries in impoverished communities in societies where democratic institutions are recently in building process, in this essay the author has given special attention to national policy and local community initiatives for sustainable development programs in order to know the main principles and aspects that should have been considered in the process of making resilient communities by dealing with the social, ecological, cultural, political and economic impacts of climate change effects in the indigenous communities most affected also by poverty. They are the impoverished urban and rural populations which have had increased social, economic an environmental vulnerability because of the climate change impacts. The climate change impact would be deepest since local governments and rural population have little or lack of understanding of the mid and long term climate change effects and strategies to adapt to it in local communities.

Therefore, it is very crucial to review the climate change factors and effects which are affecting communities not only because of atmospheric Nina and Nino phenomena, but also because of the environmental, social, political and economic impacts and constraints for climate change adaptation and poverty alleviation. Conversely, it is fundamental to correlate climate change effects with sustainability challenges such as poverty, population emigration to international labor sites in USA, and in combination with environmental degradation including deforestation, introduction of areas with planting illegal cultivation related other drugs' trafficking activities, rural land fragmentation, erosion; such factors are creating more complexity to democratic institutional capacities and economic development plans and strategies for sustainability and resilience. It is the case of the most attractive touristic spots in Guatemala where economic development derived from international tourism is jeopardized because the environmental degradation; it is the case of millennial Mayan historical places like Tikal, and international most attractive and visited spots such as Atitlan Lake and Flores Lake where level of water is increasing covering the parts of the surrounding towns. The impacts are more destructive in rural lands and towns because of land use location near risky places where there have been landslides and natural disasters from the Mitch Hurricane, Stan Storm. Other impacts are the reduction of environmental values, ecological functions, landscapes values, diminished environmental protected corridors, less touristic demand for potential touristic places losing attractiveness. Moreover, other social economic impacts are the losing the investment of private housing and state investments in municipal parks located in lands occupied by the increased water level of the lakes and rivers, the reduction of areas of agricultural lands affected by the increased water level of the lake and rivers; also, the reduction of productivity in agricultural lands affected by dryness in Niña and Niño phenomena, reduction of health conditions and nutrition of those communities.

P-3335-04

Evidence and Future Scenarios of a Low-Carbon Power System Transformation in Latin America: A Case Study in Nicaragua

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The global carbon emissions budget going forward depends critically on the choices made by fast-growing emerging economies. Yet there are few studies that develop country-specific energy system integration insights that can inform emerging economies in this decision-making process. High spatial- and temporal-resolution power system planning is central to evaluating decarbonization scenarios, but obtaining the required data and models for such analysis can be cost prohibitive, especially for researchers in low and lower-middle income economies. Recent research also highlights that although low-carbon economy transformations in emerging economies could prove challenging and expensive, cost-effective mitigation actions, such as fossil −fuel subsidy reform, decentralized modern energy access expansion and fuel switching in the power sector, are not only possible, but feasible.

Nicaragua is a country whose power system, like others in Central America and the Caribbean, has been historically dependent on imported fuel oil. Most recently, however, and despite Nicaragua being the third poorest country in the Western Hemisphere, the country is leading a low-carbon power system transformation in Latin America. In 2013 it produced 40% of its electricity from non-hydro renewable energy and in 2014, on an hourly basis, it produced up to 50% of its generation from wind power alone. Motivated by energy security, industrial development, financial risk mitigation, and the need for increased energy access to its most vulnerable populations, Nicaragua has transformed its energy sector in recent years. Between 2009 and 2014 it installed ~190MW of wind energy capacity (14% of total installed capacity), underwent an intensive geothermal technical capacity training in partnership with Iceland, and between 2006 and 2014 the country received over US$ 1.5bn of cumulative renewable energy investments. Yet, despite this great progress, Nicaragua's own ambitious goals (79% and 93% renewables-based generation including large hydropower by 2017 and 2026, respectively) seem daunting.

Here, we utilize both high-resolution open-access data and electric power system planning tools (SWITCH, an optimization model for planning power system investments and operations developed at the University of California, Berkeley) to demonstrate how low- and lower-middle income economies can develop optimal fuel-switching strategies and scenarios for a low-carbon grid. We choose Nicaragua for our analysis as it has very low electricity access (79%), oil accounts for over 80% of all energy imports (over 55% of Nicaragua's revenue from exports goes towards covering this expenditure), and its current expansion plan (2014-2030) relies primarily on large hydropower development, making the power system particularly vulnerable to hydro-climatological variability. We evaluate eight power system planning scenarios (base case, geothermal and solar development mandates, oil and large-hydro moratoriums, expensive and risky geothermal resource development, cheap fuel oil prices, and a Central American regional interconnection) that can help Nicaragua evaluate pathways for expansion of renewable and conventional generation technologies while achieving important development objectives (energy access, energy security, climate-risk mitigation and economic efficiency). Our results suggest that Nicaragua can cost-effectively achieve a low-carbon grid (≥80%, non-large hydro renewable energy generation) by 2030 while also pursuing multiple development objectives. A regional interconnection (balancing) enables the highest generation from wind and solar (18% and 3%, respectively by 2030), at the lowest cost (US$127/MWh), highlighting the importance of regional cooperation in enabling low-carbon futures. Neither oil price variability (cheap oil prices US$50/bbl increasing 2% per year) nor potentially risky geothermal and hydropower developments (which raise system costs) significantly hinder decarbonization. We conclude with a discussion on the challenges of power system decarbonization for emerging economies, and how they can use analyses similar to this one to develop and evaluate their own low-carbon transition pathways.

3336 - Post-2030 decarbonisation pathways in Europe

ORAL PRESENTATIONS

K-3336-01

Title not communicated

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Abstract not communicated

K-3336-02

Fifth Road Generation: Infrastructure integrated energy systems supporting the transition in the transport energy pool (Session number 3336 :Post-2030 decarbonisation pathways: the electricity and transport sector)

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The fight against global warming is a major challenge. In the transport sector, it means both the invention of a sustainable mobility for mitigating climate change, but also adapting infrastructure to the same climate change. Being the predominant mode of transport, the road is at the heart of these ecological transition issues, plus its own challenges such as road deaths or the upselling of the corresponding industrial sector.

In developing countries, according the International Energy Agency (IEA), the number and extent of roads will expand dramatically this century. Globally, at least 25 million kilometers of new roads are anticipated by 2050, i.e. a 60% increase in the total length of roads over that in 2010. These new road infrastructures will have to face many important and diverse challenges, such as a strong increase of the land-use conflicts between transport infrastructures and agriculture.

In western countries, even if a shift to other modes of transport is wished for, the road still represents more than 80% of individual trips and of freight transport and the situation is not likely to change. Indeed, the road network has been developed over thousands of years: emerging from the track to the paved road, then to the smooth road and on to the continuous road.

Despite all the progress made in this sector, the environmental cost of current road infrastructures is still too important. There is thus a need of strong innovation in this sector to solve the related issues. Unfortunately, the road sector is experiencing difficulties to innovate. This is partly due in France to a lack of support from public authorities, like the lack of competitiveness cluster, or of an ambitious innovation program. This fragility is even more worrying, since a number of breakthrough innovations are emerging internationally. Among the most promising technologies, one can cite the green materials, the nanomaterials and nanosensors, the electromobility, the energy harvesting, and the cooperative intelligent transportation systems.

The R5G program (R5G for French "Route de 5ème Génération") aims at changing the image of road infrastructures by designing, constructing and operating full scale demonstrators, which implement the innovative solutions, already tested in research centres. Aligned with the Forever Open Road program led by the Federation of European Highway Research Laboratories (FEHRL) since 2011, the program is elaborated in a systemic approach and is divided in three phases: labeling, appropriation and generalization. Among the seven technical challenges, the challenge of positive energy roads is currently debated in the framework of the French energy transition law and is likely to open new business models. The potential benefits of such a program are numerous: Maintaining the RAMS (Reliability, Availability, Maintainability and Safety) of existing road networks, reinforcing industrial leaderships and targeting societal objectives (education, employment, and environment).

O-3336-01

Investigation of carbon dioxide fluxes and possibility its storage in Georgia

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The major objective of investigation was study the natural CO2 sources, to investigate the properties ofrocks, which contain and absorb CO2 during its emission. Mentioned rocks are considered as anunderground Carbon dioxide reservoirs. For this case created numerical model to determine the potential of save sequestration in Carbon dioxide reservoirs and aquifers and to understand the geochemical and mechanicalprocesses associated with long-term storage of CO2 including methods to assess zones of weakness. Finally was calculated balance of carbon dioxide and how will decrees emission in atmosphere in future.

3337 - Facing floods and climate challenges: designing governance arrangements and unlocking financing on the pathway to resilient cities

ORAL PRESENTATIONS

K-3337-01

Governance for resilient cities: insights from the STAR-FLOOD project

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Between 2000 and 2010, Europe has suffered more than 175 major floods, causing deaths, large economic losses and displacement of people. In the decades to come, climate change is expected to increase the intensity and frequency of flood events. As urbanization in flood-prone areas still continues, the flood issue becomes one of the big challenges for cities in the future. Within this context, it appears that flood risk management is not only about controlling the rivers with protection systems anymore. Since the 1990s, most European countries are developing a multitude of strategies against floods.

Within the STAR-FLOOD project (www.starflood.eu), five Flood Risk Strategies are identified: risk prevention, flood defence, flood mitigation, flood preparation and flood recovery. The project investigates these strategies in six European countries (England, Belgium, France, The Netherlands, Poland and Sweden). Its overall objective is to assess the institutional embedding of these strategies at the national and local scales from a combined public administration and legal perspective. The project aims to contribute to the identification of suitable experiences of Flood Risk Governance in Europe at the scale of urban regions. National country profiles have already been produced and local cases are researched.

In our presentation, we will discuss stability and change in flood risk management in Europe, we will share our (French and Belgian) experiences with designing and implementing governance arrangements for flood risk management and we will highlight the main challenges and opportunities ahead.

K-3337-02

The Resilience Pathway 2.0; a new way of city and area development with promising climate impact

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There is an urgent need for climate adaptation to avoid huge socio-economic losses (growing from today's $6bn to $60bn p.a. by 2050 in the 136 largest coastal cities alone). However, non-availability of money and gaps in capabilities are huge barriers. A flow of private money, either besides or apart from public money, needs to be unlocked if adaptation is to happen quickly enough. Research (ABL / Ricardo AEA, 2013, Defra, 2013) shows that many cities (around 80% in Europe) have low or very low capacity and therefore cannot specify required resilience measures.

To unlock money flows and to raise capacity of stakeholders, ARCADIS and TPL have developed and successfully tested a new and unique high level business model, the 'Resilience Pathway 2.0', with European cities and have reached out to potential financial partners, with encouraging results.

Existing high level engineering skills and products and services have been brought together in partnership with leading deal-structuring experts and financial organisations to help riverine and coastal cities to access private and public money for climate adaptation.

Resilience is most needed for long-lasting decisions with outcomes that last 10+ years (e.g. water and other infrastructure), which need to be viable in unpredictable and fast changing future climate and energy scenarios, where the status quo is usually the least likely scenario. These decisions are difficult and / or expensive to reverse (in money and energy terms). This is where identifying 'moments of change' and defining 'investment opportunities' seem the way to go, while creating a 'marriage' between technical, financial and social engineering. The main phases of the Resilience Pathway 2.0 that will be explained with real cases during the speech are as follows;

Phase 1: Scoping. The output of this first phase is a clear briefing document clarifying the challenges to be addressed, also to identify potential opportunities ('moments of change') to address them.

Phase 2: Optioneering[1]. The purpose of the Optioneering phase is to identify one or several promising, fundable and feasible business cases around a development (or a combination of developments). These will provide alternative routes to meeting climate and other objectives of projects that will be attractive to private and other investors. This is a unique and crucial phase, where bringing high-level engineering and financial thinking together is essential in unlocking finance for resilience.

Phase 3: Deal Structuring. The purpose of the third phase, the Deal structuring phase, is to transform the selected intervention opportunity - as identified in the Optioneering phase - into a contract with detailed specifications and financial and legal arrangements (e.g. permitting') to deliver the project objectives: resilient projects with an acceptable (typically low) risk-return profile.

Phase 4: Project implementation
The aim of the project implementation phase is to get the projects or developments realised and well managed. This phase is a missing link in many strategies.

[1] 'Optioneering' is a term used by financial intermediaries to identify potential ways of approaching a major deal.

To be able to implement this Resilience Pathway2.0 mid or high level capacity is needed at the relevant stakeholders. The methodology both to assess and to improve the capabilities needed has been tested en proven.

And last but not least, the Resilience Pathway 2.0 generates high climate impact but also creates promising business opportunities to make it economically sustainable as well.

O-3337-01

Addressing flood risks at urban scale, the case of Geraardsbergen (Belgium)

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With its location next to the Dender river, the city of Geraardsbergen (32.950 inhabitants) is highly susceptible to flooding. The Dender is a typical spate river; whereas its water discharge is normally low, it can rapidly grow in volume during wet periods. Consequently, the surrounding land along the river traditionally functioned as a large floodplain. With the development of the Regional Spatial Plan in 1978, a significant amount of this floodplain was marked as building zone. As a result, a rapid urbanization of the Dender region took place in the following decades. The consequences of this development became clear in the 1990s. Damage was caused by flooding in 1995, 1999, 2003 and 2010. Whereas the damage of the previous floods was restricted to a small number of properties, the flood of 2010 had a wide-scale impact; 398 houses were flooded with a damage cost of about 5 million euro (Assuralia 2011).

After the 2010 flood, the City of Geraardsbergen has committed itself to a new approach, which aligns with the 3P's prescribed by the Flood Directive (2007/60/EC). A coordinator for integrated water management was appointed, who has the task to keep an overview on the actions carried out by the different departments of the City Administration and to be a medium between the several water managers involved in the basin. The City strictly applies the water assessment tool provided by the Flemish government in the deliverance of permits and has invested in measures to enhance preparedness, e.g. the mobile dams and SMS-warning service.

Improvements in flood risk management are however hampered by a number of factors contributing to inertia. Firstly, the existing legislation on spatial planning limits the political and financial feasibility to avoid further development in flood-prone areas. Recently, however, a new legal instrument was developed which should facilitate municipalities to swap land destinations. Geraardsbergen is currently investigating this possibility.

Secondly, the flood safety of the Dender basin is dependent on the infrastructure on the river. By rectifying the river and building up its floodplains, flood damage is only to be prevented by an efficient drainage of the water discharge. This is currently hampered by the outdated sluice infrastructure, which needs to be replaced. Due to complex decision-making procedures, however, the renovation is consistently delayed.

In our presentation, we want to share experiences on integrated flood risk management at urban scale. We will give an overview of recent developments in the flood management of Geraardsbergen, address remaining bottlenecks and present some possible solutions to be discussed with the audience. The evaluation is based on the results of the STAR-FLOOD project, which analysed flood risk management in Geraardsbergen in comparison to two other cities and the national policy-making level. The research was conducted through juridical and policy analysis of relevant legislation, policy documents and interviews with stakeholders. The results of the research were discussed by the interviewed stakeholders on a workshop held in January 2015.

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O-3337-02

Flood risk management and intercommunal cooperation: Lessons learnt from of the experiences of Nevers (Middle Loire, France) and Le Havre (Seine Estuary, France) Agglomerations

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The coming decades are likely to see a higher flood risk in Europe, both on coastal areas and along rivers in the inner lands. In this context, the EU PF7 project STAR-FLOOD "Strenghtening and redesigning European flood risk practices: towards appropriate and resilient flood risk governance arrangements" assumes that urban areas will be more resilient if the existing Flood Risk Strategies (risk prevention, flood defence, flood mitigation, flood preparation, flood recovery) are implemented simultaneously and aligned. From this assumption, the STAR-FLOOD project questions, in various case studies from six European countries (Belgium, England, France, The Netherlands, Poland, Sweden), the institutional embedding of those different strategies and flood risk governance at the local scale.

In France, responsibilities for those different Flood Risk Strategies are mainly divided between municipalities and the State administration. Municipalities have competences in the fields of flood defence, flood prevention and flood preparation. Such responsibilities are quite heavy and difficult to face for many of them. As a consequence, intercommunal cooperation is becoming more and more frequent in this field. In previous researches, we demonstrated that the setting up of intercommunal structures has progressively allowed local authorities to better deal with environmental issues, leading to the production of new action areas and a rethinking of environmental problems (Larrue, Fournier, 2014; Amalric et al., 2011).

Our contribution will illustrate this evolution and highlight the role of intercommunal structures to better address the flood issue and facilitate alignment of the different Flood Risk Strategies locally. Our presentation is based the example of two French agglomerations: Nevers and Le Havre Agglomerations, which are both of them case studies in the STAR-FLOOD project. Both of them are already strongly involved in flood risk management and it is possible to draw lessons from their experience.

Nevers Agglomeration is a medium-size urban intercommunality, regrouping the commune of Nevers (about 36 000 inhabitants in 2011) and 11 other smaller municipalities (about 68 000 inhabitants in total). It is located at the confluence between the Allier, Nièvre and Loire rivers. It faces slow floods from them and urban runoff. Safety on dikes is also a major issue, as most of them have been built several centuries ago.

Le Havre was about 174 155 inhabitants in 2011. Le Havre is a multi-risk city with an industrial background based on the activity of the harbour. Le Havre is also at the fringe of an agricultural and farming area, composed of intensive agricultural open fields. The main consequence for water management is the increase of soil erosion and land degradation. Above all, Le Havre is losing population since the 1980's. The risk of losing population is considered as an immediate danger by the local stakeholders. Floods are seen as less dangerous than a decrease of economical and urban growth.

In this contribution, we will describe how both Agglomerations are progressively taking the lead for flood management and facilitate coordination between Flood Risk Strategies.

In the case of Nevers Agglomeration, intercommunal cooperation has enabled local authorities to take the lead in a comprehensive approach of the flood risk. In 2007, Nevers Agglomeration launched a major study of the flood risk addressing both hydraulic and vulnerability issues on its territory. This study has provided intercommunal authorities with inputs and resources to negotiate with the State administration on the flood issue. Intercommunal cooperation has also been a real asset to promote innovative strategies, align local protection and mitigation measures and better deal with flood preparation and management crisis locally.

In the case of Le Havre, the intercommunal structure provides a range of resources (human resources, technical skills, engineering response capacity and financial powers) to all the municipalities for risk management, based on a strong local expertise in the field of Industrial Risk Management since the 1970's. The intercommunal structure gathers a joint coalition to negociate the scenario proposed by the State, not only to discuss the implementation but also to define the level of occurrence of flood.

O-3337-03

Sharing the funding of Flood Risk Management: The impact of Partnership Funding on the River Thames Scheme, London

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Cities across Europe are suffering increasing flood risks due primarily to urbanization and climate change. As a response to this, a variety of rule changes are being developed to tackle this problem at a European, national and regional level. An assessment of the effects of national policy on the delivery of Flood Risk Management at a local level has been carried out as part of the EU project STAR-FLOOD (http://www.starflood.eu/). In England, the Coastal and Flood Erosion Resilience Partnership Funding ('Partnership Funding' Defra 2011) describes a new approach to funding which requires the costs of many flood risk management projects to be shared between national and local funding sources, such as via local governments, the private sector or civil society The introduction of Partnership Funding was as a direct response to the need to unlock additional revenue streams and broaden risk sharing arrangements under scenarios of increasing risk. However, a consequence of this policy change is also a further impact upon the governance arrangement at a project scale; including the arrangement of actors, their responsibilities, their relationships as well as the power they exert within a decision-making process.

Based on interviews conducted with representatives from the local and national government, this work assesses how the Partnership Funding is impacting on the implementation of one particular project: the River Thames Scheme (RTS), in Southeast England. The RTS involves the construction of three alleviation channels to control floods in the Lower Thames segment (situated West from London), as well as other measures, such as the installation of property level measures and the improvement of warning systems, protecting in total 15,000 properties. The project has been approved but it is still subject to identifying locally sourced funding. The study presents an analysis and evaluation of flood risk governance and highlights the limitations/barriers of involving local government (of which there are seven separate councils involved) in the development of large scale flood risk management schemes. However, the study also highlights the advantages and opportunities which this new funding mechanism brings to the Flood Risk Management agenda, in particular the increased flexibility which has permitted the previously undelivered flood defence strategies in the Lower Thames. The evaluation considers the impact on efficiency and legitimacy of flood risk governance and on the current and long term societal resilience in the area of interest.

O-3337-04

Coupling Mobile Sensing, Earth Observations and E-GNSS in a Novel Flood Emergency Service

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Periodic flood events devastating urban and suburban areas are an important issue for mankind. Flood events, especially in Europe, have, in recent years, caused significant human and economic losses, especially affecting densely populated areas. The consequences of floods are exacerbated by urban sprawl and climate change, especially in areas close to large streams and rivers. This situation can produce flash floods that are very difficult to predict and hard to manage with respect to citizen alerting, operational planning, and flood evolution prediction. According to recent reports, between 1980 and 2008 there were around 2800 floods worldwide, with almost 280k people killed and resulting in approximately 400 billion dollars of economic damages.

These facts point to the need to improve the timeliness and intelligence of flood emergency systems to help public administrations to better manage flood related emergencies. Indeed, advanced monitoring and forecasting services are becoming mandatory to better address and mitigate crisis situations arising before, during and after heavy flood events.

Today, most advanced flood emergency management systems can rely on Earth Observations (EO) to acquire relevant imagery for processing, spatial analysis and dissemination via a range of technologies including geographic information systems. In terms of crisis management and monitoring of natural disasters, earth observation is one of the leading technologies, as it allows the capturing of important measurements of the hazard, both in near real-time as well as after the event. The Copernicus Emergency Management System provides mapping services for all actors involved in the management of natural disasters, with accurate geospatial information derived from EO and complemented with in situ or open data sources, whenever available. EO satellites support the collection of a wide range of measurements for different natural disasters including forest fires and floods, and they can also be used to produce detailed Digital Elevation Models (DEM) of the Earth. Overall, EO can provide current data of a specific area, allowing the creation of flood delineation maps with different time resolutions, depending on the geographical area and the satellites orbit. However, due to both the administrative operations required by the activation procedures and the need for satellites acquiring current images, some days can pass between the occurrence of a flood and its first mapping. This delay is not ideal during rapidly occurring emergency events such as flash floods, posing a significant limit in quickly providing reliable flood extent and forecast map. To overcome the aforementioned limitations we propose FLOODIS: a novel Copernicus downstream service that exploits existing space assets together with mobile sensing and state-of-the-art cloud systems in order to provide a faster, more flexible and scalable flood emergency response system, extending the capabilities of the current EMS. FLOODIS leverages the mobile sensing paradigm to improve the timeliness of accessing flood disaster related information by letting users report the flood status nearby through their mobile devices (smartphones, tablets). A Report includes a short description, a photo, and an indication of the water level in its location. We integrate these geolocated reports with EO-derived map information in order to provide a decision support system for public administrations, targeting enhanced flood information and early emergency alerts for citizens as well as for Civil Protection rescue teams. With mobile sensing, and EFAS (European Flood Awareness System) data when available, we also enhance flood extent map updates and predictions by implementing a novel flood forecast model. Furthermore, to increase the accuracy of user data, we improve mobile positioning by implementing a cloud-based service on top of the EGNOS Data Access Service (EDAS), which provides differential corrections for GPS, thus achieving both position integrity - in the form of the so-called protection levels - as well as increased accuracy.

In short, FLOODIS aims at achieving the following goals: (i) to provide a flood alert and information service for emergency response teams and affected citizens by leveraging on existing space assets; (ii) to increase social awareness and citizen involvement in flood emergencies through the application of mobile sensing; (iii) to increase the accuracy and the timeliness of flood extent and forecast maps by integrating user reports; (iv) ultimately, to reduce the social impact of floods, both in terms of human as well as economic losses.

3337-POSTER PRESENTATIONS

P-3337-01

Unpacking the notion of "more resilient flood risk governance" - a framework with examples from flood risk governance in Europe

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European countries, especially urban areas, face increasing flood risks due to urbanisation and the effects of climate change. In literature and in practice, it is argued that a diversification of Flood Risk Management Strategies makes urban agglomerations more resilient to flood risks. The latter requires innovations in existing flood risk governance arrangements, development of new arrangements and the coordination of these arrangements. We argue that the notion that diversified FRM leads to more resilience to flood risks is a plausible proposition, but one that should be critically scrutinised through comparative empirical research. To do this, we first present a brief overview of the state of the art of literature on resilience of social-ecological systems and flood risk governance. Next, based on the literature review, we operationalise the notion of "more resilient flood risk governance" into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt. Third, we use examples from an ongoing research project on flood risk governance in Europe (the EU FP7 project STAR-FLOOD) to discuss to what extent a diversification of FRM strategies is actually taking place and how the dynamics found can be scored using our criteria. The findings reconfirm that one-size-fits-all solutions for achieving resilient flood risk governance do not exist. There are different ways in which flood risk governance arrangements can be made appropriate in different social and physical contexts. We nevertheless will derive some common understandings and main lessons from this comparative research about flood risk governance in practice.

P-3337-02

Probabilistic, multi-variate flood damage modelling supports better decisions in flood risk management

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Decisions on flood risk management and adaptation are increasingly based on risk analyses. Such analyses are associated with considerable uncertainty, even more if changes in risk due to global change are expected. Although uncertainty analysis and probabilistic approaches have received increased attention recently, they are hardly applied in flood damage assessments. Most of the damage models usually applied in standard practice have in common that complex damaging processes are described by simple, deterministic approaches like stage-damage functions.

This presentation will show approaches for probabilistic, multi-variate flood damage modelling on the micro- and meso-scale, i.e. for individual objects and for aggregated land use units; and will discuss their potential and limitations.

For instance, we compared the predictive capability of six flood damage models (four deterministic and two probabilistic models) in a spatial transfer context using empirical damage data which are available from computer aided telephone interviews that were compiled after the

floods in 2002, 2005 and 2006 in the Elbe and Danube catchments in Germany. Flood damage estimation is carried out on the scale of the individual buildings in terms of relative damage. For validation a split sample approach was followed. The reliability of the probabilistic predictions within validation runs decreases only slightly and achieves a very good coverage of observations within the predictive interval. Since it is crucial to capture and quantify the uncertainty involved in order to enable informed decisions, probabilistic models are advantageous since they quantify prediction uncertainty. This additional information about the reliability of model predictions improves the usefulness of model results and even more so in spatial transfer applications.

P-3337-03

Lessons learnt in preventing health effects of floods events in the European Region

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The WHO Regional Office for Europe, within its division on health security, is actively in charge of advising its 53 Member States in predparedness and response of flood events, with a particular focus on health. Between 1990 and 2015, more then 1000 people died and several million were affected during flood events. In this presentation we will briefly outline the health effects, based on several systematic literature reviews and describe the practical lessons learnt during and after 2 major flood events: the 2002 Elbe floods and the 2014 Balcan floods. The presentation will highlight required preflood measures, during flood public health relevant initiatives as well as post flood management. Gaps in flood response will be highlighted in particular with a view of more frequent and intense flood events.

P-3337-04

Climate change adaptation : towards a legal change ?

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The world is facing climate change, which impacts on the international community at large. Such a problem requires a global response followed by local actions to deal with this new challenge. This response is characterized by the crossing of mitigation measures, in order to reduce greenhouse gas emissions, and adaptation measures for reducing the risk and damage from current (ex post aspect) and future (ex ante aspect) harmful impacts. Among the different effects compiled by the Intergovernmental Panel on Climate Change (IPCC), we could note for instance rising sea level or more frequent flash floods and marine submersion. Statistical studies have shown that natural disasters will be increasingly important in the next few years. Therefore, it is urgently necessary to draw up adaptation and risk reduction measures and all the instruments of public policy, such as normative instrument / law, have to be mobilized.

These last years, France has established a real adaptation to climate change policy through the development of the National Climate Change Adaptation Plan (PNACC) provided for in the Grenelle Act of 2009. Indeed, this plan is consistent with the European strategy of adaptation to climate change adopted in 2013 by the European Commission, which invites every Member State to adopt comprehensive adaptation strategies.

When analysing on a legal point of view these different plans or strategies adopted at national or European level, one may see there weak normative force. Even if the Grenelle Act of 2009 makes provision in Article 42 for "the preparation of a National Adaptation Plan for a variety of areas of activity by 2011", one may say that it has no legal value. Indeed, the plan has not been adopted by the French Parliament or the Government through a regulatory act. Only a consultation was carried out in 2010 bringing together panels from the Grenelle Environment Forum (elected representatives and local authorities, the state, employers, employee unions and non-profit associations). At the European level, the Strategy of adaptation to climate change has been drawn up through a communication of the European Commission. These two plans can be both described as soft law instruments used to improve stakeholders support (Dreyfus & Patt, 2011).

Even if such an intention can be laudable, it must be remembered that States are responsible for human security. This responsibility belongs to the political and legal domains. From an intern and European legal point of view, there is no explicit obligation stating that a State has to protect its population against the consequences of climate change impacts. Yet, the French disaster law is composed of the protection principle, which enjoins the State and local authorities to protect effectively their population when a natural disaster happens (Cans at al., 2014). At the European level, the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR) protects the right to life and imposes positive obligations on Member States to guarantee this fundamental right (Gouritin, 2009).

In order to avoid any action for damages against public authorities and to constrain actors to prepare effectively to climate change consequences, the implementation of a real arsenal of hard law provisions is necessary.

But how can we incorporate this variable "climate change", characterized by its uncertainty and its permanent evolution in progress, into normative instrument which are traditionally looking for a certain degree of legal certainty?

The purpose of this communication is to analyse some French legislative instruments directly or indirectly used in the field of flood risk management (flood risk prevention plan (PPRI), flood risk management plan [PGRI], local urban planning scheme [PLU], territorial consistency plan [SCoT]) from a climate change perspective. The main issue for this topic is to what extent these different instruments can be a vehicle for adaptation to climate change. On conclusion to this study, concrete propositions will be made in order to better integrate data linked to climate change into these legal instruments.

3338 - European Collaborative Research and Innovation for Climate Action

ORAL PRESENTATIONS

K-3338-01

Title not communicated

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Abstract not communicated

K-3338-02

Title not communicated

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Abstract not communicated

K-3338-03

Title not communicated

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Abstract not communicated

3338-POSTER PRESENTATIONS

P-3338-01

Floods and International River Basin Districts: Europe stands United?

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Problem definition

Through the introduction of the concept of International River Basin Districts (IRBDs), water law in Europe aims to focus on ecological boundaries as opposed to administrative boundaries. Considering the fact that approximately 60 % of EU water is transboundary, and there are transboundary waters in all Member States with the exception of Cyprus and Malta, solid cooperation and conflict prevention mechanisms throughout EU Member States are critical for ensuring quantitative water security. Indeed, actions upstream (in one country) impact the quality and quantity of water downstream (in the part of the river basin located in a neighbouring country) and vice versa. The floods in Central Europe in 2013 demonstrate the transboundary nature of the phenomena, as the floods emerged in one jurisdiction and proliferated in other jurisdictions. However, as will be demonstrated, solid mechanisms for cooperation are lacking in the European legal framework with regard to IRBDs.

Outline of the presentation

This contribution will review how the EU legal framework drives cooperation in IRBDs, in order to tackle the inherently transboundary issue of flooding. This will be done on the basis of the five pillars of transboundary water governance, as set forth by the Global Water Partnership, namely (i) scope, (ii) substantive rules, (iii) procedural rules, (iv) institutional mechanisms and (v) dispute resolution.

Through the framework of these pillars, the existing bottlenecks in the EU framework will be identified. On the basis of this analysis, ways forward will be set forth, amongst others drawing from a legal comparative analysis with transboundary river governance agreements in the United States.

3339 - Effective design and implementation of EU climate policy

ORAL PRESENTATIONS

O-3339-01

Three stylised policy scenarios

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This presentation will focus on the results of a paper assessing the ability of three stylised policy scenarios to deliver the low-carbon energy infrastructure required in the EU by 2050. First, key infrastructure requirements as commonly agreed by modelling studies will be outlined across the key sectors of power generation, industry, buildings and transport, with 'infrastructure' encompassing both stationary and mobile components of the energy system (from power generation to vehicles). The three stylised scenarios will then be introduced, each centred on a particular policy paradigm (market-based, technology-based and behaviour-based). Following this, the key benefits and problems associated with each, and their ability to deliver the energy infrastructure outlined for each sector, will be presented.

O-3339-02

Dealing with uncertainty in the European climate policy

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While the European climate policy has been the target of a large number of economic analyses, both from academics and from the European Commission services, almost all modelling exercises have been deterministic, allowing at best for testing a few scenarios. Stochastic models have been developed but in most cases without numerical application to climate policies. In the few exceptions, the climate policy only consists in CO2 pricing, implemented either through a tax, an ETS or a rate-based policy (e.g. an intensity target).

Yet the history of climate policy is full of surprises, including the swings in EU ETS allowance price and the unexpected surge in PV installation in Germany. We develop a simple stochastic model of the European energy sector featuring the most important uncertainty sources in this context, i.e. economic growth and the cost of key technologies, as well as the interaction between climate policy and renewable energy subsidies.

It turns out that uncertainty changes the (ex ante) optimal policy choice. In particular, most analysts conclude that if CO2 emissions from the power sector are covered by an ETS, there is no or little rationale for renewable energy subsidies. Yet, if uncertainty is high enough, emissions may fall below the ETS cap in some states of the world, leading to a nil allowance price. Hence, energy subsidies at a proper level are justified as a kind of insurance that at least some abatement will happen in these states of the world, which is welcome since the marginal benefit of GHG abatement is positive in these states of the world also.

This point is not only theoretical: a careful examination of existing and past ETS worldwide indicates that for most of them, emissions have been significantly below the cap during at least a part of their history. Moreover there is no guarantee that the Market Stability Reserve proposed by the European Commission will be adopted by the Council and the Parliament, and most analyses conclude that this mechanism is unlikely to stabilise the CO2 price significantly.

Moreover, we show that the design of renewable energy subsidies should take into account uncertainty. In particular, feed-in-tariff, premium and renewable quota all respond in a specific way to a change in renewable energy cost, in fossil fuels price or in electricity demand. A model is designed to compare them when implemented in isolation, which concludes that a renewable quota is by far the worst instrument, mostly because it does not respond to a change in renewable energy cost or in fossil fuels price. Finally, we analyse how this ranking of renewable subsidy instruments changes when they are implemented together with an ETS, as is currently the case in the EU. Compared to the premium, the feed-in-tariff provides a subsidy which decreases with the electricity price, itself positively correlated to the CO2 price. Hence it helps to stabilise the marginal abatement cost, which is welcome for a stock pollutant like GHG gases, whose marginal benefit curve is flat.

O-3339-03

The availability of finance for the low carbon economy. Eco innovation diffusion, sector analyses and green climate funding

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The macroeconomic setting is slowly moving towards financing the green / low carbon economy with diversified private and public oriented sources. Nevertheless, if compared to the mass of potential liquidity this

development is still in its infancy.

Sector, firm based and macro evidence is presented and integrated.

We do highlight three key findings among others.

At firm level, the overall evidence could reinforce the likelihood of a different kind of scenario, where MNEs proactively react to the recession shock and LC economy targets and find ways to bring together competitiveness and sustainability; SME react with more difficulty, some of them 'exploiting' the challenge of financial barriers and (environmental) policies by turning costs into enhanced innovative and economic performances, others failing to innovate. If this is on the one hand a typical and also normal evolution of the economic cycle which depends upon firms' creation and destruction, policy makers should be aware of the possible increasing divergences between sectors, firms, regions in the EU; some of those could possess irreversible features and create 'hot spots', namely structurally underperforming regions / sectors.

Second, financial barriers confirm to be a deterrent for the innovative capacity of EU firms in the current situation, if observe the overall quanti-qualitative evidence. This is true for the economy as a whole, and for manufacturing or construction firms taken alone. Being smaller and having low human capital in the firm also hampers environmental innovations (EI). On the 'positive' side, we note that existing regulations and expected increasing demand for green products support EI adoption. Financial barriers are perceived by firms and influenced by technological lock in, uncertainty on investments, non-competitive markets, and lack of subsidies. While policies are driving innovations to some extent, 'external knowledge sourcing' seems not to play any significant role in this context. This highlights a strong critical issue: external finance elements deters EI and external knowledge is not acting as a potential substitute; firms are currently isolated islands towards the green economy, with respect to other firms and financial institutions.

At macro level, the possibility to use environmental policy reforms is assesses by a dynamic CGE modelling approach that analyzes the case of Green Climate Funds, which are eventually generated out of carbon taxes revenues and might support sector eco innovative dynamics following countries specific needs. Green Climate Funds financed through a levy on carbon can benefit all parties, and larger benefits are associated with energy efficiency in developing countries.

O-3339-04

The politics of policy choice. Understanding political feasibility of climate policy instruments in the EU

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The EU has adopted a mix of policy instruments to achieve its carbon emission reduction targets. However, market and governance failures have led to major inefficiencies, and many call for a revision of the existing instrument mix. But what policy options are politically feasible? Political feasibility is still poorly understood, and the literature falls short in definitions, methods and empirical studies. In this paper we advance the current state of knowledge by developing a systematic framework that integrates 3 key dimensions of political feasibility, namely power dynamics among relevant interest groups, their preferences for policy instruments and the institutional setting in which proposals for instruments are discussed. The study provides novel insights into the relationship between these dimensions and the political feasibility of different typologies of instruments in the context of the EU climate policy. The empirical analysis is based on a multi-method approach that includes interviews, focus groups, an on-line survey and a policy simulation with relevant stakeholders.

3339-POSTER PRESENTATIONS

P-3339-01

Agriculture: the sleeping beauty of European climate policy? How market-based instruments could reduce emissions

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In order to achieve its long-term emissions reduction goals, the European Union has to significantly reduce its emissions from agriculture. The recent reform intended to "green" the Common Agricultural Policy is unlikely to sufficiently reduce agricultural emissions, although it might have other environmental benefits. Therefore, more ambitious mitigation policies will be necessary for European agriculture if policymakers do not want to jeopardize the achievement of the overall long-term targets. Several studies also show that there is a significant mitigation potential in European agriculture that can be harnessed cost-effectively by the implementation of market-based instruments.

Nonetheless, major barriers appear to make agriculture relatively challenging to decarbonize. In particular, this paper argues that challenges linked to (i) transaction costs, (ii) political economy and (iii) behavioral specificities of actors in the sector complicate the implementation of ambitious mitigation policies. Market-based instruments may imply significant transaction costs for farmers, for instance, related to monitoring, reporting and verification. The specificities of the sector and the degree of protection it benefits through the Common Agricultural Policy also make it more delicate to price its emissions. The interaction between a potential climate policy and the existing CAP will in fact likely be at the heart of any mitigation policy in the sector. Finally, it is also important to take into consideration behavioral aspects and that financial incentives alone might not always be sufficient.

To that end, this paper offers a new framework the coverage-stringency-transfer nexus to investigate and map options to implement climate policies in the sector, while taking into consideration the main obstacles. The coverage is the percentage of agricultural emissions covered by a climate policy, which is driven by emissions sources and the farm size in term of emissions included. The degree of stringency is the type of policy implemented. It can be a voluntary or mandatory, going from offsets to full inclusion in the EU ETS or an emission tax. The transfer dimension reflects the net impact on farmers of the interaction between a new climate policy and the existing CAP subsidies. In fact, it is argued that it is necessary to explicitly discuss potential interactions. Simultaneously, the existence of those subsidies might also represent an opportunity to facilitate the political acceptance of a climate policy in the sector.

It is concluded that heterogeneous and multi-speed policies are necessary as a first step to tackle agricultural emissions. In fact, for emission sources where transaction costs are lower, mandatory mitigation mechanism should be applied, while a voluntary approach could be implemented for emissions sources with high transaction costs. This would reduce transaction costs overtime and gradually enable increasing mandatory coverage. In addition, the paper offers different options to choose from that combine different levels of transfer to farmers and various degree of protection against leakage. These options provide alternatives to policy makers to choose from taking into consideration their perceived political feasibility.

P-3339-02

Climate change challenges for European Union in the New Millennium

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Strategies on climate change and development cooperation are both evolving rapidly within Europe. Improved scientific understanding about climate change and responses to it show the need for urgent action. This is the chasm between emission reductions pledged by countries and the actual reductions needed to stay within a safe global carbon budget. The aid landscape is also changing fast, after years of seeming stability. With the emergence of new donors (both sovereign states and private foundations) complexity is likely to increase through to 2020. As a result, the traditional multilateral and bilateral donors are likely to lose influence and power. But within the climate change framework there is still unfinished business for traditional donors, particularly in relation to the provision of finance and technology for developing countries. The European Union (EU) has stepped up to its historic responsibilities and climate change has become an increasingly important component of its development cooperation effort. But how will all this play out over the next decade and what can we learn from recent trends? This paper aims to seek answer to this question. Secondary data have been used in the paper and methodology of analysis is "descriptive research method". Within the framework of this objective, it touches upon relevance from development cooperation for climate change.

3340 - Conflict and Climate Change

ORAL PRESENTATIONS

O-3340-01

Climate Change: Adding Fuel to The Fire of Iran's Inter-provincial Water Conflicts?

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Results recently found in the Iranian third national report on climate change reveal there is evidence that several parts of the country are likely to face hotter and drier climate in the future. Nevertheless, climate impact studies still have not been incorporated into decision making processes not only in the most recent national comprehensive water plan but also as a compulsory analysis of any development schemes at the implementation phase. This paper aims at highlighting the imperative role of climate change impact assessments studies on regional conflicts over shared water resources in Iran. Two of the most important river basins at the western part of Iran are illustrated, Lake Urmia and Karkheh. The former is shared between three provinces where the latter is shared between seven riparian ones. Lake Urmia has suffered serious environmental challenges in recent years. Thirteen main rivers flowing into the lake are all experiencing decreasing surface runoffs in recent fifteen years ranging from 26 to 70 percent compared to their long term average of 1969-1999. Likewise, changes in potential renewable water resources have dropped by one forth in Karkheh river basin attributing to several factors including decreasing trend of precipitation as well as increasing infiltration and overuse of water consumption. With the observed trends in decreasing streamflow, policymakers have seriously attempted to attribute the contribution of each of the climate variability and change as well as basin-wide water consumptions. In retrospect, aggressive development projects threating sustainability of resources should have been avoided. Meanwhile, recent impact studies over the two river basins have suggested that climate change is expected to aggravate available water resources challenges under some projections of the IPCC's AR4 emissions scenarios. Surprisingly enough, the competition over exhausting water resources is likely to turn out to be the Tragedy of the commons under compounded impacts of climate change and mismanagement measures leading to conflicts arising when available resources are diminished.

Each of the so called inter-provincial basins are managed by regional (provincial) water companies. The paper suggests that in addition to the past mismanagements which have been found as a driving force of current inter-provincial conflicts, increasing temperature together with a decrease in mean annual rainfall and runoff in the face of climate change inevitably intensifies competition over the limited available resources. When surface water is not available then other sources will be sought after such as groundwater. Consequently, conflicts begin over the use and ownership of water in many settings. From 1974 to 2012, an average of 27 MCM of decrease per year in groundwater volume occurred in twelve aquifers adjacent to the Lake Urmia. In the view of this situation, neglecting to consider climate change projections is likely to expose natural systems to serious damage, even potentially irreversible in many unsustainable ecosystems such as Lake Urmia and Hoor-Al-Azim marshland at the outlet of the Karkheh river basin. Considering the high vulnerability of water resources systems, agriculture, and energy sectors together with fragile socio-economic features, conflicts over these common pool resources, will probably be unavoidable. Ultimately, understanding the effects of current development plans and climatic changes on the status of the mentioned sectors can help taking timely actions to alleviate probable conflicts. Given such a scenario, there have recently been progressive attempts in the Iranian Ministry of Energy (MOE), the main organization responsible for water resources planning and management to launch a specialized working group to address climatic change related predicaments. However, this paper argues that there are some main stumbling blocks still remained untouched on the subject. Implementation of integrated river basin management, developing climate risk frameworks based on integrating Top-down and Bottom-up approaches, thorough uncertainty analysis in addition to hedging between adaptation strategies and mitigation must be performed circumventing such a situation. At the end, the paper suggests that climate change is likely to add salt to the wound of the current challenges from a multi-sectoral point of view and that comprehensive assessment of the impacts of climate change on water bodies followed by conflict resolution provides alerting symptoms for future decision making processes and further action plans.

O-3340-02

Climate-related disasters and armed conflict outbreaks- Evidence for significant co-incidences from the observational record

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Armed conflicts are the result of a highly context-specific mixture of a variety of socio-economic factors and their multiple causality structure, which renders the attribution of armed conflicts to single factors a practically impossible task. Nonetheless, there is great interest in empirical evidence if and how much changes in potentially determining factors, in particular such related to climate change, alter the risk of conflict outbreaks at the global scale. Whether or not climate change is already contributing to armed conflict outbreaks and conflict risk is very controversial, in particular since the numerous interactions between climate change and socio-economic factors are difficult to capture by standard statistical methods.

Here we address this question regarding the specific case of climate-related extreme economic damage events. We present a comprehensive analysis of the co-occurrence between such events and conflict outbreaks for the period 1980-2011. While there is no significant statistical relationship between extreme damage events and the outbreak of armed conflicts at the global scale, for subsets of particularly conflict-prone countries of up to 10% or more of all conflict outbreaks robustly coincide with climate-related extreme economic damage events.

Our analysis reveals that climate-related extreme damage events, while not directly causing armed conflicts, can indeed significantly contribute to conflict risk in environmentally vulnerable and conflict-prone regions and possibly trigger the timing of conflict outbreaks. Given the still high number of countries at risk and the observed and projected increase in severe climate extremes, this relation represents a serious risk to societies globally.

O-3340-03

Climate change induced migration and conflicts in Nigeria

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The challenges associated with climate change have started threatening the common future of the world inhabitants. While the challenge of some localities is associated with too much water, other areas are faced with the problem of too little water available for use. Nigeria is being threatened by these two climate change challenges and each of these scenarios will result to forced migration. While the southern part of Nigeria is experiencing coastal inundation due to sea level rise, the north is being afflicted with the burden of desertification. These combined forces of climate change impact in Nigeria, prompted this study that investigated the impact of climate change on migration and possible conflicts in Nigeria. Climatic data (air temperature, rainfall amount and rainy days) for 60 years (1955 –2014) from 30 synoptic stations in Nigeria were analysed to evaluate the possible signals of climate change. With the aid of Geographic Information System (GIS) techniques, the vulnerable areas due to coastal inundation and desertification were modelled, population affected was determined and the ecological zones that will absorb the potential migrants and the expected conflicts due to such migration were analysed. The GIS technique was also used to construct the isohyets and isotherms so as to analyse the changes in climatic patterns. Time series analysis was employed for the climatic trends. 600 copies of a questionnaire were administered in six states (three in the coastal area and three in the semi-arid region) randomly selected to solicit information on the level of vulnerability, impacts and local adaptation strategies to climate change and possible migration and conflicts. These were analysed using different statistical and cartographic techniques. The results show rising temperature of 1.92OC for the 60 years. Although decreasing rainfall amount and rainy days were observed, a slightly increasing rainfall amount was noticed in the coastal area in the past two decades. A gradual shift in reduced rainfall during the short-dry-season from August to July was noticed. Another observed pattern is the southward shift in the line dividing the double rainfall peaks, thus increasing the tropical continental climate area and decreasing equatorial climatic region. Moreover, while sea level rise of 1 metre will affect 5.4% of Nigeria's landmass and 16% of the population, desertification will affect 38% of the landmass and 33% of the population. Both events may force about 49% of Nigerians from the coastal and semi-arid regions to the guinea savannah and the northern part of the forest ecological zones. This will result to scramble for arable land for farming, grazing and water resources, among others. Conflict between farmers and herdsmen is already on in Nigeria and this may intensify with increasing impact of climate change on natural resources (arable land, grasses and water). The conflicts between farmers and herdsmen have claimed 496 lives in the guinea savannah and the northern part of the forest ecological zones of Nigeria between 2013 and 2014. Adaptation measures are recommended to reduce the impacts of climate change and also to minimize migration and the associated conflicts.

O-3340-04

Sovereignty: The Unfocused Era of 'loss and damage' at Climate Summit

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One of the major decisions of COP19 is a new "Warsaw International Mechanism will be created to provide help for poorer countries hit by extreme weather events" for loss and damage issue under the Cancun Adaptation Framework-CAF. However beneath this major outcome there is a deep concern and state security associated which is yet, uncounted and overlooked. Slow onset events under loss and damage were identified as "sea level rise, glacial retreat and related impacts, salinization" etc., however, in the case of Bangladesh, "the discussion on sea level rise and salinization centred on approaches rather than needs" which indicates the uncertainty and lack of investigation and measurement in this area. The technical paper of CAF and Warsaw negotiation text both have missed the dilemma of state security while they are concentrated on 'Vulnerable developing countries will be the hardest hit due to their low adaptive capacity'; 'Slow onset events are already affecting developing countries and the resulting loss and damage'. The CAF and Warsaw agreement both have clearly missed the regional security aspect; for example, the economy of Bangladesh is poor than India which should mean that India has better adaptive capacity than Bangladesh. Since Bangladesh and India share borders, and economic opportunity is far better in India, there is potential that India will be severely affected from any emergency or slow onset climatic events in Bangladesh. This paper investigates potential geographical changes following mass migration flow brought by the loss and damages in reference to water stress in regional scale. Using high level policy interviews conducted in Bangladesh and comparing two census data of Bangladesh-India, this paper presents two tipping points which offers an important insight of the state security risk.

3340-POSTER PRESENTATIONS

P-3340-01

Forecasting Armed Civil Conflict and the Conflict Trap along the Shared Socioeconomic Pathways (SSPs)

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We investigate how "conflict trap" dynamics, specifically through reduced economic growth as a result of armed conflict, may lead to new and more persistent conflicts over the century. Intrastate conflict has widespread impacts on socioeconomic development. Importantly, conflict depresses economic productivity which in turn lowers the opportunity costs for renewed conflict. Further, economic impacts may be further exacerbated by climate change. To examine how these dynamics may evolves as a function of different expectations of economic growth, we generate our projections along the five Shared Socioeconomic Pathways (SSPs) developed by the climate change community to evaluate the impacts of climate change and policy.

To develop our projections, we first generate a model where armed conflict and economic growth are endogenous. We estimate the reduction in GDP per capita from the incidence of conflict, the duration and the effect of neighboring countries in conflict as well as the post conflict recovery using historical data. Second, we use a simulation approach to project the onset, incidence and termination of armed conflict along the five alternative economic scenarios represented by the SSPs, revising the GDP projections for conflict.

We find that the projections of armed conflict are a strong function of the assumptions about economic growth. Scenarios lower GDP growth over the course of the century experience higher propensities for armed conflict. Adjusting the expected GDP growth for armed conflict worsens the expectations, especially for regions which already experience conflict. As the projected damages from climate change increase in severity, the ability to update the SSPs for these impacts will be become more important for evaluating the full range of damages over time.

3341 - Gender and Climate Change: From Vulnerability to Mainstreaming in Adaptation and Mitigation

ORAL PRESENTATIONS

K-3341-01

Is gender being meaningfully engaged in climate change adaptation, resilience, and vulnerability research?

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The last decade has experienced a rapid growth in climate change adaptation, resilience and vulnerability (ARV) research. Concurrently, there is growing recognition that climate change impacts and experiences are gendered, and must be accounted for in research. Yet some have argued that engagement with 'gender' has been tokenistic, simply stating that climate change will have differential impacts. It is therefore necessary, given the rapid expansion of literature in this field, to critically analyze the framing of concepts of gender within the literature. In order to determine how meaningfully gender is being addressed in ARV research, we created a conceptual model capturing key components of 'meaningfulness.' Meaningfulness is ascribed as being a function of gender mainstreaming, the experience of gender, and the degree of action being taken. Using a systematic literature review methodology, 123 peer reviewed ARV articles with a gender focus were analyzed.

While 41% of analyzed articles were found to have high levels of meaningfulness, significant variations across regions and disciplines emerged. Research occurring in Sub-Saharan Africa was found to consistently engage with gender in a highly meaningful manner. Although a great deal of gender focused ARV research is occurring in Bangladesh and Australia, overall these nations exhibited low levels of meaningfulness. Health, environmental management, and hazards research emerged as disciplines engaging with gender in the most meaningful manner, although areas needing improvement became apparent. Gender focused work in this field focuses almost exclusively on women, with very little research examining male experiences and no work accounting for those identifying outside the gender binary. While meaningful work is occurring, 31% of the surveyed research was found to have low levels of meaningfulness, demonstrating a need to highlight meaningful methods to reconcile climate change and gender. This conceptual model provides a baseline understanding of how ARV research is integrating concepts of gender into their work which researchers can use to ensure more meaningful engagement with gender in future research.

O-3341-01

Looking beyond gender in humanitarian interventions: a study of a drought-stricken region of Kenya

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Slow-onset disasters such as droughts usually occur with such frequency that peoplehave no time to recover before the onset of the next drought. All members of thecommunity suffer as a result of recurrent droughts, but the effects are often more severeon vulnerable groups such as children, elderly people, and some women. This paperuses the experiences of the relief organisation Kujenga Maisha East Africa (KUMEA)to understand the importance of looking beyond gender in humanitarian interventions.Here we focus on the importance of understanding the socio-economic and politicalcontext surrounding the drought and the associated humanitarian interventions,using a feminist lens to assess power relations. This includes looking into the aspectsof vulnerability and resourcefulness in the context of food security, food distribution,nutrition, and livelihood assistance. Such knowledge is vital in improving existingapproaches to gender programming in humanitarian organisations.

O-3341-02

The importance of marital status and intrahousehold relations in climate change adaptation: Evidence from rural Tanzania

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Even though scholars have widely recognized that women in developing countries are more vulnerable to the impacts of climate change, only scant attention has been drawn to how women and men are practically dealing with these differential vulnerabilities. Climate change scholars have recognized gender as an influential factor in climate change adaptation, but generally simplify and dichotomize between men and women as homogeneous categories. Gender analysts however, have recognized the importance of the intersections between gender and other socio-economic characteristics like class, household structure, life cycle stage and age. Based on both quantitative and qualitative methods, this research examines how women's adaptation strategies are mediated through their marital status in rural Tanzania. This study finds evidence, first, for female divorcees' and widows' disadvantaged position in agricultural water management compared to married women. Second, with regard to livelihood diversification, evidence is found of a diversification at household level, combined with a specialization at individual members' level, as well as of female divorcees' high involvement in off-farm income-earning activities. We develop a typology to illustrate how adaptive capacity relates to marital to status and intrahousehold relations, and suggest that the respondents' current climate change adaptation strategies risk increasing married women's dependence on men and worsening their intra-household bargaining position.

O-3341-03

Women in Changing Climate: Findings from Cyclone Aila Affected Coastal Communities of Bangladesh

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Climate change is harsh reality in Bangladesh in terms of gradual changes and disaster events. The country has been identified as most vulnerable to tropical cyclones, third most vulnerable to sea level rise and sixth most vulnerable to floods. However, climate change associated adversity and vulnerability is contextual and gender specific and is magnifying the socially constructed inequalities between men and women where women are always the worst victim due to their gender differentiated roles and lack of access and control over resources. The study, carried out in three major cyclone Aila affected unions- tried to explore the gender dimension of climate change induced vulnerability considering women not only the victim rather an agent of change. Contrary to common vulnerability analysis and studies, this study tried to quantify vulnerability with a developed matrix framework in a scale of 3.0. The gender dimension of climate change induced vulnerability has been assessed in terms of exposure, sensitivity and adaptive capacity; considering both gradual changes or climate events and disaster events or climate extremes. The primary idea of the vulnerability assessment has been derived from the concept of Sustainable Livelihood Framework and Harvard Gender Analytical Framework. Using the basic and simplest equation of "Vulnerability = (Exposure x Sensitivity) / Adaptive Capacity," the matrix framework calculated contextual vulnerability and total vulnerability based on community (women group only) perception. The vulnerability assessment of gender community, i.e. women has been done in Padmapukur and Gabura unions from Shyamnagar upazilla, Satkhira and

Dakhin Bedkashi union, Koyra upazilla of Khulna in 2012 where the impact of cyclone Aila was most pronounced and after effect was lasted for several years. The climate change induced vulnerability of gender community of Padmapukur, Gabura and Dakhin Bedkashi was 2.56, 2.53 and 2.61 respectively. It was found that, respondents from Padmapukur and Gabura unions perceived themselves more vulnerable to climate change associated gradual changes or climate events whereas Dakhin Bedkashi respondents identified themselves more vulnerable to climate change associated extremes or disaster events. Interestingly, the perceptions greatly coincided with direct impact, number of causalities, damage done and post disaster response and development intervention as well as location of study areas. The basic idea behind the vulnerability assessment matrix development was to provide tool that can capture overall gender dimension of vulnerability due to climate change impact. Community, based on their perception ranked impact (exposure), effect (sensitivity) and effectiveness (adaptive capacity) to assess their geo-specific vulnerability; the total vulnerability score for all three study area lied in moderate to extreme category. The linkage among exposure, sensitivity and adaptive capacity showed that Bangladesh had achieved remarkably success in disaster preparedness; but significantly lacked experience to deal with the ongoing changes taking place in climate. The study also explored various complexities experienced by only women due to climate change associated events and extremes and accumulated suggestion for disaster preparedness, improvement in cyclone warning signal and modification for gender friendly design of cyclone shelters. Key suggestions also been assessed in line with climate change coping, adaptation and mitigation directly from the climate vulnerable community. Women is the integral part of the society and sustainable development initiatives and based on the overall findings, the study suggested 'bottom up-top support' institutional framework for gender mainstreaming.

O-3341-04

Household Dynamics in Adoption of Resilient Farming technologies in Semi-arid Kenya

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Countries in sub-Saharan Africa are particularly vulnerable to climate change, given their limited capacity to adapt. Strengthening agricultural production systems is therefore a fundamental means of improving incomes and food security for the largest group of food insecure households. To build such systems, development practitioners have advocated for climate smart agriculture, a system that sustainably increases productivity and system resilience while reducing vulnerability of smallholder farmers. This requires a substantial investment in agricultural technology innovations. While climate smart agriculture through agricultural technology innovations have been introduced in Kenya, their proliferation has been low, slow and incomplete among the smallholder farmers. To address this, a participatory action research project funded by the Canadian International Food Security Research Fund endeavoured to catalyze large scale adoption of agricultural innovations that enhance social and ecological resilience in Kenya's Semi-arid lands. The study focused on the adoption of three technologies; improved maize seeds, improved green gram seeds and indigenous chicken. Based on household survey data collected from Machakos and Makueni counties of Kenya, this study sought to determine the gender differences in the adoption of multiple resilient farming technologies among the smallholder farmers in semi-arid eastern Kenya using gender of the farm manager as the gender identifier. It also examines the factors that influence household level of resilience measured by the number and types of technology adopted. The results show that male-headed households differ significantly with the de facto female-headed households in terms of age, education, number of trainings and the adoption of a combination of improved maize and indigenous chicken. On the other hand, de facto and de jure female-headed households differ significantly with regard to age, education, crop mix, remittances and the adoption of improved maize, improved green grams and a combination of a combination of improved maize and indigenous chicken. Ordered probit model results on determinants of household resilience indicate that household type, education, land size, crop mix and market opportunity groups are key in influencing household resilience. This emphasizes the need for greater investment in gender and rural agricultural development to ensure equitable and sustainable livelihood improvements.

O-3341-05

Policy Gains and Implementation Opportunities: Progress on the Gender and Climate Change Front

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In Jordan, women's management of small-scale irrigation projects and involvement in water harvesting and soil conservation improves the efficiency of water use. In Nepal, women farmers avoid crop failure in the face of changing weather patterns by growing off-season vegetables and bananas, which are more resilient to flood and drought. In Mozambique, women's groups and traditional healers can offset the impacts of climate change and improve community health with 'climate change health kits'—comprising traditional and local medicinal plants, like citronella to ward off mosquitoes. Women often lead the way in adapting to climate change impacts, but they also play a key role in mitigating climate change by optimizing energy efficiency, using low-footprint energy sources and techniques, playing a vital role in forest management and mechanisms such as REDD+, and influencing a household's and community's consumption patterns.

Until recently, policy at the global and national level did not reflect this reality. For more than twenty years gender was absent from the United Nations Framework Convention on Climate Change (UNFCCC) and in the decision making by its Parties and in subsidiary bodies. This lack of a connection at the global and national level between gender and climate change prompted action on the issue. Now, after years of advocacy, outreach, capacity building, and awareness-raising, governments have agreed multilaterally that advancing gender equality is a key component in achieving climate change goals.

Since 2008, nearly 40 UNFCCC decisions on climate change have integrated specific text on gender concerns. From promoting women's participation and leadership to gender safeguards and assessments, all vital areas of climate change response include key issues for women's and gender equality—all toward ensuring more effective climate change policymaking and planning. At COP20 in Lima, Parties decided on further action for implementation of the mandates through a specific gender decision and the creation of the 2-year Lima Work Programme on Gender.

This session will explore the opportunities for implementation of the Lima work programme and how it will advance gender balance and enhance gender-responsive international climate change policy. A critical step in the implementation process will be presented at this conference: how to effectively anchor the international agreements on gender and climate change within the national contexts.

Over the last five years, International Union for Conservation of Nature's (IUCN) Global Gender Office (GGO) has spearheaded innovative work on this very topic. It has supported, to date, 15 countries through processes to develop national Climate Change and Gender Action Plans (ccGAPs.) This unique effort was born in response to the changing political context and subsequent official requests from governments all over the world to 'turn words into action' and develop concrete action plans on gender and climate concerns. Participants in this session will learn how the ccGAP process facilitates, via a participatory, multi-stakeholder and multi-sectoral approach, gender mainstreaming throughout a country's priority sectors, especially integrating gender concerns and gender-responsive components into national climate change strategies, communications, programmes, and projects. An important principle of the ccGAP methodology is to empower women as valuable partners in climate change response—so women and men alike are not merely victims but resilient agents of change.

O-3341-06

Mainstreaming gender in climate compatible development

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While there has been progress on acknowledging the gender dimension as an integral part of climate policy at international, national and local levels around the world, there is still a long way to go to promote gender equality in climate negotiations.

Yet, recognising and exploring the gender dimension of climate change enables responses to be more grounded in people's daily realities. Through highlighting societal factors that influence people's vulnerability to environmental shocks and stresses, a gender perspective helps uncovering for instance, how men are distressed to the point of suicide in India due to agricultural losses leading to an inability to repay loans[i]; and the way in which women are more likely to die from floods because they have not learned to swim[ii] and cannot leave their houses without being accompanied by a male relative[iii].

A gender analysis in climate research allows understanding of socially constructed gender roles, relations and discrimination that shape the way climate change is perceived by men and women, how it will affect them differently and how they might organise different responses to mitigate greenhouse gas emissions and adapt to longer-term impacts. This recognition has influenced the climate change and development communities to adopt various mainstreaming approaches to integrate gender into projects and programmes.

This presentation will document a few examples where projects have integrated gender considerations to highlight :

- what knowledge a gender approach enabled to uncover ;
- challenges and opportunities to implement gender integrated planning ;
- potential negative impacts of a gender-blind approach ;
- any opportunities to foster greater gender equality and better climate compatible development outcomes.

Lessons from these examples will serve to draw recommendations for future projects and for policies to ensure that attention to gender equality is not sidelined in climate debate and programming. This is particularly crucial for supporting the Lima Work Programme on Gender which aims to promote a greater awareness and consideration of gender issues within climate policy for COP21 and beyond.

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3341-POSTER PRESENTATIONS

P-3341-01

Vulnerability and Adaptation to Climate Change and Extremes: Learning from Women's Livelihood in the Coastal Area of Bangladesh:

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Bangladesh is frequently cited as one of the most vulnerable countries to climate change because of its disadvantageous geographic location; flat and low-lying topography; high population density; high levels of poverty; and reliance of many livelihoods on climate sensitive sectors. It is assumed that women are particularly the most vulnerable group affected by the climate change impacts. Rural women are educationally, politically and socially disadvantaged, resulting in economic dependency and vulnerabilities. Growing empirical evidence supports the broad view that women's overall lower access to assets, service and voice makes women more vulnerable than men to the effects of climate change and natural disasters (World Bank, 2011). This study particularly examines the context of vulnerabilities of women in the disaster prone areas of Bangladesh, the impact of climate change and extremes on women's livelihood, and the adaption approaches that are followed by the women in response to climate change and extremes. The study was conducted following questionnaire survey method, focus group discussion, and key informants' interview in Shyamnagar upazila (sub unit of district) of Satkhira district. Shyamnagar is the most southern upazila of this district, and the Sundarban laid down in the major part of this upazila. The upazila occupies about 2000 km² area including 1630 km² forest area. The upazila consists of 13 unions (lower administrative unit), and the average population of each union is 24137 (Banglapedia, 2011). This area is situated in the most southwest part of the country, and widely exposed to the Bay of Bengal. Therefore, sea level rise, salinity, water logging, water surge, cyclone, increased temperature, all these climate change impacts are prominent there. This area is also known as the most affected area by the severe catastrophic event 'cyclone Aila'. During the cyclone Aila in 2009, this upazila was severely affected, almost 100 percent of the households were affected and their livelihoods were lost (UNDP, 2009). The sustainable livelihood framework (SRF) has been applied to analyse the data of the present study. Sustainable Livelihoods Approach serves as an instrument for the investigation of poor people's livelihoods, whilst visualising the main factors of influence. The result shows that several climate change events are simultaneously affecting this area increasingly for decades. These include salinity, frequent occurrence of disasters (e.g. cyclone), extreme weather condition (e.g. high temperature), water logging, flood, and sea level rise. Almost 100% of the respondents in personal interviews and focus group discussions identified these observations about climate change effects over time. The major effects they identified are income loss (95%), damage of livestock and poultry (80%), infrastructural damage (95%), and health damage (65%). Women are particularly affected as they have less income opportunity, facing health problems, food deficiency, malnutrition, and problems of housing and drinking water. Moreover, women are particularly vulnerable to climate change impacts since they have less mobility and less education due to social and religious norms. The absence of empowerment restricts women to take decision in any kind of natural and other events. Their options for adapting with climate change effects are also very limited which put them in a very insecure position. The common adaptation practices they follow are reduce food intake (90%), selling of assets (80%), receiving credit (98%), using saving (100%), seek alternative livelihood (95%), and use of social cards (92%). The adaptation options are mostly temporary and do not ensure the sustainable livelihood of women. They are struggling to adapt with the climate change scenario yet they have to do a responsible job for their entire family. In practice, concerted efforts from all concerned are required both at the national and the grass-roots levels to uphold the present distressed condition of women in the study area and to get adapted them in the ongoing challenges of climate change.

P-3341-02

What does it take to see transformative adaptation? Evidence from sub-Saharan Africa

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Throughout sub-Saharan Africa, men and women are already adapting to climate change. However, these changes are often small, incremental changes that

modify existing practices, such as modifying planting dates or changing crop varieties (Twyman et al. 2014). Encouragingly, we do see some farmers taking up what we term transformative practices – practices that contribute to diversified livelihoods, aim to buffer the household against climate changes, increase assets, and have a longer-term time horizon, but also require investments of time, labor, or cash. Transformative adaptations are both technological and behavioral and may require an adjustment in how resource are allocated, changing priorities and norms (Kate, Travis, and Wilbanks 2012). These transformative adaptations face significant barriers, including uncertainty in climate changes, perceived costs, and institutional and behavioral barriers (Ibid). Using a data set collected under the Climate Change, Agriculture, and Food Security Research Program of the CGIAR, this paper analyzes the social, behavioral, and institutional determinants of transformative adaptations in Kenya, Uganda, and Senegal, including perceptions and experiences of climatic risk and shocks, and identifies differences between men and women in terms of developing and promoting adaptive capacity. This information will be important for practitioners and policymakers seeking to identify barriers and manage tradeoffs in adaptation options at individual and household levels, as well as ensuring that both men and women have the capacities and resources to adapt to long-run climate change.

P-3341-03

Rebuilding Home-Women's Informal Participation in the Post-disaster Reconstruction and Recovery in Rural Areas, Sichuan, China

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The vulnerable population, such as females, seniors and youths, is possible to be hit the hardest by the climate changes. Their capacity to response and their resilience towards climate changes are much lower than other groups. In the rural area of Sichuan, China, due to the fact that the adult men are usually migrant workers in the urban area, their wives, elderly parents and children are the main residents in the local rural area. Hence, facing the extreme events (such as flood, landslide, earthquake, etc.) caused by the climate changes, the adult women play an important role in dealing with those crisis as well as the reconstruction and recovery issues after those crisis's. According to the Chinese governance, however, the different levels of government conduct almost all of these reconstruction and recovery projects. This kind of government-led model extremely limits local inhabitants' participation in the process of reconstruction and recovery and most local dwellers could be only informally involved into this process. Therefore, under this unique situation, this paper examines how the local adult female residents' informal participation contributes to post-disaster reconstruction and recovery. Conducting the in-depth interviews and participated observations with the local adult woman in the reconstruction area, this paper explores the role of the adult female residents' engagements into place-making process of rebuilding their own housing in the reconstruction stage. This paper argues that the local women's limited informal participation in the reconstruction promotes their emotional attachment towards the newly built environment. This kind of emotional attachment could ease their relocation and resettlement process and eventually identify the newly built environment as their new home.

P-3341-04

Poverty-Environment mainstreaming role of improved stoves in the fight against climate change

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As part of improving the living conditions of local populations and promoting environmental education, Environmental Research Development (ERD) organization with assistance from GEF Small Grants Program realized in 18 months, a pilot project to fight against the effects of climate change. The project was oriented towards school children in their campuses as part of their initiation to trees planting, and to the population of the five target areas the promotion of sustainable development at local level: Bockle, Sangere-Paul, Ndiam-Baba, Sangere-LANAVET and Sanguéré-Gal. Among other activities, training in the construction and use of improved wood burning stove has been a flagship activity.

A total of 278 people were trained theorically and practically on improved stove manufacturing technics: Ndiam-Baba: 40 people (35 women 5 men), Sangere-LANAVET: 69 people (60 women + 9 men), Sanguere-Gal: 60 people (57 women 3 men), Bockle: 55 people (54 women +1 men) Sangere-Paul: 54 people (49 women 5 men). The great campaign of improved wood burning stove construction yielded 263 cookstoves: Ndiam-Baba (36) Sangere-LANAVET (65) Sanguere-Gal (55) Bockle (54) and Sangere-Paul (53).

Indeed, it should be noted that 85% of the trainees are now use improved stoves. The use of these stoves have a positive impact on climate change in these localities as the people who use them save half of the wood needed for cooking their meals. The people who use these stoves save half of wood needs for cooking. In addition, this reduction on wood consumption thus shows an interesting decrease of pressure on the trees in these targeted communities. Similarly, say the past, the use of improved wood burning stove has positive health impacts and some family expenses related to the acquisition of wood and cleaning cooking pots

Project sustainability is ensured by the ownership communities through the Environmental Watchdog Committee (EWC) and organized the improved wood burning stove construction sessions to improve their different locations and at the same time to train and sensitize those who are slow to adopt this good practice management of natural resources such as trees.

P-3341-05

Women's Adaptive Innovations in Land and Water Management under Climate Change in Himalaya: An Illustration of Gender Mainstreaming in Climate Change Adaptation in Marginalized Mountain Environment

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In Himalaya, constraints of terrain and climate impose severe limitations on carrying capacity of natural system, productivity of resources as well as on efficiency of infrastructure and services. As a result, subsistence agriculture constitutes main source of rural livelihood for more than 75% population even though the availability of arable is severely limited and agricultural productivity is low. Owing to the constraints of subsistence agricultural economy and lack of other viable means of rural livelihood, a large proportion of youth male population out-migrates the region in search of livelihood and employment. Consequently, women have become 'primary resource developers' and 'backbone of mountain agricultural economy', and this resulted in feminization of agriculture and process of natural resource development in Himalaya. During recent years, a variety of changes have emerged in traditional agro-ecosystem in response to population-growth, rapid urbanization and economic globalization resulting into depletion of natural resource base and land use intensifications. Moreover, climate change has stressed traditional agricultural-system through rise in temperature, changes in precipitation pattern and increased frequency of extreme weather events increasing vulnerability of large population, particularly the poor and marginalized to food and livelihood insecurity. Women, experience these changes differently and disproportionately and respond them in varying manner because of socially constructed gender relations. However, feminization of agriculture facilitated women to develop critical knowledge in agricultural resources management and adaptation of their livelihood and food system to climate change.

The paper aims at analyzing innovative adaptation mechanism evolved by indigenous women to climate

change and assessing its impact on their role in decision-making and empowerment in agricultural resources and assets and reducing gender gap with case illustration of Kumaon Himalaya in India. The study employed comprehensive socio-economic investigation techniques and empirical field observations methods, and surveyed 2197 households in 62 villages using exclusively framed schedules. Results indicated mountain women make use of their critical traditional knowledge and experience in land and water management and adapting their agricultural and food systems to climate change. It was observed that: (i) women in 27% villages replenished water sources employing traditional water conservation practices; (ii)19% women changed cropping pattern, (iii) women in 25% villages developed indigenous rainwater harvesting system; (iv) 21% women adjusted crop-rotation; and (v) 27% women relocated agriculture; (vi) 55% women taking all decisions related with management of land and water resources; and (vii) 37% women are now solely responsible for of utilization, processing and marketing of their agricultural products. It was observed that women's innovative adaptation measures are not only building climate change resilience in subsistence mountain farming system, but reducing gender gap by providing women with the opportunity to come closer to mainstream of sustainable development through increased participation and decision-making in natural resource management, improved opportunities of rural livelihood and opening access to market for their farm products. However, the knowledge and skills of mountain women; and their contributions towards climate change adaptation through sustainable resources development, household well-being, community sustainability need to acknowledged and valued, and be integrated into climate change adaptation policy planning all across the Himalayan mountains.

P-3341-06

Unraveling the gendered effects of climate change related policies in climate smart agriculture in Uganda and Tanzania

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Achieving long-term gender-sensitive climate change adaptation at local and national level requires supportive climate policy framework, especially in vulnerable and food insecure countries such as Tanzania and Uganda. Intertwined with the multiple climate change related regulatory frameworks and action is the recognition and examination of the differentiated needs, constraints and preferences that men, women and different socio-economic and cultural groups have in a changing climate. However, the way gender is understood and articulated in climate change discourses will influence and shape how gender issues are dealt with in policies and interventions. Discourses on gender and climate change will determine which lenses are being used to study social vulnerability and adaptability to climate change and consequently shape what are the perceived problems and potential solution. Differing gender considerations in policy and programs might subsequently ameliorate, perpetuate or exacerbate pre-existing social inequalities. Taking a poststructuralist reflexive approach to narrative policy analysis, this study unfolds different understandings of gender issues in climate change adaptation policies in agriculture and analyzing the effects of gender discourses in climate-smart development projects in rural communities of Uganda and Tanzania. The study answers the research question: What does gender-sensitivity policy implementation mean to the variegated actors and groups in the context of climate-smart agriculture in Uganda and Tanzania and what are the effects of the prevailing meanings?

Methods are directed to identify emergent gender discourses in climate change adaptation policies in agriculture and to analyze the effects that these discourses have in the implementation of climate adaptation policies in rural communities of Uganda and Tanzania. Throughout the research, narratives are taken as a central object of study by focusing on the diverse ways in which people make sense of their lived experiences. This research examines both narratives originated in non-structured interviews and in more informal accounts such as ordinary conversational exchanges. For the latter, narrative research is combined with observational data and ethnographic methods of data collection. The research is embedded within the Policy Action for Climate Change Adaptation (PACCA) project led by the International Institute of Tropical Institute and funded by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

P-3341-07

The role of gender in improving adaptation to climate change among small-scale fishers

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Climate change, which has intensified during the last three decades of the 20th century, disproportionately affects marginalized groups in developing countries, especially women. To guide integration of gender roles in interventions to improve adaptation to impacts of climate change, gender roles were examined in a community of fishers on Lake Wamala in Uganda, which has been increasingly affected by climate change and is a designated environmental change hotspot. Data was obtained from a lake wide frame survey and qualitative surveys using daily activity analysis and benefit analysis flow chart tools, modified from Socio-Economic and Gender Analysis Approach (FAO, 2001). There was lower participation of women than men in fishing activities, with 99% of fishers and 92.9% of fish processors and traders being men. The men had more fishing experience, started fishing at a younger age and exited at a later age, targeted more species, used more fishing gears and bought more fish for processing and trading. Although there was observed diversification to non-fishery livelihoods, such as crop and livestock production to increase food security and income among others, income from these activities was not controlled or shared equally between men and women. Compared to men, women worked longer hours, engaging in more simultaneous activities both in and out of the home and reported less time resting. Most of the income generated and controlled by women was used directly to meet household needs, suggesting that adaptations adopted by women have greater potential to build resilience to the influence of climate change. Drawing from these observations, the implications of the differences between men and women for adaptation, what men and women can do best to enhance adaptation and how some adaptation practices and interventions can be implemented to benefit both men and women are presented.

P-3341-08

Engendering climate smart agricultural Innovations in East Africa

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Gender differences amongst African societies persist particularly in social, cultural and economic roles and responsibilities, access to information and agricultural inputs. Long-term climate change in Africa will have an impact on food security and incomes, and this is likely to have ramifications for gender relations. Studies have shown that gender in conjunction with other factors such as age, wealth, religion and class determines the ways in which the changing climate is experienced. This is because extreme weather events and climate related disasters in juxtaposition with socio-economic, institutional, cultural and political factors tend to intensify existing gender inequalities and responses to climate change in the agriculture sector. In East Africa women make up a large number of the poor in communities that are highly dependent on agriculture for their livelihood and are disproportionately vulnerable to and affected by climate change. Their limited access to resources and decision-making processes further exacerbates their vulnerability to climate change.

Against this backdrop, a study was conducted in east Africa with the aim of contributing new knowledge on how men and women adjust their livelihoods and coping strategies at individual, household and village level

in response to climate risks. Using integrative gender scoping tools and methods, a qualitative and quantitative research study was carried out. The objectives of the study were a) to characterize gendered climate risks over the past five decades, b) to identify the coping strategies that men and women farmers utilize in order to ensure a measure of food security in response to climate variability, c) to understand the resources available to men and women and the decision making processes utilized, and d) to identify the institutions that support women and men's decision making with regard to climate, agriculture and food security.

Two hundred farmers, half of whom are women were interviewed and 5 focus group discussions held. Research findings show that women perform 65% of off-farm work during drought because only a few of them have property rights (25%) and hence cannot sell/or trade any household goods to fill in the food shortage gaps. In terms of perceived changes in weather-related shocks over the last fifty years, more women than men report having observed floods, erratic rainfall and droughts.

The study shows that both genders are adapting to changing climate, and their changes are seasonal rather than transformational. 64% of men and 57% of women reported to have made changes in their agricultural, livestock or livelihood practices in response to the climate risks. Most women reported that they ration foods and just a few of them reported constructing water pans to store runoff and for use during drier periods, selling baskets and ropes, altering crop varieties and planting dates. However, this is done after seeking consent from the heads of households. Without the power to decide on family resources, women's ability to manage risks for example, by diversifying crops and livestock, altering planting dates is limited. In terms of accessing weather forecast and agro-advisory services 80% of men and 40% of women report having access to information on seasonal weather forecasts, inputs supplies and extension services. Women's inability to access new knowledge makes them more vulnerable to climate impacts than men and therefore, gender transformative activities including empowerment might be one approach to adaptation.

In the interest of gender equity and climate change adaption efficiency and resilience, these barriers must be alleviated or removed. Policy, strategies and investment responses at local and national levels must meet the specific needs of women and men. The methodology developed through this study as well as the research findings will be provided to policy and decision makers to develop Local Adaptation Plans of Actions (LAPAs) and National Adaptation Plans (NAPs) at County and National levels, respectively in a pragmatic manner.

P-3341-09

Adaptation and resilience of farming households to climate change using their indigenous knowledge: A study of the Niger Delta region

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The Niger Delta region in Nigeria is home to over 30 million people (Nigerian Population Commission, 2009), the bulk of which live in the rural areas. This region is characterized by immense poverty, and has suffered from a long history of socio-economic neglect and environmental degradation such as oil pollution caused by the multi-national companies operating in the host communities in the Niger Delta region. Thus the paradox of the Niger Delta is that of a region rich in natural resource but with significant percentage of its population living below the poverty line. Apart from the problem of environmental degradation caused by oil exploration in the region, the people have to contend also with the recurring problem of climate variability and climate change. The impact of climate change increases livelihood vulnerability of the rural farming households in this region. Climate change makes access to food sources unpredictable and increases poverty and disease. Women bear the brunt of all these and the resulting impacts of climate change affects them disapropriately. Women in this region constitute the most vulnerable group since they have limited access to land, which is a crucial determinant of their access profile. Climate change according to the United Nations Development Programme (UNDP, 2005) magnifies already existing inequalities, especially gender inequality. When confronted with the problems associated with climate change, the people of the region respond to this situation by developing coping strategies, on an individual and on a collective level. How the rural people respond to and adapt to the changes in their livelihood base using their indigenous knowledge are some of the questions my research intends to answer. Specifically the study examines how women who are the most vulnerable and marginalized group adapt and respond to climate change using their indigenous knowledge, in spite of the obvious gender inequality pervasive in the society.

P-3341-10

How Climate induced male migration critically affects women left behind?

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Cyclones, floods and droughts have been on the rise in both intensity and frequency over the last decades, leaving many citizens with few or no options to earn an adequate living to sustain themselves and their families in Bangladesh. As a direct result, migration has been increasing, with large numbers of people, mostly men, travelling to other regions in search of a better life and livelihood. The female population in areas of Bangladesh not only have to cope with the increasing effects of climatic change and natural disasters, but also the increasing patterns of migration of male family members. Most often women stay behind, usually with children and other members of the family, and take care of the household and try to make ends meet. This paper is based on a study conducted in 40 villages of 10 out of 64 districts in Bangladesh with support from UN Women and Norad.

The main objective of the study was to explore how climate induced migration of male members affect the women left behind. The study interviewed 40 local women (four women from each location-two local government representatives and two community representatives) from the climate vulnerable districts. The women were selected from the households from which at least one male member migrated mainly because of climate-induced hazards e.g. cyclone, increased tidal surge, salinity intrusion in surface water and soil, drought, water logging caused by tidal surge/excessive rainfall etc. Secondly, 20 Focus Group Discussions were conducted to meet the objective of the study. The secondary literature were collected and reviewed to determine tools and complement and verify the study findings.

The study denotes that migration of a male member from a family has various social, economic and mental impacts on the females and children of a family. The left behind family members feel insecure and face many problems including decision-making. The workloads on the female members also increase accordingly. The adaptive capacities of individuals greatly depend on income, education, health and access to natural resources. Scarcity of food can worsen a woman's nutritional status due to her marginalization within a household. Also, as women are mainly responsible for gathering water for the household, paucity of water might increase the burden on women. The impact on women is likely to be worse in developing countries like Bangladesh because of the deeper economic and social gender divide. It was found that women, mostly living alone with children and other female members and in-laws face adversity on a day-to-day basis. In most cases it was found that the male members were unable or in cases simply unwilling to send money back to their households, leaving the women to find any means of survival during these periods of migration. In some situations, women were being looked down upon by the other members of their society due to the absence of their male family members, some reported harassment and assault. In some regions, women living without their male family member have become targets and thieves are targeting their households. Still existing social norms and practices across the country lead to the discrimination of women and their rights, which are only exacerbated during times of male migration. On top of unpaid care work such as fetching water, cooking and taking care of children, women who can find employment often have unstable income with some women reporting an increase in physical, emotional and mental stresses. Moreover, women eat less and work more, either because

they cannot earn enough, or because of social norms and practices that dictate women must to feed their families first. With a lack of social support mechanisms and adequate policy environment to protect women's rights, the process of male migration due to climate change may in fact contribute to a worsening situation for gender inequality.

Yet, in spite of the negative impacts of migration in most cases, if not all, migration can help families to stay afloat, and in even improve overall financial conditions. Thus, in a disaster stricken country like Bangladesh, migration can be a negative and positive approach to dealing with climate change.

P-3341-11

Gender Justice and Sustainability in REDD/REDD+ Climate Change Projects in Indonesia and the Philippines

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Women's empowerment and indigenous rights have been widely embraced as foundational principles of international social and economic development for several decades in recognition of the transformational potential for achieving intertwined goals of human rights and sustainable development. Programs to address climate change are no exception, and the growing urgency of finding means to mitigate its potential ravages requires finding effective ways to fully incorporate women and other marginalized groups into these efforts. A growing body of literature documents the importance of gender justice to this effort, yet achieving it often remains illusive. A prime example is found in REDD/REDD+ projects, the United Nations collaborative program for Reducing Emissions from Deforestation and forest Degradation. As a key initiative for preserving forest resources and associated ecosystem services, it is equally important for goals of sustainability, gender equity, and empowerment of marginalized groups.

According to the UN, REDD "is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. 'REDD+' goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks" (http://www.un-redd.org/aboutredd/tabid/102614/ default.aspx, accessed May 25, 2014). These projects have been initiated in a variety of countries and regions with significant forest resources and forest resource loss, and different levels of economic development. The goal of REDD/REDD+ is to encourage developing countries to conserve and maintain their forest resources by making standing forests more profitable than felled forests. In addition to creating an economic incentive for the conservation of these forests, REDD/REDD+ was envisioned as catalyst for addressing social issues facing these countries, including poverty and inequality. In theory, REDD/REDD+ projects must both comply with gender mainstreaming practices and benefit indigenous communities. A major criticism of REDD/REDD+ is that, as a neoliberal policy that prioritizes economic growth, the principles of gender mainstreaming and community inclusion remain lofty policy ideals rather than on-the-ground reality. Due to limited capacity for monitoring and evaluating projects, as well as on-going corruption and mismanagement, the fear of critics of REDD/REDD+ is that disempowered groups, including women and indigenous communities, will be further marginalized through the implementation of REDD/REDD+, despite stated policies to the contrary.

This paper is based on the comparative research on challenges and progress toward effective gender equity and mainstreaming as well as involvement of indigenous communities in REDD sites in Indonesia and the Philippines. We focus on these two countries because of the similarities in the level of economic development and the characteristics of the ongoing REDD/REDD+ projects. We interviewed scholars, community members, policy analysts, and activists who have been involved in designing and implementing various REDD/REDD+ programs in these two countries. The results highlight the development and obstacles of these two resource rich countries in implementing REDD/REDD+ programs.

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3342-POSTER PRESENTATIONS

P-3342-01

Adaptation pathways for inland aquaculture in northern Thailand

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Background: Aquaculture systems are likely to be impacted by changes in climate; not all impacts are expected to be negative, and in some situations aquaculture may become an alternative to land-based agriculture. Most aquaculture systems, however, are vulnerable to water scarcity, and their interactive effects on water quality, as well as extreme floods, storm surges and sea-level rise. Inland aquaculture in Northern Thailand is important for livelihoods and a significant economic activity that is sensitive to climate variability and water management. Aquaculture production for commercial purposes, as well as direct consumption, takes place in earthen ponds, and in cages in rivers and reservoirs. Adaptation pathways with inland aquaculture in Northern Thailand are needed which allow reasonable actions to be taken now, for instance, to strengthen management of climate-related risks, while also leaving flexibility in households, and the sector as a whole, for adjustment of strategies in the future.

Purpose: The purpose of this paper is to report on the findings of the AQUADAPT research and assessment process to: (1) identify the key sensitivities of inland aquaculture systems to climate-related risks; (2) assess farm household efforts to manage those risks under current climate variability; and (3) apply this understanding to identify strategies for building the resilience of aquaculture social-ecological systems, and in developing plausible, context-specific, adaptation pathways for aquaculture in northern Thailand.

Methods: Combination of new research, review of past work, expert synthesis and participatory, local assessments, was used. Four qualitative climate change scenarios - wetter, drier, more seasonal, and less seasonal - were constructed, based on a set of downscaled climate projections for 2040-2059, to capture key uncertainties in future climate in northern Thailand. Scenarios were also developed for water and fish demand to complement the four for climate yielding a total of 16 combinations or final scenarios. These 16 scenarios were used to explore the robustness of proposed adaptation strategies at various levels, and construct alternative adaptation pathways.

Results: Adaptation measures or strategies are being pursued, or have been proposed, at the farm (household), watershed (community) and sector (national) levels. At farm level the focus is on rearing practices and business management. At the watershed level important actions relate to sharing of warning information, and the formation of fish farmer's groups to influence water resources management. At the sector level insurance, voluntary standards, and investments in research and development

are frequently recommended. Examples of measures emphasizing the management of specific climate risks, as well as broader strategies for building resilience of the aquaculture social-ecological system, were found at each level. The emerging adaptation pathways for aquaculture include some contradictory elements reflecting uncertainties about effectiveness, differences in development ideologies and expectations for the sector. Either way, it is clear that adaptation strategies need to be integrated with other efforts to improve sustainability, for instance, encouraging best practices in disease management or waste water treatment and disposal

Significance: Identifying adaptation pathways for aquaculture in northern Thailand, in particular, and in the tropics or subtropics, more broadly, seems plausible as key species can be reared in a broad range of systems in the warm waters and the sector has significant capacity for self-organization and innovation. At the same time there are widespread concerns about the availability of suitable quality water for production in the future, underlining the importance of sustainability of water use and aquaculture practices to adaptation. Public sector support for building climate resilience of aquaculture industry in northern Thailand should: (1) strengthen the knowledge foundations for adaptation; (2) support improvements in the management of climate-related risks under current climate variability; (3) improve water and watershed management; and, (4) acknowledge in policy and planning that adaptation will need to be context specific.

P-3342-02

Coastal hazards and climate change in the Loyalty Islands (south-west Pacific), multi-disciplinary approach

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This communication presents the objectives and preliminary results of a study concerning the evolution of atoll's coastlines with climate changes and their social involvement. This work is carried out in the southwest Pacific and is funded by the Government of New Caledonia, the European Union (Program INTEGRE) and the French Ministry of overseas territories (Program MOM). In order to provide some guidelines for the Ouvea (Loyalty Islands, New Caledonia) stakeholders involved in costal risks management, a dual methodological approach is undertaken to understand the complexity of the relationships between social and physical processes associated to coastal evolution of atolls with climate changes.

Concerning the physical process, the geomorphologic vulnerabilities of islands are first studied in relatively large spatial and temporal scales, using diachronic analysis of aerial and satellite imagery of Ouvea Island over the last 60 years. At the same time, a monitoring of current coastal sediment dynamics is realized on the sandy shores of the Island. A continuing survey over two years is planned on the main beaches of the Island, which strongly suffer from erosion processes. The goal of this survey is to obtain in-situ data concerning the impacts of rapidly evolving phenomena such as cyclones, tsunamis, tornadoes, or blows. As an example, we will present a quantified analysis of the impact on the northern part of Ouvea Island after the passage of the cyclone PAM (Category 5, 894 mbar, mid-March 2015) that hits the Vanuatu archipelago, which is close to Loyalty Islands. The topometry measurements are performed through two approaches: (1) various specific and expensive methods (DGPS, Photo restitution from aerial surveys by UAV) and (2) less sophisticated methods (up to the frame, site level) less precise but less expensive and without requiring specific technical skills, allowing the involvement of local people. In a Pacific area bereft of resources, the purpose is to provide methods to survey environmental phenomena affecting small isolated islands. The aim of this approach is to initiate a participatory monitoring program of the coastline. Training observers throughout this project, coupled with the creation of wide information campaigns / awareness raising and maintaining a strong link with the local administrative structures and tribal representatives are essential for long term success in Oceania. This approach is particularly vital for theses islands, where the land planning and management is almost exclusively under tribal authorities. Therefore, it is essential to involve people in the implementation of these strategies. The recognition of tribal law in New Caledonia prohibits any top-down or bottom-up process in management.

Another aspect of the method is the creation of a quantitative and qualitative database of extreme weather events, such cyclones and tornadoes, based on the processing of historical archives. The aim is to better understand the current evolutions of the region from the perspective of the dynamics of the hazard (time, power, path ...) by providing additional analysis of documents and data, now available to the Caledonian Weather Service. Moreover, we will address vulnerability issues (human, environmental, economic) and capacity and / or resilience strategy developed in societies studied for over 150 years. Mastering these issues related to the past and present social and climate change will help to better understand the abilities of atoll's stakeholders in terms of adaptation and limitations to which these strategies will be faced by the end of the century. A database of more than 285 extreme weather events that impacted the New Caledonia since 1830 has been established and is being analyzed. The case study of the tsunami of March 28th 1875 to determine the exact impact of this major event on the Loyalty coastlines will be presented.

In conclusion, we point out the importance of developing integrated, holistic approach of coastal dynamics, both from physical and socio-cultural perspectives, and so to provide the best adaptation strategy regarding the evolution of atoll's coastlines with climate changes.

P-3342-03

Balancing Consumers' Satisfaction with Water Quality and Reducing Energy Use: A Case Study in Japan

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Japan ranks fifth among the countries that produce the highest Greenhouse gases (GHG) emissions (UNFCC, 2012). In light of the Fukushima nuclear disaster in 2011, the country has revised its GHG reduction targets to 3.5% in 2020 from 2005 levels. The Fukushima disaster led to the shutdown of atomic power plants leading to rise in the use of fossil fuels, which makes this reduced target also look daunting. Although the water supply sector in Japan accounts for less than 1% of the total emissions, it is important for this sector to reduce energy use since it is only through collective contributions of all sectors that the GHG reduction vision can be achieved.

Japan has a well-developed water supply system and over the years, there has been a systematic progress in the nature and type of water treatment. However, in recent years the consumers' expectations of water quality in Japan have been on the rise. A survey conducted in Osaka by the authors in 2007 revealed an increase in the number of complaints with regard to water quality in the last decade, suggesting a decline in Consumers' Satisfaction with Water Quality (CSWQ). CSWQ can be improved with advanced water treatment like membrane filtration, ion exchange etc., but the energy requirement for such processes is high. Hence, it is difficult for the utilities to meet the GHG emission reduction targets as well as maintain/improve CSWQ. There is a need to arrive at an optimal balance between the two, which is the objective of this study.

The rationale behind the study's methodology is to link the energy source with CSWQ so that when scenarios of reduction in energy use are considered, corresponding changes in the CSWQ can be observed. Data required for this study was procured from Kobe City Waterworks Authority (KCWA), Japan. The study involved three distinct stages:

(a) Evaluating CSWQ: An internet based questionnaire survey was used to assess the CSWQ, in which respondents were asked to evaluate eight items. Factor Analysis was then performed to quantify CSWQ, as presented in

Equation 1.

CSWQ = (0.347 x Trust in water utility) + (0.313 x Good quality water) + (0.197 x R&D in water utility) + (0.162 x Equity of distribution) + (0.144 x Price of water).....(1)

(b) Developing a mathematical model to link CSWQ with energy use: To do so, a two-step procedure was followed. In the first step, ten services areas were chosen from where maximum questionnaire responses were received, and the CSWQ for each area was calculated using Equation 1. After this, for the same service areas the magnitudes of selected Performance Indicators (PIs, developed in our earlier study) of water supply delivery— Financial Sustainability (FS), Green Water Supply (GWS) and Economic Value of Water (EV)—were evaluated. The relationship between the CSWQ and the PIs was then established using multiple linear regression, (Eqn 2).

CSWQ = 0.083 - 0.004 FS - 0.001 GWS + 0.001 EV.....(2)

In the second step, relationships of the PIs with energy use were established. To do so, a series of models were developed. For KCWA, the main source of GHG emissions is due to energy use (power). Hence, the first model, Model 1, was developed to relate the GHG emissions with Power Consumption (PC), using appropriate emission factors. A second model was developed to relate PC and water production volume (eqn 3), and water production volume was linked to the three PIs through models 3, 4 and 5 (Eq 4, 5, and 6).

Model 2: Water production volume = 1.75 + 2.68 x 10^ -3 Power Consumption.....(3)

Model 3: Financial Sustainability = 2.07 - 5.34 x 10^-3 Water production volume.....(4)

Model 4: Green Water Supply = 4.78 - 0.14 Water production volume.....(5)

Model 5: Economic Value of Water = 17.06 + 0.41 Water production Volume.....(6)

(c) Balancing CSWQ and reduction in energy use: In order to do so, five scenarios of reduction in GHG emissions from the base condition (2010 level) were considered: 5, 10, 15, 20 and 25%. On one hand, the reduction in PC required for each scenario was calculated. On the other, the CSWQ for each scenario was calculated using Equation 2, with the corresponding values of the three PIs (using models 1 and 2 consecutively). The optimal GHG reduction is found by equating the two trends. The study revealed that the KCWA can target only 3.5% GHG reduction for balancing CSWQ and reducing energy use.

P-3342-04

Fugitive methane emissions from Indian coal mining and handling activities: Estimates and opportunities for its utilization to generate clean energy

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Fugitive methane emissions from coal mining and handling activities are a prominent source of greenhouse gas (GHG) emissions from India. The total GHG emissions from India's energy sector were around 1.4 million Gg-CO2 equivalent in 2007, out of which ~34,000 Gg-CO2 equivalent belonged to fugitive emissions from fuel extraction [1]. The fugitive emission estimates calculated mainly by using India-specific emission factors developed by CIMFR suggest that Methane emitted annually to the atmosphere from Indian coal mining and handling systems has gone from 0.555 Tg for the year 1991 to 0.772 Tg in the year 2010.

The Integrated Energy Policy of the Government of India projects that coal consumption in India shall grow at the rate of 6 per cent per year. The current production is projected to touch 630 million ton in 2015 and around a billion ton by 2020. Taking the future projections of coal production and consumption, we also project the future trend of methane emissions from coal mining and handling activities of India.

The methane generated from coal mining and also as coalbed methane has the potential to serve as a clean fuel. There are several opportunities for this methane to play its part in the meeting of sustainable energy demands in India. This is more so relevant with the Indian government showing signs of encouraging clean coal technologies (CCTs). There are several mechanisms for this in the Indian context. This includes:

1. Coal Mine Methane (CMM): We completed a project recently funded by the US EPA for feasibility of CMM in three major coalfields in eastern India, viz. Jharia, Bokaro and Raniganj coalfields. At first glance, it appears that Kalidaspur and Ghusick collieries in the Raniganj Coalfield, Murulidih, Amlabad, Sudamdih and Parbatpur mines in the Jharia Coalfield and Jarangdih and Sawang collieries in the East Bokaro Coalfield are promising sites for CMM recovery. The measurements and potential for CMM in these mines shall be talked about in details in this paper.

2. Ventilation Air Methane (VAM): CIMFR, along with Southern Illinois University at Carbondale completed a joint project on VAM utilization in India. We have made some assumptions with the (½) × 10 model, wherein it is assumed that fifty per cent of the CMM resource within a mine boundary can be exploited in 10 progressive years. Our calculations suggest that installation of just two rotary kilns, revenue of US$ 2.8 million can be generated in two years. The details about VAM opportunities shall be covered in detail.

3. Abandoned Mine Methane (AMM): There has not been any effort to identify the abandoned mines and quantify the AMM resource in India. It is thus, imperative to undertake a study to evaluate the AMM resource potential of the country before any utilization potential is planned.

4. Coalbed methane (CBM): An estimated potential of 400 BCM of coalbed methane exists in three states alone (Jharkhand, West Bengal and Chhatisgarh). Efforts are already underway for exploitation of CBM in India [2].

Such mechanisms, if employed shall serve as a useful tool to reduce atmospheric emissions as well as to find new avenues of cleaner energy in India. This is even more important because India is naturally devoid of high natural gas reserves and such methods can help in bridging the gap for this.

It is hoped that this paper shall present a useful analysis for policy makers and the industry to get an overview of the scientific status for clean energy in India through methane emissions from coal mines.

References:

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P-3342-05

Linking Climate Change and Disaster Risk Reduction in Asia and the Pacific

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Climate change adaptation is receiving increased attention, particularly among developing countries. As part of the work under the Cancun Adaptation Framework, UNFCCC Parties established the Warsaw International Mechansim for Loss & Damage associated with Climate Change Impacts at COP19 to consider approaches to address loss & damage associated with extreme and slow-onset events, particularly for countries most vulnerable to climate change.

Under its Climate Adaptation Framework, the Asia-Pacific Network for Global Change Research is addressing adaptation through approaches that support research, data collection, enhanced coordination, enhanced regional cooperation and strengthened institutional arrangements. Specifically, the APN launched a special focussed activity that aims to link climate change adaptation (CCA) with disaster risk reduction (DRR) and loss & damage (L&D). A series of projects are underway that are addressing such

issues as the risk of slow onset events, economic and non-economic L&D, CCI on most vulnerable, approaches to slow onset and extreme weather events, integrating slow onset and extreme events into climate resilient development processes, and how climate change is affecting patterns of mitigation, displacement and human mobility.

The presentation will provide an overview of how APN's Climate Adaptation Framework is responding to climate change challenges by providing a flavour of the fifteen projects currently underway in the Asia-Pacific region, all of which are undertaking regional-based research activities and/or capacity building with specific foci on linking CCI, DRR and L&D. The session will then go into more detail by providing information and important outputs to date from projects being conducted in South and Southeast Asia.

Topics covered will include:

(1) major low-lying coastal cities Southeast Asia that are severley impacted by severe flood events and how sectors, such as agriculture, in these areas will face increased challenges as impacts of extreme events are projected to worsen;

(2) solutions-oriented research outputs of how best to integrate climate change adaptation with disaster risk, particularly for slow onset events; and

(3) work being undertaken to address the important need to integrate adaptation to climate change into development planning in policy- and decision-making communities.

4401 - Sustainable development goals and the new climate regime : synergies for change ?

ORAL PRESENTATIONS

K-4401-01

Sustainable Development Goals, Science and Politics

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Based on his experience as co-chair of the Open Working Group (OWG) on Sustainable development goals (SDG), Mr C. Kórösi will be talking about the lessons for the SDGs learnt from the OWG negotiation process, especially focusing on science policy interface. This will include his personal reflection of the OWG process in terms of science and policy, and personal views on how science could contribute to the post-2015 development agenda and their implementation process.

O-4401-01

Governance through Goals: Options and Opportunities for the SDGs

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Two unanticipated consequences in formulation of the Sustainable Development Goals (SDGs) from the outcome of Rio+20 are of great importance for governance for sustainability: that the SDGs would link sustainable development to the continuation and strengthening of the Millennium Development Goals (MDGs) in a single agenda at the centre of a post-2015 development framework; and that their negotiation would entrench "goal-setting" as a dominant strategy in global governance. This single, goal-oriented agenda, is not simply a continuation of unfinished elements of the MDGs, but it aspires to build from their central mission of poverty eradication and social inclusion a universal, integrated agenda that also responds to growing social and planetary complexity in the twenty-first century. While the very notion of negotiating a set of SDGs is remarkable in its own right, they mark an equally significant shift in global governance strategy: from norm promotion and rule-making to goal-setting.

O-4401-02

Allocation of resources to LDCs for adaptation - A climate vulnerability index

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An amount of resources, still to be determined, will be made available for the adaptation to climate change in developing countries, in particular to Least Developed Countries. Since these countries are not responsible for the global impact of climate change, it seems equitable to allocate concessional resources mainly according to their vulnerability to climate change (beside their low level of income per capita). For doing that we suggest to use a physical index of vulnerability to climate change reflecting the likely shocks resulting from climate change and faced by each country independently of its will, what means an index not taking into account any policy factor of resilience. Such an index has been built on an exploratory basis at Ferdi with this aim in view. Complementarity and consistency with the allocation of development assistance models using income per capita, structural economic vulnerability and governance indicators as criteria will be also underlined.

O-4401-03

A poverty - adaptation -mitigation window within the Green Climate Fund

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The stakes for poverty alleviation and the measures required to avoid unbridled climate change are inextricably linked: on the one hand, climate change may slow down and even reverse trends in poverty reduction; on the other hand trajectories consistent with a 2°C - temperature increase require poverty alleviation strategies to integrate the constraint of a low carbon development.

Existing climate funds have failed to target poverty alleviation as a high priority of adaptation strategies

It is important to distinguish adaptation actions that are purely aimed at adapting to impacts of climate change and would not otherwise be initiated, from broader adaptation needs and development-related actions to reduce climate change vulnerability, i.e. actions to reduce the adaptation gap. The existing project-based approach of the Adaptation Fund is more adequate to deal with the first category of adaptation actions, while it is likely that poorer regions and communities need to look more specifically to the adaptation deficit. How can a single financial instrument address both in an optimal manner? So far, all attempts to create aggregated vulnerability indicators relying on a single number have revealed unsatisfactory to determine where available funding should be used in priority, as these indicators lead to contradictory results and often depend on value judgments on which there is no consensus.

Allocation of climate funds focusing on development-related actions to reduce climate change vulnerability requires defining a set of indicators that reflect factors of poverty.

Existing climate funds and the CDM have failed to target poverty alleviation as a necessary component of a low carbon development

Existing climate funds and the CDM have mainly allocated resources to high-emitting developing countries, or to countries with a rapid growth in their GHG emissions. To maximize the environmental efficiency, climate funds and financial mechanisms favour projects or actions that maximize the quantity of emission reductions. Such indicators are not adequate with poor countries with no mitigation potential relative to a historic reference because the development deficit leads to low initial emission levels.

To favour low carbon development opportunities in poor countries, other indicators than emission reductions relative to a historic reference scenario should be used.

Description of the poverty-adaptation-mitigation window (PAM-W)

To go beyond these obstacles in targeting poverty alleviation as an adaptation strategy and as a component of a low carbon development, we propose to complement the existing adaptation and mitigation windows of the Green Climate Fund (GCF) with a window focusing on synergies between poverty alleviation, adaptation and mitigation.

Actions funded within this window would either be sectoral programs or policies in order to be consistent with the GCF objective of paradigm shift.

A series of macro indicators that reflect factors of poverty would be used for the selection of beneficiaries.

The aid mechanism would be based on national or regional benchmarks reflecting the per capita cost for providing a specific basic need (the cost of providing access to sanitation to one additional person, the cost of providing access to electricity to an additional person).

Part of the funds allocated would be transferred based on the actual implementation of the action. The allocation metric would be the actual net changes in the number of people gaining access to the concerned basic need. Countries would be free to develop their own strategy, and they would have to finance it initially, from domestic resources, existing development aid channels or international private capital.

Given the huge financing needs to address GCF objectives, available financial resources for the PAM-W would be limited and financial modalities within the PAM-W would have to limit windfall profits and to vary according to income category of countries. Additional conditions could reinforce the appropriation of actions by countries: co-financing for low income countries, private financing for upper -middle income countries.

O-4401-04

SDGs as way to better mobilize funding for climate and for development ?

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(1) African Development Bank, Director, resource mobilization and external finance department, Tunis, Tunisia

Based both on his expertise in development economics and on his experience as an economist within a multilateral development bank (the African Development Bank), Dr D. Vencatachellum will present his analysis of how SDGs could help better mobilizing funding for climate and for development, and will also react to the proposals made by other presenters in the panel.

O-4401-05

Raising the ambition: How the global climate agreement can affect the achievement of the Sustainable Development Goals

N. Walmsley (1)

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N. Walmsley (HR Wallingford), A. Ansuategi (Metroeconomica), P. Greño (Metroeconomica), V. Houlden (HR Wallingford), A. Markandya (Metroeconomica), L. Onofri (Metroeconomica), G. Tsarouchi (HR Wallingford) and H. Picot (CDKN)

In the coming year, key decisions will be made on several intergovernmental agendas, including climate change, disaster risk reduction, sustainable development and financing for development. The impacts of climate change resulting from varying levels of ambition over long-term horizons (e.g. to 2050 and beyond) are a current focus of much global research effort. However, little is known about the projected impacts of the climate deal on development in the shorter term.

This paper seeks to fill a knowledge gap by investigating the development impacts projected for varying levels of climate ambition in the 2015 climate deal, as such a deal will necessarily impact on national decision making around resource allocation and development priorities. The Sustainable Development Goals (SDGs) are used as a lens through which to measure and frame the question: How can the global climate agreement affect development in the period to 2030? Using a combination desk study, integrated assessment modelling (IAM) and information from the literature, a subset of the 17 proposed SDGs are assessed according to the projected socio-economic outcomes of binary climate ambition scenarios.

Two scenarios are considered: a high ambition agreement (to limit global warming on pre-industrial levels to 2C by 2100) and a low ambition agreement (to limit global warming to 3-5C by 2100). These scenarios are represented by coupled representative concentration pathways (RCPs) and shared socioeconomic pathways (SSPs). This allows both climate impacts and socioeconomic impacts of a high or low ambition 2015 climate deal to be considered, and the impact on national and regional development pathways to be investigated.

A broader regional scale assessment of Africa, Asia and Latin America and the Caribbean (LAC) is complemented by deep dives into 3 case study countries/regions: Uganda, Pakistan and the Caribbean. This selection of climate vulnerable countries gives a representative coverage of a least developed country (LDC), a middle income country (MIC) and a small island developing state (SIDS), all of which are groups of countries with particular development challenges.

Our findings show:

- The decisions taken at UNFCCC COP21 in Paris will have a significant impact on global development by 2030, even before the resulting climate impacts are felt.
- A high ambition agreement that aims to minimise global warming to 2C by 2100 on pre-industrial temperatures is essential to have the best chance of achieving the SDGs by 2030.
- A high ambition agreement is most crucial to achieving the draft SDGs on poverty (SDG 1), inequality (SDG 10), climate change (SDG 13) and global partnerships for sustainable development (SDG 17).
- Country case studies were used to compare and contrast with the above high-level regional findings.

Negotiators and the development community should find the outputs of this research useful to advocate for a stronger climate deal, and to ensure that the SDGs deliver climate smart development in the poorest and most climate vulnerable countries.

4401-POSTER PRESENTATIONS

P-4401-01

Bottom-up formation and stabilization of a grand climate coalition under rationality

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After the Copenhagen failure, recent negotiations have seen a shift from the Kyoto top-down agreement to the Durban bottom-up process of national pledges. Economic models had predicted that an effective (near-)global climate protection "coalition" was likely "unstable". The public good character of emissions reductions, related positive externalities, and the resulting incentives for noncompliance and freeriding pose difficulties for achieving sufficient levels of international cooperation (Barrett 2005). Although the bottom-up approach may enhance negotiations, Lima has again shown the slow progress and the large uncertainties involved about the process. Formal analyses of the strategic interactions can shed light on the negotiators' behaviour, but often neglect the time-evolving ("dynamic") process inherent in negotiations.

In this talk, we present a dynamic and stochastic game-theoretic model of the process of coalition formation and its implications for the prospects and uncertainties of bottom-up climate coalition formation under the usual assumption of rationality. It includes these novel features: (i) Unlike most existing models, we assume that over time, the major GHG emitting nations can form, grow, merge, shrink, split, or terminate any number of coalitions. (ii) In proportion to bargaining power, players can repeatedly propose changes in the coalition structure, and a proposal will be accepted if it is profitable for the responsible players and not dominated by another move of the same or fewer players. (iii) When assessing profitability, players may farsightedly anticipate later moves to some degree. (iv) Uncertainty about who will propose next leads to unresolvable uncertainty about the sequence of moves (the realised "pathway"), leading to a consistent scenario of different branching pathways and their probabilities. (v) Uncertainty about players' expectations may lead to the existence of several competing consistent scenarios, each of which represents a different (but common to all players) set of expectations.

Our main findings support the hopes that a bottom-up process may work eventually: (1) for each parameter

setting, there is typically more than one consistent scenario, but in all of them a stable global coalition will be formed eventually. (2) No formed coalition will be terminated later although the model explicitly allows unilateral termination of agreements. (3) Typically, there are several handsful of competing pathways towards global cooperation, and they differ in the number of steps needed and in their allocation of mitigation costs. (4) This path uncertainty is largest in the early steps of the process, where typically (a) the most vulnerable nations and those with the lowest mitigation potential ("reluctant" players) exhibit chicken-game-like behaviour by trying to delay their own cooperation, in order to free-ride for as long as possible and to achieve a better bargaining position for their later entrance into an existing coalition, while (b) at the same time, the least vulnerable players and those with the highest mitigation potential ("eager" players) compete for forming a coalition with many reluctant players and few other eager players, in order to get a higher share of the vulnerable nations' gains from avoided climate change via surplus sharing and to get a higher compensation from them for their mitigation services. (5) Surprisingly, in our model these strategic interactions do however not lead to a stalemate without progress since such a stalemate would not form a consistent set of expectations. (6) Among the alternative consistent scenarios, there is typically one "focal" (Schelling 1960), relatively symmetric scenario in which no player has a considerable advantage, and several asymmetric scenarios in each of which one player is at an advantage.

To complete our strategic analysis, we finally present a strategy by which a coalition of rational players may incentivise compliance with their agreement to make the latter self-enforcing (Heitzig, Lessmann, Zou, PNAS 2011). It consists of a simple temporary redistribution of liabilities in proportion to preceding shortfalls and can be seen as a renegotiation-proof improvement of the Kyoto protocol's noncompliance rules.

P-4401-02

Building an Index of Physical Vulnerability to Climate Change

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The Index of Physical or Geophysical Vulnerability to Climate Change differs from the other indices on vulnerability to Climate Change by only considering this part of the vulnerability which does not depend on the present policy. To this aim it relies only on physical components likely to reflect an impact of climate change, without any use of socioeconomic data. It is an index of physical vulnerability to climate change, changing only progressively and slowly.

It also differs from other vulnerability indices, both from the more general environmental vulnerability indices, which most often include resilience and policy components, and from the Economic Vulnerability Index (EVI) used by the Committee for Development Policy for the identification of the Least Developed Countries (LDCs). The EVI is related only to physical vulnerability, as the present Physical Vulnerability to Climate Change Index (PVCCI), but it differs from the latter: it covers all kinds of exogenous shocks likely to affect economic growth, it refers to a shorter term horizon and it tries to capture a handicap to economic growth rather than a risk of a change in geophysical conditions. Thanks to these features, the PVCCI, set up at the country level, could be used as a criterion for the geographical allocation of the international resources available for the adaptation to climate change. It is a relevant criterion precisely because it doesn't depend on the present policy, and it only gives an indication of the need for adaptation. By the same way the EVI has been proposed as a possible criterion for the allocation of development assistance. The design of the PVCCI draws both from the environmental literature and from the attempt to measure physical economic vulnerability, as it is done by the Economic Vulnerability Index. As an environmental index, the index relies on components reflecting the physical consequences of climate change that can directly affect population welfare and activity, rather than an assessment of their long term economic consequences, which would be more debatable. The index relies on eight components, considered as relevant, reliable, and available for the whole set of developing countries and easily understandable, so that the index can be used in a transparent manner. These eight components respectively capture the risks related to progressive or cumulative shocks due to climate change and the risks related to the intensification of recurrent shocks due to it.

The PVCCI has been calculated on the basis of data covering the last 60 years for 146 developing countries and territories. Results evidence a high heterogeneity among countries in the level of physical vulnerability to climate change and an important vulnerability of SIDs, even within a same regional area. The high physical vulnerability to climate change of the LDCs and SIDs is highlighted by the index. These groups of countries are already found to have aa high economic vulnerability, as evidenced by EVI.

4402a - Low carbon pathways for staying below 2°C: Global requirements

ORAL PRESENTATIONS

K-4402a-01

Dr. Leon Clarke

L. Clarke (1)

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The long-term goal of limiting temperature change to less than 2C will require deep reductions in greenhouse gas emissions. Net global CO2 emissions, in particular, must eventually be brought to or below zero to meet this or other long-term temperature goals. Emissions reductions of this magnitude will require large-scale transformations in human societies, from the way that we produce and consume energy to how we use the land surface. The more ambitious the stabilization goal, the more rapid this transformation must occur. A natural question in this context is what are meaningful "transformation pathways" towards stabilization; that is, how do we get from here to there? This presentation provides an overview and introduction for understanding transformation pathways to 2C and other temperature goals.

This presentation will draw heavily from a large body of scenario research summarized in Chapter 6 of the Working Group 3 contribution to AR5. Over 1000 new scenarios published since AR4 were collected from integrated modeling research groups, many from large-scale model intercomparison studies and synthesized in WG3. These scenarios provide important information on key questions such as the near-term emissions reductions consistent with meeting long-term goals, the costs of mitigation, and the energy and land system transformations. In comparison to AR4, new scenarios have considered more ambitious concentration goals, a wider range of assumptions about technology, and more possibilities for delays in global mitigation and fragmented international action than those published previously..

Drawing on this literature, the presentation will address several questions that provide context for understanding transformation pathways. First, to what degree is it possible to link between near-term emissions reductions with the goal of limiting temperature change to less than 2C or other goals? While it is possible to draw some conclusions about this link, the relationship is heavily influenced by assumptions of what sorts of future emissions reductions are feasible. Further, the relationship between any temperature goal and emissions and concentrations is highly uncertain, meaning that this relationship can only be expressed in terms of the probability that temperature will remain below 2C. Second, what are

some key characteristics of transformation pathways that maintain likely temperature change below 2C? Key characteristics include emissions reductions rates, sectoral emissions reductions, economic costs, and technology transformations. Finally, to what degree can scenarios inform questions about which pathways are more feasible than others? Mitigation actions inherently involve a wide range of tradeoffs that link to social and policy objectives such as economic growth, energy and food security, the distribution of economic costs, local air pollution, other environmental factors associated with different technology solutions, and economic competitiveness. All of these linkages will influence the likelihood and feasibility of different pathways. Assessments of feasibility must, in addition, account for the rapidity at which social and technological systems would need to change to maintain temperature change below 2C.

K-4402a-02

Staying below 2°C: What are the implications of and requirements for short-term policies?

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Current efforts to mitigate climate change are not in line with mitigation pathways stabilizing global warming below 2°C in a cost-optimal way. Over the past decade, global greenhouse gas emissions have further increased and are projected to reach 50-59 GtCO2e by 2020. This is much higher than emission levels in mitigation scenarios that assumed comprehensive mitigation action towards 2°C stabilization from 2010. The discrepancy between the long-term ambition of climate policy, i.e. limiting global warming to 2°C, and the weakness of mitigation action raises important questions: What are the consequences of delaying comprehensive climate policies? What are requirements for policies and measures to keep the 2°C target within reach?

This presentation will draw on a number of recent studies based on integrated energy-economy-climate models (AMPERE, LIMITS and RoSE multi-model intercomparison projects, as well as single-model studies) to address these questions. There are a number of robust, policy-relevant insights that emerge from these studies about the adverse consequences of a further delay of comprehensive mitigation action:

- Due to the tight constraint on cumulative CO2 emissions implied by the 2°C limit, higher than optimal emissions in the near-term have to be compensated by lower emissions in the long term. This implies a much faster pace of emission reductions in the medium term. Scenarios with high 2030 emission levels feature post-2030 emission reduction rates that are roughly twice as high as those in scenarios with optimal timing of mitigation efforts.
- At the same time, a lack of meaningful mitigation action in the near-term reduces the longer-term mitigation potential. This is due a further lock-in into carbon intensive infrastructure, and insufficient up-scaling of low-carbon technologies. As a consequence, the deep emission reduction required become more difficult to achieve.
- The deep long-term emission cuts also imply a greater reliance on specific technologies and reduced societal choices. In particular, in case of weak short-term policies the 2°C limit can only be kept with large-scale deployment of bioenergy and CCS.
- A further delay of mitigation action results in greater overall costs of the mitigation effort, and a more unequal distribution of these costs over time. In particular, we find that a further delay substantially increases the economic costs during the transition from a weak to a comprehensive climate policy regime, thus raising the barrier to the low-carbon transformation.
- Finally, replacing fossil fuels by climate-friendly alternatives comes with several co-benefits, in particular in the form of decreased air pollution and improved energy security. Delaying climate policy implies that crucial co-benefits, such as decreased air pollution and improved energy security, are foregone.

The presentation will further explore how enhanced near-term action and post-2020 policies can reduce these adverse effects, thus helping to keep the 2°C target within reach.

O-4402a-01

The energy transformation in 2°C pathways: upscaling technology, investment needs, stranded assets and the role of energy demand

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A major challenge in limiting temperature change to 2°C compared to pre-industrial levels is the transformation of the energy system which requires rapid upscaling of low-carbon technologies to significantly reduce GHG emissions. Deploying the energy technologies needed to initiate a sustained energy system transformation requires continued research and development as well as significant investments to be mobilized by the global economy.

The timing of mitigation action and in particular the stringency of near-term climate policy determines the challenge we are facing now versus the challenge we may face in a couple of decades. While delaying stringent climate action has the benefit of allowing for more development space over the coming decade or two, it amplifies the need to rapidly decarbonize the energy system thereafter if temperature change should be contained to 2°C or less. An important implication of weak near-term climate policies is the need to prematurely retire carbon-intensive infrastructure such as coal power plants, coal mines or oil wells, once moving to a more stringent climate regime. This trade-off particularly affects developing nations that are still in the process of building up a large part of their infrastructure.

In this contribution we will present results on technology upscaling, investment and decarbonization rates from integrated, model-based scenario studies. These will be put into the context of historical developments, both at the level of countries and regions and at the level of individual technologies.

In addition, the decarbonization of the energy supply sector needs to be complemented by a switch to low-carbon energy carriers in the end-use sectors as well as the reduction of energy demand, both of which are key strategies to reduce GHG emissions. In particular the latter is shown to provide additional flexibility for an energy system transformation by hedging against potential resistance to large-scale deployment of energy supply technologies and by reducing stranded assets as well as generating multiple non-climate benefits.

O-4402a-02

Global Energy and Climate Outlook: Road to Paris - Economic Assessment of Low Emission Levels under World Action Integrating National Contributions

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On 25 February 2015, the European Commission has set out its Communication, «The Paris Protocol - a blueprint for tackling global climate change beyond 2020" in the EU's Energy Union package. This paper presents the modelling work undertaken in the context of the abovementioned EC communication regarding the economic impacts of post-2020 global climate change mitigation policies. The analysis presented here mainly lies on results from the economic model GEM-E3, combining the work undertaken with the energy systems model POLES for the purposes

of the EC preparation for the global climate negotiations. It focuses on possible ways to stay below 2°C through processes established in the run-up to Paris COP21 by studying a combination of domestically determined mitigation targets for the period beyond 2020.

The GEM-E3 model is a recursive dynamic computable general equilibrium model which covers the interactions between the economy, the energy system and the environment. The model is calibrated to the 2004 base year of the GTAP 8 database. This version of the model represents 21 sectors, 10 power technologies and 25 regions, including all major economies. The six Kyoto greenhouse gasses represented are CO2, SF6, PFC, HFC, CH4, and N2O. The POLES model is a global sectoral simulation model for the development of energy markets.

The GEM-E3 and POLES models share a harmonised Baseline with population and economic growth projections based on the UN and OECD. The projections do not consider the impacts from unabated climate change. In this Baseline scenario, global emissions would increase at unsustainable levels: from 48 GtCO2e in 2010, 61 GtCO2e in 2030 to 68 GtCO2e in 2050. Along such trajectories, the world is at risk to experience a global temperature increase of +4°C, with sizeable impacts on sustainable growth and vulnerable groups in all regions. The Global Mitigation scenario is in line with staying below 2°C, with global GHG emissions peaking in 2020 and reaching about 43 GtCO2e in 2030, still higher than in 1990 (+20%) but lower than in 2010 (-10%).

The economy-wide impacts are twofold. Firstly there are direct costs of mitigation due to regional emission constraints and the reallocation of resources for the mitigation effort. Secondly there are indirect costs or benefits from changes in competitiveness, production patterns, investment and relative prices of energy, labour and capital. It is seen that carbon-intensive sectors need to adjust their investments in order to reduce their emissions, and sectors with a low emission-intensity are affected according to their level of openness to emitting sectors. The effects analysed include GDP, sectoral activity, exports and imports, employment, private consumption and investment. The results indicate that, although due to reallocation of resources created by a global mitigation effort, negative impacts on GDP are seen for all regions, in effect, climate change mitigation policies only marginally reduce the yearly economic growth rates in fast-growing low-income regions. A decomposition analysis of the drivers of GDP change gives a further insight on the impacts of the global mitigation policies.

Another dimension of the analysis is the choice of policy instruments. For this purpose, we compare the use of free allocation of permits with the use of auctioning or taxation. The revenues of auctioning or taxation are recycled as a lump-sum to households, a reduction in labour taxes or in indirect taxation on consumption and investment. It is found that, depending on their regional economic characteristics, for the majority of the regions the optimum recycling of permit auction revenues is to lower indirect taxes while for some countries it is best to use emissions revenues to reduce taxes on labour. Economic costs can be reduced further if the auction revenues are not used only for tax reductions but are combined with a financial scheme.

4402b - Low carbon pathways for staying below 2°C: Global requirements

ORAL PRESENTATIONS

K-4402b-01

Regional greenhouse gas emission pathways within the context of the 2 °C target: Insights from the LIMTS project

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Integrated assessment models can help in quantifying the implications of international climate agreements and regional climate action. In several recent model comparison studies, different possible outcomes of post-2020 climate negotiations were explored in relation to the 2 °C target. The scenarios developed in these projects can be used to derive key information for individual (major) economies and regions. This includes for instance information on emission peaking, regional carbon budgets and emissions allowances. In this contribution, we present these otutcomes (especially those of the LIMITS project) and focus on the differences across these regions. For instance, in terms of mitigation measures, costs and carbon budgets clearly different results can be noted. In our contribution, we also highlight the distributional consequences of climate policies, and discuss the role of carbon markets for financing clean energy investments, and achieving efficiency and equity.

As the models presented in this contribution do have global coverage - the presentation allows also to act as a bridge between the two important parts of the session on low carbon emission pathways (global and regional).

K-4402b-02

National pathways to deep decarbonization - Methodological insights from the Deep Decarbonization Pathways Project (DDPP)

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Can countries take the carbon out of their economies, and still provide economic prosperity for their citizens? National circumstances and approaches differ, but four pillars of decarbonization are identified universally, in developed and developing countries alike: (i) strong improvements in energy efficiency, (ii) making energy carriers almost zero carbon (low-carbon electricity sources, biofuels, hydrogen), (iii) shifting energy use as far as possible to these low-carbon energy carriers , (iv) fostering structural changes reducing output from carbon-intensive activities and (v) reduction of remaining direct emissions, using a variety of technologies.

An initiative of the Institute for Sustainable Development and International Relations (Iddri) and the Sustainable Development Solutions Network (SDSN), the 'deep decarbonization pathways' project (DDPP) analyses how the different pillars of decarbonization can be operationalized in 15 countries representing, in total, 70% of global 2010 GHG emissions: Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Japan, Mexico, Russia, South Africa, South Korea, the UK, and the USA.

The approach of DDPP is to have country research team develop a national-scale pathway analysis for deep decarbonization consistent with the 2°C global target to 2050. This study is supported by expert-based assessments of national decarbonization as basis for an internally coherent and transparent analysis of the country-specific transformations able to satisfy the twin objectives of development and deep decarbonization.

The preliminary results from this work were published in a report for the UN Secretary-General, in support of the Climate Leaders' Summit on September 23, 2014. Revised analysis providing a comprehensive vision of technical, socio-economic and policy aspects of long-term deep decarbonization will be conducted in early 2015 and delivered to the French Government in the lead-up to COP-21.

In this presentation, Michel Colombier, IDDRI's scientific Director, will present the scientific approach and the methodological specificities of the scenario analysis that make the DDPP relevant to inform national and international policy debates. Notably, a focus will be given

to the backcasting long-term approach, the «dashboard» methodology that allows transparent and explicit representation of the pathways and the iterative process for elaboration of the national pathways.

K-4402b-03

Technology Policies and Accelerated Diffusion of Decarbonization Wedges

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The rapid and deep decarbonization of energy systems that is required in the 2°C scenarios will result from a complex mix of institutional, behavioral and technological changes. While many economic models and mitigation scenarios have initially focused on the role of economic instruments for triggering these changes, the role of new technologies have been progressively been made more explicit as a central element for the feasibility of low carbon futures. In particular, filling the gap between bottom-up nationally determined contributions and the requirements of 2°C scenarios will require a worldwide effort to accelerate the diffusion of energy efficiency and low carbon options.

Following to pioneering studies (Stabilization wedges, Socolow and Pacala [2004], Energy Technology Perspectives, IEA, since 2006) the role of new energy technologies has been extensively studied in the past ten years (EMF 24, different projects in European Framework Programs, IPCC AR5…). While a new stage in climate negotiations and policies is expected to start when the Paris Climate 2015 results in a positive outcome, the fulfillment of the announced Nationally Determined Contributions will involve a quick mobilization and scaling-up at world level of low carbon technologies, on the demand as well as on the supply side.

Research projects such as the Deep Decarbonization Pathways Project of UN-SDSN provide clear images of what has to be accomplished in the different countries in order to come closer to emissiontrajectories compatible with the 2°C scenarios. However further enquiry is needed to explore both the radical/systemic innovations and the policy and social dimensions of the accelerated diffusion of low carbon technologies. In this context, the National Alliance for the Coordination of Energy Research (ANCRE), which gathers the scientific resources of the main public research institutions in France, proposes a communication on the development of low carbon energy technologies and systems. These are the "Decarbonization Wedges" that ANCRE is currently exploring in an eponym study that mobilizes the knowledge resources of this organization.

The communication will first identify the main decarbonization wedges to 2050 and analyze their potential, Technology Readyness Level, and expected development in different regions according to international studies such as Deep Decarbonization Pathways. It will then analyze the different types of barriers to be overcome before their rapid and massive diffusion: either technical, economic or social. It will then present elements of consistent RD&D strategies at the international and national level to speed-up the diffusion of these technologies in the different regions of the world.

O-4402b-01

Analysis of current climate policies, intended national determined contributions (INDCs) and possibilities for strengthened policies at the regional scale

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This study provides an overview of projected greenhouse gas emissions in major emitting countries/regions up to 2030, taking into account the emission trajectories based on the most effective current and planned climate and energy policies, as well as selected enhanced mitigation measures and the intended national determined contributions (INDCs). In addition, we also analyse the ambition of the INDCs using a wide range of methods (see below). The country-specific mitigation policies in promising areas for enhanced actions are in line with national priorities and opportunities (e.g. co-benefits). The analysis focuses on 13 countries/regions (Australia, Brazil, Canada, China, European Union, India, Indonesia, Japan, Mexico, Russia, South Korea, Turkey and the US). The impact of the most effective current and planned policies on greenhouse gas emissions was estimated based on calculations from energy and land use model calculations, and scenarios from national and international studies. The main findings are:

- The degree to which countries/regions are likely to achieve their 2020 pledges under current policies varies: of those considered here, Brazil, China, the EU, India, Japan and Russia are likely to achieve their pledges through existing policies. Australia, Canada, Indonesia, Mexico, South Korea and the US require additional measures to achieve their 2020 pledges. The US and Mexico could achieve their pledges if planned policies are effectively implemented.

- Even though current and planned policies are projected to have an effect on emissions, increases would still occur in Australia, China, India, Indonesia, Mexico and Turkey until 2030. Emissions in Brazil, Canada, South Korea, the Russian Federation and the US would remain stable approximately at 2010 levels. For the EU, emissions are projected to decrease further under current policies, but not enough to meet the INDC of EU of a 40% domestic reduction target by 2030.

- In all the countries/regions considered, significant further reductions are possible through a selection of policy enhancement measures that are in line with national priorities. The selection of policies and measures is illustrative and not exhaustive. With the selected enhancement measures included here, China and Mexico would stabilise emissions by 2030, at the latest. The EU, Japan, South Korea, and the United States would achieve a pathway with further reductions in line with their long-term targets. The EU would meet its INDC for 2030, and the US its announced 2025 reduction target. Emissions in India, Indonesia and Turkey would continue to increase strongly, but less so than under current and planned policies.

- Looking only at 13 major emitting countries/regions, the enhanced policy scenarios in this report could reduce emissions by 6.1 GtCO2e by 2030, compared to under current policies. This is roughly a third of the difference in global emission levels between a scenario consistent with the 2 °C target and a current policies scenario based on the UNEP's Emissions Gap Report 2014.

- Countries' efforts should be of similar ambition. A large variety of methods exist that allow to compare countries' efforts. For a comprehensive ambition assessment we propose to use an array of methods that we group in terms of whether they assess "moral obligation" or "technical necessity".

Applying these methods to existing proposals by the USA, China and the EU, a consistent picture emerges that the proposals by EU and China are more ambitious than the proposal by the USA. The methods do not provide a consistent picture on whether EU's or China's proposal is more ambitious. While China leads slightly on "moral obligation", the EU generally leads on "technical necessity".

4402 - POSTER PRESENTATIONS

P-4402-01

A 90% Reduction in Canada's Emissions by 2050: Macroeconomic and physical evolution or revolution?

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What does 90% decarbonization of the Canadian economy look like, physically and financially? Is it a financial evolution, or a revolution? An opportunity or a calamity, and for whom? What are the uncertainties? Canada already has strong and binding long term policies on transport and buildings whereas, with a couple of exceptions, regulations are largely missing for industry. In this analysis I strengthen the existing transport and buildings regulations and add policy for industry. I use a regionally and sectorally disaggregated CGE methodology to model the following policy package. 1) Advanced efficiency regulations for transport, buildings and appliances, on the premise there are significant plausible market failures & pricing policies may be ineffective. 2) Regulations requiring oil and gas fugitive control and CCS on formation gas processing and hydrogen production, with the right to sell verifiable reductions into the following "market". 3) A tradable emissions intensity standard for all large emitter based on sector specific "best-in-class" technology intensity targets. 4) I complete the policy package with an initally low but continually rising British Columbia style carbon tax with 50/50 recycling to labour and corporate labour taxes that eventually eclipses the other policies. For results I will review GDP, emissions, changes in sectoral investment and economic structure. I will conclude with a methodological discussion of the modelling changes that were needed to hit 2 tonnes per capita, including additional decarbonization technologies and changes to the modelling structure.

P-4402-02

Complementing carbon prices with technology policies to keep climate targets within reach

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Economic theory suggests that comprehensive carbon pricing is most efficient to reach ambitious climate targets, and previous studies indicated that the carbon price required for limiting global mean warming to 2 °C is between US$16 and US$73 per tonne of CO2 in 2015. Yet, a global implementation of such high carbon prices is unlikely to be politically feasible in the short term. Instead, most climate policies enacted so far are technology policies or fragmented and moderate carbon pricing schemes. This paper shows that ambitious climate targets can be kept within reach until 2030 despite a sub-optimal policy mix. With a state-of-the-art energy-economy model we quantify the interactions and unique effects of three major policy components: (1) a carbon price starting at US$7 per tonne of CO2 in 2015 to incentivize economy-wide mitigation, flanked by (2) support for low-carbon energy technologies to pave the way for future decarbonization, and (3) a moratorium on new coal-fired power plants to limit stranded assets. We find that such a mix limits the efficiency losses compared with the optimal policy, and at the same time lowers distributional impacts. Therefore, we argue that this instrument mix might be a politically more feasible alternative to the optimal policy based on a comprehensive carbon price alone.

To limit the mitigation costs and risks of achieving the 2 °C target, it is essential to start comprehensive climate policy as early as possible. Recent studies have shown that pledged reductions are not consistent with cost-efficient emissions pathways reaching the 2 °C target. Furthermore, a continuation of climate policy at the current ambition level will not lead to a stabilization of climate change, and the delay of more stringent mitigation actions will significantly exacerbate the challenge of reaching long-term climate policy objectives. Current policies fail to induce the transformation of the energy system to the extent required by long-term climate targets and lead to further lock-in into carbon-intensive infrastructure. Not only do too much emissions occur in the near term, but also mitigation later on is rendered more difficult. It is an important question whether technology policies can reduce such lock-in and mitigate the impacts of delay. Although a few studies based on global energy-economy models have considered single packages of technology policies in their analysis of twenty-first-century mitigation pathways, none of them explored this question.

The environmental economics literature has also not focused on the scope of technology policies for overcoming deficiencies in carbon pricing. In this strand of scholarly work, technology policies have mainly been analysed as means to cure market failures beyond the pure pollution externality, for example, due to learning spillovers, information asymmetries and so on. In contrast, here we analyse their complementary role under sub-optimal carbon pricing. There is wide agreement that market-based instruments pricing the externality of emissions have an advantage in terms of efficiency. At the same time it is debated whether or not setting a price (carbon tax) or a quantity of tradable permits (cap-and-trade) is preferable. Some authors find that the interaction with other instruments favours the price instrument, a finding that our study extends to the case of sub-optimal carbon pricing combined with technology policies.

This study is the first to assess which mix of emission pricing and technology policies is effective in avoiding further lock-in and initiating the transformation required for limiting warming to 2 °C. We thus fill an important gap in the literature by informing the ongoing climate policy debate, which so far revolves around modest approaches to carbon pricing and various forms of technology policies in several countries around the world, tantamount to a lack of comprehensive emissions pricing in line with the 2 °C limit.

Our analysis identifies a policy mix that—based on the positive effects of technology policies under sub-optimal carbon pricing—keeps ambitious climate targets within reach and is possibly easier to implement politically. It does so by addressing two crucial questions: (1) how weaker-than-optimal carbon pricing schemes and additional technology policies interact, and (2) which combination can best reduce the adverse effects of sub-optimal carbon pricing.

P-4402-03

Energy transitions in France: lessons from a forward-looking study

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The general equilibrium model Imaclim France-R is used to examine various energy transition strategies leading to a path 'Factor 4'.The macroeconomic balance a set of assumptions about the technical conditions of supply and demand for energy varies as it is or not housed in a package that does not come from one area of energy policy: fiscal policies to prevent the spread of the additional costs of energy in the production system, social and wage bargaining to manage the recycling of the product of a carbon tax, reform of financing structures, industrial policies and training for new jobs, infrastructure policies and behavioral change.We then show how a funding policy lowering the coefficient of investment risk 'low carbon' would, by enhancing the credibility of public policies, reduce fears that explain the reluctance of market participants and trigger a shift in investment towards faster simple equipment into energy.The macroeconomic balance changes according to the terms of the transition, but is positive in the medium and long term in terms of growth and employment, this because of the synergy between three mechanisms: decrease of energy imports, energy savings releasing purchasing power of households in non-energy goods and services, lower labor costs allowed by a carbon tax.Economic Support of the Transition is critical to move from a slightly negative balance in the short term to a positive balance sheet, in order to give the 'grist' needed to reduce these tensions.The challenge is an effect credibility 'from the consistent conduct of pricing policies and funding guiding expectations of actors in a negative context.As for the nuclear issue, we see a big difference between a nuclear constrained by increased demands 'precautionary' and a voluntary exit 2050 with a ban on building new plants. This last assumption is to respect the F4, an important and early development of CCS and leads to growth retardation of 4.5 years over 40 years excluding conversion costs, and, conversely, profound changes behavior and economic structures.Scenarios precautionary nuclear 'limit its place around 40% of the energy mix in 2050 and allow a decision to back exit or new deployment that can be taken later «better informed».The challenge now is to get into position to take it with a strong national consensus not only the ultimate technology choice, whatever it is, but also economic and social policies consistent with this choice.

P-4402-04

Technology and innovation to low-carbon pathways in Brazil

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The UNFCCC intends to approve more stringent targets to reduce carbon emissions globally. One of the instruments that has been created by the Climate Convention is the Technology Mechanism. This mechanism comprises a Technology Executive Committee (TEC) and a Climate Technology Centre and Network (CTCN).

Developing countries are asked to prepare reports detailing their technological needs to develop mitigation and adaptation climate plans. These reports are known as Technology Needs Assessment (TNA) and are prepared according to suggested guidelines and offer the basis for technological procurement and transfer efforts of select stablished solutions very often already dominated and commercialized by industrialized countries.

CGEE (a non-profit organization with the mission of rendering Science, Technology and Innovation as Brazil's best allies for economic growth, competitiveness and well-being) is coordinating, as a subsidy for the Ministry of Science, Technology and Innovation, a group of experts with wide experience on technology development and transfer in order to propose a suitable methodology for the Brazilian reports, oriented to formulate a Technology Capacities and Needs Assessment (TCNA). Therefore, technology needs are associated to national capacities and competencies supporting the designing of a Technology Action Plan (TAP) to fight climate change. Moreover, preparing a TCNA indicates the possibility for developing countries to not only attract know-how and new technologies, but also to be able to offer these resources to other countries.

The contribution aims to improve the assessment and action plans taking into account the opportunity for developing countries to enhance and promote its science and technology base and to create new solutions to more meaningful low-carbon pathways in their own social context. One key step in the proposed methodology is a detailed inventory of local capacities and competences not only within the science and technological communities but also their industrial base. So, it will be possible to enhance the national innovation chain and place developing countries as more relevant international players in the arena of scientific and technological activities, being able to generate more patents and solutions that can be applied in other similar developing countries as well. Additionally the adaption capacity of more vulnerable countries and regions could be upgraded.

P-4402-05

Analogues between rapid mobilisation for World War 2 and the Great Energy Transition: Lessons and caveats

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To have a high probability of limiting further global warming—at least to stabilise it to an average temperature increase of 2°C—climate science suggests that global greenhouse gas emissions must peak by 2020 and be reduced to close to zero by 2040. Current trend, however, heads towards at least 4°C by end of this century; yet, little effective climate action is being taken. In this presentation, I talk about contingency plans developed for a scenario in which governments are galvanised to implement an urgent transition of conventional energy systems—the biggest GHG contributor—to sustainable renewable energy systems. This Great Energy Transition, climate activists and some academics assert, would be feasible, invoking the magnitude of World War 2 mobilisations. I critically examined the plausibility of this analogue in this talk. The findings, which I published in the journal Energy Policy, suggest some potential strategies especially in areas of finance and labour mobilisations, as well as in the governance and administration of these resources. Nonetheless, the analogue has severe limitations, resulting from its lack of democratic processes, most especially. Moreover, since the threat of climate change is less obvious to many non-scientists, it is unlikely that the public will be unified in support of a highly centralised action. It appears therefore that prosecuting the Great Energy Transition seems to be more complex than prosecuting a great war.

P-4402-06

Global scenarios of greenhouse gas emissions reduction: the 2°C target and less stringent goals

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In this paper we present a study performed with the latest version of the TIAM-UCL model on the possibility to achieve different targets on the global temperature change due to greenhouse gas emission reduction. The study specifically analyses what will take us to meet the 2°C target in term of peaking years and subsequent reduction rates needed. We also analyse two less constrained targets at 2.5°C and 3°C.

The first part of the study focus on the relationship between the peaking year for emissions (before mitigation policy) and the minimum percentage change in the emissions reduction afterward allowing the target to be achieved. Increasing temperature target (2.5 and 3°C) or the maximum rate of emissions reduction reduces the need of early mitigation policies (before 2025). In the case of the 2°C target, allowing overshooting of the target before stabilisation has the same effect. Given the continuing delay in implementing a global agreement on greenhouse gases emission reduction, we initially examined the window of opportunity to continue increasing emissions whilst still limiting the average surface temperature rise. We found that while it may still be possible to limit the average global temperature rise to the nominal 2°C target agreed on by policy makers, the opportunity window for realising this is closing rapidly.

We study in a second part more specifically the pathways toward the stringent 2°C target. The focus is now on where the mitigation occurs between developed, emerging and developing economies and what technologies and resources are needed. Per capita emissions were found to fall in all regions globally: in high-income regions these drop to less than a quarter of their 2010 level by 2050, while in middle and low-income regions they fall by 50%. On the technology side, we present the deployment rates of the low-carbon technologies needed to achieve the target. The first sector to decarbonise will be the electricity generation; the overall level and rate of installation of new capacity that is required globally is found to be entirely unprecedented at such temporal and geographical scales.

In conclusion, the opportunity to prevent a temperature rise less than 2oC remains possible and is indeed entirely necessary. However perhaps this opportunity becomes increasingly unlikely due to the required scale of the investments required.

P-4402-07

Development of pathways to achieve the SE4ALL 2030 objectives

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The objectives of the United Nations Sustainable Energy for All Initiative (SE4ALL) are to achieve, by 2030: 1) universal access to modern energy services; 2) a doubling of the global rate of improvement in energy efficiency (in terms of the rate of energy intensity reduction); and 3) a doubling of the share of renewable energy in the global energy mix (in terms of renewable energy share in the global energy

mix). The study explores the techno-economical pathways of sectoral and regional developments to 2030, taking into account realization of the potential for energy efficiency improvement and renewable energy deployment.

Beyond the reference scenario (which includes no additional policy measures or technology development beyond the current status quo assumptions), we create three alternative scenarios. The first alternative scenario focuses on meeting the SE4ALL 2030 energy efficiency target through a combination of more ambitious technological improvements and policy incentives within end use energy consumption in the buildings, industry and transportation sectors. To create this scenario, we simulate substantial improvements in conventional technologies' efficiencies, phasing out of energy intensive technologies at an accelerated pace (replaced with more advanced counterparts), and the emergence /proliferation of innovative new technologies not yet widely available in the market.

The second alternative scenario focuses on achieving the SE4ALL 2030 renewable energy targets. This scenario sets both global and region-specific targets to closely follow those outlined by the International Renewable Energy Agency Global Renewable Roadmap (IRENA REMap2030).

The third alternative scenario combines the first two.

The alternative scenarios also incorporate the effect of various barriers to energy efficiency development, to simulate various known social, political, and economic effects that curtail adoption of new technologies. This allows for a more effectual representation of meeting the SE4ALL targets.

The technology-rich TIMES Integrated Assessment Model (TIAM) is employed to analyze the various scenarios. From here, we develop technology and policy pathways for different regions for meeting the SE4ALL energy efficiency and renewable energy goals. The pathways are evaluated in terms of cost effectiveness and by assessing the degree to which modern technology is dispersed across the various regional technology profiles (the first objective of SE4ALL). The optimal pathways are converted into policy recommendations and cost estimates for best achieving the SE4ALL objectives.

P-4402-08

Towards a low-carbon Chinese economy: the role of transportation

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Rationale and Objective: Chinese economic development goes hand in hand with (i) a growth of the production that is accompanied with an increase of the freight transport, and (ii) an enriched population and fast-growing urbanization that induce increasing demand for passenger transport (notably an increase of the motorization rate). Given the high reliance of transport on oil products, its increasing energy demand and CO2 emissions, the transportation sector is a crucial sector for China, particularly regarding energy security and climate change issues. In its attempts to have a sustainable development, the transportation sector is indeed particularly challenging for China. To avoid important "lock-ins" in carbon-intensive pathways, especially given the high coal availability and the important life span of infrastructures, China has to redouble its efforts with voluntary schemes promoting mobility growth control. This paper investigates the role of transportation activities in the transition to a low carbon Chinese society. A particular attention is given to specific measures designed to control the growth of mobility. It is an attempt to quantify the impact of urban voluntary policies on Chinese mitigation costs.

Methodology: This article revisits the role of the transportation sector in low-carbon pathways by using the Energy-Economy-Environment model IMACLIM-R. It is a hybrid multi-region, multi-sector CGE model, which embarks a detailed description of passenger and freight transportation. The standard representation of transport technologies is supplemented by an explicit representation of the "behavioral" determinants of mobility. The model relies on hybrid matrices ensuring consistency between money flows and physical quantities and allows an explicit representation of the interplay between transportation, energy and growth patterns. It accounts for the rebound effect of energy efficiency improvements on mobility, endogenous mode choices in relation with infrastructure availability, the impact of investments in infrastructure capacity on the amount of travel, and the constraints imposed on mobility needs by firms' and households' location. Moreover, IMACLIM-R represents the second best nature of economic interactions and the inertias on technical systems that limit the flexibility of adjustments, a crucial dimension for emerging economies when envisaging large structural change over the course of the century. **Complementarily to carbon pricing to reach a stringent climate objective (3.4W/m2 in 2100), we consider actions to control the "behavioral" determinants of transportation in the course of the low-carbon transition, and assess their effects on the Chinese economy. More specifically, we consider (i) urban reorganization lowering the constrained mobility (i.e. mobility for commuting and shopping), (ii) reallocation of investments in favor of public modes at constant total amount for transportation infrastructure and (iii) adjustments of the logistics organization to decrease the transport intensity of production/distribution processes.

Results: This analysis demonstrates the risk of high losses if using carbon price as the sole instrument of mitigation. Transport proves to be the sector for which carbon emissions are the more difficult to reduce. It thus represents a dominant share of remaining emissions in the long-term when ambitious mitigation objectives are set. Because of its weak reactivity to price increases, very high levels of carbon prices are needed in the second half of the century to reach low mitigation targets. We find indeed that they can reach 1400$/tCO2 by the end of the century. But we find that controlling mobility growth allows limiting these effects by offering mitigation potentials independent of carbon prices. The considered measures allow significant reductions of carbon price levels (on average 25% lower over 2050-2100) and hence help limiting the macroeconomic costs of the mitigation policies (e.g. long-term mitigation costs are reduced by 5 points in 2050 and by 10 points in 2100).

Conclusion: This study highlights the role of transport in the mitigation process. Given a climate target, the implementation of measures fostering a modal shift towards low-carbon modes and a decoupling of mobility needs from economic activity prove to modify the sectoral distribution of mitigation efforts and to significantly reduce the mitigation macro-economic costs relatively to a "carbon price only" policy.

P-4402-09

A pathway to a low-carbon society for China

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As the leading primary energy consumer and the largest carbon-emitting country in the world, China is facing great international pressure to reduce its carbon dioxide (CO2) emission, as well as a tight domestic fossil energy supply and a high level of air pollution. In the "U.S.-China Joint Announcement on Climate Change" released on November 12 2014, China announced to achieve the peaking of CO2 emission around 2030 and to make best efforts to peak early. Therefore, this study aims to answer whether and how China's CO2 emission can peak before 2030. A dynamic multi-objective optimization model will be developed based on the multi-region input-output model to explore an appropriate low-carbon pathway for China's sustainable development, comprehensively considering factors like industrial structure, energy structure, energy efficiency, consumer behaviors, and environmental capacity. Under this pathway, China is expected to assume its responsibilities to mitigate global climate change, reduce domestic pollution, and sustain a rational economic growth.

P-4402-10

Pathways to be Opened towards Low Carbon Society - Findings on Multi-model Comparison in ICA-RUS Project

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Although the world agrees with the need for the greenhouse gas control in the long views, there are still serious barriers to be resolved towards the near term policy decisions. The scientific and the societal uncertainties in the climate change policies must be the large part of this barrier. Besides the unknown factors in the natural science field, various heterogeneous uncertainties in the macro and micro economic outcomes of mitigation policies, the technology strategies, possibility of adaptation options, and the risk and benefits of the geo-engineering will cause complicated debate. Distribution between current and future generation as well as among regions will also be the problem. The most preferable and acceptable decision making towards the agreement should be established from the risk management perspectives. Quantitative and comprehensive analysis is indispensable as a basis of discussion.

The Ministry of the Environment, Japan established an interdisciplinary research project, Integrated Climate Assessment - Risks, Uncertainties and Society (ICA-RUS) conducted by Dr.Seita Emori, National Institute for Environmental Studies. In order to deal with the various uncertainties, four different type integrated assessment models, i.e. MARIA-14(Mori), EMEDA(Washida), GRAPE(Kurosawa) and AIM(Masui), participate in this project to provide different views and the common information with respect to societal impacts of global warming strategies. For instance, the iterative optimization CGE model EMEDA has a capability to provide gaming simulations among states. MARIA and GRAPE provide detailed technology strategies as well as the land use changes through the inter-temporal optimization. AIM which consists of multiple model modules provides most comprehensive information. In the ICA-RUS project, these models generate various solutions under same SSP and RCP based scenarios, providing common information on economic loss and regional GHG emission pathways. Three models of the above give energy technology option and land use changes while EMEDA provides sectoral impacts. We also employ three "Alternatives left to humanity" represented by mitigation targets, 1.5, 2.0 and 2.5 degrees C global mean temperature increase (with assuming the climate sensitivity of 3.0 degreesC.

The current tentative conclusions are summarized as follows: first, in the stringent climate target, the regional economic losses among models tend to diverge. This variety seems to depend on the assumption on the malleability of the final energy demand, especially of the transportation sector. Second, CCS as well as BECCS will be essential to achieve the stringent climate target. Third, industry structure changes in Asia and Africa will show different patterns depending on the climate policies. Fourth, the models show small changes in the crop production and land-use patterns among various climate scenarios suggesting that the implementation of BECCS and the biomass energy expansion may not seriously conflict with the food supply under the reference optimistic yield assumptions.

Finally, some additional simulations on multi-stage decision making to deal with adaptive energy technology strategies will also be shown.

P-4402-11

Linking leadership to the upcoming global climate regime: Insights from the German Energiewende

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In a nutshell, the main current problem with action for climate protection is that too many countries are doing too little. The run-up to COP 21 in Paris will without doubt see the formulation of numerous recipes on how to cope with this challenge. But leadership exerted by frontrunning countries has the potential to stand out in the end as one of the most effective ways of pushing climate action. The particular clout of leadership is that ambitious countries can take immediate action out of their own accord without being thwarted by inconclusive international negotiations. The hope behind this is to attract followers for a similar course of action and thus sidestep global stalemate. It is true that unilateral leadership - i.e. acting when no one else does, with a hope to set an example - entails the risk of being in vain if it lacks followers, resulting in considerable costs for the leader. Nevertheless, in a world of increasingly polycentric climate governance, action at the national level is indispensable - and leadership puts this national action at the service of a common cause. But what does it precisely mean for countries to be a leader and how can leadership be put into practice outside institutionalized multilateral negotiations, in a polycentric regime? Answering these questions is essential to increase the leverage of national action in supporting climate action at the global level. A better understanding of leadership in a polycentric climate regime is thus what we aim for in this paper.

The particular case we look at is the German energy transition, now widely known as the "Energiewende". Formally enacted in 2011, but based on a much longer history of transition, the Energiewende has sparked considerable interest around the globe. Beyond its perception as a potential source of - positive and negative - lessons, choosing the Energiewende as a case is particularly relevant given the fact that gaining followers on the way to a more sustainable energy system has been a main rationale and German decision-makers frequently claim leadership in this field. Our investigation concentrates on "leadership by diffusion" outside multilateral negotiation settings and uses a simple analytical framework derived from the literature on leadership and policy diffusion. In a first step, we analyze the specific motivations for international Energiewende leadership and then review measures taken to translate this aim into action. We subsequently discuss Germany's approach to Energiewende leadership against the background of an evolution of the Energiewende itself. From this analysis, we find that while Germany has been a highly active leader facilitating the worldwide diffusion of renewables, a comprehensive leadership strategy in line with the very high ambitions of the Energiewende - towards a comprehensive energy system transformation - has not yet emerged.

Based on this finding, we discuss the requirements for such a strategy, including consistency across government, transparent communication and open dialogue with potential followers. Given that the main declared motivation for Energiewende leadership is to advance global climate action, this strategy above all needs to be geared towards effective climate leadership. Crucial for this is (a) to safeguard legitimacy of the Energiewende as a policy model by giving priority to climate protection at the domestic level ("sending side"), and (b) to ensure that knowledge created in the implementation process is shared with and adaptable to the local context in other parts of the world ("receiving side"). We eventually lay out how these activities could be linked to and supported by the upcoming international regime, and how in turn the requirements of effective climate leadership can be taken into account in the future course and implementation of the Energiewende.

P-4402-12

Interactions between agriculture mitigation choices and fossil CO2 emissions within integrated low-carbon pathways to limit warming to 2 degrees

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Agriculture currently directly contributes 10-12% of global greenhouse emissions, with additional emissions from land-use change and energy consumption in food production, processing and transport. Emissions from agriculture are projected to continue to increase for much of this century as a result of a growing and more affluent population that demands more high-quality and protein-rich food. In total, agriculture is thus responsible for more emissions than global air, land and sea transport, and (depending on the method of allocating indirect emissions) almost as much as stationary energy supply.

This suggests that mitigation of agricultural emissions must be part of integrated abatement strategies, especially for stringent goals such as limiting global average warming to below 2 degrees relative to pre-industrial levels. However, while the challenge of decarbonizing key sectors responsible for emissions of carbon dioxide from fossil fuels is increasingly well understood, there is much less visible action at a global scale to tackle emissions from agriculture, due in part to perceived tensions between food security and poverty eradication on one hand and reducing greenhouse gas emissions on the other. In addition, while there is significant potential to reduce emissions per unit of product for most agricultural systems, there is little prospect of completely 'decarbonizing' food production at the global scale, in contrast to e.g. the electricity and potentially even transport sectors. The limited abatement potential and intersection of food security and poverty with mitigation goals thus tends to relegate agriculture into the 'too-hard' basket for climate policy priorities, and a perception that the global climate benefits from enhanced agriculture mitigation would not be commensurate with the effort and trade-offs required.

Here, we use global integrated assessment models to demonstrate that even though technical mitigation options for agriculture are more limited than for some other sectors, accelerating agriculture mitigation outcomes can make a crucial contribution to keeping the goal of limiting warming to below 2 degrees viable. We show that different assumptions specifically for agriculture mitigation potentials and policy approaches strongly influence global shadow prices for GHGs throughout the 21st century, overall climate policy costs and the timing of the global peak of carbon dioxide emissions from fossil fuels in global cost-effective multi-gas abatement strategies, and also influence the rate of decarbonization required from fossil-fuel intensive sectors after emissions have peaked. We further explore how different approaches to agriculture mitigation (encompassing closing yield gaps, reducing demand, and increasing technical abatement options) could influence global commodity prices and land demand, and thus what measures could enable achieving goals of food security, poverty eradication and limiting climate change jointly.

We conclude that expanding the overall mitigation potential for agriculture-related emissions and supporting practices to realize this mitigation potential in practice are critical components of integrated efforts to achieve low-carbon pathways, and that therefore the role of agriculture in climate policies and integrated approaches to mitigation warrants much higher attention than has been evident in climate policy design to date. Perhaps ironically, we note that in a globally cost-effective approach to mitigation, the greatest near-term benefits from enhanced agriculture mitigation would accrue to the most CO2-intensive sectors and regions due to the ability to defer costly near-term emissions reductions by a few more years. However, even the most ambitious scenarios for agriculture mitigation do not change the fundamental need to achieve net zero carbon dioxide emissions globally by or before the end of the 21st century to retain a reasonable prospect of limiting warming to 2 degrees.

P-4402-13

Integrating domestic political constraints in a global agreement on pollution reduction

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One of the famous but unfortunately unsuccessful approaches to deal with global warming has been to create the missing carbon market emission. While it appeared at first to be a hope, it failed by not taking into account asymmetric information and transaction costs associated. Mechanism designs coupled with incentives literature constitute a new promising approach. To design optimal contracts, two major constraints appear: countries need to voluntarily participate and they need to provide optimal effort. Taking into account asymmetric information, the first best could not be implemented. Martimort and Sand-Zantman (2012) demonstrate there is a trade-off between the provision of incentives for participating countries and the provision of incentives to participate. To deal with this double free-riding problem, they design menu contracts such that all countries will participate to a fund but only the more efficient would provide efforts to reduce their emission. By taking into account the diversity of countries, global contracts reducing pollution below the non-cooperating level (also called 'business as usual level') could be proposed.

Martimort and Sand-Zantman model (2014) does not take into account domestic political constraints in the design of the global agreement. Starting from their model, my contribution attempts to open the "black box" of government involved in negotiations. National governments face an asymmetric information issue: they are not perfectly informed about the firms' technologies (especially technologies to reduce emissions). Indeed, firms have an informational rent, which is source of distortions. Government could try to collect information on firms -thought bureaucrats for instance-. However, lobbies could try to capture bureaucrat. Avoiding capture for the governments could be costly. To tackle with these domestic constraints various mechanisms such as market or contracts should be considered at a domestic level.

Once taking into account domestic internal constraints, the setting up of general agreement mechanism could be modified. This analysis implies introducing double-edged incentives constraints to tackle asymmetric information issues both across and inside countries.

Research over contracts offers a way to focus on countries' different interests, maybe the more important issue that avoid any common agreement to be reached if denied. The integration of countries' internal political constraints makes more plausible the design of a global agreement. For that reason, this approach is relevant for the theme of day 4 "Collective action and transformative solution".

P-4402-14

Low carbon pathways prioritising human needs and development

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Human societies have always required environmental resources, in the form of energy and materials, to survive and flourish. However, the exact level of resource requirements may be difficult to estimate, since it can depend on many factors. These factors include: local biophysical conditions, such as climate or available crops for food; technological options and efficiencies for delivering key services; but also socio-economic parameters, including consumption levels and inequality in distribution. This talk will present recent advances in the international study of energy requirements for human needs. These results demonstrate that high levels of human wellbeing are attainable at moderate as well as very high energy use, and that the average level of energy use required to achieve high human wellbeing is declining over time. Moreover, it can be shown that energy itself does not play a dominant role in explaining the considerable advances in human wellbeing over the past half century. Research analysing the resource requirements to fulfil universal basic human needs within a low carbon future will be presented. This research must take into account political, social and economic factors, since fulfilling human needs at low levels of resource use most likely requires a fundamental restructuring of social and economic systems alongside technological advances.

P-4402-15

Pathways to Deep Decarbonization in the United States by 2050

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Limiting the anthropogenic increase in global mean surface temperature to less than 2 degrees Celsius will require a reduction in global net greenhouse gas (GHG) emissions on the order of 80% below 1990 levels by 2050. As a result, there is a growing need to understand what would be required to achieve deep decarbonization

in different economies. We examined the technical and economic feasibility of such a transition in the United States, evaluating the infrastructure and technology changes required to reduce U.S. GHG emissions in the year 2050 by 80% below 1990 levels. Using the PATHWAYS and GCAM models, we find that multiple alternative technology paths exist to achieve this level of decarbonization in the U.S., assuming existing commercial or near-commercial technologies, natural replacement of infrastructure stocks, and the same level of energy services and economic growth as a reference case based on the U.S. DOE Annual Energy Outlook. Reductions are achieved through high levels of energy efficiency (1.8 GJ/$2012), deep decarbonization of electricity generation (<20 gCO2/kWh), electrification of most end uses (>50% of final energy), and switching remaining end uses to lower carbon fuels. A highly granular annual infrastructure stock-rollover model shows the physical adoption rates and investment required for key technologies in power, transportation, buildings, and industry. A regional hourly dispatch model of the electricity system for high renewable, high nuclear, high CCS, and mixed scenarios shows that flexible production of fuels from electricity can simultaneously provide both supply-demand balancing for reliability in systems with high levels of inflexible generation (e.g., >75% renewable) and low carbon fuels for applications that are difficult to electrify. Incremental energy system cost is equivalent to <1% of gross domestic product (GDP) in the base case, with an interquartile range of -0.2% to +1.8% across a variety of technology scenarios and cost sensitivities, not including non-energy benefits from avoided climate change and air pollution. The future terrestrial carbon sink and the level of biomass feedstock that can be considered sustainable and low-carbon are key uncertainties for future energy sector emission reduction costs.

P-4402-16

A dashboard and linked, top-down economic and bottom-up energy system models that demonstrate development indicators, technology deployment, investment and economic structure trajectories consistent with emissions pathways to achieve the 2oC goal

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Global top-down models indicate that it is possible to achieve global emissions consistent with limiting climate-change warming over the 2015-2050 timeframe to 2 oC. This will require a fundamental techno-economic transformation towards low-carbon societies. However, across nations, historical, social, economical, political, and environmental conditions vary widely and thus credible transition pathways at national level require analysis using national data and proper consideration of national conditions.

Similarly, national statistical, analytical and modeling resources and capabilities used to conduct this analysis vary widely. The global effort requires best possible analyses of national potentials for contribution to global mitigation efforts. A South African team is working with the Deep Decarbonisation Pathways Project (DDPP), conducting such a national analysis. Teams participating in the DDPP are providing similar analyses for countries representing more than 75% of global emissions. The timing of the initiative, and coordination of generation of results from the analyses are designed to support global processes such as the UN Climate Leaders Summit in September 2014 and the 21st COP in Paris.

Over the past two decades the Energy Research Centre (ERC) at the University of Cape Town has been building local capability to model the South African energy and economic systems. This includes aspects related to emissions trajectories consistent with contribution to achieving 2 oC. Building on its rich tradition of research into energy, economy, environment and development, the ERC has been developing a linked economic energy system and emissions model. The ERC team has particular interest in inclusion of development indicators in the analysis, as well as those for climate change. The inclusion of these indicators in the international dashboard is used to provide a common set of data for national and regional analysis and also provides a full set of economic, energy system and emissions data for the pathways.

In addition to providing results coordinated to support global processes the novel combination of a dashboard and soft-linked, top-down economic and bottom-up energy system models also provides impetus and direction necessary to identify key issues to focus efforts for further model refinements and development for ongoing support of these processes, and national level processes.

To support the DDPP the team has worked to provided results consistent with the global initiative while also focusing on model developments relevant to specific South African issues such as high unemployment, existing socio-economic structures, labour force skills profiles and skills development scenarios, and options for future economic structures and other associated socio-economic research and data for informing the development indicators. This novel approach of combining data on multiple issues from multiple sources and tailoring models to address specific challenges is used to provide relevant, credible, evidence-based storylines showing what is required for South Africa to achieve acceptable socio-economic development and greenhouse gas emissions pathways from 2015-2050.

P-4402-17

Back to the future: Assessing the risks of 2°C pathways

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According to the most recent contribution of the IPCC, decision makers have some flexibility in terms of climate change mitigation timing and technology choices to achieve ambitious climate targets, such as the 2°C target. At the same time, they would like to pursue multiple other objectives beyond climate change mitigation that are affected by mitigation timing and technology choices. Depending on locally specific priority settings and risk perceptions, this could imply delaying mitigation efforts and/or ruling out specific technologies compared to the globally most cost-effective mitigation pathways and technology portfolios analyzed by Integrated Assessment Models (IAMs). Understand the implications of deviating from these cost-effective mitigation pathways for other risks related to mitigation choices could allow national decision makers to trade off various risks and priorities in a more informed way when choosing their mitigation policies.

On a global level, alternative mitigation pathways based on IAMs are primarily characterized by (i) the probability of exceeding a pre-determined temperature threshold and (ii) the aggregate economic costs of reaching that temperature threshold. Some studies have also analyzed (i) the potential co-benefits for non-climate objectives (such as energy security and air quality) and (ii) the risks for non-climate objectives (such as land availability and food security). While the first two characteristics have been in the focus of recent model intercomparison projects and scientific assessments (e.g. WGIII AR5/UNEP), and the co-benefits of mitigation pathways have gained in prominence (see, e.g., the Global Energy Assessment), the risks of alternative global mitigation pathways have attracted less attention - possibly except food security - both in the literature and in the public mainly for two reasons: (i) Mitigation risks are challenging to quantify, let alone monetize, on a global level - the discussion thus usually focuses on technology-specific risks, such as those associated with nuclear power, CCS or bioenergy. (ii) The mitigation risks tend to be smaller, less persistent, less prevalent, less irreversible and hence better manageable compared to the risks of unabated climate change (see IPCC AR5 SYR).

This paper aims at improving our understanding of mitigation risks for choosing amongst alternative ambitious mitigation pathways by drawing on IAM results. To this end, the paper will first review literature that has used various IAM outputs to discuss those challenges to mitigation pathways that have a bearing on risks for non-climate objectives and will hence serve here as

risk indicators for attaining/failing these objectives. In contrast to existing studies that focus on specific challenges or IAMs, this paper will proceed to analyze risk profiles of alternative mitigation pathways across a more comprehensive set of risk indicators most directly linked to other non-climate objectives, drawing on multi-model outputs from recent IAM intercomparison projects.

The ambition of the paper is to shed light on the risk tradeoffs involved in pursuing policies not consistent with the most cost-effective mitigation pathways to limit global warming to below 2°C. For instance, recent advances in the IAM literature stress that delaying mitigation efforts beyond 2020/2030 will lead to a lock-in of high-carbon and high energy demand development pathways and hence mitigation costs. But these scenario results have not yet been used comprehensively to evaluate the risks of delayed mitigation efforts for a large set of other non-climate objectives, particularly not in combination with additional technological constraints and/or assumptions for ambitious energy intensity improvements. This paper wants to address this research gap and show in what way the flexibility of future decision makers in choosing climate policy consistent with the 2°C target will be reduced by climate policy decisions today.

Based on a preliminary evaluation of the scenario results, the paper puts forward that delaying mitigation as well as ruling out technologies from the portfolio of mitigation options could lead to problematic risk trade-offs for future decision makers that have to balance increasingly high risks of unabated climate change and increased mitigation risks for those technologies still on the table. These results could serve as a basis for developing new approaches to climate policies more adapted to locally specific priority settings and risk perceptions without endangering globally agreed climate targets.

4403 - Revising the 2015 Paris Climate Change Agreement architecture for better governance and outcomes

ORAL PRESENTATIONS

O-4403-01

«Revising the 2015 Paris Climate Change Agreement Architecture for Better Governance and Outcomes» Session chair

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The Durban platform calls for "strengthening the multilateral rules-based regime under the [UNFCCC] convention". Issues of particular importance still to be decided are the particular legal form to be applied; if elements of the legal form are to be legally binding; how responsibilities are to be balanced across and among developed and developing countries; and the agreement's role, if any, in regulating or facilitating international emissions trading. Of the three approaches to choose from (expanded Kyoto-like approach, legalization of the Cancùn architecture, multi-track approach), this session will focus on aspects of a multi-track approach. This approach would allow a variable geometry with different configurations of countries involved in different parts of the overall regime. [1]

The session is built around the observation that the climate regime needs innovative modes of governance that recognize that the current regime is a transnational regime complex that is increasingly inadequate for inter-state governance. The chair will then note that the speakers' suggestions are all built around clubs of firms/cities/states that are conducive to the goal of building confidence (e.g. tackling easier problems such as soot with co-benefits; start linking with like systems to build confidence; designing smart border measures). This confidence-building approach is needed to build the collective action that has eluded the climate regime so far.

The chair will close by taking the example of the ongoing negotiations on an Environmental Goods Agreement (EGA), a good example of the three elements that are needed for a successful climate agreement (all were missing from the Kyoto Protocol). First, the treaty must encourage and promote full participation by countries. Second, the treaty must demand that parties change their behaviour substantially. Third, the treaty must provide parties with an incentive to comply with the obligations they have pledged to fulfil. Depending on the willingness of the parties engaged in the ongoing negotiations which should be concluded prior to the COP21, the EGA could turn out to the first global climate agreement. [2]

[1] For example, see Abbott " Strengthening the Transnational Regime Complex for Climate Change"(2015), Bodansky "The Durban Platform: Issues and Options for a 2015 Agreement" (2012), Stewart, Oppenheimer, and Rudyk " Building Blocks for Global Climate Protection" (2013) Victor "Climate Clubs" (2015)

[2] See http://blogs.worldbank.org/trade/wto-environmental-goods-agreement-why-even-small-step-forward-good-step

O-4403-02

Revising the 2015 Paris Climate Change Agreement Architecture for Better Governance and Outcomes

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For two decades, the global response to climate change has centered on a top-down, targets and timetables oriented, government-funded, nation-state-driven framework of regulatory mandates. But this international treaty architecture has produced neither the action orientation nor the on-the-ground results needed to address the build-up of greenhouse gases in the atmosphere. Thus, the 2015 Paris Climate Change Agreement should be recast to support a 21st Century bottom-up climate change policy strategy that focuses on broadening «engagement" to ensure that those who make the decisions that matter from the perspective of changed behavior and transformed outcomes -- Mayors, Governors/Premiers, CEOs, and other civil society leaders — are recognized and given more formal roles in the global community response to the climate challenge.

Professor Esty's presentation will explore three elements of what should be done to advance this strategy of broader engagement: (1) options within the 2015 Paris Architecture for formalizing the role of subnational jurisdictions and the other non-national actors -- and ensuring their "ownership" of and leadership on the climate change challenge; (2) a framework of metrics designed to encourage the contributions of this broader set of actors as well as providing structure and mechanisms of accountability for their actions; and (3) a strategy for dramatically expanding the funding for clean energy and other critical climate change investments through a focus on using limited government funds to leverage private capital. He will further explain how a reframed Paris Agreement that promotes broader engagement offers not just a pathway to more successful climate change action but also a 21st Century model for managing international interdependence.

O-4403-03

De-fragmenting the climate regime for a better international climate governance

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At the international level, a regime complex could be defined as «an array of partially overlapping and non-hierarchical institutions governing a particular issue-area» (Raustiala & Victor). More precisely, regime complexes form «a network of three or more international regimes that relate to a common subject matter ; exhibit overlapping membership ; and generate substantive, normative, or operative interactions recognized as potentially problematic whether or not they are essential in

identifying regime complexes and analyzing their effects» (Orsini, Morin & Young).

Our contribution will try to give a legal analysis of the regime complex for climate change, which has been until now mainly defined and characterized by international relations and political scientists.

After a legal mapping of the regime complex for climate change, the contribution will wonder what role could play the Paris accord in the «de-fragmentation» of the climate regime. Beyond the well-known finding of a fragmented, polycentric and complex international climate governance, how to build a more integrated and effective regime complex on climate change? Much of the institutional innovation in regime complexes arises at the joints between regime éléments. By drafting the Paris accord, negotiators should pay attention to various emergents networks of norms and actors. Finally, how to inject new life into the global community's response to climate change through systematic links (legal or institutional, formal or informal) to other regimes like for example the trade regime, the ozone regime or the biodiversity regime?

Our work forms part of a collective interdisciplinary project funded by the French National Research Agency and named CIRCULEX (Circulations of Norms and Actor Networks in Global Environmental Governance <ANR-12-GLOB-0001-03 CIRCULEX>). Concerning the international regime complexes for climate change and biodiversity, the first objective of CIRCULEX is to highlight the plurality of "sites of governance» and formal and informal links between these sites. This work highlights the diversity of actors involved and their modes of interconnection, as well as the diversity of standards that circulate in the complexes, in terms of origin, content and scope. A first set of conclusions could be drawn about the internal dynamics of regime complexes, conflicts and convergence of standards and interconnections with other regimes. We describe also the modalities of circulation of norms and experts in the regime complexes, and measure the permeability of economic actors to environmental governance standards, evaluate the interrelationships between public and private actors in the regulation. Finally, our project highlights the impacts of norms and networks of actors on the functioning of regime complexes, especially in terms of implementation and effectiveness. Does permeability favor a greater effectiveness of regimes or not ?

O-4403-04

The role of the trade system in promoting climate action

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COP21, scheduled for December 2015 in Paris, is expected to deliver a "protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties". Whereas the exact shape of the future climate change architecture is still to be defined, the work under the ADP, including the INDC-process, indicates that we are heading towards an approach of best-endeavor pledges by countries on individual mitigation contributions.

An advantage of this scenario is that it gives much leeway to countries to design and implement climate policies which suit their individual situations, needs and capacities. Among the challenges to be addressed are first how to ensure that the individual contributions add up to an ambitious enough response to climate change, and second that they are if not coordinated so at least mutually supportive.

In this context, the emergence of collaboration between groups of countries in "clubs" is an interesting and noteworthy development. Indeed, framing climate deals in smaller groups, designed in a way that encourages expansion of membership and linkages among groups over time, could be an effective way forward which complements multilateral efforts and reinforces the dynamic towards reaching collective agreements.

Taking into account the complexity of designing deals in the UN-oriented system of diplomacy, encouraging smaller club-like initiatives could contribute to the larger climate goal.

A recent ICTSD paper[1] identifies six main tasks that clubs could perform. They could provide a forum for enthusiastic countries to "do the deals" that would get reluctant countries to make bigger efforts; play a role in designing smart Border Carbon Adjustment Measures, BCAs; craft conditional commitments; craft and demonstrate technology strategies; tackle easier problems and last, learn how to help countries adapt.

In order for clubs to be effective and eventually attract new members, they will need to rest on coercion and on positive incentives working to ensure the realization of real gains. In this context, there may also be a need to develop benefits that are exclusive to club members. In the area of climate change, this is particularly challenging as the main gain of joint action on mitigation is aggregate emissions abatement, the benefits of which accrue to the whole world.

The possible linking of clubs, as well as the creation of certain exclusive benefits, are pertinent questions with respect to the world trade system. Can and should trade governance play a pro-active role to promote and facilitate the interplay between clubs, and if yes in what respect?

This intervention, based on recent and upcoming work in ICTSD, in particular under its joint E15-initative, will address such questions. [2]

[1] Victor, David G. The Case for Climate Clubs. E15Initiative. Geneva: International Centre for Trade and Sustainable

Development (ICTSD) and World Economic Forum, 2015. www.e15initiative.org/

[2] http://e15initiative.org/

O-4403-05

Internal coherence of the Paris outcome and connections to other regimes : conditions for confidence, cooperation and ambitious action for climate

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From the experience of the last Conferences of the parties to the UNFCCC, many things have changed in a very short time. Climate negotiations are not any more to be considered a zero sum game, but are now explicitly aiming to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one's efforts towards their own decarbonized and climate resilient future. The biggest challenge is to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, at least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from constructive attitudes to speed up the transformation, while also ensuring the capacity to maintain a full multilateral perspective and a global adequacy assessment mechanism. The second one relates to the bridges between the climate community of stakeholders and the outside world, between the climate regime and other regimes of governance at different scales : the objective is to build a new normality where climate action is consistently mainstreamed in other decision processes -either public or private, policy or investment measures, be they sectoral, regional or local-. What are the conditions for such an integration in a diversity of decision frameworks ?

Building the internal coherence of the Paris outcome as well as ensuring its connections to other regimes and fora will be two key milestones for the decades to come. This communication will develop some proposals concerning the expected Paris agreement and the organization of the post COP21 climate regime.

P-4403-01

Avoiding dangerous climate change: the role of shipping in delivering on the IPCC's latest carbon budgets

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In 2015 and with global emissions rising at unprecedented rates one clear certainty is that the future will be very different from the past. Whether the world continues to follow a trajectory of greenhouse gas emissions exceeding those in RCP8.5, the highest in the IPCC's suite of scenarios and associated with an expected temperature increase of between and 3°C and 5°C, or whether we begin a programme of stringent mitigation, is a decision for the international community. These two paths lead to very different futures, each radically different from the past. This paper reflects on and analyses the role of the global shipping industry as an important player in both these potential futures.

The Kyoto Protocol has called on the International Maritime Organisation (IMO) to "... [control greenhouse gas emissions from shipping]". In 2009, the then secretary general of the IMO concluded that "our collective way of life has become unsustainable" and stressed "the need to make some tough decisions ... and ... to start putting life ahead of lifestyle". In contrast, the baseline suite of six shipping emissions scenarios in the 2nd IMO GHG Study (2009) has CO2 emissions between 2007 and 2050 rise by a factor of between 2.2 and 3.1. Similarly, the 3rd IMO GHG Study (2014) presents a suite of sixteen scenarios, with rises of up to 3.5 times those estimated for 2012.

It is important to that the updated emissions estimates in the 3rd IMO GHG Study (2014) demonstrate a fall in CO2 over the period 2007 to 2012. It argues that much of this emission reduction was due to slow steaming in response to a global economic downturn. Recent emissions reductions may, therefore, represent 'latent CO2', that could be realised once the economic situation changes and vessels revert to pre-crisis speeds.

The paper contrasts the different emissions pathways for the shipping sector, placing them in the quantitative context of global emissions scenarios and associated temperature responses. It concludes that steering a mitigation course has never been more critical, nor the choice more stark.

P-4403-02

Opportunities and challenges for decarbonising the shipping sector

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The growth in transport emissions poses a particular challenge in meeting wider 2 °C emission targets. The demand for shipping experienced a significant period of growth during the first half of the previous decade, prompted by growth in regions such as Asia in conjunction with an increasing trade in manufactured material and dry bulk goods. This incentivised speculative ordering of new ships which meant that the fleet experienced over-capacity during the subsequent reduction in demand during the economic downturn. The third greenhouse gas report commissioned by the IMO estimates that between 2007and 2010 CO2 emissions due to international transport decreased by 13%. This can be attributed to an increase in ship size in some instances but also due to a reduction in ship speed, made possible by the overcapacity of ships. Therefore a reduction in ship speed and an increase in ship size (in conjunction with a reduction in demand) represent an opportunity to reduce the emissions associated with the shipping sector.

As the ships which experienced the greatest reduction in speed appeared to be the fasted ships, (such as large container vessels) it could be argued that such vessels will have the most to gain by resuming pre-existing speeds once demand returns. Therefore the cyclical nature of the shipping sector may be seen as an opportunity for opportunistic emissions reductions but makes realising long term savings difficult. Through the generation of alternative scenarios for future global shipping emissions, this study seeks to better understand the elements, both internal and external to, the shipping sector which may assist or hinder it in reducing its emissions, commensurate with meeting wider 2 °C targets, which require a significant reduction in carbon emissions by 2050. For example while a significant reduction in speed is necessary, it must also be compensated for by making sure sufficient fleet capacity (in terms of number and size) is available to ensure adequate scheduling needs are met.

Furthermore as shipping remains a derived demand, changes to existing trading patterns will influence the extent to which the sector can decarbonise. However the shipping sector itself cannot readily influence the demand for trade. Scenario results show that under a different decarbonisation scenarios, a reduction in fossil fuel trade may be compensated for by an increase in biomass trade, or the successful implementation of carbon capture and storage technology may allow fossil fuel trade to continue. A scenario in which the future demand for trade is projected to increase makes decreasing the carbon intensity of shipping even more important. In that regard, decarbonisation cannot be envisioned without penetration of both appropriate technologies and the availability of alternative low carbon fuels. The scale of the emission reduction necessary implies that widespread uptake of new-build and retrofit technology will be necessary. The efficiency of former will depend on levels of ship turnover which also reflect fluctuations in the shipping market. Supporting technological uptake will necessitate the availability of appropriate financing and opportunities to de-risk the uptake of new technologies. This will require identification of the most appropriate technological solutions, such as identifying the optimal routes for the application of wind technology. However lack of available berth space as well as a lack of appropriate training can impede the uptake of retrofit technologies.

Despite the scale of the challenge, the shipping sector arguably has greater opportunity to decarbonise than other sectors, such as aviation sector. However, given the urgency, it is imperative to identify synergies which may assist in sectorial decarbonisation in the near term. A reduction in trade demand, in conjunction with an increase in ship size will make a reduction in speed more viable, which can increase the impact of low carbon technologies. Modifying the conditions of vessel hire or enhancing supply chain flexibility will also assist in making fuel savings more attractive and viable. In summary, allowing shipping to meet its commitments within a 2 °C framework may not be wholly within the gift of the sector itself and will require support from the wider system of which shipping is a reactive part.

P-4403-03

Geography of International Trade, Maritime Transport and Climate Change in XXI Century: A Descriptive Basis for Multilateral Action from a South Perspective

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This paper puts the focus of its analysis in the relationship among the main tendencies of the international trade of goods, the essential characteristics of the seaborne trade and the challenges of climatic change. From the beginnings of the XXI century, three economic characteristics can be pointed out. First, the significant expansion of the global value chains that represent the new form of disintegration and de-localization of the production of goods and services which has driven to a new international division of the production (WTO, 2014). Second, the deepening of the regional integration and the cooperation South-South that reconfigure the seculars unequal relationships between the North and the South. In third place, the exponential growth of commercial exchanges. In this context, 80% of the world trade is carried out by maritime mean. Supply places have been diversified due to technological improvements and transport efficiency. Marine routes have been enlarged and new ones have been open (i.e. Channel of Panama and Artico routes). While some emergent economies (specifically in South Asia) reorient their exports toward medium and

high technological incorporated manufactures, many other monopolize their exports in agricultural products or mineral resources. Volumes expanded at the rate of 3.8% of nearly 9.6 billion tons. Of these shipments, dry cargo (major and minor dry commodities carried in bulk, general cargo, breakbulk and containerized trade) accounted for the largest share (70.2%), followed by tanker trade (crude oil, petroleum product and gas) which held a 29.8% share (UNCTAD, 2014). Developing countries have increased their contribution to these flows, although in an uniqual contibution at individual terms. Regionally, Asia remained the main loading and unloading area in 2013 with its share of imports (unloading) being particularly dominant. Americas is the other major loading area and Europe on the unloading side. These shares are likely to further evolve with changing trade patterns and partners, the emergence of Africa and developing America as areas with a significant growth potential, and fast growing trade on secondary container trade routes supporting South-South and intraregional trade. Global containerized trade is projected to grow, given among other factors by improved prospects for mainlane East-West trade. The global fragmentation of the production and the development of multimodel systems of international transport are the elements that also lead to a reorganization of the ports.In this context, the sector of marine transport needs to adjust its commercial strategies to adapt to the changes of the world economy and rules of the trade, besides risks and current environmental uncertainties. As world seaborne trade increases, the main challenges - especially from the perspective of a social and environmentally sustainable development, as well as from the point of view of the transport and trade facilitation - consist in reducing the GHG (mainly CO2) emissions from international shipping and define mitigation and adaptation policies. In terms of CO2 emissions/ transported ton, it is recognized that the marine transport is the more effective one. Nevertheless, due its enormous scale, it is estimated that ship emissions (especially from oil-tankers and container ships) represent 11,8% of the emissions of the transport sector and 1,6 to 4,1% of the CO2 world emissions resulting from burning; according to the International Maritime Organization (OMI), they will increase in a factor from 2,4 to 3 between 2007 and 2050 (UNCTAD, 2008; OMI, 2009; OMC/ PNUMA, 2009) This linking of climate change challenges with the tendencies of international seaborne trade and their emissions of GHG have relatively little presence in the multilateral negotiations. But OMI has recently adopted a group of technical and operative measures to improve the energy efficiency and of GHG emission from ships with the aim to promotes trade but in turn energy efficiency and sustainable development, according to the principle of the common but differed responsibilities among developed and developing countries. In this sense then, it is sought to advance in this proposal a detailed characterization of the main tendencies of international trade and seaborne trade in the XXI century, analyzing their complex links with climate change, and the main challenges for a negotiated multilateral action, putting the accent, as case analysis, in the emergent economies of Latin America (in particular Brazil, Mexico and Argentina).

4404 - Climate finance: New sources, new instruments, more effects ?

ORAL PRESENTATIONS

K-4404-01

Sources and instruments for climate finance

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Long-term investments in climate-friendly and climate change resilient infrastructure, buildings and energy is essential to both mitigate greenhouse gas emissions and adapt to climate change impacts. Such climate finance is particularly in need in many developing countries due to limited economic resources and expected impacts from climate change. Direct government contributions can help, but a large share of the agreed 100 Bill. USD annually from 2020 for climate measures in developing countries can only realistically come from the private sector.

What is the status of sources and channels of long-term climate finance? I present a new status report on the most promising sources of climate finance. Relevant sources are public carbon-related revenues (taxes and emissions trading), carbon offset markets, international transport, removal of fossil subsidies, direct budget contributions, finance development institutions, private flows, green bonds, 'debt-for-climate' swaps, and export credits.

What can developed country governments do to catalyze private sector investment in developing countries? There is a range of de-risking interventions and instruments available, from credit enhancement to guarantees.

Green bonds finance low-carbon or climate-robust projects. Private sector investment in green bonds has tripled in each of the last two years. Pension funds, insurance companies, and socially responsible investors are increasingly investing in green bonds. Can the momentum of the green bond market be harnessed to make a real difference to the climate and for climate finance in developing countries? Can Green Bonds funding be combined with multilateral climate finance such as the Green Climate Fund?

Key issues discussed are:

- What are the most promising sources of climate finance?
- What is the scope for government de-risking of private finance?
- What government measures are most efficient to stimulate private finance?
- To what extent can Green Bonds make a difference in climate mitigation and adaptation?
- How can Green Bonds be adapted to the needs of developing countries?

How can governments facilitate Green Bond investments in developing countries?

K-4404-02

Mobilising capital for green infrastructure investments

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A keynote presentation focusing on OECD analysis on what developed country governments can do to catalyse private sector investment in green infrastructure of developing countries.

The presentation would cover key lessons from the following OECD work streams: Mapping Channels to Mobilise Institutional Investment in Sustainable Energy: An OECD Report for G20 Finance Ministers and Central Bank Governors; which uses an empirical base of 70 deals to identify barriers and advise on how governments can overcome them to mobilise institutional investment in sustainable energy and how governments can support the development of potentially promising investment channels and consider policy interventions that can make institutional investment in sustainable energy infrastructure more likely.

Green Bonds: a new report will analyse the potential, barriers and policy solutions for scaling up green bonds across their various different forms (including municipal, corporate, asset-backed, covered, project).

The OECD-led Research Collaborative on Tracking Private Climate Finance, an OECD-led network of governments, research institutions and international finance institutions. Over the past two years it has explored data and a range of methods to estimating private finance mobilised by developed countries for climate action in developing

countries. In 2015, work conducted under and in co-operation with the Research Collaborative will focus on the further development and ground-testing of estimation methods in the context of pilot measurements of mobilisation for climate-relevant sectors, different types of interventions/instruments, as well as at the level of individual/groups of countries and public finance institutions.

The OECD Policy Guidance for Investment in Clean Energy Infrastructure: Expanding Access to Clean Energy for Green Growth and Development is a good example of our efforts to improve the enabling conditions for private investment in clean energy infrastructure. Non-prescriptive tool to help governments identify ways to mobilise private sector investment in clean energy infrastructure, annexed to the Communiqué of G20 Finance Ministers in 2013.

OECD report on Overcoming Barriers to International Investment in Clean Energy discusses the rise of hidden indirect protectionism in clean energy since the 2008 financial crisis. The report provides empirical evidence on the negative impact that LCRs have on international investment in solar PV and wind energy, as they increase the cost of inputs for downstream segments of the value chain like renewable energy-based electricity generation. By assessing the impacts of measures such as LCRs across different segments of the value chains, this report provides policy makers with evidence-based analysis to guide their decisions in designing clean energy support policies.

O-4404-01

Result Based Financing for Mitigation: choosing the right "triggers" to drive a "paradigm shift"

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Results-based finance is an emerging tool to link public and private financing to a more sustainable and climate-friendly future. The main goal of many of these new funding sources is to create a "paradigm shift" towards low carbon and climate resilient development. But what does this mean for how new mitigation financing could be allocated and what types of projects, programmes or larger policy changes could be targeted? This contribution explores two specific question in the RBF decision making process. This first is how to ensure that RBF for climate finance promotes mitigation even after the payments for emissions reduction stop, and supports technologies and practices that are part of the "end game" for climate stabilisation. Long term results typically require policy and institutional changes, which are not normally linked to project or programme-based financing. In addition, focusing on long term results means avoiding technology "lock in" and driving innovation in mitigation technologies. The second question is what type of non-climate criteria are needed for RBF, including environmental and social safeguards, and how might these be integrated in the payment system. In other words, how might non-climate impacts not only be monitored, but how would their achievement (or avoidance) affect the results-based payments.

O-4404-02

Smart Unconventional Monetary (SUMO) policies: giving impetus to green investment

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Today, given the amount of investment needed to reach a 2-degree emissions reduction target and the tight budgetary constraints of governments worldwide, public spending alone will not be sufficient alone. Therefore, there is a double need to not only shift private financial flows from "brown" sectors to "green" sectors, but also to leverage new sources of financing. Addressing the second challenge, this study reviews three families of proposed funding mechanisms based on unconventional monetary policies targeting "green" or "climate" investments. These "Smart Unconventional MOnetary" (or SUMO) policies include: (i) the use of Special Drawing Rights (SDRs) issued by the International Monetary Fund (IMF), (ii) green quantitative easing and (iii) the issuance of Carbon Certificates.

This contribution will first present the basic elements of these three approaches. It will then identify and discuss the implementation challenges to overcome. These include both concerns over inflationary worries as well as the difficulty to reach multilateral agreements in the short run, and the involvement of the private sector. Finally, the presentation will look at the key conditions for ensuring the environmental integrity of the unconventional monetary policies, both ex-ante - during the selection of eligible projects - and ex-post . This contribution will look at lessons drawn from Monitoring, Reporting and Verification (MRV) methods used in the Clean Development Mechanism as well as other existing schemes (white certificates, etc.).

4404-POSTER PRESENTATIONS

P-4404-01

Public Financial Institutions and the Low-Carbon Transition: Five Case studies on Low-Carbon Infrastructure and Project Investment

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This study, jointly undertaken by the OECD and CDC Climat Research, analyses the role of Public Financial Institutions (PFIs) in fostering the low-carbon energy transition through domestic climate finance activities. The study maps the key tools and instruments currently used by five institutions to mobilise private sector investment in low-carbon infrastructure projects in OECD countries in three sectors: sustainable transport, energy-efficiency and renewable energy. Between 2010-2012, these five institutions - Group Caisse des Dépôts in France; KfW Bankengruppe in Germany; the UK Green Investment Bank; the European Investment Bank and the European Bank for Reconstruction and Development - have provided over 100 billion euros of equity investment and financing for energy efficiency, renewable energy and sustainable transport projects. The results of the study indicate that these institutions play a key role in leveraging private sector participation in low-carbon, climate-resilient investment through the use of traditional and innovative approaches to link low-carbon projects with finance through enhancing access to capital; facilitating risk reduction and sharing; improving the capacity of market actors; and shaping broader market practices and conditions.

P-4404-02

Tracking low-carbon investment in France in 2011: a landscape of sources, flows and channels

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This report presents the first comprehensive view of climate finance flows in France to reduce GHG emissions. Funding for the energy transition is a central issue for which the available data are often incomplete. This report aims to further the current debate by providing economy-wide estimates. This study identified and analyzed the investment spending in France in 2011 that contributed directly or indirectly to the reduction of greenhouse gases emissions (GHG); this corresponds to investment in low-carbon infrastructure and fixed assets (renewable energy, building high environmental quality, public transport, etc.). This information has been used to identify the distribution of flows across sectors, the share of different instruments, their use and the role of different actors.

This analysis has identified EUR 22.2 billion of investment in France in 2011in physical or tangible assets that reduce greenhouse gas emissions. Across all sectors, renewable energy accounted for EUR 9.0 billion of investment, including investment subsidies of 1.0 billion EUR. Energy efficiency was the second largest area of climate investment, totaling EUR 8.3 billion. The share of grants and concessional loans - with thus a cost for the public sector - totaled EUR 2.3 billion. These investments are

concentrated in the construction sector (buildings) (EUR 6.7 billion).Private actors financed 75% of renewable energy and energy efficiency investments. In the transport sector, the picture is less clear as project were initiated principally by public bodies, and with financing provided (through debt and other means) in part by private actors. The EUR 22.2 billion annual investment estimated by this report - and excluding investments in the nuclear energy - is below the annual flows identified as necessary to achieve long-term objectives. The financing challenge should thus not be underestimated. The Panorama France 2011 suggests that part of the funding needed for the energy transition is already being provided, however efforts are still needed to reach long-term climate and objectives.

4405 - On the macroeconomic opportunity of climate policy

ORAL PRESENTATIONS

K-4405-01

Why finance ministers might favor carbon taxes, even if they do not believe in climate change

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The economic forces of globalization constrain democratic governments increasingly. According to Dani Rodrik, we cannot have democracy, national sovereignty, and hyperglobalization at the same time (Rodrik, 2011)[1]. Hyperglobalization impinges on democratic choices within sovereign nations by giving rise to corporate tax competition, which "restricts a nation's ability to choose the tax structure that best reflects its needs and preferences" (ibid., p. 193). Declining corporate tax rates, complemented by a rising share of labor taxes, give evidence of the resulting race-to-the-bottom.

The fact that this race-to-the-bottom impedes a government's ability to raise sufficient funds has far reaching consequences. Funds are required, e.g., not only for health care or education, but also for productive public infrastructure, which is important for both efficiency and equity. Accordingly, an emerging consensus in the empirical literature suggests that these stocks are underfinanced. This raises the question how to reduce exposure to tax competition and generate funds to finance essential public goods.

We identify taxes on the use of carbon resources as a superior alternative to capital taxes. Even though fossil resources are also traded internationally, there is an asymmetry in efficiency between capital and resources as tax base. While ownership of fossil resources gives rise to a rent, capital does not. Taxes on either factor cause an interregional reallocation by driving economic activity out of countries with relatively high tax rates. The carbon tax has the advantage, though, of capturing part of the resource rent. Governments can use the appropriated rent for productivity enhancing infrastructure investments, which in turn attracts investments in domestic capital stocks.

Further, it turns out that a carbon tax may not only have fiscal benefits. When the motivation to tax the use of fossil resources is based exclusively on fiscal needs, then resource exporters react by reducing both the rate (a timing effect) and the cumulative amount of resource extraction (a volume effect). Thus, carbon taxes do not cause a green paradox in this situation, but can be part of an effective green tax reform. Governments may not take climate externalities into account, as modeled in our paper. In that case, timing and volume effects per se do not affect decisions about fiscal policy. Nevertheless, these observed effects show that a unilateral tax reform which introduces a carbon tax also has beneficial environmental implications.

Our contribution is thus twofold. First, we bridge the gap between horizontal fiscal federalism, in particular the tax competition literature on the one hand, and the economics of exhaustible resources on the other. Using a numerical general equilibrium model we compute optimal tax portfolios and precisely assess their opportunity costs. To our knowledge, our model is the first to combine the following key features. We implement a decentralized market economy with several representative agents and strategically interacting governments. The tax instruments, which governments use to finance productive infrastructure stocks, are determined endogenously for both cooperative and non-cooperative behavior in the Nash equilibrium. Capital and fossil resources are traded on international markets. Finally, we include the intertemporal dynamics of capital accumulation and resource extraction (based on the respective models of Frank P. Ramsey and Harold Hotelling). Second, we shed light on the supply side dynamics of fossil resource extraction. So far, most of the research on the conditions under which a green paradox occurs has used partial equilibrium analysis. Only recently has this strand of literature been extended to general equilibrium. Now, we take even one step further. Our model allows strategic interactions between fossil fuel selling and buying countries, as well as among the governments of buying countries themselves.

We conclude that even when governments do not intend to address climate change, they still have an incentive to implement a carbon tax to improve their fiscal policy. Then, the carbon tax nevertheless helps mitigating the adverse effects of climate change. It is thus not only the environmental ministers who should favor carbon taxes, but also the ministers of finance.

K-4405-02

Climate change and adaptation. A new opportunity for public debt relief?

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Notwithstanding a consolidated and vast literature on the possibility to conjugate development and environmental protection, a view still rooted in the policy domains considers the environment as a luxury good less important than social goals like growth or employment. This is epitomized by the climate change challenge. On the one hand the trade-off development/ GHG mitigation is at the heart of the difficulty to involve developing countries in an international agreement on emission reduction. On the other hand, especially in a background of a financial crisis along with high levels of indebtedness and aging population, high unemployment levels and the need for fiscal outlays for unemployment compensation or welfare benefits, climate change policies seem to appear as something which would not be regarded as an urgent policy also in many European countries. In fact, in a situation where public budgets are overstretched due to economic crisis, there is an increasing need to understand the implications of climate change impacts, climate change mitigation and adaptation policies on the fiscal side.

This is particularly true for those countries which experienced growing levels of deficit and debt in the last decades, and especially for adaptation that typically implies an increase in expenditure coming from the public sector. In this context, cuts in public expenses to reduce the gap between revenues and expenditures might appear to be the winning strategy, however there are also impacts to cope with whose timing and magnitude are uncertain as uncertain are their fiscal effects. Policy intervention may lead to an inefficient result with negative ramifications for the economy if adaptation measures are either too paltry or too ambitious. Different options also have different implications for fiscal costs and government revenues.

We tackle these issues using a recursive-dynamic Computable General Equilibrium (CGE) model: the Intertemporal Computable Equilibrium System (ICES) model, enriched with a more realistic description of the government sector both on the revenue and the expenditure side. The relations between debt sustainability and climate change are analyzed both in their short-term

and long-term dimensions.

More specifically: firstly, we assess the "direct" or "first round" effects of climate change on the public budget through changes in total tax revenues induced by impacts on production, consumption patterns and trade structure. This also originates indirect fiscal costs (or second round effects) as it impacts governments' fiscal capacity.

Then, we introduce the possibility of adaptation expenditures to reduce the climate change impacts. We explore adaptation long-run effects on fiscal capacity and fiscal flexibility under different assumptions of financing. Could there be room for issuing more debt (adaptation bonds) to cover climate adaptation expenditure inducing anyway in the long term a decrease in the debt/GDP ratios exploiting adaptation effects on avoided future damages? Even though possible, would it be more efficient and growth enhancing to support adaptation expenditure with revenues from other, e.g. carbon-energy, taxes? What are the different crowding out effects on public/private investment?

It can be established, that climate change has introduced a new aspect into the structure of public finances both in expenditure and in revenue side. In the context of the current multi-year crisis, public finances in the EU are strained, and thus the fiscal consequences of climate change are important to estimate and the worst case scenarios need to be avoided. From few case studies in literature, it is evident that the fiscal consequences are not negligible. However, there has not yet been any study that satisfactorily addresses the way climate change and adaptation affect the state budget, and particularly its stability, in a general equilibrium framework.

K-4405-03

Complexity and Green Growth: A Practical Perspective

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Practical policy aiming to seize macroeconomic opportunities for climate policy has to deal with complex interactions between macro-variables and the many processes that may or may not lead to such opportunities. The Global Institute of Sustainability at Arizona University is presently involved in a Chinese initiative to implement a green growth strategy in a poor rural region where these interactions can be investigated in real time.

The initiative is based on the seminal report «China 2030» produced by the Development Research Council (DRC), the think-tank of the Chinese prime minister, together with the World Bank. This report outlined the new growth strategy pursued by the Chinese leadership installed in 2013. The key macroeconomic variables relevant for the initiative are straightforward: GDP, employment, etc. The policy variables, however, are much more complex than typical discussions about simple variables like carbon prices, government deficits and the like suggest.

The initiative started by outlining a shared vision in an intense dialogue between the provincial government, DRC and international partners like Arizona State University and the Global Climate Forum. This on-going dialogue involves a wide variety of local actors. An instructive example is the founder of a large company for electric bicycles who established a green theme park in the region in question. A key instrument to launch this dialogue was a trans-continental conference on green growth connecting audiences in America, Europe and China. On this basis, a selection process is presently under way in order to determine initial intervention points. These may include sites for a green community center and an international study center, collaborations between specific enterprises and research institutions, platforms for e-commerce and e-learning, product designs to create a regional green growth brand, and more. A commercially operating green-growth investment funds will be established by leveraging contributions from the provincial and central governments. In a step-by-step process these initial interventions shall lead to new, environmentally friendly jobs and revenues, expanding up to the point where macroeconomic advantages for the region in question become visible and can be reproduced in other regions.

The initiative is based on a series of theoretical conjectures and insights. They include the following:

- the environmental crisis is fundamentally due to the inability of present societies to process the complex information flows generated at the interface between society and environment
- therefore, effective crisis responses require an enhancement of the societal capacity to process complex information by combining new information technologies with new concepts and institutions
- in particular, this means to increase the division of labor by reducing transaction costs, in line with the insights of Adam Smith, Xiaokai Yang and others
- it also means to embed climate policy in a comprehensive vision of green growth
- this strategy fosters cultural diversity by treating money not as the common denominator of preferences and values but as one of several dimensions of social status competition
- a competition for successful models of green growth is a promising way towards a transition to global green growth.

K-4405-04

Modelling the macroeconomic opportunity of climate policy

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(1) Global Climate Forum, Berlin, Germany

Economic policy analysis modelling has largely depicted climate change mitigation as a drag on economic development. In contrast, concepts as green growth or green economy and results of recent studies, such as the New Climate Economy Report, suggest that reducing emissions need not slow down but may benefit the economy.

The possibility of protecting climate while enhancing economic development deserves to be carefully researched; economic models constitute an important tool for doing so. Unfortunately, this possibility is beyond the horizon of the marginal analysis conducted with many conventional climate policy analysis models. Rooted in the general equilibrium framework, these models mostly find economic costs of mitigation when optimizing in the vicinity of a «business as usual» equilibrium.

A survey of models that can represent economic benefits from climate change mitigation reveals a large spectrum of approaches for going beyond this standard modelling setup. At the more conventional end of the spectrum, the literature provides theoretical model extensions, for example to address external effects, that open up the possibility of positive economic effects from climate policy. Computational models further away from the general equilibrium and optimization approach, such as system dynamics models or a macroeconometric model for climate policy analysis, can be viewed as the other end of the spectrum. Within the general equilibrium framework, but outside common modelling practice, several studies conceptualize the current fossil-fuel based economy and a low carbon economy as different equilibria of the economic system. For example, inframarginal economics generalizes the marginal analysis approach by considering different structures of specialization and division of labour. By modelling structural change to the division of labour that is triggered by mitigation policy, the possibility of green growth can be represented and analysed. Similarly, an analysis of a virtuous circle of expectations, investment and learning-by-doing has shown that investment oriented climate policy can induce a shift to a new growth path with lower emissions but higher growth and employment.

This contribution focuses on the question how climate policy can facilitate a recoordination of investors' expectations so as to induce a transition to a green growth equilibrium and how this can be modelled.

O-4405-01

Overview of climate finance at scale

TE. Downing (1)

(1) Global Climate Adaptation Partnership, Oxford, United Kingdom

Climate finance is essential to reducing climate risks, and take advantage of emerging opportunities. This presentation introduces a panel on Climate Finance At-scale. Four questions drive the search for solutions:

1. Three major domains--sustainable development, climate change and disaster risk management--are negotiating goals, governance and finance in 2015. What modalities of governance achieve synergies?

2. Achieving at-scale impacts requires transformative investment: What are the modes and prospects for engaging the private sector?

3. Negotiations on loss and damages are well advanced and widely seen as a mechanism for scaled up finance. What are the prospects for a robust analytical regime?

4. Transformation of climate resilience requires leadership that recognises emerging good practice: What does recent research offer to inform sound investment in adaptation?

O-4405-02

Managing Climate Change Risks and Vulnerabilities: A Microfinance and Climate Finance Perspective

D. Chirambo (1)

(1) Seeds of Opportunity, Blantyre, Malawi

Climate change touches upon a myriad of inter-related and multi-dimensional aspects of societies, economies and the environment. From an African perspective, climate change may be considered as a phenomenon that may seriously hamper the continent's future development and pose as an additional impediment to sustainable development. Since climate change impacts are anticipated to vary across countries and localities with some geographic regions being anticipated to suffer more from climate change than others due to variations in national capacities, it can be argued that the poorest and most vulnerable groups and countries will likely be the most affected, consequently increasing world inequality.

Even though different countries have various models and approaches for climate change risk assessments and management, it is widely believed that in-order to reduce the impacts of climate change on various countries, and to ensure that international consensus and policies for climate change mitigation, adaptation and financing can be achieved, the post 2015 development agendas should increase funding towards climate change initiatives most notably in developing countries and promote mechanisms for raising the capacity for effective climate change management in Least Developed Countries (LDCs), including focusing on women, youth and local and marginalised communities

To date, most climate financing modalities and projects in Africa have had limited or no effect in terms of poverty alleviation and sustainable development due to a lack of emphasis on strengthening the participation of marginalised groups, and the continent's adaptation deficit as caused by a lack of institutional, financial or technological capacity to adapt effectively to climate change. In addition to this, even though climate financing for mitigation and adaptation should be addressed with the same priority, research has shown that the implementation of climate finance modalities are highly construed towards mitigation efforts whereby 91% of climate finance flows are for mitigation efforts, 7% for adaptation efforts and 2% for activities with both mitigation and adaptation objectives. Cumulatively, these issues suggest that most communities in Africa could be becoming more vulnerable to the impacts of climate change.

Recent research shows that almost three-quarters of climate finance flows are invested with the expectation of earning commercial returns, hence signifying the need for innovative climate financing models that provide win-win situations for funders and recipients, as well as the world at large as the risks and consequences attributed to climate change can be minimised. In-order to determine the opportunities that exist in enhancing the capacities and opportunities for microfinance for climate change mitigation and adaptation initiatives, and disaster risks and management, this paper expounds the Microfinance-Climate Finance Framework that was shortlisted for the 2014/2015 UNDP MDG Carbon Climate Finance Innovation Award. Using this framework, it is possible to highlight the challenges and opportunities that microfinance institutions could have in the mobilisation of funds and resources from various types of funders, and redistribution of funds and resources to various types of recipients. This paper concludes that fostering international and domestic policies that encourage remittances and financial inclusion may be an effective strategy to encourage microfinance based climate change management funding.

4405-POSTER PRESENTATIONS

P-4405-01

Relative price adjustment of energy and labour: The case of energy-dependent and small open economies

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(1) Centre International de Recherche sur l'Environnement et le Développement (CIRED), Nogent-sur-Marne, France

The increase in energy prices is the corner stone for policies that seek to manage efficiently energy systems in the long run (including climate policies). However, such a price increase may harm the economy during the transition, when substitutions have not yet taken place. In this paper, we consider an increase in the relative price of energy with respect to labour, and we analyse its consequences for aggregate domestic production and employment. We develop a general equilibrium model of small open-economy assuming unemployment and high dependence to imported energy. Simplified enough to be solved analytically, this model does not restrict the analysis to the neighbourhood of an optimum. We examine how the qualitative result - a net positive or negative impact on production and employment - is sensitive to a set of debated parameters on 1) the behaviour of the economy (the reactions of domestic wage and the response of external trade), and 2) the initial state of the economy (the levels of energy consumptions, unemployment and wages, the import price of fossil energy, and the relative initial taxation of energy and labour).

P-4405-02

Carbon Tax, Pensions and Deficits

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This paper aims to draw attention on the consequences of the prevailing intellectual compartmentalization between 'energy and climate', on the one hand, and 'the viability of social security systems', on the other. We take the methodological venture of building a general equilibrium model to analyse jointly these issues. The model is applied to France and projected to a future horizon (2020). It ensures consistency by linking together 1) a description of the future constraints on energy and demand, and 2) a partial forecasting scenario of the pension system. First, we analyse two types of archetypical reforms that use one instrument to meet one objective. The first type recourses to one of the present instruments of the pension system (social security contributions on wage income, age of retirement). The second type absorbs the deficits of the pension system by preempting revenues generated by the climate policy (here a carbon tax). After examining the limitations of those single-instrument/single-objective policies, we provide an example of a multi-objective policy package that enables the limitations to be removed. In so doing, we present a way of exploring potential synergies between long term development goals.

P-4405-03

The role of transparency and accountability for impact investment

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Today's financial markets are characterized by globalization and interdependence, while nations around the world are still suffering from the economic and social aftershocks of the global financial crisis. Politicians, economists, NGOs and concerned citizens have scrutinized the weaknesses of the current financial system. A consensus is emerging that the current financial and economic structures are not sustainable and the danger of another socioeconomic crisis persists in spite of a plethora of regulatory changes. A grass-roots movement for sustainable development is leveraging investments as a tool to achieve social and ecological benefits while promoting fundamental structural changes in the finance industry and in public finances. A variety of innovative investment strategies including ethical, "green", "social", "responsible" investments as well as social banking and sustainable investing combine social, ethical and/or ecological objectives with financial returns, distinguishing them from so-called mainstream investments pursuing only risk-adjusted returns. At the same time, many large financial institutions have jumped on the "sustainable investment bandwagon", trying to profit from the rapidly growing demand for sustainable investment products by "greenwashing" conventional investment products, which do not offer any sustainability benefits. Contradictory marketing claims confuse potential investors and prevent the successful mainstreaming of genuine sustainable investment products. False marketing claims lead to consumer cynicism and growing mistrust towards the financial services industry. We draw upon a case study of "Impact Investments" to explore this issue. We are going to utilize analogous cases in different industries to draw lessons for marketing and certification strategies for Impact Investments. In view of the insights from diverse economic sectors, e.g., the chocolate, forestry and fishery industries, we observe that certification systems are an efficient mechanism to foster principles of sustainable development within a globalized market economy (i.e. Fair Trade, Forest Stewardship Council, Marine Stewardship Council). We further identify the current certification schemes existing in the financial sector and discuss their repercussions, also considering ongoing projects that seek to tailor accounting guidance to different actors of the financial system. Based on the insights taken from these case studies, we plead in favour of the idea that a standardized international certification would help to restore trust in financial services and help to mainstream impact investing (getting it out of the «green niche»). Certification could help impact investments gain the necessary «critical market share», and ultimately, intentionality to consume impact investment products.

P-4405-04

Impact of community own revolving fund in adapting with changing climate in Nepal

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(1) The Small Earth Nepal, Kathmandu, Nepal

By now the scientific community agrees that climate change is occurring and its impacts are more in low income countries. Nepal is experiencing significant changes in climate, which have a direct and severe impact on the livelihood of its people, most of whom are still rural. A study has been undertaken to look at the impact of a community own revolving fund - a concept of micro-financing in adapting the changing climate in Nepal. The farmers in three agro-ecological zones of Nepal have been provided with the bucket drip irrigation set for their kitchen gardening, the system which is highly water efficient and less time consuming. The farm cooperative is charging NPR 100 (~USD 1) per set and the money is collected as a source of revolving fund. The money has now been given to the needful member of the cooperative which needs to be invested only in vegetable cultivation sector which gives quicker income. After six months, the amount is offered to the second needful persons and so on. In this particular paper, we describe the fund circulation mechanisms, community engagement on the project and its benefits in short and long run.

4406a - Climate, Sustainable Development and Energy Security

ORAL PRESENTATIONS

K-4406a-01

Energy and Climate Challenges: The case of India

P. Shukla

Abstract not communicated

K-4406a-02

Energy and Development in Emerging Countries: Examples drawn from China

J. Reilly

Abstract not communicated

O-4406a-01

Nexus of climate mitigation and key development objectives - An analysis for South Africa

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South Africa is a rapidly growing middle-income economy with a coal-based energy system that generates high greenhouse gases emissions, on par with the richest economies in the World. The country has pledged to significantly reduce its emissions (by 34% in 2020 and by 42% in 2025 relative to business-as-usual, under the condition of finance and technical support from the international community). It is actively discussing policies to achieve this goal, including a carbon tax.

Yet, climate mitigation is not the only challenge that South Africa faces. Despite significant progress in overcoming the inequalities inherited from the Apartheid era and in improving quality of life since the onset of the democratic regime in 1994, economic growth has slowed down in recent years, poverty remains high and large inequalities persist. In particular, the South African economy is still experiencing very high unemployment, in particular amongst low-skill individuals, while there is shortage of high-skill workers.

The present paper aims to provide some insights on the nexus between South Africa's mitigation objectives and the key development challenges outlined above. It focuses in particular on economic growth and unemployment, in the context of inequality and education. For this purpose we developed IMACLIM-SA a dynamic, computable general equilibrium of the South African economy. IMACLIM-SA represents the South African economy as a small, opened economy with ten sectors (five energy, five non-energy) and five household classes. Calibrated on 2005 data, the model produces an equilibrium of the economy in 2035 based on assumptions about change in key parameters.

Particular attention is paid to the input data, with the production of a revised social accounting matrix to match monetary flows drawn from macroeconomic statistics and energy flows drawn from energy tables. The model also captures differences in the prices of goods and services (notably energy) between firms, households, the public sector and exports. We use outcomes of runs of the SA TIMES model of the Energy Research Center of the University of Cape Town to inform changes in electricity production in IMACLIM-SA. Particular attention is given to the labour market, in terms of supply—with three skill classes—, labour demand in production and market functioning and imperfections.

In the reference scenario, given our assumptions, GDP grows at an average rate of 3.4% per year, and GDP per capita more than doubles over the period. It must be noted

that to generate such level of growth in the baseline, we must assume not only capital and labour productivity improvements, but also an increase in international prices relative to domestic ones, thus improving competitiveness of South African products on the export market. Unemployment decreases markedly, though it remains important in 2035, and shortage of high-skill labour persists. In the reference projection, emissions increase substantially, despite implementation of the Updated Integrated Resource Plan of 2013.

We then explore seven policy packages based on the imposing a carbon tax of 100 Rand (ZAR 2005) per tonne of CO2 with different recycling schemes. We find that CO2 emissions in South Africa are sensitive to even a relatively "small" carbon tax by international standards, though it is high relative to 2005 domestic prices of energy. A R300/tCO2 carbon tax might help achieve the country's pledges. This is consistent with prior literature on mitigation in South Africa. Impacts on GDP growth and on unemployment reduction can be significant, with total GDP in 2035 at 2.5% to 15% lower for a R300/tCO2 carbon tax, but strongly depend on the revenue recycling mechanism.

Amongst the recycling options we test, using carbon tax proceeds to reduce a sales tax results in GDP growth on par with the reference projection, plus in a higher level of employment, while CO2 emissions decrease. Using carbon tax proceeds for lump-sum transfers to households underperforms the reference in terms of GDP and employment, but achieves a strong reduction of inequality. Using part of the proceeds to invest in education results in accelerated growth, reduced employment and lower emissions—but this result depends on assumptions concerning the impact of additional investment in education, namely a joint increase in growth of labour and capital productivity relative to the reference projection.

O-4406a-02

A Dynamic General Equilibrium Assessment of the Energy-Climate-Development Link in Mexico

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This paper offers an empirical application of the notion of energy transition to the Mexican economy and takes the next step of simulating medium- and long-term impacts of proposed and future energy policy on the environment and the Mexican economy. The starting point of the analysis comes from ThreeMe framework, a Multi-sectoral Macroeconomic Model for the Evaluation of Environmental and Energy policy, which is motivated by neo-Keynesian theory. It is designed to address dynamics of global economic activity, energy system development and carbon emissions causing climate change. The ThreeMe model is well suited for policy assessment purposes in the context of developing economies as it informs the transitional effects of policy intervention. In particular, disequilibrium can arise in the form of involuntary unemployment, inertia of technical systems and rigidity of labor and energy markets, as a result of delayed market-clearing in the goods markets and slow adjustment between prices and quantities over the simulation time path.

Calibrated to updated aggregate and sectoral national accounts data, a Mexican version of the ThreeMe is developed that accounts for 24 commodities-including 3 energy sources-and 32 sectors, with an explicit distinction between 11 energy sectors and 7 transport sectors. Electricity production is disaggregated into 9 technologies: hydro, geothermal, wind, solar, biomass, nuclear, coal-based, oil-based and gas-based. The ThreeMe-Mexico model is used to gauge the economic and environmental effects of energy fiscal policy measures in Mexico (namely the phasing out of energy subsidies and the implementation of a carbon tax). Different policy scenarios are assessed, each reflecting a different strategy of fiscal revenue recycling. We consider fiscal policy for energy transition in Mexico of the type of carbon tax and simulate the effects on Mexico's economy and carbon emissions of alternative government's patterns of transferring tax revenues. The level of the carbon tax is endogenously computed to meet national emissions reduction targets, as stated in the Mexican "Climate Change Law". In line with government's "IDEAL scenario", we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

Then we test the hypothesis of full redistribution of carbon tax revenues among consumers (through reducing household income taxes) and producers (through compensating for social security payroll taxes), which appears as a way to reconcile environmental and economic goals. It is shown that such pattern of revenue transfer has beneficial impacts both on GDP and CO2 emissions reduction. With respect to the no-redistribution pattern scenario gains on latter feature slightly lower (75% vs 80% decrease in emissions, respectively) because of rebound effects: increased economic activity from redistribution leads to enhanced production and consumption, which ultimately drive energy use. Our results support the notion that promoting a carbon tax is compatible with both environmental and economic gains. Sensitivity tests are undertaken including utilizing alternative parameter values for the alternative substitution mechanisms. It is found that CO2 emissions reduction is low when the elasticity of substitution between capital and energy is constant (in absence of endogenous energy efficiency) and when the elasticity of substitution across types of commodities is low. Moreover, the economic gains from the tax crucially depend on the inflationary pressure resulting from the taxation policy (and therefore on the wage setting process) and on responsiveness of Mexico's economy to foreign competition.

This paper is the result of a two-year research collaboration involving the National Institute of Ecology and Climate Change (INECC) the French Economic Observatory (OFCE) and the French Agency for Development (AFD).

O-4406a-03

A conceptual framework for the quantification of co-benefits

D. Urge Vorsatz

Abstract not communicated

O-4406a-04

The Interaction of Climate Mitigation and Universal Energy Access Policies

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The vast majority of scenarios assessed in the IPCC's AR5 focus attention on mitigating greenhouse gas emissions, but fail to sufficiently analyze some of the critical linkages between climate and development (IPCC, 2014b). One of these linkages is the risk that higher energy prices from mitigation policies exacerbate energy poverty, which can in turn increase mortality from indoor air pollution. Four million lives are lost every year from traditional stove use (Pachauri et al, 2013). In India alone, over 700 million people still depend on solid fuels for cooking, whose eradication is an important development objective. With increasing pressure from the international community to undertake mitigation efforts, including removing fuel subsidies, the risk of slowing modern energy uptake is real.

No studies have examined the interaction between policies to promote (fossil-based) modern energy access for cooking and climate mitigation policies. The distributional outcomes depend on existing subsidy policies, patterns of income growth, and the types of climate policies. This paper presents a rigorous assessment of these issues using the MESSAGE-Access model, a household

fuel choice model that is part of the MESSAGE integrated assessment model at IIASA. The regional focus of this paper is South Asia. The paper will present outcomes of solid fuel dependence, income shocks, policy costs and environmental impact under different climate and access policies.

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Pachauri, Shonali, et al. «Pathways to achieve universal household access to modern energy by 2030.» Environmental Research Letters 8.2 (2013): 024015.

4406b - Climate change and Development: Alleviating poverty and achieving inclusive development within the constraints of a global carbon budget and other planetary boundaries

ORAL PRESENTATIONS

K-4406b-01

Climate change and poverty

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Climate change and climate policies will affect poverty reduction efforts through direct and immediate impacts on the poor and by affecting factors that condition poverty reduction, such as economic growth. This presentation will summarize a research program conducted at the World Bank with many external partners to explore this relation between climate change and policies and poverty outcomes by examining three questions: the (static) impact on poor people's livelihood and well-being; the impact on the risk for the non-poor individuals to fall into poverty; and the impact on the ability of poor people to escape poverty. The presentation proposes four channels that determine household consumption and through which households may escape or fall into poverty (prices, assets, productivity, and opportunities). It then discusses whether and how these channels are affected by climate change and climate policies, focusing on the exposure, vulnerability, and ability to adapt of the poor (and those vulnerable to poverty). It reviews the existing literature and offers three major conclusions. First, climate change is likely to represent a major obstacle to a sustainable eradication of poverty. Second, climate policies can benefit the poor provided that (i) poverty concerns are carefully taken into account in their design and (ii) they are accompanied by the appropriate set of social policies. Third, climate change does not modify how poverty policies should be designed, but it creates greater needs and more urgency. The scale issue is explained by the fact that climate will cause more frequent and more severe shocks; the urgency, by the need to exploit the window of opportunity given to us before climate impacts substantially increase.

K-4406b-02

Planetary Boundaries: Abundance within a Global Carbon Budget

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Planetary Boundaries: Abundance within a Global Carbon Budget

Extraordinary climate stability since the end of the Holocene 11 000 years ago, has provided the necessary conditions for human development. Human activity is now pushing the Earth system towards the limits of its ability to support further unsustainable development, in many cases posing the greatest threat to the survival of the poorest and most vulnerable societies. These planetary boundaries describe the human influence on and limits to Earth's life-support systems. Within the current paradigm of development, we have already crossed planetary boundaries associated with carbon dioxide levels driving climate change, the loss of biodiversity, the addition of phosphorus, nitrogen and other nutrients to ecosystems, and deforestation. The latest research shows that in some cases these changes may be irreversible, having crossed a tipping point.

A new framework of sustainable development is required to ensure that humanity remains within the 'safe operating space' of the planet defined by the planetary boundaries, whilst allowing all societies to become more prosperous on a resilient planet. 2015 offers a unique opportunity to address key aspects of this existential challenge. Negotiations on the new Global Climate Agreement in December and discussions on the UN Sustainable Development Goals in September, are important fora for charting a holistic path to an equitable and safe future for all societies. The risk of crossing additional planetary boundaries will rise with delayed action on both these fronts, driving the Earth system further away from the stable conditions that have supported human development until now. In particular, a global climate change agreement that limits warming to well below 2 degrees and respects key equity principles is necessary to enable achievement of development objectives.

This contribution draws on recent new research on Planetary Boundaries and on the Earth Statement project led by the Earth League.

K-4406b-03

Feasible Mitigation Options for Developing Countries

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This talk will emphasize challenges and possibilities for climate change mitigation in the context of sustainable development imperatives. Mitigating global climate change will require large scale reductions of GHG emissions not only in industrialized, but also in developing countries. However, historically, economic and social development has been highly correlated with fossil fuel use. In the recent past, economic growth in China, which has lifted hundreds of millions people out of poverty, has gone hand in hand with a dramatic carbonization of the Chinese energy system. As other newly industrializing countries are currently following the same track there is a risk of creating a lock-in of carbon-intensive energy infrastructures which will render ambitious climate stabilization targets difficult to achieve.

Even though the recent surge in coal has been accompanied by a market-driven proliferation of renewables in emerging economies such as India and China, the question arises how, and to what extent, the pursuit of economic growth and poverty alleviation can avoid the repetition of historical carbon-intensive development patterns.

While mitigation costs are expected to be moderate on the global scale, they still can - depending on the burden sharing scheme in place - pose serious challenges for financially and institutionally constrained developing countries. For these countries, other considerations, such as poverty alleviation, are likely to constitute more pressing short-term policy objectives. Even with financial support from the global community, there are serious concerns regarding the potential negative effects of financial inflows e.g. on the development of advanced industries.

Various approaches have been proposed to support developing countries in formulating national climate polices, including financial assistance of USD 100 bn per year from the Green Climate Fund. Such transfers can only be effective if they are designed in a way that minimizes potential adverse effects by means of transparency mechanisms, monitoring and conditionality. They also need to guarantee ownership by recipients by embodying a broad perspective on climate change that takes into account particular countries' specific development objectives. In this regard, recent research has highlighted that policies that do not only aim at reducing emissions, but also leverage substantial co-benefits are most likely to be politically feasible. Prominent examples of such 'win-win policies' include clean-air policies, reforming fossil fuel subsidies, and improving public transport systems, as well as improved agricultural practices and inclusion of climate change considerations in regional trade agreements.

As a consequence, these policies have the potential to overcome the "dangerous climate change vs. dangerous mitigation" dilemma. By defining appropriate guardrails for natural as well as social objectives, they incorporate a multi-dimensional perspective of sustainable development. Such sustainable development objectives could further advance bottom-up incentives for individual countries to embark on climate-friendly development pathway which provide an important entry point for more ambitious climate policies - including an internationally binding agreement - in the future.

O-4406b-01

Human development in a climate-constrained world: what the past says about the future

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Energy consumption is necessary for the delivery of human development by supporting access to basic needs, services and infrastructures. Given prevailing technologies and the high degree of inertia in practical rates of decarbonisation, raising global living standards may entail growth in energy consumption and consequent greenhouse gas emissions (GHG) impact on the climate system. Yet despite considerable elaboration in the literature on equity proposals and the 'fair burden-sharing' of emissions rights between industrial and developing nations, there is very little research on the actual energy use necessary for development and likely arising emissions. This is a prescient issue in the context of on-going international negotiations, where it is now recognized that the participation of all major emitters, including key developing countries, is required to break the climate impasse. Our question thus focuses on extrapolating existing trends in energy growth, emissions and human development progress; highlighting the level of policy ambition that will be necessary to meet the twin challenges of climate change and poverty alleviation.

We build on recent work analysing the interaction between human development, energy use and GHG emissions [1-3] and base our presentation on a forthcoming publication in Global Environmental Change [4]. Yearly cross-section regressions on 3 pairs of country development and environmental impact indicators are performed for the period 1990-2010: life expectancy, access to basic needs and GDP per capita as dependent variables; per capita final energy consumption as an independent variable. Access to basic needs is a composite indicator comprising six dimensions of the bare minimum requirements for development (access to sanitation, electricity, water, food supply, education and a survival rate). Following Steinberger et al. [1] and Costa et al. [2], we estimate hyperbolic saturation curves from this historical data, on the basis of which we project future energy for 'development as usual' (DAU) to threshold levels of each human development indicator. This scenario incorporates the observed autonomous improvement in the efficiency of delivering human development, but assumes no near-term climate policy. In the final stage of our analysis, the DAU scenarios are translated into GHG emissions using intensities from an integrated assessment model (IAM) and the resulting pathways are compared to a cost-based allocation of emissions rights. This allows us to contrast likely development emissions with a mitigation scenario in which only economic efficiency is prioritised.

We find an unbroken, near-continuous trend in human development improvement over the past two decades. As in previous studies we find a high rate of decoupling between human development and energy consumption, but with regionally distinct patterns leading to diverging estimates of the total GHG emissions required for meeting development needs. Nonetheless, in the absence of policy, human development in these regions is likely to generate approximately 1000Gt CO2eq by 2050, a quantity unlikely to be compatible with internationally agreed goals to limit climate change to 2oC. The results are sensitive to the rate of decoupling and level of ambition in human development progress, with existing examples of more efficient pathways offering hope that such emissions may be avoidable. Compared with the IAM scenario, a cost-based allocation of emissions rights also appears difficult to reconcile with poverty alleviation; while high levels of basic needs and life expectancy can be satisfied at lower levels of emissions than continued economic growth.

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O-4406b-02

Projecting Household Surveys to Assess the Impact of Future Economic Conditions and Climate Change on the Poor

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This paper quantifies the potential impacts of climate change on poverty in 2030 and 2050, in 92 countries covering 90% of the developing world population. It accounts for the deep uncertainties that characterize future socio-economic evolutions. It also considers many impacts of climate change, based on original work commissioned by the World Bank.

To build scenarios, we use a micro-simulation model based on household surveys and explore a wide range of uncertainties on future structural change, productivity growth or demographic changes. This results, for each country, in the creation of several hundred scenarios for future income growth and income distribution. We then explore the resulting space of possible futures, using several indicators of poverty and income distribution and use scenario discovery techniques to identify the main drivers of inequalities and poverty reduction. Inequality and poverty depend on drivers that differ across countries. We find that in many countries, redistribution and structural change are powerful drivers of poverty and inequality reduction, except in low-income countries. In the poorest countries in Africa, for instance, reducing poverty cannot rely on redistribution but requires low population growth and sustained productivity growth in agriculture.

Once we have explored the space of possible outcomes for poverty and inequalities in each country, we choose two representative scenarios of the best and worst cases and model the impacts of climate change in each of these two scenarios. Climate change impacts are modeled through 4 channels. First, climate change has an impact on labor productivity growth for people who work outside because of higher temperatures. Second, climate change has an impact on human capital because of more severe stunting in some places. Third, climate change has an impact on physical capital via more frequent natural disasters. Fourth, climate change has an impact on consumption because of changes in food prices. Globally, we find that climate change increases poverty in the two scenarios. Impacts are very heterogeneous across countries and

are mostly concentrated in African and South-East Asian countries. For high radiative forcing (RCP8.5), the impact of climate change on poverty is 6 times larger in the pessimistic scenario than in the optimistic scenario, illustrating how development and poverty reduction are powerful adaptation tools. Our results stress the urgency of achieving poverty eradication by 2030 in order to limit the negative impacts of climate change on the poor.

O-4406b-03

Climate resilient development: indicators and selection criteria for climate aid financing

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This work aims to contribute to the debate on climate change policies and their link to development. We adopted a climate resilient perspective to understand how climate change policies objective can be reconciled with development goals and to explore win-win opportunities given by the integration of the climate change and poverty reduction policies.

First, we review the main theoretical concepts that characterise the scientific literature on climate risk and vulnerability assessments, and identify climate resilient indicators accordingly.

This made it possible to build the theoretical foundations for a newly design index, design to improve our understanding of the implications of aid financing on reversing unsustainable paths, reducing vulnerability to climate change related hazards and get more equitable outcomes.

The novelty of our contribution lies on the emphasis given to economic aspects related to climate risk assessment, most notably: the concepts of loss and damage, the understanding of factors enhancing economic resilience, the links between climate change policies and development (besides economic growth) and the acknowledgment of the role of natural capital in pursuing development policies.

By reviewing grey and peer-reviewed literature, we identified 133 suitable indicators, which have been grouped along six components. These have been selected from a preliminary list of 300 indicators, on the basis of general criteria like validity, data availability and their value in terms of information potential. Other specific criteria have been considered, to ensure that the indicators shortlisted are theoretically robust.

O-4406b-04

Historical analogies to forecast climate change induced fluctuations of Western African countries' macroeconomic indicators

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Due to the increased impacts of climate-related extreme events, a rapidly growing literature has documented the relation between macroeconomic outputs, climate variability and human induced climate change. Methodologies either rely on modelling or on statistical approaches showing that climate variability and future human induced climate change could have effects on gross domestic product (GDP). However, current statistical approaches mostly rely on linear econometric regressions with limited specifications of climate variables, while models have a limited evidence basis.

Using a statistical approach for its evidence basis, we investigate the relationships between macroeconomic variables (investment, trade balance, sectoral value added and GDP) and climate variables in Africa from the 1960s to the present. The approach is based on a nonlinear econometric model using a piecewise regression function adapted from Schlenker and Robert (2009). Time-lagged effects are also investigated. A large set of specifications of climate variability is assessed as regressors including among others: weighted anomaly standardized precipitation, and Palmer drought severity index. For each "piece" of climate variability in Western Africa we infer climate analogy coefficients estimating the relation between climate variability and a climate-induced fluctuation of macroeconomic output.

Applying the inferred coefficients to projections from global and regional climate models, we estimate their effects on GDP and adjust African Development Bank's forecasts for Western Africa.

This research project is supported by the United Nations Environment Programme (Regional Office for Africa), the African Development Bank and the United Nations Economic Commission for Africa.

4406 - POSTER PRESENTATIONS

P-4406-01

Underlying causes of the growing adaptation deficit in the context of development

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Evidence is presented to show that climate change adaptation (CCA) and disaster risk reduction (DRR) are promoted and implemented with little or no reference to the development practices that are generating increased risk. The reverse is also true. Aggregate public annd private investments made largely regardless of their contribution to increased exposure and vulnerability, exceed by orders of magnitude the present and projected expenditures on CAA and DRR. Reports on Inclusive Green Growth (World Bank 2012) and cumulative evidence on the changing pathways to impact (van de Berg and GEF 2013) provide information to show that the «cure to damage» ratio is in the order of 1:1,000. In the public sector a current estimate of what funds are available annually to developing countries for adaptation ($1 billion) compares with $1 trillion as a conservative estimate of amounts of public funding available for harmful practices such as subsidies for fossil fuels, water practices that deplete resources, fisheries and agriculture (IMF).

A similar story applies to increasing losses from «natural» disasters that will be increasingly related to weather and climate. The dominant economic and investmeent paradigm of development accords little attention to the incidental effects, in increasing exposure and vulnerability. Thus the adaptation deficit (Burton 2004) contines to grow along with the disaster risk reduction deficit.

Development investments (especially in the private sector) that increase risk are being explained as «the cost of doing business», or simply as «externalities». This is reminiscent of the problem of acid precipitation and other pollution issues of a generation ago, where eventually transboundary and regional agreements were achieved through the recognition of «the polluter pays principle». If humanity is to move more effectively towards a common future there will have to be a similar recognition of the principle «the creators of disaster risk and the adaptation deficit pays». Without such transformation the adaptation deficit and the disaster risk deficit are likely to keep on growing with serious consequences for our common future.

P-4406-02

Climate policy architecture for the Cancun's paradigm shift: Building upon the lessons from history

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In the succession of Conferences of the Parties (COP) since Copenhagen, the Cancun conference (COP-16) marked a turning point at least on paper: it calls for "...a paradigm

shift towards building a low-carbon society that offers substantial opportunities and ensures continued high growth and sustainable development'' (paragraph 10). It introduced a notion of ''equitable access to sustainable development" (EASD) "in the context of "shared vision for long-term cooperative action" and "global peaking of GHG emissions"". The economics of climate policy after Rio led to a climate centric paradigm which departs from the original UNFCCC's cooperative framework for setting climate policies in the perspective of sustainable development. This resulted in a pure cap-and-trade approach of which adverse effects on development should be mitigated through appropriate transfers. This "fair burden sharing" paradigm could not but fail to untie the development-climate Gordian knot and lead to lose sight of the benefits of cooperation in a global agreement to abate GHGs emissions.

The challenge is now to align development and climate objectives considering the changing context since the nineties with both a re-equilibrium of the world economic balances and the adverse context created by the 2008 financial crisis. This paper proposes an organization of carbon finance as part of a general reform of the financial system, with the adoption of a carbon value as a notional price to trigger a wave of low carbon investments in the world and redirecting parts of the global savings towards low carbon investments, thus providing a lever for an equitable access to development.

The paper begins first by elucidating the misconceptions about the Kyoto Protocol (KP) so as to identify which of these may impair any approach to enforce the Cancun's paradigm shift. Second, it discusses the rationale for an international climate regime when the Nationally Appropriate Mitigation Actions (NAMAs) embarked in the INDCs are considered as the primary tool of GHGs abatement. Third, it lays out the principles of a climate regime centered on scaled up climate finance, through the issuance of a carbon asset by the Central Banks of volunteering Parties. A right balance between an aspirational regime and a least common denominator regime should follow five principles: a) preserve the idea of allocating targets and timetables for countries with a controlled degree of "when" and "where'" flexibility (COP3, 1997), b) leave latitude to Parties to select the NAMAS apt to align their climate and development policies so that there is no misgiving about environmental colonialism, c) follow principle of "common but differentiated responsibilities (CBDR)" in accordance with the article 3.1 of the UNFCCC, d) ensure that renegotiations every five years will not generate instable signals for economic agents, e) motivate countries to respect announced emissions pledges and to narrow the gap between these pledges and an emissions trajectory compatible with the 2°C target, and f) deprive a defaulter country of the benefits of the system approach of technological cooperation or in varied scholars' proposals of a "carbon club" of voluntary countries.

A mechanism organized around carbon based assets could meet these principles through a pull-back force anchored around two pillars. The first pillar rests on allocating to each participating country a part of the global emissions budget. What makes a compromise easier with this mechanism force compared to the cap and trade system is that the pull-back force does not trigger immediate adverse impacts for households and industry. The second pillar rests on emissions pledges and commitments to issue carbon assets as means of motivating each country to announce emissions target at every five year period and to comply with their commitments.

The key features of this regime does not prescribe the content of the climate architecture several decades ahead but launches a learning process that follows principles robust enough to align climate and development policies without abandoning the 2°C stabilization objective.

P-4406-03

Can climate compatible development provide an alternative development pathway for the global south?

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Climate compatible development (CCD) is increasingly important to policy makers as a 'triple-win' strategy, combining climate adaptation and mitigation with development (Mitchell and Maxwell, 2010). CCD characterises a development pathway in that it is multi-sector, multi-stakeholder and multi-scalar (Stringer et al, 2014). What is less clear is if in bringing together climate adaptation and mitigation with development, CCD is creating an alternative development pathway or providing a mechanism with which to connect already existing development trajectories to wider mitigation and adaptation initiatives. This is an important distinction, yet there has been little research addressing it, both conceptually and empirically.

To date much of the empirical research on CCD has been at the project level, analysing how initiatives such as climate smart agriculture are simultaneously lowering carbon emissions and improving rural livelihoods (Lipper et. al., 2014). However, there has been significantly less research on the institutional adaptation and implantation of CCD at the national level where such initiatives and policies are developed and approved (Ficklin et al, forthcoming). This is, in part, due to the complexity of contextualised framings of climate change and development issues and the diversity of how they are being integrated into policy frameworks. However, we argue that it is also because CCD is an emerging concept and there is not a clear conceptualisation of what CCD is, and how it differs from other development pathways such as 'climate resilience', 'green growth' and 'low carbon development'.

In this paper we compare and contrast the opportunities and challenges, motivations and resistance to creating an alternative CCD development pathway in Tanzania and Swaziland. The research presented draws from semi-structured interviews conducted with national policy makers and stakeholders in the NGO and private sectors working at and across multiple levels, to provide the institutional perspective of CCD that is missing in the current literature. In addition, analyses from existing and forthcoming climate adaptation, mitigation, and development policies for each country are presented. The data presented was analysed with coding software and thematic matrices to source similarities and distinctions between the two country contexts. We draw out key discourses around adaptation, mitigation and development, identify what kind of CCD is occurring, and how it is being presented in national polices. We present further findings on stakeholder engagement, analysing how CCD is being contextually understood and practised and whose definitions and values count at different levels.

Our data suggest that CCD rhetoric in policy is in its infancy and that its component parts are framed differently in each country context. Therefore triple-win thinking with adaptation, mitigation and development is not as yet being extensively considered in policy. However, as it is emerging it is provoking questions and debate about the definitions of adaptation, mitigation and development in policy and by extension the coherence of these definitions between institutions, policies and financers. Our data from Tanzania and Swaziland makes an interesting comparison between different contextualised national framings of climate change and development issues and how this affects the opportunities, challenges, motivations and resistance to CCD as a development pathway in two contrasting country contexts.

In analysing CCD as an alternate development pathway, this paper presents data about the conceptualisation and framing of climate change and development issues in Tanzania and Swaziland. Furthermore, it analyses how CCD rhetoric is shaping how adaptation, mitigation and development are defined in national policies and institutions, and the impacts this has on the opportunities and challenges presented by a CCD development pathway. Our analysis suggests that although CCD rhetoric is only just emerging, it is gaining traction with international financers and national policy makers. As such further research on CCD development pathways in both national and regional contexts is required.

P-4406-04

Ending Energy Inefficient Foreign Aid

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Improving energy efficiency is one of the most effective

ways to reduce energy demand and energy-related greenhouse gas emissions around the world. However, the adoption of energy efficient infrastructure and technologies often faces many barriers. One of the biggest barriers in the developing world, where many of the largest opportunities for improving energy efficiency reside, is finance—access to predictable and affordable capital for infrastructure and manufacturing.

One of the most significant and influential sources of capital in developing nations is official development assistance (ODA) flowing through bilateral and multilateral development banks, such as US Agency for International Development and the World Bank.

Unfortunately, ODA may actually be helping to perpetuate the use of inefficient infrastructure and technologies in development countries. While international development agencies do finance energy efficiency investments—$200 billion between 2007-2013—they invest far larger sums in infrastructure and industry, without necessarily considering energy efficiency impacts. The extent to which ODA may actually be locking in energy inefficient infrastructure and industry —and thereby contributing unnecessarily to climate change, energy poverty, air pollution and other development challenges—is not well understood. And standards and best practice for mainstreaming energy efficiency into the core lending portfolios of international development institutions are not well developed.

ClimateWorks and Climate Advisors are currently researching and assessing the potential for energy efficiency improvements in current ODA financing in order to make recommendations to end energy inefficient ODA. Though difficult to quantify now because data is limited, such changes could deliver a massive reduction in climate emissions in key developing nations. The project seeks to measure the global mitigation potential of ODA reform relating to energy efficiency and assess the politically feasibility of securing those reforms. The latest project research will be shared at the conference and discussion stimulated about the sectoral, institutional and regional focus, to ensure maximum progress in ending energy inefficient foreign aid.

P-4406-05

Need for Subtle Policy Changes to ensure Food Security under Climate Change: Perspective from Global South

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Food basket, in India as well the global South, over the years, became Wheat/rice based but with inherent limitation of irriated land. For instance, India has only 42.9% land equipped with irrigation. Rest of region that cultivates Coarse Cereals such as Pearl millet, Finger Millet, Sorghum, Barley, but were left out as their produce is no more part of food system. On the other hand, there was a spike in global food prices in 2008. Some say that it is Indian attempt to offset its shortfall in paddy production from international market was the cause, making 'food affordability' a global concern. Put differently, this inter-linkages stresses the need for diverse food basket for food security. On the other hand, records show that in India, from 2001 to 2011, an area of 3,768,000 ha which was under coarse grains such as Pearl millet, Finger Millet, Sorghum, Barley was put to other crops. Another angle of Indian agriculture is its changing land ownership pattern. With economy growing, contribution of agriculture as sole source of household income decreased. It contributed for increased absentee land ownership and lease farming. Neither of it cares for maintaining / promoting land fertility nor the global food security. However, we argue that with suitable subtle policy changes such as a) shift to more effective and direct transfer of benefits, b) promotion of coarse cereals, c) Focused target group benefits would help achieve food Security sooner.

P-4406-06

Development perspectives of Sub-Saharan Africa under climate policies

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Reduction of global greenhouse gas emissions at acceptable costs requires the inclusion of developing countries into a climate policy regime because their emissions grow rapidly. But the less developed countries fear to suffer in terms of economic growth and domestic wealth. This study focuses on Sub-Saharan Africa as the lowest income region and demonstrates how it could benefit from joining an international climate agreement without delay. Based on a scenario analysis with the Integrated Assessment model REMIND, we estimate the economic costs and transformation needs under different assumptions on the climate stabilization target, cooperation and technology diffusion. From simulation results it turns out that Sub-Saharan Africa will suffer aggregated consumption losses of up to 3% under a global tax regime, but can even gain under a cap-and-trade climate policy regime that starts early with cooperative action and consistently follows acknowledged equity principles.

P-4406-07

Trading off climate change mitigation and poverty eradication in developing countries: drivers and constraints to institutional change

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The assumption of a trade-off between climate change mitigation and poverty eradication generally goes unchallenged. The UN Framework Convention on Climate Change established this trade-off, arguing that climate change responses take "into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty" (UNFCCC 1992). Developing countries can in theory call for support under the principle of shared but differentiated responsibilities, but the attempts to support Nationally Appropriate Mitigation Actions (NAMAs) haven't materialized at a large scale. Currently, countries focus on defining intended nationally determined contributions (INDCs). The results will be presented in the next Conference of the Parties (COP) in Paris.

This contribution is part of a research project that challenges this assumption asking the question whether this trade-off is always there or if win-win situations are possible? [1]

The main question of this contribution to the conference is to find out how the trade-offs between climate change mitigation and poverty eradication translate into the national climate policy process in developing countries. The findings can inform climate responses that can solve this trade-off and meet both climate and development objectives. Another purpose of the research is to better understand who benefits and loses from climate response and how barriers to institutional change can be overcome.

The theoretical contribution of the paper adds to the literature on institutional change in the studies of political economy. The paper identifies the drivers and barriers to institutional change in the existing literature (e.g. Streeck and Thelen 2005). It establishes the argument that trade-offs and distributional conflicts are significant determinants of success or failure of institutional change.

The methodology is an innovative discourse network analysis combining qualitative discourse and quantitative network analysis (Leifeld 2012). The analysis shows how actors organize in competing coalitions in relation to others depending on whether they support or oppose a specific policy intervention.

The research design consists of three climate change mitigation policies in South Africa. (There will be more results from Mexico and Thailand coming out later this year). The three policies are the carbon tax, the renewable energy program as part of the electricity sector reform, and the National Climate Change Response White Paper (NCCR) process (RSA 2011). South Africa exemplifies the need for urgent emissions reductions and poverty eradication. The country's emissions range with 0.9 Mt per capita at levels similar to Germany, while poverty

levels remain at 39% counting the national poverty line of 390 Rand/~ 30 Euros per household per month (NPC 2011). The main source of greenhouse gas emissions is the coal dependent electricity and liquid fuels sector. All three policies were announced before the 17th COP held in Durban in 2011, but only the renewable energy program and the NCCR are under implementation. The analysis shows that the discourse in the debate on the carbon tax establishes trade-offs between economic growth, poverty alleviation and emissions reductions. Mechanisms to offsetting the carbon tax attempt to minimize these trade-offs. The reason for the lack of implementation lies in the distributional conflicts. The negotiations between the competing coalitions occur mostly without the participation of poor parts of the population and lack clear evidence of the impacts on low-income households.

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P-4406-08

Climate Change-related loss and damage: An opportunity for transformative change?

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The residual impacts of climate change - or loss and damage - are already being experienced in both developing and developed countries and given current emission trajectories the level and extent of loss and damage will almost certainly increase. The fact that loss and damage is being incurred now is evidence that the global community has not been successful at achieving the objective of the international climate change regime, to prevent dangerous anthropogenic interference on the climate system. Clearly the collective global mitigation effort has been insufficient to avoid loss and damage. However, it could also be argued that business as usual efforts at addressing the impacts of climate change through adaptation have also been insufficient to avoid the residual impacts of climate change. In fact, in many parts of the world the limits of incremental adaptation are being reached and human societies are being forced with a choice between incurring loss and damage or undertaking transformation. This paper will argue that the loss and damage agenda should be used as both a vehicle through which to implement comprehensive risk management frameworks and a platform to transform both development and adaptation to address the underlying drivers of vulnerability and enhance resilience.

4407 - The Challenges and Opportunities of Multilevel Adaptation Governance

ORAL PRESENTATIONS

K-4407-01

Adaptation principles and their application: Effective determinants for multilevel climate governance?

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The UNFCCC COP 21 climate summit in Paris at the end of 2015 is expected to yield a new agreement on climate change, that will provide the framework for international climate policy cooperation in the coming decades. Advancing adaptation to climate change is a political priority for many countries, especially island states and least developed countries, and a major expectation towards the outcome of COP 21.

At the international level there are emerging norms on the conduct of adaptation interventions - for instance through adaptation principles stipulated by the UNFCCC's Cancun Adaptation Framework decided in 2010. The presentation addresses the question of how these principles are taken into account in programming adaptation actions by international climate funds and bilateral initiatives. Initial results based on a standardized analysis of board and programme policy documents as well as project documentation point to an uneven uptake and effect of internationally agreed adaptation principles on these institutions. I use these insights to discuss the effect of broad level policy principles on multilevel climate governance and adaptation practice, and to debate the relevance of an evolution of adaptation norms in the context of advancing the climate regime in Paris.

K-4407-02

Challenges of scales: exploring pathways to integrate locally-developed adaptation initiatives with national and regional development plans and adaptation policies

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Abstract not communicated

O-4407-01

Opportunities for municipal climate adaptation: aligning local adaptation plans with provincial and national policy in South Africa

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While some argue for a dedicated policy domain to focus on reducing climate impacts, others suggest that more comprehensive responses that integrate climate into existing policy domains are important. This presentation seeks to share the opportunities that enabled a local government municipality in South Africa, the Bergrivier municipality, to develop an adaptation plan that aligned with local development policy, provincial climate change initiatives and developments in national climate policy. We suggest that multiple opportunities converged to enable a municipal plan to be rapidly developed through a collaborative process that aligned with policy across different levels. The process built on the successful partnership between a range of scientists, local government and provincial government actors that worked together to develop a municipal adaptation plan. Key elements of success include ways that scientists worked with different levels of government, the flexibility of the process and the knowledge sharing and capacity strengthening this enabled. This knowledge exchange helped to strengthen understanding across the science - policy - practice divide, resulting in climate scientists having a better understanding of the multiplicitous complexity of local level governance and service delivery challenges, and by the same token, provincial and local officials and councilors gaining a better understanding of the complexity involved

in producing locally relevant climate information. The research suggests that mainstreaming local climate adaptation plans with local development plans on one side and aligning local climate adaptation plans with provincial and national priorities on the other side, can help to create a conducive environment to co-producing local adaptation plans that aim to reduce both specific climate risk and meet generic socio-economic development needs.

O-4407-02

Limits and opportunities of private finance for adaptation in Least Developed Countries

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Interest in private finance for climate resilience is increasing rapidly. A wide range of actors - finance institutions, intergovernmental organizations, policy-makers, negotiators, research institutions, insurers and reinsurers, and private investors themselves - have been quick to join efforts to further identify opportunities for private investment in developing countries. However, it is far from clear how the private sector might make a substantial contribution, particularly for adaptation, where attempts to assess the finance landscape have so far been unsuccessful. Research has shown that private adaptation finance has yet to prove its worth and the role of the private sector in adaptation and adaptation finance has received little attention from developing countries in the UNFCCC climate change regime.

This paper considers the limits and opportunities to stimulating private sector contributions for climate-resilient development. Its focus is on three aspects of climate finance governance - enabling environments, established and innovative mobilisation mechanisms, and delivery mechanisms - as well as their ability to ensure scaled-up finance for climate resilience, and developing-country accessibility to this finance.

Specifically, the paper questions the potential of private finance for adaptation in Least Developed Countries (LCDs). National Adaptation Programmes of Action (NAPAs) are used to indicate overall national adaptation priorities, and complemented with national development plans for selected countries. Foreign Direct Investment (FDI) is analysed as a proxy for where foreign private sector investment flows autonomously. This is complemented with qualitative assessments of alternative forms of private investments, including green bonds, risk guarantees and mutual approaches. Through policy analysis and semi-structured interviews the paper: 1) highlights the institutional and regulatory frameworks, as well as knowledge and cognitive aspects, which are currently a barrier for an investment friendly enabling environment for the private sector; 2) the paper assesses existing and innovative mechanisms for mobilisation of private sector investment; and 3) the paper's third focus on delivery mechanisms maps private sector investments through participation (purely private and public-private) and scale (micro, meso, macro).

It is found that private sector flows to adaptation priority sectors are scarce, and their impacts on resilience often unclear. Increasing these flows would require that country-specific challenges be addressed. The paper highlights a lack of innovative mechanisms for LDCs and discusses limits and opportunities for multilateral climate funds, such as the Green Climate Fund, to attract and leverage private finance for adaptation in key sectors, including food security, water resources, health, and energy security and access. It concludes that climate funds need to seek a combination of climate change adaptation and social and economic development and employment in order to maximise private sector contribution, both financial and non-financial.

O-4407-03

Bridging Communication and Trust Building for Local Climate Adaptation: A Case study of Tainan, Taiwan

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Local implementation is a key to the overall efforts in response to climate change. In local settings, adaptation planning copes not only with various consequences induced by climate change, but the multiple interests raised by those affected stakeholders. Dissonance is commonly seen among different sectors with regard to agenda setting and resource prioritization. This study, as a part of state-funded program, "Taiwan Climate Change Adaptation Technology" (TaiCCAT), is designed to reveal and remedy the discrepancy among different policy sectors by focusing on a Taiwanese city, Tainan.

With a long colonial history Tainan is a vivid city of tourism and cultural events. However, as a municipality Tainan has an extensive jurisdiction covering urban, coastal, and rural areas. This diversity in life styles and ecosystems has invited severe vulnerability to extreme weather and its impacts, both floods and droughts. The primary investigation of this study has shown there are a series of asymmetries existing in policy participation, information sharing, resource allocation, and action taking among different sectors. Employing social network analysis, text mining techniques, and co-design research principles, this study further examines the contents of these discrepancies and aims to identify the key actors who are in the best network positions to smooth the channels of communication and trust building for local adaptation initiatives and water resource management.

4407-POSTER PRESENTATIONS

P-4407-01

Climate Change Adaptation: A Community Adaptation Small Grants Facility in South Africa

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Internationally, there is increased funding for Climate Change Adaptation (CCA) projects, especially in support of bottom-up or locally-driven initiatives. This recent emphasis stresses the relevance of local knowledge and practices in risk management - including dealing with climate variability and change. It also attempts to avoid top-down adaptation plans that often fail to address local climate vulnerability and needs. As a response to climate change, bottom-up approaches build on existing knowledge and practices to propose locally-relevant adaptation strategies. Moreover, bringing adaptation to communities provides more tangible impacts at the local level.

The Adaptation Fund (AF) is one of the international institutions promoting this approach. The AF is currently pioneering a direct access climate finance modality where developing countries can directly receive financial support for CCA, without working through an intermediary. This presentation describes the project "Taking Adaptation to the Ground: A Small Grants Facility for Enabling Local Level Responses to Climate Change», which is an initiative of the South African National Biodiversity Institute (SANBI). SANBI is the National Implementing Entity for South Africa, accredited by the AF, and works with and through the Department of Environmental Affairs, who is the National Designated Authority. The Community Adaptation Small Grants Facility (SGF) project aims to enhance resilience to anticipated climate change impacts in two project target areas in South Africa: the Mopani District Municipality (Limpopo Province) and the Namakwa District Municipality (Northern Cape Province). The project's Executing Entity is SouthSouthNorth. The Facilitating Agency for Namakwa is Conservation South Africa and the Facilitating Agency for Mopani is still to be appointed.

Poor, vulnerable communities often lack the capacities to access adaptation funding and to implement well-informed adaptation measures. To ensure that climate finance for adaptation activities reach those most at

risk, the SGF pioneers a community-driven CCA initiative that involves engagement with local stakeholders and beneficiaries in project development and implementation. Three main components will be implemented: 1) providing small grants to vulnerable communities for projects that deliver tangible and sustainable benefits; 2) empowering local institutions to identify and implement adaptation actions; and 3) compiling and sharing lessons to facilitate future up-scaling and replication of enhanced direct access modalities.

The SGF approach is, thus, an example of an internationally-funded initiative that is rooted firmly "on the ground". It is designed specifically to pilot an enhanced direct access modality for climate finance under the AF. Through the learning component of the project, lessons will be identified, collected and shared in order to provide recommendations for scaling up and replicating enhanced direct access in South Africa and beyond. This presentation will explore opportunities and challenges of bottom-up approaches for adaptation and the interplay between adaptation governance, management and execution at different levels of the SGF project.

P-4407-02

Considering one's options when the fish leave: A case study of the traditional commercial hand line fishery of South Africa's Southern Cape region

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Many pressures (socio-economic, resource scarcity, policy, and regulation) make small-scale fishers and their communities vulnerable on a variety of fronts. Fishers need to cope with local and global changes and require systems that support their strategies to achieve resilience. The impact and interplay of these stressors at multiple scales need to be taken into account to develop a clear understanding of social-ecological linkages if sustainable livelihoods are to be promoted and guaranteed. There is however, a shortage of appropriately scaled, context-specific data, which is needed to inform various decision-making processes.

The present study researched vulnerabilities, as well as coping and adaptation in the small-scale, commercial handline fishery in six communities of South Africa's Southern Cape region: Witsand, Vermaaklikheid, Stilbaai, Melkhoutfontein, Gouritsmond and Mossel Bay, using semi-structured interviews, available census data and literature. Participants comprise boat owners, skippers, rights holders, crew, spouses/partners, as well as fish buyers and other persons associated to the fishery. Faced with multi-scalar changes to the broader fishery system, these fishers are forced to employ a wide range of strategies to cope and adapt to change. These changes, driven by multiple stressors on various spatial and temporal scales, affect not only the region overall, but display much variation in the impact felt by both individuals and individual communities. Not only are fishers required to cope with, and adapt to variability in the biophysical system, but they are also subjected to social and economic pressures as well as those created by policy and management decisions. Examples of such pressures include variability found in the natural environment with specific reference to weather fluctuations and the scarcity of the primary target species, pressures created by a perceived inadequacy of regulatory oversight and the administration of fishing rights as well as pressures created by increased input costs and cost of living. Notably, these fishers have very little to no control over most of these stressors, as many of these changes are the result of larger, macro-scale events and developments, from which they are disconnected.

The coping and adaptation strategies employed by these fishers can be grouped into three main groups with socio-economic conditions and life histories of individuals within the six communities seemingly the biggest determining factor in decision-making. Both cognitive and reflexive decision-making processes are shaped by the experience of their past and present environments of both individuals and their communities and cannot be understood by direct impacts of stressors alone, which highlights the need to understand indirect effects and feedback loops in the future. Practical implications of actions are not always the overriding concern in decision-making, underscoring the importance of culture and belief systems in decision-making. The severity of the challenges experienced with policy and regulatory processes may be exacerbated by a strong resistance to change, and the varying levels of resilience displayed by the different communities may be viewed in both a positive and negative light. Whereas one group of fishers have modernised their business strategies and intensified their fishing by going further offshore on larger, but more economic craft, the second and third group of fishers navigate the status quo because it is "what they know". The second group, characterised by low formal education, poverty and political marginalisation, mostly waits for help from the outside (e.g. through government poverty relief programmes or international aid). The wide array of alternative income options displayed by the third group in particular has so far allowed them to make it through hard times whilst always resuming fishing with largely changed business and fishing strategies. Tightening regulatory frameworks are forcing fishers to make decisions that particularly those in the third group are not comfortable making, especially when considering implications of the implementation of a recently legislated small scale fisheries policy. Coupled to this is an unwillingness to accept that the biophysical system may not always return to, or be able to return to, its former state, exacerbated by current considerable scientific uncertainty of climate dynamics in this region.

P-4407-03

The approaches to learning in multilevel adaptation governance research – a systematic literature review

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Within just the last few years the governance of adaptation to climate change has become a truly multilevel affair from global to local levels. International institutions like the UNFCCC are currently building an institutional framework to support adaptation governance at national and local levels; but also "local" and national actors are increasingly taking an active role in international policy processes and seeking to shape these creating an emerging multilevel institutional context. In this context learning has been recognized as a central mechanism for individual and collective actors in adaptation at different governance levels to better adjust their responses to environmental change and uncertainty.

Climate change adaptation has been addressed in the literature mainly as a local or regional activity and thus learning has been also explored principallly linked to the participation of local actors. From a multilevel perspective learning and learning-loops happen in layers from individual to groups to institutional/social at different governance levels. In the context of adaptation governance, as the one shaped by the UNFCCC learning will be needed across different governance levels to be effective in pursuing adaptation goals, adequate to the scale and magnitude needed, and ensure a better fit between top-down and bottom-up approaches.

This motivated the systematic literature review of learning in multilevel governance of adaptation to climate change presented in this paper.

The paper analyzes how learning has been addressed both in the general multilevel governance literature and in the climate change adaptation governance literature. The paper summarizes a typology of learning as described in multilevel governance and climate change adaptation literature, discussing the concept of learning emerging from this two literature branches, the main methodological approaches used to assess and measure learning, different learning types and the factors that typically foster, blockt or inhibit learning in the way it is viewed by the literature.

The review contrasts these results with additional insight from policy learning and social learning approaches frequently used in multilevel governance and climate change adaptation literature to discuss the implications for multilevel governance and climate change adaptation governance literature and extract the elements for conceptualizing multi-level learning in the governance of climate change adaptation.

P-4407-04

The role of residents in climate adaptation: a systematic overview of default and alternative roles

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Literature on roles and responsibilities of public and private actors in climate adaptation has hitherto devoted limited attention to the roles of residents (homeowners/tenants). Yet their role is crucial in addressing non- or maladaptation, as their initiative or consent is often necessary to take private property level adaptation measures. This paper provides a systematic sketch of default and alternative roles of residents in climate adaptation, based on a review of literature on the climate adaptation actions of residents. This covers three forms of residents' commitment to adaptation: (a) as citizens falling under the jurisdiction of various governmental levels; (b) as consumers (including home owners) in the market; (c) as civil society members. The overview suggests that there would be scope for alternative roles for residents in climate adaptation, especially regarding the latter two forms of commitment. The paper also discusses implications for research into and practice of adaptation governance.

P-4407-05

Sustainable Climate Change Adaptation through Community Organizing and Participation: The Case of Bakhawan Eco-Park in Kalibo, Aklan, Philippines

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This study aimed to analyze how community organizing and participation helped ensure sustainable climate change adaptation in Kalibo, Aklan, Philippines. Through key informant interviews, focus group discussions, and other personal communications, data were collected primarily from community members, local leaders, and development workers. Data were analyzed qualitatively.

It was found out that sustainable climate change adaptation takes place through collaborative action. It involves the participation of the local government, people's organization, community members, the academe, the private sector, and other government agencies. Findings also show that pooling resources, mobilizing the community, and providing livelihood opportunities enhanced adaptive capacity.

Since sustainable climate change adaptation requires the active engagement of different sectors of society, community mobilizing and participation should be given more importance in climate change adaptation interventions.

P-4407-06

Interpretation of adaptation to climate change and governance

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Over the last decade, many studies have focused on the institutions responsible for managing climate risks by analyzing responses, limits or barriers. Several studies have explored this path by focusing on the sources of the cognitive barriers that prevent actions, on the reasons and aspects of interests that motivate the denial and on the influence of cognitive factors on decision-making. Today, it has been widely acknowledged that people's beliefs and perceptions influence implementation of climate change adaptation. Regarding perception barriers, some authors keep highlighting the confused definition of adaptation and its various interpretations. However, few studies explored these issues directly with local policy makers who work directly on the elaboration or the implementation on adaptation strategies to climate change. Moreover, a clear definition of what really means "adaptation to climate change" is still working in progress, letting local authorities with their own interpretation of the notion.

Based on this framework, the ABSTRACT-colurba was launched in January 2014 by CDC Climat Recherche and two French public agencies (ADEME and AFD). The project proposes to increase knowledge on climate risk management at the urban scale by analyzing the levers and barriers (economic, organizational, cognitive) attached to decision-making processes upstream to the implementation of adaptation strategies to climate change. Based on a field study through 10 French local urban communities, the project is conducted within an action-research approach integrating local stakeholders. More specifically, the focus of the project is made on the intermediate size urban areas (50.000-100.000 inhabitants) chosen through different criteria (local dynamism, awareness, diversity of issues). Based on interviews and focus groups directly collected in the chosen case studies, the project analyzes the way the local communities elaborate and implement their own actions to reduce the vulnerabilities to climate change of their territories. The first results of the project show that each urban community has its own way to interpret what does "adaptation to climate change" mean, depending of the local issues, the local stakeholders dynamism or the allocated resources. The study aims to contribute to better define the shape of adaptation strategies to climate change once implemented and to better understand the influence of the cognitive factors on the decision-making process linked with local climate policy. Through restitution to the local stakeholders, the results participate to reinforce the capacity of local authorities to cope with the new climate realities.

P-4407-07

A field study at the urban scale on adaptation: the ABSTRACT-colurba project

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Launched in January 2014, the ABSTRACT-colurba project proposes to increase knowledge on climate risk management at the urban scale by analyzing the levers and barriers (economic, organizational, cognitive) attached to decision-making processes upstream to the implementation of adaptation strategies to climate change. Based on a field study through 10 French local urban communities, the project is conducted within an action-research approach integrating local stakeholders. The contribution aims to present the original approach and the preliminary results of the ABSTRACT-colurba project and to contribute to continue to define what adaptation to climate change means at local level.

P-4407-08

Current status and future prospects of community based adaptation: sharing experience of coastal Bangladesh

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This study investigates the impacts of climate change on the two most vulnerable coastal districts of Khulna and Bagerhat in Bangladesh by analysing both current and predicted changes to the coastal environment and livelihood patterns. In particular, it examines the climate change adaptation strategies undertaken at the grass-roots level, in order to propose improved strategies for mainstreaming climate change adaptation and mitigation. Although some community based adaptation strategies through livelihood diversification have already been implemented to mitigate the impacts of climate change, but there seems to be a lack of adoption of these initiatives at the local level. Accordingly, this paper examines ways to more effectively implement strategies that will mitigate the impacts of climate change in the affected communities. Our first principal finding is that the coastal region of Bangladesh currently experiences livelihood and food insecurity as a result of the impacts of climate change. In particular, large numbers of people are being

displaced, either through a temporary move to find work during the lean seasons, or a permanent move to another place to avoid the unstable living conditions experienced in these vulnerable coastal districts. Our second finding is that the climate change adaptation initiatives currently implemented in the vulnerable coastal districts of Bangladesh are inadequate to support the huge number of people affected by the impacts of climate change in a way that will ensure the security of their livelihood. Accordingly, we conclude that less overlapping and more effective integrated actions between communities, civil society organisations, NGOs and various local government departments are needed in order to support community based adaptation and build a climate change resilient community at the grass-roots level.

4408 - Risk and Insurance

ORAL PRESENTATIONS

O-4408-01

The role of insurance for flood risk reduction in London: An agent based model approach

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Flooding is recognised as one of the most common and costliest natural disasters in England. In London surface water flooding is considered to be the most likely cause of flood events, and probably the greatest short-term climate risk. More than 800,000 properties are estimated to be at risk, and while most drainage systems are designed to cope with a 1/30 year storm event, maintenance is often poor and so parts of the network can perform below these standards.

A particularly interesting aspect of flood management in England is the public-private partnership on flood insurance between the UK government and the insurance industry. Flood insurance is underwritten by the private market, while government commits to flood risk management activities. However, this agreement is currently under review with a new insurance system, Flood Re, proposed. The proposed system, which creates an insurance pool for properties at high risk of flooding, is presented by government and industry as a roadmap to future affordability and availability of flood insurance, with an anticipated run-time of 20 to 25 years. The mechanisms of the new Flood Re scheme are still being negotiated, and to date there is little mention of how the partnership between government and insurers, and the new Flood Re scheme could also promote effective flood risk reduction measures.

In order to investigate this partnership an Agent based Model (ABM) has been developed for Greater London. The ABM characterises five different agents: property owners, insurer, developer, government, and bank, which interact within the environment. The ABM has been designed such that it can investigate the public-private partnership and the specific issue of surface water flood risk, and analyse how the current and future proposals for the partnership could influence London's resilience to surface water flood risk today and in the future under various scenarios of climate change. Important questions it can address include the effect of surface water flood risk and insurance on household wealth; consequences of flood damage and insurance (un)availability for the housing market; and the role of incentives for risk reduction among different partners (including the government, insurers, and developers) to support flood defences, household level flood protection, and more appropriate spatial planning.

Ultimately, the model aims to highlight the potential benefits and limitations of the proposed Flood Re scheme for risk reduction, and test various options for the scheme, such as the inclusion of certain types of properties, and the financial implications of different transitional pathways to risk-based pricing of insurance in the longer-term. The model and research is highly relevant for the ongoing regulatory and political approval process for Flood Re, which have until now not received sufficient attention due to lack of data or analysis.

The presentation will provide an overview of the ABM, the modelling of a spatially coherent probabilistic surface water flood event set, and highlight the key findings of the analysis of the current and proposed public-private partnership for risk reduction. It will highlight benefits and limitations of the current and proposed scheme, and provide recommendations for the scheme in order to help promote flood risk reduction and increase resilience in London.

O-4408-02

Implications of risk based insurance premiums for flood preparedness and affordability of coverage

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In some countries, such as Germany and France, it has been proposed that a movement towards risk based pricing of natural disaster insurance can stimulate investments in flood risk mitigation measures by policyholders. However, providing financial incentives for risk reduction activities through charging risk based premium may conflict with the affordability of insurance. This study examines the potential trade-off between risk reduction and affordability in a model of (risk based) public-private flood insurance in France and Germany that includes household flood preparedness decisions. Flood risk preparedness is modelled over time to examine adaptation to changing flood risk caused by climate change. In order to do so a risk flood risk misperception distribution is calibrated from observed survey data in order to provide a baseline estimate for the current employment rate of household flood risk reduction measures in order to judge the aditional risk reduction benfits of insurance based financial incentives.

The results show that an insurance scheme offering premium discounts for reducing risk is potentially unaffordable for, at most, 23% of households at risk. Risk based incentives are able to promote the employment of risk reduction measures in both France and Germany. In particular, flood risk can reduce by 13% in Germany and 23% in France by 2040 compared with the current situation in which financial incentives for mitigation are absent. The higher level of flood risk in France results in a strong incentive to reduce risk in the present. Rapid growth of flood risks in Germany results in more effective financial incentives in later periods. The trade-off between affordability and financial incentives can be overcome via a voucher scheme. Providing these vouchers after 2040 is estimated to result in a level of damage reduction that is larger than the cost of the vouchers. A policy recommendation is that there is ample room for these countries to link flood insurance with financial incentives to guide household adaptation to changing flood risk.

O-4408-03

What is the Role of Insurance for Addressing Climate-Driven Extreme Events?

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The insurance of climate-driven extreme events is widely viewed as a potential ex-post means of reducing the damage born by those affected. However, while there are certainly valid arguments that support the use of insurance

when it comes to climate-driven extreme events, it is also clear that insurance cannot be the first-best solution to dealing with this mankind-induced problem.

In this article we discuss under which circumstances insurance may be viewed as a complement to adaptation and mitigation measures, and in particularly we shall focus on the following aspects: 1) when is the insurance of extreme events a desirable alternative to adaptation and mitigation policies; 2) how much value should be placed on the insurance of extreme events relativ to adaptation and mitigation policies; 3) how important are the aspects of the insurance industry for these trade-offs, in particular the transparency of the insurance sector when deciding upon its premia; the investment perspective of the insurance industry; the coverage of the insurance industry and its interplay with a social security system.

O-4408-04

Weather index insurance in a changing climate

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Insurance and risk transfer products are increasingly being made available to low income households in developing countries to protect livelihoods from extreme weather and climate events. Index insurance products - where premiums and payouts are based on a proxy for loss (e.g. total seasonal rainfall) rather than the actual economic losses suffered - typically have lower administration costs, and therefore premiums, than traditional claims based insurance. Furthermore, payouts are made immediately when the proxy is triggered, thus reducing the time between a loss event and the receipt of an insurance payout. Various proponents, including the United Nations, have therefore supported the widespread dissemination of weather index insurance as a means to reduce vulnerability to weather extremes in low income communities. However, like most lines of climate-related insurance, weather index insurance products are typically designed using historical observed data only. It has not previously been well investigated how climate change might impact the viability of weather index insurance products.

It is with this background that we developed and demonstrated a method for assessing the viability of weather index insurance under altered climate conditions (Daron and Stainforth 2014). We utilise Bayesian Networks, which are graphical networks that propagate probabilities between variables and outcomes of interest. In our study we develop them as a tool for exploration - to help understand sensitivities and support insurers in assessing pricing structures and assumptions with different climate information. We apply the tool to a case study of weather index insurance for the rice crop in Kolhapur, India.

A hypothetical weather index insurance product is used in Bayesian Networks of increasing complexity that include different sources of climate information. We include observational rainfall data in addition to output from the UK Met Office Hadley Centre regional climate model (HadRM3), driven by model reanalysis data (ERA-Interim) and general circulation models from the Hadley Centre (HadCM3) and Max Planck Institute for Meteorology (ECHAM5). We show that the model data significantly underestimates the historical observed data and therefore question the reliability and utility of the climate model output. Furthermore, we discuss how observations can also be subject to errors and uncertainties.

Depending on the choice of input data, and the process of combining different datasets, we determine very different implications for the viability of the weather index insurance product under climate change. Yet the purpose of the study is not to provide definitive answers of how climate change might impact weather index insurance in the case study region. Rather it is to demonstrate a possible method for combining multiple data sources to inform insurance decisions.

We conclude that without consideration of multiple sources of climate information, and an acknowledgement of the associated biases and errors, insurers are likely to miscalculate and misrepresent the underlying climate hazard risks with potentially adverse implications for policyholders. Used to understand the sensitivities of pricing structures and premiums to different sources of climate data, the Bayesian Network method shows promise as a potential tool to help insurers in making pricing decisions. However, the current generation of climate model output is shown to be of limited value and difficult to use by index insurance practitioners. We therefore caution that in the context of climate change, the absence of reliable, robust, quantitative model projection data means that choices considered optimal based on today's available model information may lead to maladaptation and risk significant losses to insurers in the future.

References:

Daron, J. D. and D. A. Stainforth (2014) Assessing pricing assumptions for weather index insurance in a changing climate. Climate Risk Management, 1, 76-91

O-4408-05

Sharing of Climate Risks across World Regions

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Uncertainty is prevalent in the context of climate change impacts. Moreover, the distribution across the globe is not uniform. We analyze how climate risks could be reduced via an insurance scheme at the global scale across regions and quantify the potential welfare gains from such a scheme. Starting from the standard welfare analysis in Integrated Assessment Models (IAMs), which assumes no risk sharing across region, we introduce global risk sharing via a market for state-dependent Arrow-Debreu securities. We show that this allows equalizing relative consumption differences between states of the world across regions. We estimate that such risk sharing scheme of climate risks could lead to welfare gains reducing the global costs of climate change by up to one third, while the amount of transfers required is substantial. This provides arguments for considering risk sharing in IAMs, but also for potentially welfare increasing negotiations about sharing risks of climate change at the global level.

O-4408-06

On the cost of climate change for an insurance company

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Climate change is of great concern for insurers because of increasing in frequency and intensity of extreme weather events which may represent some very serious insolvency issues. From a mathematical point of view, we derive asymptotics for the ruin probability of the insurance company in a risk model which has been updated in a way to take into account projected changes in some specific weather-related events like tropical storms for exemple. In practice, the results obtained so far are used to try to calculate the cost of climate change for an insurance company in a simplified portfolio. Some examples are presented to illustrate the theory.

4409a - The «new» climate governance: Driving societal transformations?

ORAL PRESENTATIONS

K-4409a-01

The Evolving Role of the UNFCCC in Global Climate Governance: From Regulator to Facilitator?

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It is widely acknowledged that the United Nations Framework Convention on Climate Change (UNFCCC) does not operate in isolation in global climate governance. Governance of climate change and options for improving its effectiveness are not properly understood through an exclusive focus on one of its elements (e.g. the UNFCCC process), but require examining how various elements work in conjunction. Such a broadened focus draws attention to the (potential) facilitative and catalytic role of the UNFCCC, an aspect that has been largely overlooked by commentators and has only recently received more attention in the Durban Platform negotiations on a future climate agreement. The paper explores this possible new role for the UNFCCC, in which it can keep track and review the outcomes of other actions, and strengthen them where possible. It explains the rationale for the new role, and highlights opportunities for as well as risks of 'outsourcing' parts of global climate governance to other international and transnational institutions, focusing in particular on the case of short-lived climate pollutants (SLCPs). The case is of high relevance since a variety of intergovernmental and public-private institutions have started to tackle SLCPs, such as black carbon and tropospheric ozone, including intergovernmental agreements such as the Montreal Protocol as well as new public-private partnerships such as the Climate and Clean Air Coalition. The paper concludes that a better understanding of the UNFCCC's facilitative role leads to a more nuanced assessment of the achievements of the UNFCCC in global climate governance.

K-4409a-02

National climate governance. National Climate Policy Activity

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States have been widely criticized for failing to advance the international climate regime. Many observers now believe that a "new" climate governance is emerging through transnational and/or local forms of action that will eventually plug the resulting governance gaps. Yet states, which remain oddly absent from most discussions of the "new" governance, will remain key players as governance becomes more polycentric. This presentation is based on two special issues (both edited by Andrew Jordan and Dave Huitema) that explore the ability of states to rise to these interconnected challenges through the analytical prism of policy innovation. We reveal that policy innovation is much more multi-dimensional than is often thought; it encompasses three vital activities: invention (centering on the 'source' of new policy elements), diffusion (that produces different 'patterns' of policy adoption), and the evaluation of the 'effects' that such innovations create in reality. The papers in the special issues, which range from qualitative case studies to large 'n' quantitative studies, offer new insights into the varied roles that states play in relation to all three.

They show, for instance that: the policy activity of states has risen dramatically in the past decade; that state innovation is affected to similar degrees by internal and external factors; and that policies that offer flexibility to target groups on how to meet policy goals are most effective but that voluntary reporting requirements are ineffective. This presentation draws upon these and many other insights to offer a much more nuanced reflection on the future of climate governance; one that deservedly puts states at the front and center of analysis.

K-4409a-03

Transnational Climate Governance: Performance and Future Prospects

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Today, the governance of global climate change takes place in a complex, multi-level and multi-actor landscape through a wide range of mechanisms such as multilateral treaties, carbon markets, certification schemes, urban planning codes, corporate sustainability programs, and so on.

Critical to this transformation is the emergence of transnational governance arrangements which cut across traditional state-based jurisdictions and operate across public-private divides. This talk will present the findings from a recent international research collaboration (Bulkeley et al., Cambridge University Press, 2014) analyzing 60 transnational climate governance arrangements to better understand the emergence, nature and consequences of this phenomenon and consider the broader implications for global climate governance.

K-4409a-04

'The political economy of contending pathways to de-carbonisation'

P. Newell (1)
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Drawing on recent work on the politics of green transformations, this presentation will apply insights on competing pathways to sustainability to the case of de-carbonising the economy. It will look at a range of state-led, market-led, technocentic and civil society-led transformations, drawing both on contemporary and historical examples, to explore what light they shed on our ability to de-carbonise the contemporary global economy.

4409b - Climate Governance: New and emerging challenges after Paris

ORAL PRESENTATIONS

K-4409b-01

Paris and beyond: strengthening the research-policy interface

A. Sagar (1)
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While there has been some progress in the climate negotiations as well as in the broader climate arena, this still is not commensurate with the magnitude and urgency of the climate challenge. Therefore identifying the key issues underlying major roadblocks in the climate policy arena and then exploring way of realistically overcoming such roadblocks could be of great help. The Global Climate Policy Conference, which will be held in Delhi in April-May 2015 aims to provide an opportunity to research scholars

from around the world, selected through a competitive, rigorous evaluation process, to present their ideas on how to overcome roadblocks in the climate policy arena and also bring together a set of leading international experts to discuss specific key policy issues where research and analysis could contribute to improved climate policy-making. This session will present the best ideas discussed at the conference, along with their anticipated impact on climate policy-making at Paris and beyond.

K-4409b-02

Transparency and Accountability in Global Climate Governance

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In this paper, we review recent scholarship and the state of the art on the nature and consequences of a transparency turn in global climate governance. Transparency, as information disclosure, is being embraced by public and private climate governance arrangements, including, inter alia, the United Nations Framework Convention on Climate Change (UNFCCC) and the Carbon Disclosure Project, as a way to monitor and/or reward various actors' climate mitigation actions and performance. Such "governance by disclosure" is intended to further a variety of goals, including empowering recipients to exercise informed choice or hold disclosers to account for their (non-) performance, and improving sustainability performance. Our review assesses these posited relationships between transparency, accountability and sustainability in climate governance. We conclude by deploying our own "critical transparency studies' perspective, one that views information itself as fundamentally contested political terrain, to assess the transformative potential of transparency and informational governance in the climate realm.

K-4409b-03

The Legal Nature of the Paris Agreement: Much Ado About Nothing?

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In 2009 at the Copenhagen UNFCCC Conference of the Parties protesters had banners stating "We will not leave until we have a fair, ambitious and legally binding agreement". Ever since Copenhagen the international climate change legal regime has experienced a metamorphosis from a top down to a bottom up approach, that does not rely (or does not have to rely) on a legally binding agreement. Nevertheless, the ADP is currently negotiating a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties. Against the backdrop of the increasing debate between legally binding and non-legally binding climate change policy avenues, this presentation will discuss each one of these three options and its relevance post Paris.

In the first part of the presentation the status of the current negotiations will be addressed in order to determine whether a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties has received more traction. Taking as a starting point that the level of ambition embedded in any of the three outcomes will most likely need to be upgraded if the Paris Agreement is to meaningfully deal with climate change in the long term, the second part of the presentation will seek to explain why some countries are still advocating for a legally binding outcome, despite the turn towards a bottom up approach. In the third and last part of the presentation the options that may not fall neatly under the rubric of legally binding will be explored. The rationale and their effectiveness will be presented.

In conclusion, it would not be a surprise if banners appear once again in Paris seeking for a fair and ambitious outcome. Whether or not those banners will also ask for a legally binding agreement is more dubious. The three do not necessarily go hand in hand, and a legally binding agreement can also be unfair and not very ambitious. So, is the debate about the legal form of the Paris outcome much ado about nothing, or will the legal nature determine (at least partly) not only the success of the outcome, but also its Post-Paris effectiveness?

K-4409b-04

Accepting reality: we need new post-Paris governance for effective long term climate transformation

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Using the Grubb framework for analyzing climate policy, it seems that current negotiations center around short-term policy approaches in his Domain 1 and 2, while our common future depends on deep long-term transformations, in Domain 3. Also, the Domain 1 UN discussions assume some central authority to ultimately regulate behavior on this globe, with a Binding Agreement on yearly allowable emission capped per country. This seems not feasible for basic reasons. First, risks are uncertain and are very different for different countries. Next, there is no agreed-upon equity principle, with deeply conflicting justice concepts. Also, under a binding agreement, countries growing faster than expected would have to buy permits from lower growth countries. Next, effective implementation is not feasible politically and administratively in many if not most countries. And economically, if a binding cap were implemented through tradable permits, the inherent price instability of a fixed cap could hardly guide long term technology development and implementation. Most basically, the Binding Agreement would not really be binding because there is no global enforcement agency. With only partially applied cap-and-trade systems at the national level those getting around the many corners - politically and administratively or through corruption - will earn substantial amounts of money. It seems quite unrealistic to expect such an interventionist type of policy to drive deep societal transformations.

The current move in discussions towards more bottom-up governance mechanisms is an essential step, as it is at that decentralized level that creativity resides. However, bottom-up governance can hardly counter strong market forces in a globalized capitalist system. Cheap coal, oil and gas are available way beyond the 2, 4, and even 6 degrees climate target. Incentive structures will have to be changed in the core institutions of our global capitalist society for the deep transformations required.

For climate effectiveness generic, encompassing emissions pricing therefore is a sine qua non. Expectations on long term cost for non-fossil energy are to be made lower than for fossil energy. When fossils start to get pressed out of the market, their prices can be very low, for a very long time. Coal, always cheap, is joined by cheap oil and gas. At $40 per barrel of oil equivalent, the extreme CO2 emission reductions required for climate stabilization just will not happen, how good intentions may be. Renewables will lose the uphill battle, even if winning some niche fights. So generic table carbon pricing is a must, replacing partially applicable and volatile cap-and-trade systems like the EU-ETS.

The administrative implementation of carbon pricing, through Duties & Excises, is relatively simple. Most countries have hundreds of years of experience. A post-Paris agreement can be based on an equal level of national emission taxes, administered upstream as an excise on primary fossils production and imports, with a refund upon export and CCS, similar to taxing alcoholic drinks. A CO2 emission tax would result.

The post-Paris agreement would have at its core an equal level of the emission tax between Parties, slowly but steadily rising to relevant levels, in the order of maybe $300 per ton of CO2 in 2050. With that level, natural gas would press out oil and coal, unless CCS would become cheap enough. Relative to intermittent renewables natural gas might remain competitive, but then only in large scale applications combined with CCS. The proceeds of the tax would correspond to actual national emissions, also in EU member states. Nobody will pay more than what is due, and tax authorities don't go for less. Such opposed interests are essential for effective implementation.

The agreement does not need to be a global one to start with. Major powers, like China, EU and US, could start as the Climate Block, open to all others to join on equal conditions. Those not joining would be confronted with an excise on their fossil energy products upon export to the Block. This is not an import tax but an upstream emission tax, treating imports the same as national production. Border Tax Adjustments might also be introduced, on imported products with high emissions abroad, not yet taxed there. Joining the group of emission taxing countries would be attractive. This simple international climate agreement seems most feasible politically, administratively and economically. This institutionalist approach seems a most realistic post-Paris option.

4409 - POSTER PRESENTATIONS

P-4409-01

Lima Dialogues 2014 &Local Government Climate Roadmap at COP20 (CMP10): Malaysian Position on Climate Targets and Preferences for Emissions Reduction

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This study critically evaluates the Malaysian position on climate targets and preferences in the Lima Dialogues in 2014. To capture the local government climate roadmap and Malaysian emissions reduction agendas at the COP20 (CMP10), an 'Empirical Regional Downscaling Dynamic Integrated model of Climate and the Economy' is deployed following the top-down disaggregation strategy. The model takes account of national macroeconomic indicators with various climatic variables, such as a temperature increase limit of 20C (agenda for COP20), carbon cycle, carbon emission reduction, climatic damage, carbon control, and carbon concentration, adapted from observational records of global warming climatic factors; and predicted climate targets for the years 2010 to 2110. Four scenarios forecasted based on the vision of the Copenhagen agendas, reintensified in COP20, are analysed and the results are contrasted with the prevailing baseline scenario of the Malaysian climate vision:2040, with Nordhaus and Stern proposing suggestions and calibrations. According to the COP20 targets, the findings indicate that the cumulative cost of climatic damage over the period 2010-2110 will amount to MYR40,128.1 billion under the present climatic regime in Malaysia, however, it would fall to MYR5,263.7 billion under the COP regime. Thus, the climate results are tempting in terms of prioritizing emission reduction and climate change mitigation for the future looking at the 'local government climate roadmap', but there are a number macroeconomic costs that the national economy needs to take on and these are critically raised for further action. The critical evaluations from this study would help national policy makers to take a proper climate decision in Malaysia before the COP21, scheduled to be held 2015 in Paris and elsewhere with similar economic environments.

P-4409-02

Citizenship participation in the public policy making processes in Chile: A glance back

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The citizenship participation in the environmental issues has been a standing requirement of the legal systems as of the principle 10, established in the Rio Declaration. In line with the above, the international law regime of the United Nations Framework Convention on Climate Change has promoted, in a systemic manner, that climate change governance must be developed and pursued by the States involving to the citizenship in the decision making process. This article explores the evolution of the citizenship participation in the Chilean climate change governance, mainly expressed during the public policymaking processes, leads by the Environmental Ministry. The different state of proceedings information, the public consultation process, and the answers to the questions raised have been fundamental to monitor the real impacts of the citizenship intervention.

As a global conclusion is possible to observe a slow but sustained and effective increase in the participation levels, contrasting with others on-going process which are being carry out in the region.

P-4409-03

Preferences for Energy Efficiency vs. Renewables: How Much Does a Ton of CO2 Emissions Cost?

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Concerns about climate change are growing, and so is the demand for information about the costs and benefits of mitigating greenhouse gas emissions. This paper seeks to estimate the benefits of climate change mitigation, as measured by the public's willingness to pay for such policies. We investigate the preferences of Italian and Czech households towards climate change mitigation policy options directly related to residential energy use. We use conjoint choice experiments, which are administered in a standardized fashion to representative samples in the two countries through computer-assisted web interviews (CAWIs).

In our choice experiments, the alternatives are policy packages described by four attributes: i) the goal of the policy, i.e., addressing energy efficiency or promoting renewable energy; ii) the policy mechanism(s) (which may entail one or more of the following: incentives, taxes on fossil fuels, standards or information); iii) the reduction in CO2 emissions per household, and iv) the cost of the policy to the respondent's household. Items iii) and iv) are expressed as per year for each of 10 years.

The questionnaire was self-administered using CAWI by a total of 1005 respondents. The Italy survey was conducted in July 2014. The Czech Republic survey was similarly structured, and the section of the questionnaire dedicated to the renewables or energy efficiency policies, and the associated discrete choice experiments, was identical to that in the Italy survey instrument (translated into the Czech). The design of the choice experiments was likewise identical across the two surveys. The Czech Republic survey was conducted in August and September 2014 using CAWI and yielded a total of 1385 completed questionnaires.

The responses to the policy choice questions appear reasonable: About 40% of the Italy survey respondents selected program A, 37% program B, and 23% opted for the status quo. The Czech shares are, 33%, 36% and almost 31%. Clearly, the Czech respondents choose the current situation more often than the Italians, implying that their WTP for the policy packages is lower. Responses are stable over the choice exercises, and there is no evidence of anomalies or unusual response patterns. This is the case for both the Italy and the Czech Republic respondents.

We fit the conditional logit models separately for the Italy and Czech Republic samples. The results from the Italy sample are reasonable and suggest that individuals were correctly trading off the attributes of the policies when selecting their most preferred ones. The status quo is the omitted category, and so the positive and significant coefficients on the energy efficiency and renewables dummies indicate that these policies were generally preferred over the status quo. However, the coefficient on the renewable dummy is greater than that on the energy efficiency goal dummy, and a Wald test indicates that they are significantly different from one another at the conventional significance levels. Our survey respondents also have a preference for incentives over other implementation options. The coefficient on fossil fuel taxes is negative and significant, and similar in absolute

magnitude to those on energy efficiency standards and information-based approaches, but the latter two are statistically significant only at the 11% and 5% levels, respectively.

The larger the CO2 emissions reductions delivered by the program, the more likely is a respondent to choose a policy, and the lower the cost, the more attractive the policy, all else the same. These effects are strongly statistically significant at the conventional levels. The results from the surveys indicate that respondents prefer policies that promote renewables over policies that target energy efficiency, and, all else the same, they prefer incentive-based policies over standards and information-based approaches. The respondents in the two countries differ sharply in terms of their preferences for fossil fuel taxes: The Italians have a strong dislike for them, but the Czechs are relatively neutral. The willingness to pay per per ton of CO2 emissions avoided is €130 from the Italy sample and CzK 1514 from the Czech sample, and implies an income elasticity of willingness to pay equal to one.

P-4409-04

'Top Down' AND 'Bottom Up' AND 'Sideways' Climate Governance Solutions: The Realities, Potentials and Perils of a Pluralistic International Institutional Landscape

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The chapter on 'International Cooperation' in volume 3 of the IPCC AR5 documents that the international climate change institutional landscape already consists of a variety of institutional arrangements that include hierarchical 'top down' relationships (as in the multilateral UNFCCC) as well as 'bottom up' initiatives (such as unilateral subnational mitigation and adaptation programs). There are 'sideways' relationships (such as those among cities), and there are also 'sideways' relationships between climate and non-climate regimes. Institutional proliferation along multiple pathways seems likely, including for example 'sideways' linkages among carbon markets. These realities of a pluralistic institutional landscape should be taken into account in order for effective new international institutional arrangements to be devised; ignoring these proliferating tendencies could result in a dysfunctional fragmented international 'system.' Each pathway has its own distinctive combination of advantages and disadvantages vis-à-vis standard evaluative criteria: effectiveness in promoting climate change mitigation and/or adaptation, equity in the distribution of benefits and costs, economic efficiency, political viability and administrative feasibility. Analytic work and diplomatic initiatives are needed to develop pathways that will ensure collaboration and coherence among diverse institutional arrangements.

This presentation explores the implications of these observations for international institutional design. Empirical data and case information are drawn from the energy sector and the international transport sector, which are of course inherently significant in terms of their contributions to greenhouse gas and particulate emissions. The sectors are also significant for international institutional design issues because of their differences and interactions. The international maritime shipping industry is subject to regulation by the International Maritime Organization (IMO), as per provisions of the UNFCCC. The sector's emissions of carbon dioxide, methane and black carbon are thus potentially covered by the IMO. At the same time, the Arctic Council and the Clean Air and Climate Coalition (CACC) also have black carbon and methane on their agendas, and the World Trade Organization has some aspects of international maritime shipping within its purview. There are therefore many potential 'sideways' relationships among them. Yet, the memberships of these various international institutions vary from only 8 member states in the Arctic Council to 39 in the CACC to 170 in the IMO, and their decision-making procedures are quite disparate. In short, there is already a complex mixture of sectoral, multilateral, regional and plurilateral institutional arrangements concerning emissions of black carbon, methane and carbon dioxide. Yet, there is not yet an adequate institutional arrangement in place to address the carbon black and methane emissions issues in the international maritime shipping sector. The presentation thus proposes the negotiation of an Arctic Black Carbon Agreement (ABCA) and an International Maritime Methane Agreement (IMMA). The proposals take into account 'top down' as well as 'bottom up' and 'sideways' institutional relationships.

The presenter is: IPCC Lead Author, 'International Cooperation' chapter, AR5, volume 3; author of articles in the refereed journals Climate Policy and Energy Policy; author of The United States in a Warming World: The Political Economy of Government, Business and Public Responses to Climate Change. Cambridge University Press, 2014; and Senior Fellow, International Centre for Trade and Sustainable Development, Geneva. All views expressed are entirely his own as an independent scholar.

P-4409-05

Global emissions chains and multinational enterprises: measuring responsibilities following the control criterion

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The Kyoto Protocol framework establishes the Production-based (PR) criterion (IEA, 2001) as the emissions responsibility allocation method. Greenhouse Gases emissions (GHG) are assigned depending on the country where they occur, regardless of the country where the consumption is done. This approach has generated controversy and is the point at which many emerging and large exporting countries base their refusal to sign the emissions reduction international agreements. Emerging countries argue that they are adversely affected in a context where production and consumption decisions are increasingly separated in different parts of the world. Moreover, carbon leakage through international trade threatens national reductions achievements at global level. One of the most popular scientific literature on alternative approaches proposes to shift responsibility to the consumer (Peters and Hertwich, 2008 or Davis et al., 2012). A country would be responsible for the emissions generated in the production of goods that are consumed within its borders, independently where the goods or services are produced. However, the consumer responsibility criterion (CR) has not managed to become part of international environmental legislation yet.

The global nature of climate change requires the establishment of allocation responsibility criteria that allow to involve more participant agents of different countries in the process: governments, consumers, suppliers, workers, investors (Hoekstra and Wiedmann 2014). Taking into account the presented context, in this paper a control-based criterion is proposed, previously presented in López et al. (2014), in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometres away in countries with weaker environmental policies. This criterion assign to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises' responsibility is not determined by the country's borders, this limit is given by the control that the parent companies has on its subsidiaries firms and suppliers too, regardless of geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

Therefore it is necessary to find new frameworks that encourage more countries to sign emissions reduction international agreements and also that allow the responsibility transfer to companies and citizens as main actors' in the mitigation of climate change. To shift the focus to the role of companies, instead of nation-states, has some advantages as, for instance, not to deal with the problem of restricting responsibility to territory (PR) or of the ability of governments to act beyond their frontiers (CR). Moreover, recent research states that nearly two-thirds of historic emissions can be attributed to 90 companies (Heede 2014). Companies, and thus consumers, do not become knowledgeable about the environmental impacts of their production networks (O'Rourke, 2014); these firms do not take responsibility for the external costs associated to these impacts. The quantification of these emissions under the control criterion and the allocation of responsibility to firms would help to provide positive incentives for the more efficient

management in environmental terms of the global value chains by the companies.

The aim of this paper is to calculate a control-based criterion for China in a multiregional input-output context (MRIO), which allows the assessing of the impact of international trade considering all the emissions associated with the entire global value chains. The Chinese choice is due to foreign enterprises operating and exporting in China account for 54% (Feenstra et al., 2013) and have a strong potential influence over the global production chains with respect to technology and emission intensities (Skelton, 2013). Estimations will be done using the World Input-Output Database (WIOD) that provides information about 41 regions with a sectorial disaggregation of 35 industries. These data will be combined with information about multinationals operating in China for the year 2009.

P-4409-06

Preventive communication and risk preventive policy in Guadeloupe

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Located in an area geographically and geologically unstable, the Caribbean basin, is regularly attacked by natural hazards. Thus, earthquakes, hurricanes, volcanic eruptions and all their consequences are an integral part of the lives of various people and institutions in the Caribbean area. The threats that people must face and that institutions must support the policies of prevention and risk management. Since the recent decades, the focus was on climate change by the scientific community. The result is party to the increase in the temperature of which one of its consequences is the increase in the frequency and magnitude of natural hazards.

The Guadeloupe is part of the French Departments of America, it has implemented the risk of public policies, among them measures relating to the dissemination of preventive information. Because, recently, the effectiveness of natural risk prevention and management plans based on the citizens' information procedures. But public policy risk through natural risk prevention plan does not clearly define the information broadcasts measures. Thus it is clear will to respond to threats that raise natural hazards and of involving people in the management of these, the association «consensus-communication» under the Risk Prevention Plan. Then, reaching to emerge, communication as a «means to mobilize» in the context of preventive actions, and also prevent the risk from climate upheaval.

This study aims to analyze public policies for risk management and dissemination process of preventive information. To do this, it will make a brief review of the history and contributions of the state of the scientific literature in the humanities and social sciences, the concept of risk, highlighting briefly science developments information, communication, and finally, it will analyze synthetically the natural risk prevention plan for the city of Petit-Bourg in Guadeloupe, especially for highlighting the organization of public consultation required by the plan.

P-4409-07

Climate Change and Collective Action: Lessons from Elinor Ostrom and the Bloomington School of Political Economy

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Climate change has been largely mischaracterized as a "public good" subject to a Prisoners' Dilemma game, where it is in the individual interest of each country to continue emitting greenhouse gases, even though it is the global interest for each country to curtail its emissions. Given this characterization, the collective action problem posed by anthropogenic climate change is practically insurmountable.

But climate change is, in fact, a different type of good and subject to a different kind of game to which a cooperative solution is available (though not guaranteed). Whereas prior to the Industrial Revolution it made sense to think of the climate as a "public good" (in its strict sense), the very existence of the climate change problem indicates that the climate is now more in the nature of a "common-pool resource" (CPR) with characteristics similar to many situations Elinor Ostrom studied during her storied career, albeit at a much larger scale. As a "common-pool resource" (CPR) the global climate is subject to the same kinds of analytical frameworks, theories, and methods that Ostrom and her colleagues in the Workshop in Political Theory and Policy Analysis at Indiana University have used over the past 45 years to study other types of CPRs.

Like virtually all other CPRs, the collective action problem posed by climate change really is not in the nature of a Prisoners' Dilemma, but more like an "Assurance Game," as originally defined by Amartya Sen. In contrast to a Prisoners' Dilemma, an Assurance Game has both cooperative and non-cooperative equilibria. Which equilibrium solution is reached depends largely on the level of reciprocal trust among the players. The higher the level of mutual trust, the higher the payoffs from cooperation, relative to non-cooperation.

In a variety of experimental and field settings, Ostrom and her colleagues found that, under the right conditions, mutual trust can be fostered over time, raising the perceived returns to cooperation. Among the conditions they found that fostered trust are frequent opportunities for communication and interaction. Specifically, Ostrom found that increased communication (1) facilitates development of socially optimal strategies; (2) allows for exchanges of promises; (3) increases mutual trust; (4) adds value to payoffs; (5) reinforces shared norms; and (6) promotes the development of shared or group identities. However, the building of mutual trust does not depend on communication alone but also on the ability to observe and verify that others are acting in a trustworthy fashion. Thus, monitoring and accountability are crucial parts of the puzzle for successful collective action to resolve any kind of CPR problem, including climate change. Trust is not a matter of blind faith; verifiability is part and parcel of trust.

Beyond culling lessons from Ostrom's large corpus of empirical, theoretical, and analytical studies, I will exemplify those lessons by reference to recent trust-building, cooperative ventures on climate policy between the US and China. The regular, bilateral negotiations of the "US-China Climate Change Working Group" already has achieved substantial positive outcomes for climate policy, and more quickly than anyone had imagined possible. Meanwhile, cooperation is ongoing at various levels of governance, including the local government level and even in private governance. Thus, climate negotiations are becoming increasingly "polycentric," as Vincent and Elinor Ostrom defined that term.

Far from being a threat to global negotiations under the UNFCCC and its Protocols, these lower-level negotiations should be perceived as activities in furtherance of goals established in global-level agreements. They are the kinds of interactions that are in fact necessary to build, over time, the kind of mutual trust that is required to make further progress on climate change mitigation at the global level. The increasing bilateral and multilateral communications and agreements we have been witnessing do not guarantee a cooperative outcome to the Assurance Game of climate change, but without them a non-cooperative outcome is almost guaranteed.

P-4409-08

Explaining climate bargaining strategies of developing countries

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Although the efforts made during the last COPs, Parties are still far from achieving an agreement for the implementation of a new climate regime. As demonstrated by the debate about the interpretation of the Common But Differentiated Responsibilities principle, the growing role played by developing countries in negotiations is one of the main causes behind the deadlock. For this reason, attention should be paid to the composition of the negotiating coalitions of developing countries. By applying a cluster analysis, this paper aims at investigating the role played by the heterogeneity in structural features of

developing countries in forming bargaining coalitions in the climate negotiation.

The final cluster structure reveals that developing countries are grouped into nine clusters, which are very different from each other depending on some crucial characteristics. The principal driving forces forming the clusters are related to the energy system, the climate vulnerability and the economic development level.

It is worth noting that these are all crucial variables for climate change negotiations and might help better understanding the reasons behind bargaining positions of these countries, as well as the effective impacts of a potential climate agreement on heterogeneous interests.

Turning to the specific results of this statistical analysis, four out of the nine clusters deserve particular attention. A first group represents large energy exporting countries, mainly formed by OPEC countries. A second group very closed to the first one is formed by small energy exporting countries. Even though this second group has different structural features from the first one, the driving force played by the particular vulnerability to climate agreement caused by the dependency on energy exports might influence this second cluster to make a coalition with the large energy exporters, thus influencing substantially the negotiations outcome. The first policy suggestion for climate governance is to refine the criteria to protect energy exporting countries in order to account for their relative dependence on fossil fuels export with respect to their economic sustainability.

The third cluster gathers the largest number of countries, grouping together the Least Developed Countries in Africa and South East Asia. This group is characterized by a high vulnerability degree to climate change and a low responsibility in GHGs emissions. This explains why LDCs ask for a stringent agreement including emerging economies. In terms of climate governance, this group might influence the final agreement in the direction of a challenging mitigation action but they also need a strong financial support for recovering climate damages. This particular double interests position might reduce their bargaining influence in the climate negotiations since they will not contribute to mitigation costs and they will benefit the most from international assistance.

On the contrary, the fourth cluster reveals that there are countries whose structural features put them in a contrasting position with respect to any potential climate agreement outcome. More specifically, these are poor and vulnerable countries with a strong economic dependency from fossil fuels export. This means that if a challenging mitigation action will be settled, they will be negatively influenced by the reduction in international energy demand. At the same time, if the current GHGs emission pathway is not corrected by a climate agreement, these are countries that would face several damages caused by global warming. This can lead these countries to advocate different interests, joining alternative bargaining coalitions (LCDs as well as fossil fuel producers) during different COPs. Given that whatever the results in negotiations, they always lose as they have to sacrifice an improvement in terms of vulnerability in favour of economic benefits or vice versa, this specific group represents a source of particular uncertainty in the climate governance process.

The results obtained by applying a statistical cluster method to group developing countries involved in climate negotiations help highlighting the specific features driving vulnerability as well as bargaining positions. This brings to suggest to policy makers that in order to facilitate climate governance is highly recommended to take into account the largest number of vulnerability sources to climate issues, in order to design specific complementary measures necessary to minimize costs for every country.

P-4409-09

Renewable energy: past trends and future growth in 2 degrees scenarios

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Many studies agree that a transition to a sustainable energy supply is needed in order to safeguard the supply of energy for future generations and abate greenhouse gas emissions. Limiting the average global surface temperature increase to 2°C, compared to pre-industrial average, is commonly regarded as an adequate means of avoiding dangerous climate change. In many scenarios that envision a development of energy supply that would be in line with a 2 degrees target, a large component of the solution consists of renewable energy and energy efficiency. Renewable energy would be in the range of 200-300 EJ in 2050, equivalent to 40-80% of total primary energy supply in 2050. This means an increase by a factor of 3 to 4 compared to 74 EJ in 2012 (IEA, 2014).

In spite of a significant increase in the use for renewable energy in the period 2000 to 2012 (from 54 EJ to 74 EJ), the share of renewable energy in total energy use has remained constant at 13%. A reason can be found in the growth of total energy use and hence non-renewable energy use, which increased likewise.

This research explores past growth rates for different types of renewable energy and required future growth rates in available 2 degrees scenarios. For this purpose past trends in renewable energy use in the period 1971 to 2012 are analysed and future contributions are explored.

From the analysis of past trends it becomes clear that in spite of comparatively high growth of renewable energy in the period 2000-2012, the share of renewable energy stayed the same due to similar increases in non-renewable energy use. Only a few countries managed to increase the share of renewable energy in their fuel mix. Most notably Germany demonstrated an effective increase in renewable energy from 3% in 2000 to 11% in 2012. This was achieved by a high overall growth rate for renewable energy of 11%/yr and a decrease in primary energy use of 0.7%/yr. Energy and climate policies in EU28 overall showed an effect by increasing the share of renewable energy from 6% in 2000 to 11% in 2012 with slightly decreasing energy use. China and India showed decreasing shares of renewable energy due to a high growth rate for total energy use combined with more moderate overall growth rates of renewable energy.

The overall increase in renewable energy amounted to 2.2%/yr in the period 1971-2012 and 2.6%/yr in the period 2000-2012. In order to be consistent with a 2 degrees pathway these growth rates would need to increase to 3-5%/yr. Biomass is at the moment the largest source of renewable energy used globally, equivalent to 10% of total primary energy use in 2012, followed by hydro power responsible for 2%. A transition of energy supply in order to help achieve a 2 degrees target would not only require a strong growth of renewable energy in absolute and relative sense, but also a strong shift to other renewable energy sources than biomass and hydro. Especially high growth would be required for wind, solar and geothermal in the order of 10%/yr. This would lead to a change in the mix of renewable energy used, with a much higher share of variable renewable energy sources (VRES). Overall wind and solar energy use would need to increase by as much as a factor of 30-60 in 2050, in comparison to 2012 (from 3 EJ to 58-155 EJ). The share of renewable energy would be in the range of 40-80% of energy use, with the share of wind and solar amounting to 25-54% of renewable energy use.

However most notable from the assessment of future needed growth rates is, the strong difference in the required development of energy use, compared to past trends. For decades primary energy use needs to consistently decrease by 0.1-0.5%/yr for OECD regions. A decrease in energy use has not occurred in the past 40 years in OECD countries, except for a couple of years during a time of recession. This would therefore require a breach from past trends. But especially for non OECD regions the needed change is large. Regional growth rates for energy use in the period 2000-2012 range from 1.5%/yr to 5.5%/yr and should decrease to be within the range of -0.2%/yr to 0.9%/yr. Therefore, a main challenge, besides increasing the uptake of renewable energy, would lie in the decrease of energy use growth rates in non-OECD countries.

P-4409-10

Routes to an ambitious climate agreement in 2015

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As shown by the collective action for the protection of the ozone layer under the Montreal Protocol, the success of a multilateral agreement rests on three pillars: strong political commitment, an independent and rigorous monitoring system, and economic instruments that transmit the right incentives. For it to be a success, the 2015 Paris climate conference will need to make progress on each of these three pillars. The Climate Economics Chair has focussed its research efforts on the pillar of economic instruments.

- The Fifth Assessment Report of the IPCC states unequivocally that from 2020 all major emitters of greenhouse gas emissions must participate in the global effort to reduce emissions and limit average warming to no more than 2°C.
- In order to drastically curb emission trajectories, global carbon pricing should be rapidly introduced, so as to put pressure on governments to act cooperatively and to encourage economic actors to reduce emissions at the lowest cost.
- To encourage governments to reach a global agreement, a bonus-malus carbon pricing system, calculated on the basis of average emissions per capita, could be introduced at a rate of $7-9 per tonne of CO2 equivalent from 2020.
- The most realistic way of introducing an international carbon price into the global economy is to lay the foundation, between 2015 and 2020, of a transcontinental carbon market, based on prototypes developed in Europe, China and the United States.
- The introduction of double carbon pricing would be subject to the principle of "common but differentiated responsibilities", aimed at reconciling joint action on climate change and the priority of access to development.

P-4409-11

How to increase mitigation? Some lessons from the Montreal Protocol on the protection of the ozone

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The necessity to increase mitigation efforts, while addressing carbon leakage and generating climate finance, represents one of the most daunting challenges of the future climate regime. We argue that these goals could be achieved through the adoption of an agreement (hereafter the "Agreement") by a group of countries that set ambitious mitigation targets for specific sectors and impose border tax adjustments on commodities from non-parties that do not meet comparable carbon standards. The institutional architecture of such an agreement would be construed along the lines of the Montreal Protocol on the protection of the ozone layer, i.e. it would contain rules that assure that non-participants loose more from being outside the agreement than they gain. Moreover, to induce countries to participate, carrots would be offered in the guise of financial and technical assistance, based on the principle of common but differentiated responsibilities.

As the Montreal Protocol the new Agreement would a) provide for majority voting for the adoption of amendments b) have effective compliance mechanisms and c) rules ensuring due process of law. It would depart from the model of the Montreal Protocol insofar as 1) it would not address a progressive phase-out of specific substances, but aim at a progressive tightening of mitigation goals in specific carbon-intensive sectors, 2) it would not use trade bans of controlled substances from non-parties but adopt carbon taxes at the border 3) it would principally depend on the revenue of carbon taxes to pay financial and technical assistance. To ensure the comparability of mitigation efforts the Parties would inter alia develop common rules for sector data requirements, measurement, reporting and verification practices, methodologies underlying the calculation of the level of BCA from non-parties.

P-4409-12

Does fragmentation pay? Multiple international environmental agreements with asymmetric countries

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While the negative effects of greenhouse gas emissions and the global climate change are relatively well acknowledged amongst scientists, solutions for what should and could be done to tackle these problems are less agreed upon. Spillovers and the absence of clear property rights make it difficult to reach effective cooperation through international environmental agreements (IEAs). In light of the slow progress in international climate negotiations, the idea of climate clubs is getting increasing attention while the aim of negotiating one single universal agreement is identified as one primary obstacle to a global treaty within the United Nations Framework Convention on Climate Change (UNFCCC).

We investigate whether global cooperation for emission abatement can be improved if asymmetric countries can sign multiple parallel environmental agreements. In a two-stage game, countries first choose whether they sign one agreement, or to be a non-signatory. In the second stage, each coalition acts as a unitary actor in a non-cooperative Nash game between the coalitions and the non-signatories. We compare emissions abatement and coalition stability in the multiple IEAs case with the standard case where not more than one IEA is possible. After solving the model for the case of constant marginal benefits from abatement and constant marginal costs of abatement with two agreements we relax our assumptions and allow for multiple coalitions with multiple types of asymmetric countries. We then analyze the effect of multiple coalitions for the case of increasing marginal costs of abatement as well as for decreasing marginal benefits of abatement more generally. The results are sensitive to the assumptions on the benefits from abatement. For constant marginal benefits, the possibility of multiple agreements increases the number of cooperating countries and total abatement (compared to the standard case with a single agreement). For decreasing marginal benefits, total emissions are independent of the number of admitted agreements.

The comparison of the different cases shows that the effect of climate clubs substantially depends on the qualitative properties of abatement benefit functions. However, we can generally show for the above made assumptions that climate clubs are at least not detrimental to global cooperation. This paper already shows how different assumptions lead to different effects of country clubs. It is thus a consequent stepping stone towards a more detailed understanding of the determinants for beneficial or detrimental effects of climate clubs. In any case, it has to be concluded that the idea of climate clubs enhancing global climate protection has to be taken with precaution, but that it clearly deserves more analytical attention.

P-4409-13

Adapting, transforming, strategising: A conceptual capacities framework for transilience climate governance

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Climate change will profoundly shape the future of human societies (IPCC 2014, Smith et al. 2011). Addressing climate change requires sustainability transitions of deeply entrenched drivers of climate change (Meadowcroft 2009). Uncertainties, the likelihood of surprises, non-linear and extreme impacts resulting from climate change demand managing social-ecological resilience across scales and times (Pelling 2011, Nelson 2011, Wise et al. 2014, Jäger et al. 2012). From the integration of transitions and resilience scholarships, we developed a conceptual framework for dealing with high uncertainty contexts and navigating through high level of complexity found in these contexts (Hölscher et al. 2014). The developed

governance framework conceptualises about the different types of agency capacities needed so as to reorient and/or transform on-going processes towards sustainability while fostering system's resilience, transilience.

Transilience governance requires scale- and time-dependent stabilising and maintaining of system functions (adapting), creating of fundamentally new system structures and functions (transforming), and strategising towards sustainability within environmental and social preconditions. The governance capacities reside in public and private actors at local, regional, national and international levels and their abilities to "define the content of public goods and to shape the social, economic, and political processes by which these goods are provided" (Knill and Lehmkuhl 2002:43). In this paper we will address the following research question: How do certain agency factors shape the capacities for transilience governance?

We approach this question by developing and testing a conceptual capacities framework that is based on a literature review of transition studies, resilience thinking, social-ecological systems and climate change literatures. Our framework encompasses adaptive, transformative and strategic capacities that together enable transilience governance (Table 1). We conceptualise that the capacities are interrelated (Marshall et al. 2012, Wilson et al. 2013). The capacities are produced by the collective abilities of actors (individuals, organisations, networks) in social-ecological-technological systems. One actor can also enact different capacities.

Table 1: Definition of adaptive, transformative and strategic capacities

Adaptive capacity	Transformative capacity	Strategic capacity
The ability to adapt system structures in order to maintain and stabilise system functions, reduce and/or enable coping with disturbances and/or operate upon origins and attributes of disturbances	The ability to transform system structures and functions in order to create fundamentally new system structures and functions when limits of adaptation are met and/or to operate upon origins and attributes of disturbances	The ability to strategise towards sustainability goals within environmental and social preconditions to orientate, balance and build adaptive and transformative capacities.

The collective abilities of actors to adapt, transform and strategise are determined by actors' willingness and skills and the strategies they employ to mobilise (human, mental, natural, artifactual, financial) resources (Adger et al. 2004, Armitage and Plummer 2010, Avelino 2011, Brown and Westaway 2011, Farla et al. 2012, Folke et al. 2002, Moore and Westley 2011, Westley et al. 2013). Adaptive skills and strategies accumulate resources, e.g. building reserves for protection or recovery of infrastructure, densifying networks, or institutionalising. Transformative skills and strategies draw and/or appropriate resources and/or mobilise latent or unused resources through e.g. networking, innovating, creating disturbances or visioning. Strategic skills and strategies orientate, divest and/or invest resources through e.g. goal-setting, bridging across scales and time, encouraging stakeholder participation and designing contingency plans for those loosing from trade-offs.

We test our capacities framework by conducting an exploratory, comparative case study (Yin 1994) of the Rotterdam Climate Initiative and New York City's PlaNYC programme. Both programmes are set up to establish and implement sustainability and resilience policy goals in important urban deltas adversely affected by climate change. We explore how agency factors shape the capacities to transilience governance. This yields insights on how the three capacities interrelate over time and how climate governance could be facilitated.

P-4409-14

Co-producing climate change responses: incorporating practitioner knowledge in the IPCC Process

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The process and flow of information and expertise on climate change is complex. The multiple interfaces existing between scientists, policymakers and practitioners are far from well understood to adequately assess and refine strategies for climate adaptation. The gathering of evidence for the Intergovernmental Panel on Climate Change (IPCC) reports is an exercise conducted primarily by the scientific and political communities, and does not take into account the needs, and the role, of the experts working on the ground. Although increasing efforts are being made to improve the science-policy interface, the disconnection between science and practitioners remains a key barrier to progress in climate change adaptation.

The latest findings from Working Group 2 on Impacts and Adaptation of Climate Change remain largely inaccessible to practitioners and do not fully incorporate their ongoing work on climate change issues. This is mainly the result of the IPCC process being highly academic-oriented and based on the peer-review mechanism with long lag times, and communication challenges, including different language and cultural interpretations. Building on the IPCC's recent review of how to make its reports more accessible going forward, this research assesses the extent to which models of co-production can capture the depth and breadth of the practitioner community's work and effectively incorporate this into the IPCC process. For example the practitioner community is starting to adopt the term "resilience" instead of adaptation.

The premise for adopting models of co-production acknowledges that knowledge from different stakeholders (e.g. academics, policy, media, NGO, business, public, and practitioners) can be seen as 'useful frames for capturing different approaches to knowledge production'. Such a process would ensure that future IPCC reports are more up-to-date, robust and complete in their analysis and that the climate change resilience solutions proposed incorporate the most practically viable research.

Through a series of workshops and interviews with academics, policy officials and practitioners in the United Kingdom this research focuses on the following three questions:

1. Can a co-production process facilitate the incorporation of practitioner expertise in IPCC reports?
2. What are the limits and opportunities from (i) adopting such an approach and (ii) incorporating practitioner based evidence?
3. How can the role of those involved in this process ensure better communication of the IPCC and wider climate messages and better co-design climate resilience?

This presentation will outline preliminary findings from these workshops and interviews and will provide valuable insights into how a co-production approach and the incorporation of practitioner based evidence could improve the production, dissemination and use of IPCC WG2 reports going forward in designing strategies for climate resilience.

P-4409-15

Closing the emission price gap

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Even without internationally concerted action on climate change mitigation, there are important incentives for countries to put a price on their domestic emissions, including public finance considerations, internalizing the climate impacts of their own emissions, and co-benefits, such as clean air or energy security. Whereas these arguments have been mostly discussed in separate strands of literature, this article carries out a synthesis that exemplifies how policies to put a price on emissions can be conceptualized in a multi-objective framework. Despite considerable uncertainty, empirical evidence suggests that different countries may face quite different incentives for emission pricing. For instance, avoided climate damages and co-benefits of reduced air pollution appear to be the main motivation for emission pricing in China, while for the US generating public revenue dominates and for the EU all three motivations are of intermediate importance. We finally argue that such unilateral incentives could form the basis for incremental progress in international climate negotiations toward a realistic climate treaty based on national interest and differentiated emission pricing and describe how such an agreement could be put into practice.

P-4409-16

Adaptation of Legal Framework to Combat Climate Change in India

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India is facing challenge of sustaining rapid economic growth while dealing with the global threat of climate change. The threat mainly is from increasing greenhouse gas due to industrialization, automobile, intensive agriculture, reduction in green cover and high consumption life styles. This phenomenon may alter the distribution and quality of India's natural resources and adversely affected the livelihood of its people. With the economy closely tied to its natural resource base and climate-sensitive sectors such as agriculture, water and forestry, India may face a major threat because of the projected climate change. Recognizing this fact and knowing that climate change is a global challenge, India has entered actively in multilateral negotiations in the UN Framework Convention on Climate Change, in positive, constructive and forward-looking manner.

India signed the United Nations Framework Convention on Climate change (UNFCCC) on June10, 1992 and ratified it on November 1, 1993. It ratified the Kyoto Protocol on August 26, 2002, with the objective to establish an effective, cooperative and equitable global approach based on the principal of common but differentiated responsibility, enshrined in the UN framework.

India is one of the leading developing countries in so far as having incorporated into its Constitution the specific provisions for environmental protection in year 1950. Article 48A of the Constitution of India provides that 'the State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country'. Similarly, Article 51A (g) makes it obligatory for every citizen of India, 'to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures.' Despite the fact that India's contributions to greenhouse gas emissions are very small, the Government of India has taken many measures to improve the situation in this regard. India has initiated several climate-friendly measures, particularly in the area of renewable energy. It has one of the most active renewable energy programmes besides having a dedicated Ministry for non-conventional energy sources in general and mitigation of greenhouse gases in particular.

This paper is an attempt to provide an overview of the legal framework for combating climate change in India and to examine the existing environmental law and policies which can reduce greenhouse gas emissions. It reviews existing national legislation, relevant overarching policies in the environmental field so as to reduce their impact specifically on climate change.

P-4409-17

Climate Diplomacy from the Perspective of the Emerging 'Climate Security Paradigm'

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Within the UNFCCC process, various efforts have been made to craft a regulatory system for managing climate change, which gave birth to a complex of tangentially connected regimes and various bilateral and unilateral initiatives from top-down and bottom-up approaches. To engage effectively with this complex framework, state actors are supposed to go beyond conventional and reactive forms of diplomacy to take an approach that merges climate and foreign policy in creative, proactive, and preventive ways. At the upcoming UNFCCC meeting in Paris 2015, it is hoped that nations will commit to a new and binding agreement on climate. At present, the goal of climate diplomacy is to build the political conditions to make this goal achievable. However, the current failure to agree on how to limit dangerous climate change through an effective and equitable regime is generally pointed out as one of the greatest ongoing failures in modern diplomacy. Many observers consider the weak political will and leadership among main carbon emitters and the lack of trust within the international community as the key factors behind this failure. This has been heightened by the fact that some nations have backtracked on their commitments to reduce emissions or to provide assistance to countries with limited adaptive capacities, while other nations' efforts to reduce emissions have gone unacknowledged. This fractured political environment hinders advanced commitments and deepens the North-South divide, especially with regard to the question of how to best allocate the critical global mitigation responsibility.

Within this context, climate diplomacy may present a way to overcome existing dilemmas since it is essentially an interface between national interest debates and international cooperation. It is capable of ensuring the accurate assessment of other countries' interests and intentions, and finding the needed space for agreement. To do this it must interpret conflicting national interests around many issues such as climate vulnerability, low carbon businesses opportunities, high carbon asset exposure, sovereignty and perceived fairness. Climate diplomacy must ensure national priorities are reflected and understood in the often abstract world of international climate change agreements. It is indeed the role of climate diplomacy to deliver the timely construction of international climate regime, ensure its effective operation, and shape its evolution to address emerging challenges.

To deal with the internal and external challenges to success, climate diplomacy must draw on the best practice of modern diplomacy and also innovate new approaches, especially as it is evolving in scope and complexity as the climate regime shifts its focus from target setting to implementation and climate risk management. This shift has prompted better integration of climate change into broader foreign policy and geopolitical discussions, a proliferation of overlapping alliances between both state and non-state actors, and new approaches to shaping a global dialogue on the consequences of, and solutions to, climate change. However, and in order to boost the evolution of climate diplomacy within this perspective, while anchoring commitment to climate change at the highest level on the international political agenda and raising the level of ambition for an efficient global climate governance, the security implications of climate change - from human, economical, environmental, and geopolitical perspectives - should be widely recognized and mainstreamed.

Based on these assumptions, this research aims to investigate the following topics:

- What is the relevance level of the 'climate security discourse', and in which areas further research and investigation should be undertaken to qualify the 'climate security paradigm' as a referential for building an effective climate regime?

- Are there any risks of linking climate change to security such as the ones which assume that framing climate change as a security issue may overshadow important social and environmental concerns and sending ironically fear-based and disturbing messages to relevant decision making processes?
- To what extent the mainstreaming of climate security as a priority in the agenda of climate diplomacy can narrow, or otherwise broaden, the scope and scale of action internationally and domestically?
- What kind of adjustments to be undertaken on all levels to make the 'climate security approach' relevant and effective in terms of climate governance?

P-4409-18

Critical Mass Governance: How Unilateral Climate Actions Create Global Impacts

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The current practice of UN based climate multilateralism under the UN Framework Convention on Climate Change (UNFCCC) focuses upon broad, consensus based legal treaties that cover a large number of issues. It is an approach that is creating diminishing returns over time. Despite this, it appears that the next climate agreement to be decided upon at the 21st Conference of the Parties (COP21) to the UNFCCC, will also prioritise the construction of a treaty with 'universal participation'. This paper argues that a switch towards smaller treaties which attempt to work by coalitions of the willing are a more viable approach forward. By drawing together ideas from a range of fields such as 'The Theory of Critical Mass' from sociology, 'Bandwagoning' and 'Norm Cascades' from international relations, pluritilateral proposals for both the climate and trade regimes, and practical examples from the EU and Kyoto Protocol, a theory of "Critical Mass Multilaterism" for climate change is developed. These disparate ideas and examples all deal with the notion of 'positive feedback': that a single action can cause further effects which amplify it over time. Accordingly, there is both a theoretical foundation and precedence for the mitigation actions of a few states to spread to others. This conceptual framework is then applied to case studies of both the Convention on Biological Diversity, the Kyoto Protcol and Montreal Protocol. The Theory of Critical Mass Multilateralism would suggest the the next climate agreement should focus on facilitating and linking strong unilateral and pluritlateral actions, instead of seeking a universal and consensual deal with the ratification of all major players including the US. The future of climate multilateralism, should, and most likely will, be in a number of smaller, more focused treaties, regardless of whether the Paris negotiations succeed or fail. The primary challenge of a future climate treaty is not to address free-riding and carbon leakage concerns, but to enable a critical mass of action that will generate the neccessary feedbacks in terms of market prices, norms and political will. Addressing climate change internationally is not a matter for a global deal, but simply a critical mass of progressive actors.

P-4409-19

Leadership in Climate Change Mitigation: Consequences and Incentives

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So far, the UNFCCC climate negotiations have not delivered a decrease in global greenhouse gas emissions. In contrast to this lack of ambition at the global level, several local, national, and regional initiatives have emerged in the past that pursue more ambitious unilateral abatement targets – for example the European Union or California – and more initiatives can be expected to emerge in the future. This comes as a surprise in view of classical theory, which suggests that ambitious unilateral provision of a global public good is never beneficial for the actor performing the abatement. Instead, global emissions tend to increase as a consequence of unilateral action, reducing the effectiveness of the abatement and resulting in losses for the leader. Recent academic advances in climate leadership have however revealed diverse consequences of unilateral emission reductions that lead to decreases as well as increases in global emissions. Taking all negative and positive reactions into account, leadership in ambitious abatement efforts could pay off for some actors, at least in expectation. The ongoing debate on the effectiveness of climate leadership in greenhouse gas abatement among the academic, the political as well as the public sphere emphasizes the importance of a clear and comprehensive understanding of the net consequence of unilateral action.

We analyze all major channels through which countries are influenced by unilateral abatement of a climate leader and derive functions for the resulting reaction in emissions. Carbon leakage effects are included by considering that (i) countries increase their emissions because more of the public good is provided, which decreases the demand for the individual production of the public good of all other countries, (ii) the leader decreases demand for emission intensive energy carriers which decreases their global price and leads to increasing demand in other countries and hence higher emission, and (iii) emission intensive production relocates from the leading country to countries with less stringent policies and hence emissions increase abroad. The negative carbon leakage effects are counterbalanced by several positive reaction functions, in which countries decrease their emissions in response to unilateral abatement. First, the leading country will develop new technologies to decrease its emissions in the face of ambitious abatement targets. Through technological spill-overs to other countries global emissions decrease even without additional emission policies by other countries. Second, a leading country decreases abatement cost uncertainty by performing ambitious emission reductions. Risk-averse countries will in turn increase their emissions reduction targets after learning about the costs of the leader. Third, through the process of policy emulation, policies diffuse to and are adopted by other countries because of their normative and socially constructed properties instead of their objective characteristics. Fourth, countries may have an incentive to reciprocate to the ambitious actions of a leader. Lastly, a leading country may signal to other countries that it is implementing the cooperative effort, inducing other countries to adopt an analogous effort.

The common modeling framework for each of the above described effects enables us to identify the critical parameters that shape the overall reaction to unilateral emission abatement and allows us to distinguish in how far the reactions differ among following countries and for the leading actor. The analysis suggests that effective leadership in climate action is facilitated by (i) high visibility and credibility in the actions of the potential leader, (ii) a strong international connectedness, both in economic and political terms, (iii) a leader whose emitting sectors are similar to those of the main global emitters, and (iv) the capacity and infrastructure to develop technology effectively.

However, due to the number of channels of interaction between leader and others, each of which is only imperfectly known, we expect the actual reactions of countries without ambitious targets to be highly uncertain. We show that despite this, leadership may be profitable (in expectation) for the leading country if it has a high valuation for the public good or exhibits little risk aversion. Our analysis can thus produce rationales for observed ambitious abatement of current climate policy leaders and their future abatement policies, and help to identify possible future leaders in the abatement of greenhouse gases.

P-4409-20

Soft and/or Hard - What Set-Up for a Future Governance System to Implement a New Climate Deal?

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A new climate regime is not only about the nature, reach and ambition of such an international agreement, but also about effective arrangements to ensure its implementation. This presentation will analyse the existing governance

system under the Kyoto Protocol (KP). By shedding light on how implementation of the emission reduction targets under that regime have been monitored so far, the aim is to understand what elements of the governance mechanism were useful for fostering compliance and why. In particular, the role of facilitative elements is assessed. Building on existing literature on reasons for non-compliance/ lack of implementation and ways to best achieve compliance/implementation, advantages and disadvantages of facilitative and coercive approaches are addressed both from a theoretical and practical angle.

Empirically, enforcement has often, although not always, been rather successful in achieving compliance with commitments under the KP. However, many states have shown not to be inclined to subscribe to such 'hard' measures. Therefore, knowing about the (perceived) usefulness of 'soft' elements to support and facilitate compliance of states is of high relevance, especially when discussing a new governance system for compliance/ implementation.

The presentation will start by outlining the current compliance system under the KP, focusing in particular on the interplay between facilitative and enforcement elements. Lessons learnt will be developed by drawing on empirical findings of usefulness perceptions hold by different stakeholders, in particular of the 'soft' components of compliance monitoring. These insights will be used to develop different scenarios for a future governance system. The talk will finish with an outlook of plausible and desirable governance set-ups post-2020.

P-4409-21

The Stability and Effectiveness of Climate Coalitions: A Comparative Analysis of Multiple Integrated Assessment Models

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International climate policy suffers from the adverse incentive structure of public good provision, and it is well known that non-cooperative behavior results in under-provision of such goods. How much a climate coalition improves upon this dilemma depends on the costs and benefits of the individual nations. It is particularly dependent on their heterogeneity and whether nations can compensate each other, i.e. the existence of transfer schemes. In this study, we investigate coalition formation with real-world heterogeneity and various transfer schemes for the first time using an ensemble of five numerical models.

Numerical models give particularly valuable insights beyond those of their analytical counterparts, when the analysis depends on regional heterogeneity in costs and benefits, quantitative estimates, or detailed representations of reaction functions. The models in this study are diverse both in their modeling approaches and in the data sources used for calibration, representing a range of estimates for the costs and benefits of real-world regions and their dynamics. We make these differences in cost and benefit assumption comparable through two new indicators measuring the abatement potential and climate change damages for key countries and world regions. We find that the five models frequently differ in the assumed costs/benefits structure of specific countries or regions, with stronger disagreement about regional damages and better agreement about mitigation costs, which mirrors the large uncertainty in our knowledge about climate change impacts.

Consequently, the models do not necessarily agree in their assessment of the stability of specific coalitions. Remarkably, however, the models are very consistent in translating the cost/benefit information revealed by the indicators into whether or not a region supports a climate agreement, i.e. coalitions with similarly characterized signatories are stable in all models. Thus, the reason why a specific coalition is found to be stable only in a subset of models is traced back to the cost/benefit assumptions.

We also assess the potential of transfers that redistribute the surplus of cooperation to foster the stability of climate coalitions. In contrast to much of the existing analytical game theoretical literature, we find substantial scope for self-enforcing climate coalitions in most models that close much of the abatement and welfare gap between complete absence of cooperation and full cooperation. This more positive message follows from the use of appropriate transfer schemes that are designed to counteract free riding incentives. By comparison, transfers that specifically take the incentive to sign a climate agreement into account frequently differ from the transfers implicit in common normative and pragmatic burden sharing schemes, which are found to be comparatively high in volume and often to transfer payments in the wrong direction.

P-4409-22

Using the theory of planned behaviour to understand and promote stakeholder engagement in local adaptation to climate change

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Most policy documents on climate change highlight the need for stakeholder engagement on policy making regarding local adaptation to climate change. There appear to different rationales for this. Engagement is promoted as way to achieve greater acceptance of policies and environmental awareness and to improve quality in decision making. In parallel, engagement ensures democratic legitimacy because citizens have a right to be included in climate-change related decisions that affect their lives (Lee et al., 2013). However, the levels of engagement in climate change issues are not typically high (e.g., Few, Brown, & Tompkins, 2006) and more research is needed to learn how engagement can be increased and improved.

The theory of planned behaviour (Ajzen, 1985) can be used to understand and promote engagement in adaptation to climate change. Even if several theories explain human behaviour and decision-making, this is one of most influential and powerful, both for its ability to predict and explain behaviour and for its contribution towards framing and evaluating behaviour change interventions (Nosek et al., 2010). Previous studies have used it to understand climate change mitigation (e.g., Tikir & Lehmann, 2011). In this study, we explored its usefulness to understand stakeholder engagement in adaptation to climate change. The theory of planned behaviour is a useful conceptual framework that incorporates central concepts in the social and behaviour sciences. It postulates that behaviour is motivated by situation-specific beliefs about the likely consequences of the behaviour (behavioural beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may influence performance of the behaviour (control beliefs). Behavioural beliefs create a favourable or unfavourable evaluation of the behaviour (attitude toward the behaviour); normative beliefs produce the perceived social pressure regarding the behaviour (subjective norm); and control beliefs create the perceived ability to perform the behaviour (perceived behavioural control). Behavioural intention, which is the immediate antecedent of behaviour, is formed based on the attitude towards the behaviour, subjective norm, and perception of behavioural control.

Based on previous research and on a literature review, we explored different types of behavioural beliefs (e.g., costs and benefits of adaptation, attitudes towards public participation), normative beliefs (descriptive and

injunctive) and control beliefs (e.g., information on climate change and public participation, stakeholder salience). Stakeholders from different case studies in the Mediterranean were surveyed (e.g., policymakers, elected officers, researchers). Results show that the behavioural intention to engage in the process of planning adaptation to climate change was significantly predicted by particular variables of the theory of planned behaviour, depending on the characteristics of the case studies. Furthermore, descriptive results indicate which specific beliefs should be stressed in future interventions to promote stakeholder engagement.

This work has received funds from the ADAPT-MED project (CIRCLE2-MED).

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P-4409-23

Framing a post-Kyoto Climate Accord

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The forthcoming Paris conference of the parties under the UNFCCC, to be staged in November 2015, is tasked with developing a global climate agreement focused on carbon reduction, as successor to the Kyoto Protocol. If this "Paris Protocol" (if such is to be its name) is to be effective it will need to go beyond a list of countries committing to make reductions in carbon emissions, to incorporate measures needed to address the promotion of green industry and its diffusion around the world. A putative Part II to the Paris Protocol could be addressed to the WTO, and list green products or processes that are agreed will lead to reduced carbon emissions - and as such provide countries with justifiable "exemption" from the rules of fair trade for a designated period. It is argued that such a bold step is needed to reduce the severity and frequency of trade disputes over green industrial policies and clear the way for the carbon reductions anticipated to come to fruition.

P-4409-24

Who governs local climate adaptation? A comparative analysis of governance arrangements in urban areas

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The allocation of responsibilities between public and private actors has become a key urban governance issue for adaptation to the impacts of climate change. While this issue has been explored conceptually to some extent, empirical studies are scarce and have not yet been performed in a systematic manner. This paper addresses the research question of who governs urban climate adaptation, by offering a synthesis of three empirical studies in which governance arrangements between public and private actors are analysed and compared. Each study contains an in-depth comparative case-study analysis of arrangements for adaptation measures in frontrunner cities in Europe and North America: 1) green roofs for storm-water retention purposes, 2) adaptive flood risk measures for water safety purposes, and 3) a selection of measures for heat stress prevention. In total, 20 governance arrangements were analysed and compared based on data derived from over 100 policy documents; from 97 in-depth interviews; and from two multi-stakeholder workshops. The meta-analysis offers insights into emerging patterns of urban climate adaptation governance arrangements. Furthermore, it offers a first evaluation of the performance of those governance arrangements in terms of effectiveness, legitimacy and fairness. Finally, conclusions related to the types of responsibilities of local public authorities are drawn, showing how indispensable they are for both adaptation planning and action.

P-4409-25

Fostering Socio-Ecological Resilience to Climate Change by Shifting from National to Negotiated Law-Making Approach

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International and national laws constitute a legal positivism which, by definition, excludes any form of legal pluralism. At these scales, we remain exogenous to territorialized communities since regulatory frameworks are mostly enacted on international or national levels. Face to climate change challenge, it is increasingly important to investigate how local communities can be involved in climate actions if we assume that existing top-down regulatory frameworks will not fully consider socio-ecological adaptations and resilience as highly crucial for local communities to persist and maintain their identities.

The interrelations between governance scales cannot exclude local territories. At the local level, communities tend to adapt and build their resilience to climate change by regulating the relations among groups and individuals and between social and ecological systems. Therefore, the idea of a law emerging from the bottom is becoming increasingly relevant in order to enhance the bottom-up approach as an appropriate coping strategy. In other terms, the law-making processes will no longer remain exclusively vertical but will evolve in a horizontal mode, thus abandoning the power relations to embrace the logic of negotiation.

Two examples of negotiated law-making will be presented in this research: the first pertains to the ongoing construction of a socio-ecological resilience pact in the Moroccan High Atlas involving two tribes (including four rural communities and regions); and the second case concerns the formalization of an already-implemented pastoral pact being adopted in the French Cevennes and involving sixteen counties (including one department and one region). In each case, the co-construction process is put forward and analyzed on the basis of a territorial project. The three-dimensionality aspect of the project (involvement of agro-pastoral actors, decision makers and experts) is presented as the core pillar of the design and implementation of concerned regulatory frameworks. These frameworks, materializing a territorial law perceived and formalized in a solemn text labeled «territory pact», fully integrate national laws by local deliberation.

P-4409-26

Why establish a climate legislation to address climate change in a Latin American context?

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The most ambitious Latin American countries have had a sustained political commitment with regards to the climate change actions as it can be seen in the public policies elaborated since the signature of the UNFCCC - especially in the commitment of 2009 - and the current resourceful position during international negotiations.

In this context, the initiative of a climate legislation seems

to be an adequate way for institutional strengthening and coordination of climate change at national, regional and local level. This is relevant in the current context of the national contributions' definition with regards to the Conference of the Parties (COP) in Paris in 2015.

The overall objective of this presentation is to demonstrate the necessity and viability of climate change legislation for Latin American countries and outline the recommended basic content of such a law to support the determination of the countries' Intended Nationally Determined Contributions (INDC) which are to be presented to the UNFCCC secretariat in the lead-up to the 21st COP in Paris in 2015. At a time when strengthening public policy on climate change can be a cause for concern in certain sectors of society, the results of this presentation will ground the debate on climate change legislation in objective terms and will deliver concrete inputs and tools to demonstrate the need and viability of such legislation.

P-4409-27

Ex-post evaluation of the Kyoto Protocol: Four key lessons for the 2015 Paris Agreement

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Agreed in 1997, following the 1992 United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol (KP) is the first international tool focused on greenhouse gas (GHG) mitigation involving as many countries: in its final configuration, thirty six developed countries committed to reduce their emissions by 4% between 1990 and 2008-2012 - the first commitment period (CP1). In April 2014, the data from the CP1 was officially published. This report thus presents the first comprehensive ex-post analysis of the first period of the KP.

Based on the results of this report, it is possible to draw four key lessons from the Kyoto experience for the establishment of a new global agreement that is expected to be signed in Paris in 2015:

1. Expanding the coverage: striking a balance between overall environmental integrity and flexibility for specific circumstances
2. Removing the virtual specter of internationally legally binding commitments and limiting the focus on methods of compliance
3. Focusing on MRV processes
4. Providing flexibility in the agreement and its adoption process

P-4409-28

Medium term implications for Africa's adaptation planning in Agriculture

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Many of the sustainable development goals to 2030 recognize the role agriculture can play in ending hunger, assuring food and nutrition security as well as promoting healthy lives with a sustained income and economic growth; thereby reducing poverty globally. For Africa, a post 2015 agreement presents the opportunity to merge a shared vision on sustainable development with that which stipulates a pathway to a low carbon transition of food systems. However, it is unlikely, given the short time available to prepare an agreement in Paris in 2015, that the United Nations Framework Convention on Climate Change (UNFCCC) subsidiary bodies and work streams will conclude discussions on agriculture to pave way for a new climate deal.

The national adaptation plan (NAP) process was established in 2010, under the Cancun Adaptation framework of the UNFCCC. It was intended as a mechanism for countries to address their vulnerability to the impacts of climate change, building their capacity to adapt to current and future climatic changes. A key focus is to integrate climate change adaptation into development planning processes and strategies across all sectors and at local to national scales. Under this framework NAPs address medium to longer term needs building on the experiences of Least Developed Countries (LDC) National Adaptation Programme of Action (NAPAs). If we examine the state of the negotiations, the subsidiary body on implementation (SBI) is currently considering guidelines for the formulation of NAPs. The LDC Expert Group (LEG) has identified the need to fast track the application of NAP guidelines emphasizing integrated development planning as a key consideration. Through the adaptation planning process, we examine how Africa is dealing with agriculture.

Since NAPA experiences are being incorporated into a new set of guidelines for NAPs, it is expected that any emerging protocol will highlight specific agriculture, fisheries and forestry actions. The result is that agriculture and food security, which is to a great extent reflected in proposed and ongoing country NAPA programmes, receives greater attention in defining the medium and long-term issues around food security and food consumption. Because these issues are not yet well understood, and are often bundled with concerns about trade and commerce and non-food products from alternative land uses such as with bio fuels, it is important to foster dialogue for the parties as they prepare for the upcoming COP21 in order to reach agreement on how to treat agriculture in a new global deal on climate.

Under the NAP process, many countries have conducted some or other form of impact assessment, usually on a sectoral basis. There exist no guidelines for initiating and completing risk and vulnerability assessments of the agriculture sector and particularly as it relates to the impacts of climate change on agriculture as well as the impacts of agriculture as a contributor to climate change. In many cases too, the economic impacts of climate related risks has not been enumerated therefore compromising the design of effective adaptation strategies and measures at the national level. The inclusion of 'national planners' is therefore critical to this process, such as from the ministries of finance and the support for LDCs under the Global Support Progamme (GSP) is crucial to advancing the NAP process. In addition, the identification and procurement of funding for adaptation is only nascent and limited to early action, therefore it is not expected that agricultural adaptation will receive significant funding commitments in the foreseeable medium term period post 2015 and pre-2020.

P-4409-29

The Road to Paris and beyond: Prospects for International Climate Policy

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All commentators agree that the climate conference in Lima (COP20) left a great deal of work for diplomats on the road to Paris later this year. The talks produced a quarry of language the negotiators can choose from. What was a mere annex to the "Lima Call for Climate Action" was further expanded in a first round of intersessional meetings in Geneva in February and formally adopted as a negotiating text. Narrowing down the options will be the major task for the upcoming sessions. While the progress on the post-2020 agreement (Workstream 1) was perceived as slow and tedious, somewhat surprisingly the developments in Workstream 2 (pre-2020) were rather positive and it has developed into a forum of open exchange, thus establishing a new and fruitful mode of collaboration within the UNFCCC process.

Our analysis is guided by a structurational regime model (Arts, 2000). This model assumes that the UNFCCC institutional system serves as part of the structure that guides the agency of firms and individuals within those socio-technical systems that are responsible for driving global climate change. The UNFCCC structures behaviour via the implementation of formal treaties in the respective national law of the Parties to the treaty, but also directly by providing signification and legitimation to transnational and subnational institutions to govern climate change, and immediately to corporations and consumers to develop

more sustainable behavioural routines.

Based on this model, we analyse the „Lima Call for Climate Action", the negotiating text formally adopted in Geneva in February 2015, and other developments in Lima and therafter. We look into the elements that have been tabled for the new global treaty to be agreed in Paris in 2015 and discuss their potential contributions. From this we derive recommendations for a fair and effective treaty.

Our analysis shows that the UNFCCC hitherto failed to provide an adequate impulse to act on climate change. It has become increasingly obvious that the UNFCCC institutional system as it is designed now is not delivering what it is supposed to do according to Article 2 UNFCCC: to prevent a dangerous anthropogenic interference with the climate system. This is due in large part to the consensus-based approach, which does not work well with a quantity-based system of commitments but rather calls for other forms of cooperation. The concept of Multi-Dimensional Commitments developed by the Wuppertal Institute might offer a way out of this dilemma. Furthermore, the article explores a fresh start, options to supplement the UNFCCC system with an alliance of countries that want substantial progress on climate protection – an alliance of the ambitious or a forerunner club. Such a special treaty outside of the UN framework, if appropriate feedback mechanisms are established within UNFCCC, could help injecting some of the much-needed dynamic that is required to bring our civilization on a path compatible with earth's ecological limits.

P-4409-30

Climate Governance in two non-independent Caribbean Insular Territories: two different or similar trajectories?

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This contribution shows how two non-independent islands of the Caribbean reflect the multiple scales dynamics for Climate Governance. For Puerto-Rico, the adopted solutions must be understood through USA relation and for Guadeloupe, through Europe and France.

To do so, this work synthetizes the first initiatives regarding wind energy on both islands; and the recent ones/ or projects since 2009. We explore then the emerging representation of climate change issues inside those two insular territories by exploring the local press, and interviews of local population living next door wind farms in Puerto-Rico and Guadeloupe.

Both territories indeed traduce the integration of the international level conceptualization as they become "laboratories for experimentation" to demonstrate successful transformative solutions to transfer to other insular territories or even to their metropolis. We present here some international key documents or political discourses in Puerto-Rico and Guadeloupe that contribute in understanding climate governance within islands.

P-4409-31

Multilevel climate governance, between deliberative system, precaution and shared responsibilities

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This paper aims at being relevant to the overarching theme of the Day 4 (themes: Climate Governance, Transforming Science to Transform Society, Information for Decision-Making, Mediating Climate Change Dialogue, Transformative Solutions, Adaptation Governance, Equity and Responsibility, Collective Action, Social Movements, SDGs and Climate Agreement). It could be relevant for Day 3 too (themes: Innovation, Technology Deployment and Policies; Climate Policies; Governance and Justice; Conflicts and Climate Change).

If climate sciences requires interdisciplinary approaches (Jeandel and Mosseri, 2011), it is the same for climate multilevel governance (Winter, 2011; Brondizio, et alii, 2009; Bache I. and Flinders M., 2004). We have to explore transformative solutions to climate change from a cross-sectorial perspective in order to reach integrated solutions especially through collaboration. This collaboration concerns different levels. 1) The actors level covering the complex and inter-related socio-political and human aspects (individuals, associations, institutions), 2) The level of different kinds of responsibilities, 3) The level of different sources of knowledge. The latter concerns scientific knowledge on the climate (description and forecast) as well as normative justifications and decisions (political, economical, legal and ethical). We have the entities, their respective responsibilities and the disciplines, more or less relevant to treat the different problems. To lead to transformative pathways to climate change challenges, we have not only to make up solutions across a range of stakeholders and sectors that encompass technological, institutional, economic and behavioural changes, but across disciplines, they are descriptive and predictive or normative and prescriptive. To be complete we have to consider multiple scales (spatial and temporal). The governance perspective of this paper is not only multi-lateral, managing different entities from a political perspective, but multi-disciplinary to explore the wide range of topics that cut across climate change issues, from physical feedbacks to social and economic impacts. Indeed to reach relevant, responsible and high quality collective decision on the international level, we need to take into account these three levels and match them carefully.

We need new concepts to match these three different levels. We have chosen here three promising ones: deliberation, precaution (precautionary principle) and responsibility.

Deliberative system is promising in the democratization of global climate governance (Stevenson, Dryzek, 2014). Precautionary Principle has the potential to combine both sides of assessment, scientific and normative in case of uncertainty (Gardiner, 2006; Reber, 2015). Moral responsibility help to make the link between mitigation and adaptation and the two kinds of justice entailed (corrective and distributive) that is not already done in UNFCCC. The common climate requires a common approach according a balanced cooperation between the three levels of governance, that can be constructed through the combination of inclusive and deep deliberation among actors (humans, publics and institutions), balanced between scientific and normative assessments, in a «conversation» among distributed responsibilities.

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P-4409-32

Unlocking deadlocked negotiations: The relevance of group pressure and policy learning in the global climate negotiations

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The UNFCCC negotiations have been deadlocked for over 20 years due to incompatible national interests. At the same time, the objective of avoiding dangerous climate change drifts out of reach as we near the end of this decade. Yet, there is increasing scope to break up this deadlock, for which mutual learning, policy diffusion and capacity building will be central. Initial evidence suggests that learning is a key-multiplying factor in accelerating policy diffusion via the international level. Learning can be a helpful factor to progress along transformative pathways

to sustainable development, in particular effective climate mitigation and adaptation. Within the UNFCCC negotiations, countries can learn from each other's successes in low carbon economic development, share knowledge on designing domestic climate legislation that is co-beneficial for sustainable development and even come to understand that addressing climate change is an opportunity to create a green industrial revolution, thus entering on transformative pathways towards sustainable development. Realizing that there are long-term benefits from acting on climate change can even influence how actors understand the issue and result in readjustments to negotiation positions based on altered national interests. In combination with group pressure, these experience, knowledge and belief-based types of learning are currently altering the negotiation dynamics within the UNFCCC. Transgovernmental city networks and non-governmental organizations are creating non-negotiation settings for governmental representatives to explore options and learn from other countries' successes. These learning platforms and networks were established by a number of actors to help countries share their experiences with low carbon economic development plans to address climate change while decoupling their economic growth from negative climate impacts. Based on interviews and participant observation at the UNFCCC negotiations between 2013 and 2015, this contribution examines the learning among government representatives about each other's low carbon economic development plans and climate legislation within (UNFCCC) non-negotiation forums and increasingly formal negotiations. Mutual learning and policy entrepreneurial strategies of key negotiators helps to create positive competition towards more ambitious climate legislation on the national level. Presenting these national climate policies in the UNFCCC creates group pressure among countries to revise their negotiation positions towards improving action on mitigating climate change to avoid being branded as 'laggards'. The key implication of this research points towards the importance of better understanding underlying learning mechanisms, which can contribute to overcoming negotiation deadlocks by helping countries shape their national interests over time towards increasing cooperation on sustainable development.

P-4409-33

Climate change governance in Small Island developing States

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Climate change governance in Small Island developing States (SIDS) is a pressing priority to preserve livelihoods, biodiversity and ecosystems for the next generations. Understanding the dynamics of climate change policy integration is becoming more crucial as we try to measure the success of environmental governance efforts and chart new goals for sustainable development. At the international level, climate change policy has evolved from single issue to integrated approaches towards achieving sustainable development. New actors, new mechanisms and institutions of governance with greater fragmentation in governance across sectors and levels make integration of policy in the area of climate change governance even more of a challenge today. What are the best frameworks to achieve successful climate change policy integration in environmental governance – especially as the complex interconnectivity of new actors, institutions and mechanisms make the process of integration even more challenging? Are the same climate change policy coherence frameworks useful or indeed applicable for environmental governance in developing states more generally and for SIDS in particular? This article reviewed the debates around policy coherence for climate change governance, creates a framework to test or measure policy coherence and examines how relevant this has been to actual regional climate change governance processes in Caribbean States. The findings fill a gap in the literature on climate change governance through policy coherence in SIDS.

P-4409-34

Review of the experience with monitoring uncertainty requirements in the Clean Development Mechanism

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In order to ensure the environmental integrity of carbon offset projects, emission reductions certified under the Clean Development Mechanism (CDM) have to be 'real, measurable and additional', which is ensured inter alia through the monitoring, reporting and verification (MRV) process. MRV, however, comes at a cost that ranges from several cents to EUR1.20 and above per ton of CO2e depending on the project type. This article analyzes monitoring uncertainty requirements for carbon offset projects with a particular focus on the trade-off between monitoring stringency and cost. To this end, existing literature is reviewed, overarching monitoring guidelines, as well as the 10 most-used methodologies are scrutinized, and finally three case studies are analysed. It is shown that there is indeed a trade-off between the stringency and the cost of monitoring, which if not addressed properly may become a major barrier for the implementation of offset projects in some sectors. It is then demonstrated that this trade-off has not been systematically addressed in the overarching CDM guidelines and that there are only limited incentives to reduce monitoring uncertainty. Some methodologies and calculation tools as well as some other offset standards, however, do incorporate provisions for a trade-off between monitoring costs and stringency. These provisions may take the form of discounting emissions reductions based on the level of monitoring uncertainty – or more implicitly through allowing a project developer to choose between monitoring a given parameter and using a conservative default value.

P-4409-35

Designing monitoring rules in climate policy: the uncertainty issue

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This paper assesses the environmental and economic efficiency of three different approaches to treat monitoring uncertainty in climate policy, namely no special rules, minimum certainty thresholds and discounting proportional to uncertainty. Our microeconomic model of the behavior of profit-maximizing agents demonstrates that under the simplest set of assumptions – likely representative of many practical cases – the regulator has no interest in reducing unbiased monitoring uncertainty. However, in the presence of information asymmetry monitoring uncertainty may hamper the integrity of climate policy. We find that in that case applying discounting proportional to monitoring uncertainty is preferable to setting minimum certainty thresholds or not enforcing any constraints at all, as it is currently practiced in most carbon pricing mechanisms.

P-4409-36

Forecasting the Paris Agreement

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International negotiations are under way to conclude a 2020+ agreement in Paris in December 2015 within the confines of the UN Framework Convention on Climate Change (UNFCCC). Neither are the contours of such an agreement presently clear nor whether any agreement will be concluded by the end of this year. To fill this void, we undertake a prediction of select dimensions of the present negotiations with the Predictioneer's Game (Bueno de Mesquita 2009a).

The Predictioneer's Game builds on three decades of model development. In essence, it is an advanced expected utility negotiation model with incomplete information between N parties who make bilateral negotiation offers and counteroffers. Based on knowledge of who the actors (or stakeholders) are, their basic influence in world politics, the salience of the specific issue under negotiation (see

below), the actors position on the issue, as well as their flexibility on that position, the Predictioneer's Game forecasts the negotiated outcome round-by-round until no additional utility can be gained on average. The model has been used to predict outcomes on a wide range of governance and policy issue. The Predictioneer's Game correctly predicted the outcome of the 2009 Copenhagen Conference of the Parties – despite high expectations for a cooperative outcome at the time (Bueno de Mesquita 2009b).

For the conference "Our Common Future Under Climate Change," we will undertake a prediction of the likely common mitigation goal of the parties negotiating under the auspices of the UNFCCC. We will concentrate on the most important country actors and pertinent negotiations groups. In addition, we will undertake a prediction of the likely outcome of the present negotiations on "loss and damage" and its potential inclusion in a Paris agreement.

In order to calibrate our input data, we will draw, on the one hand, on the expertise provided by CICEP Norwegian Center for Excellence in Research – Strategic Challenges in International Climate and Energy Policy, which comprises CICERO, the University of Oslo, and the Fridtjof Nansen Institute, and PIK – Potsdam Institute for Climate Impact Research, on the other hand.

The analysis will be undertaken in April–June 2015 in lieu of the Intended Nationally Determined Contributions (INDCs), corroborated by a broad range of robustness checks to both reflect uncertainty about input values and external shocks on the negotiation dynamics.

Initial test calibrations of the model suggest that the common mitigation goal will not substantially differ from those discussed at Lima in late 2014, an agreement will be reached after late 2015, and an extension of the "loss and damage" negotiations towards a compensation fund will not materialize in the near future.

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P-4409-37

Transparency and Accountability in Climate Finance Governance

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Climate finance, to reduce greenhouse gas emissions or to adapt to the harmful effects of climate change, remains one of the central issues of current international negotiations. Progress in the fulfilment of the developed countries collective commitment, adopted in 2009 in Copenhagen and set out, the following year, in the Cancun Agreements, to provide new and additional resources to developing countries, in the range of 100 billions of dollars by 2020, may determine the conclusion of an inclusive and ambitious agreement in 2015.

However, some developed countries advanced the argument of the economic crisis to postpone the provision of public finance, to ask for the efficiency of funds provided in terms of climate change mitigation, and to consider that a major part of the climate finance will come from the private sector. Many developing countries, more preoccupied by the effectiveness of climate finance, conditioned their participation within a 2015 agreement to the actual disbursement of funding and consideration of adaptation to climate change, as well as capacity building, to estimate their needs. Finally, voices had been raised against inter alia human rights infringements resulting from previous climate projects, putting emphasis on the need for the integrity of climate finance.

These demands for efficiency, effectiveness and integrity of climate finance plea for transparency and accountability at all stage of the funding cycle, that is to say from its mobilisation to its disbursement and administration. Indeed, transparency and accountability are core democratic values, linked to the procedural rights to information, participation in decision-making and access to justice that should apply to the overall governance of climate finance. These elements, participating to public scrutiny in the field of climate finance, are particularly important to enhance developing countries' confidence by ensuring that developed countries respect their commitment and to evaluate, progressively, developing countries' needs in order to take up the challenge of dealing with climate change. They also appear crucial to adopt a holistic approach of climate action by avoiding deleterious side effects of internationally funded projects, and more broadly favouring public acceptation of the efforts needed.

Yet, the assessment of the provided and received financial support, its new and additional character or its effects on the ground raises numerous difficulties. Despite the establishment of a Green Climate Fund (GCF), meant to centralize as much as possible the financial mechanism of the international climate regime, and the setting up of a Standing Committee on Finance (SCF), intended to encourage the coordination of climate finance, governance in this domain remains highly fragmented. Different scales of decision and action are mobilized (international, regional, national and local), within the climate regime (UNFCCC) as outside. Climate funds are functioning, moreover, according to different rules and are not all managed by the same institutions. This is even truer if one takes into account private climate finance next to public climate finance.

Therefore setting up a transparency and accountability system in climate finance constitutes a major challenge, as related rules and procedures are currently incomplete and inconsistent. That is why, to elaborate such a system, the SCF and the GCF are proceeding from relatively unprecedented way, in particular by encouraging involvement of all "stakeholders". Initiatives from multilateral banks of development, the Organisation for Economic Co-operation and Development and some non-governmental organisations, like Transparency International, are also relevant in this regard. From then on, it is especially interesting to study in details this process of normative production that could apply to other fields of climate governance.

Indeed, it first favours a better understanding of the mapping of the current transparency and accountability systems relevant for climate finance, which is necessary to compare them, in order to identify their harmonisation and/or articulation potential. This presentation aims to analyse these four stages to improve the overall climate finance governance.

P-4409-38

The Continental Approach to Climate Change: An Analysis of the European Union's Emissions Trading System

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The European Union's Emissions Trading System stands as a model for managing a changing climate in a complicated international environment. As the international community prepares for negotiations on a post-Kyoto climate regime, an understanding of players and their performance in the EU's governance system is essential to validating the potential success of emissions markets. Concerns that wealthy countries will purchase permits, rather than reduce their real emissions, have created skepticism about emission trading's potential for success.

In this study, I examine ambition exhibited by countries in using less than maximum levels of offsets to achieve Phase II reductions. Through fuzzy-set Qualitative Comparative Analysis, I explore a number of variables including: economic growth, Green Party representation, public opinion, and renewable energy investment to construct a model explaining variety in exhibited ambition among ETS countries. Results show that renewable energy and public opinion play the most significant role in explaining a country's use of offsets. Specific case studies demonstrate wide variance in explanation for member state performance, tied closely to business group influence and early environmental action.

4410 - Citizens and governments as drivers of cultural and political change

ORAL PRESENTATIONS

K-4410-01

New norms and institutionnal practices towards radical political changes

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The theme of my lecture will be the relationship between cosmopolitical citizenship and political citizenship faced with climate change. The questions considered will touch as much on general principles as on an examination of concrete examples of collective action in local and national contexts. In the age of the Anthropocene, the urgent and indispensable norms and modes of regulation to save our species have not yet been clearly formulated. The deep reasons for the gaps between diagnoses and action have their roots in various levels of the way in which societies function.

It is by mobilising the collective action of citizens in each state, as well as that of human beings as citizens of the world, that we shall probably find a large part of the answers. Our discussions will thus be situated on two levels: cosmopolitical and political. We are in fact living in a time when political citizenship can no longer ignore the status of every individual as a citizen of the world; that is to say, our responsibility with regard to the present and the future of the earth and of the whole living world.

K-4410-02

The political economy of decarbonisation

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What and how we produce and consume is largely shaped by markets. However, markets fail to solve many of the environmental challenges we are facing. Therefore, we need governments to intervene, thus reclaiming the primacy of public policy in setting and implementing societal objectives. While safeguarding the sustainability of human life on our planet makes this kind of government intervention a highly normative undertaking, its economic case is strong as well – the success stories of such 'green' frontrunners as Germany and Denmark demonstrate the competitiveness potential of the new technologies.

However, as shown by decades of discussion on industrial policy, government intervention almost invariably brings about risks of political capture and government failure. Government intervention towards sustainability is thus not only governed by ethical norms, but also by politics. The risks of failure are magnified by the urgency and scale of today's global environmental challenges, requiring particularly bold, comprehensive and well-orchestrated government intervention under high uncertainty. By highlighting lessons learned from practical cases of both success and failure, we show how these risks can be, and have been, managed. In particular, we submit that a broad-based social vision and contract need to be forged – supported by change coalitions and coupled with policy process safeguards, openness to policy learning, and an alignment of transformative policies with market mechanisms.

K-4410-03

Urban narratives and collective mobilizations in the field of adaptation to climate change

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With the exception of climate skeptics who appreciate climate change only as a natural phenomenon to the exclusion of all human causes, climate change is not referred to nature. Climate change as a whole refers to an abstract scientific phenomena and/or a disruption of the natural order by human activities. Characterized by science, climate change involves a complex interpretative framework linked to a network of measurements, statistics and modeling, combined with scientific judgments about their relevance. It is therefore important to understand how these changes are part of the natural and built environments both in terms of representations and of social practices. We seek to address the interests of narratives regarding these issues, in particular, adaptation to climate change in urban space. Our collection of city-dwellers stories in urban situations of various constraints and resource levels as well as the CSO narratives framing their action tells us about adaptation to climate change. The capabilities require to take into account both the constraints and the resources with which people have to live and operate daily to adapt to changes of various kinds. The important thing is that it is possible to develop a reflection on the capabilities from ordinary stories. This means to explore sustainable practices in everyday life. These practices will allow us to envision social invention of new forms of action support or resistance to normative injunctions in the field of adaptation to climate change. The problematic issue is to see if the exploration of capabilities through stories can be a path to a sustainable culture.

O-4410-01

Reinvigorating International Climate Policy: A Comprehensive Framework for Effective Non-state Action

S. Chan (1) ; H. Van Asselt (2) ; H. Thomas (3) ; K. Abbott (4) ; M. Beisheim (5) ; M. Hoffmann (6) ; B. Guy (7) ; N. Höhne (8) ; A. Hsu (9) ; P. Pattberg (10) ; P. Pauw (11) ; C. Ramstein (12) ; O. Widerberg (10)
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As countries strive to negotiate a new climate agreement in time for the Paris climate summit in December 2015, a different kind of climate politics is emerging as cities, regions, businesses, and civil society groups take mitigation and adaptation actions, independently and together with each other and with national governments and international institutions. In Paris, governments have an historic opportunity to develop a framework to catalyze, support, and steer these initiatives. Social science research highlights the need for a comprehensive approach that promotes ambition, experimentation and accountability, and avoids unnecessary overlaps. This contribution specifies the functions of and design principles for a comprehensive framework for non-state climate actions that could build positive linkages and provide effective coordination.

Drawing empirical lessons learned from sustainable development governance (in particular 'Partnerships for Sustainable Development' and 'SD in Action'), we envisage a comprehensive framework as a long-term program to support, strengthen, and orchestrate non-state initiatives that contribute to international climate goals, targets and agreements.

Designing a concrete framework will not be simple, but current social science research on non-state action suggests three clear guidelines for that process. First, design and

maintenance of the framework must be collaborative, and the framework itself must be jointly 'owned' by the UNFCCC secretariat and participating non-state actors and initiatives. Second, a comprehensive framework should include a global clearinghouse, bringing together existing sources of information. The clearinghouse should build upon existing registries maintained by a network of non-state actors in partnership with the UNFCCC. Finally, as climate actions are heterogeneous, the platform should combine low thresholds for inclusion with a layered structure that would provide increased visibility - coupled with increased levels of accountability - for particularly significant actions.

The road to Paris offers a unique opportunity to ratchet up ambition, mobilize action and engage more actors in climate action. Governments and non-state actors can create a robust, capable, and long-term comprehensive framework that orchestrates and supports non-state initiatives to contribute to internationally agreed climate outcomes, and that counteracts the inefficiencies of a fragmented governance landscape. Yet inpursuing this approach we need to avoid repeating the mistakes of previous frameworks.

O-4410-02

Community Renewable Energy in Australia - examining and comparing an emerging social movement

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Local action for global problems finds expression in the growing field of Community Renewable Energy (CRE). Community actors develop and own renewable energy projects and play an increasingly important role in the transformation of energy system providing local solutions (del Río & Burguillo, 2009; Hicks & Ison, 2011; Rogers, Simmons, Convery, & Weatherall, 2012; trend:research GmbH & Leuphana Universität Lüneburg, 2013; Walker & Cass, 2007; Walker & Devine-Wright, 2008; Walker, Hunter, Devine-Wright, & Evans, 2007).

Australia is a relative newcomer to this development, yet many communities are becoming increasingly enthusiastic about the Community Renewable Energy. However the country's communities seem to face particular challenges when it comes to implementation due to a limited support by the national government and a rather complex energy market (Hicks & Ison, 2011).

The CRE movement in Australia counts currently (as of October 2014) around 60 groups attempting to develop projects and 10 operating projects across the country (ISF, 2014).

The presentation will present results of two national surveys of community energy projects in Australia and provides insights into the "scope, scale and character" of this nascent community energy movement. The surveys were created and conducted in 2012 and 2014 by members of the Coalition for Community Energy, which included the two authors of this article.

The results of the survey have been analysed in a similar vein to that offered of the UK by Seyfang et. al. (2013). Like them, we use the STEEP (social, technical, environmental, economic, political) and SWOT (strengths, weaknesses, opportunities, threats) frameworks as the foundation of our analysis. We discuss the key issues for the further development of community energy in Australia in its socioeconomic and political context.

However, we take our analysis a step further to reflect on how this emergence in Australia has been different from other countries and what this means for different understandings of the nature and role of community energy.

For this component we employ existing concepts of community energy (Walker & Cass, 2011; Walker & Devine-Wright, 2008; Walker et al., 2007) and social movement theory (Davis et al, 2005; Schneiberg & Lounsbury, 2008; Seyfang & Smith, 2007). We draw on a literature review and historical data from other countries such as Denmark, Germany and the UK.

O-4410-03

Collective national and transnational action towards «green grabbing»

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Land remains the most fundamental productive asset for the vast majority of populations in the Global South. Agriculturalists' pre-existing vulnerabilities are not only compounded by climate change impacts and lack of socio-economic assets, but also by large-scale land acquisitions that have risen since the convergence of multiple global crises (financial, environmental, energy & food) (Borras & Franco 2012). If we were to compare the phenomenon to colonial times, the fact that climate change legitimises a large part of such acquisitions is a main novelty. Since the neoliberal turn, there is a widespread belief that the market is synonymous to development leading to the commodification of the ecological commons through so called "green" market solutions such as carbon trading, emissions offsets and biofuels (McMichael 2010). Whilst the proponents refer to these transactions as "direct investment in agriculture", highlighting their potential for agricultural modernisation, employment creation, local food security and "green" energy production, the retractors point to the various threats that these deals can actually pose to the environment, to local food security and to traditional livelihoods. Furthermore, such projects stimulate the industrialization of agriculture, which is at the basis of many of our environmental problems today.

Local communities and grass root organizations have protested in several countries around the world. Yet, corruption, military intervention and landlessness are all factors which are creating obstacles for effective local collective action. Land activists are still facing considerable threats of imprisonment and murder by corrupt governments that are aligned with corporate interests. Several local and transnational NGO's and academics have been actively drawing attention to the social and environmental threats that these large scale land concessions can pose to already vulnerable communities. Despite persisting obstacles to effective local collective action, the demands of transnational grass root organizations have been key in the development of international "good governance" norms. As a result of these pressures, multilateral organizations such as the WB, the EU and the FAO have developed codes of conduct and principles for responsible agricultural investment. Transparent negociations, respect for existing land rights, sharing of benefits, environmental sustainability, and adherence to national trade policies, are the most frequently addressed challenges in order to attain "win-win" outcomes. All of them seem to suggest that good governance norms would diminish negative socio environmental impacts. Yet, despite the well-intended rationale behind such principles, they still fail to question agro-industrial development per se, as if other possible development pathways, such as smallholder agriculture and family farming, would not be better suited to address our social and environmental challenges. In a world where climate change impacts are expected to considerably reduce the resilience of already vulnerable populations, there is a need to rethink our whole model of neoliberal development and to promote other types of investment asides from corporate investment. Furthermore, the voluntary nature of such principles makes the implementation process difficult, making it arduous or impossible to track down and penalize those who fail to follow such principles. Even in cases where such guidelines are legally institutionalised at the national level, practical implementation remains scarce or inexistent. The principles are still too vague in a context where governments and elites of developing nations often take the side of investors for purposes of personal enrichment or supposedly national development. Drawing from fieldwork conducted in both Senegal and Cambodia, this presentation will shed light on the actions of citizens, NGOs and activists in pressuring governments and donors whilst shaping and contesting a model of development that has often resulted in further environmental stress and recurrent Human Rights violations. Based on field evidence this presentation will highlight cases in which collective action has resulted in positive outcomes and cases in which local demands have remained largely overlooked. The aim of this presentation will be thus to highlight the key variables that determine positive collective action

outcomes as well as to underline the obstacles that persist in the implementation of socio-environmentally sustainable agricultural development projects.

4410 - POSTER PRESENTATIONS

P-4410-01

Strengthening the climate action movement: strategies from histories

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Since many governments lack the motivation to lead deep emission reduction initiatives, the climate action movement must strengthen its campaigns. This paper offers strategies for the movement derived from historical analysis of mechanisms that achieved effective social change in the past. Common elements of climate action with past social change movements, together with some differences, are identified. Although technologies, strategies and tactics vary, climate action groups can agree to support a shared common goal: effective climate mitigation, that can be accomplished not only through outward-oriented tactics, but also by forms of climate activism that are prefigurative - that is, based on action within local communities. Furthermore, the diverse campaigns that take place on a variety of scales and spaces, conducted by heterogeneous groups, should be integrated by establishing national and international hubs to facilitate coordination and communication.

P-4410-02

"Re-Imagining Radical Climate Justice for the Post-Paris World"

F. John (1)

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The science is not in question: climate change is here now, not in the future,[1] and it is already having devastating effects on people's lives. That's the bad news, of course.

Even worse, the massive social, economic, and political inequalities already generated by neoliberal capitalism would seem to set the social and natural worlds on a collision course which the elites cannot win -- even on their own terms -- without destroying the basis for all human life. To put it bluntly, the climate crisis is perilous, our 500 year-old economic system cannot see us through it safely, the window for resolving this dilemma is closing inexorably, and the forces arrayed against our common survival are strong, very strong.

The good news is that there's a global climate justice movement which is growing in numbers, reach, strength, and inventiveness. This movement is impossible to encompass easily, because it consists of literally thousands of organizations at every level - community, city, bio/region, nation, and the global - interlinked in a vast network of networks.[2]

The next few years will be the years that those of us in the climate justice movement must scale up our efforts toward the end of mounting irresistible pressure of all kinds on our governments and on the corporations, banks, and all the institutions of neoliberal capitalism that they serve. We must force them to take the decisive steps we all need and want, such as a fair and binding global climate treaty and a deeply sustainable post-capitalist society free of structured violence and run democratically by the ninety-nine percent.

Consider the following:

Parts of the radical left are turning their attention to climate change (System Change Not Climate Change in North America), while many members of the radical climate justice movement are turning their attention to anti-capitalist politics.

At the same time, the Big Green environmental organizations (the Sierra Club in the US), the mainstream global climate justice movement (CAN), and the biggest climate social movement organization (350.org) are all radicalizing.

The same can be said of climate science in general (The IPCC Fifth Assessment Report etc.) and particular climate scientists, such as Kevin Anderson, Alice Bows-Larkin, Michael Mann, James Hansen, et al.

Finally, there is an enormous push coming up from young people, and indigenous forces on all of these levels.

The question is: what are the prospects for synergy and movement building among all these forces? What is the way forward?

It appears evident that we will need to assemble the greatest social movement the world has ever seen to achieve these ends. The global climate justice movement is growing steadily, but it is still far too weak to win - at least for the moment.

This essay will trace some of what it has accomplished so far, asking where the major points of impact lie at the moment, and what strategic decisions must be faced moving forward.

[1] IPCC [Intergovernmental Panel on Climate Change], "Summary for Policymakers," pp. 1-28 in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley (Cambridge: Cambridge University Press, 2013), http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdfhttp://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.

[2] Paul Hawken makes the claim that the movement organizations number in the thousands: Blessed Unrest: How the Largest Movement in the World Came into Being and Why No One Saw It Coming (New York: Viking, 2007). For a partial, annotated list of some of the key climate justice movements and resources of which I am aware, see "The Global Justice Movement On-line" at www.iicat.org.

P-4410-03

Climate Change and Ebola Outbreaks: Are they connected?

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The climate factors have an impact on pathogens (resistance, selection, etc), hosts (biology like immunity, ecology like migration movements, etc), vectors (ecological niches, vector capacity) and epidemiological dynamics. The climate can affect the rate of transmission, the way in which pathogens are dispersed, contact networks between individuals and between different species, community structures. Livestock farming methods, or biodiversity and its ambivalent role in disease emergence are also depending of climate factors. The diseases most sensitive to climate factors are parasitic diseases with external life-cycle, vector-borne diseases and infectious diseases passed on by water or micro-mammals including bats. Most of them are zoonosis.

For a zoonosis like Ebola, several potential drivers are suspected to connect climate change to ecosystems, virus transmission to Human and heath care policies:

1. Ecology and behaviour of the bat species suspected to be Ebola virus reservoir could be affected by climate change: population density, migration, habitat utilisation, reproduction, feeding behaviour, and nature or intensity of inter-specific contacts. All those parameters would have an impact on the ecology of the Ebola virus. Therefore, researches for understanding the mechanisms of virus maintenance, circulation and transmission and for identifying reservoir and bridge species need to address the correlations between Ebola foci and its environmental factors, including climatic factors.

2. Human contamination by Ebola virus can occur through close or direct contact while hunting or through eating meat from wildlife. Climate changes can for one side, favour

contact between wildlife and humans by impacting the natural habitats of the reservoir species and by influencing their movements. For other side, climate evolution may also exacerbate food insecurity, which can in turn modify human behaviour, particularly by prompting people to look for alternative food sources, such as bushmeat.

3. Low-income countries must reinforce their health systems to detect earlier infectious zoonotic diseases and control outbreaks, by taking into consideration potential impact of climate change in their sanitary strategy and policy. Indeed, health systems are structurally inadequate in the least advanced countries, where they endure rather than anticipate climatic conditions and their variations. The recent Ebola epidemic in West Africa bears witness in particular to the need to step up the early detection and management of the emergence of zoonosis taking into account accurate environmental, social and climatic data.

Research and health management regarding these 3 items should be carried out through the "One Health" concept. This holistic approach includes both animal health and human health in their shared environment. The implementation of a multidisciplinary and intersectoral approach requires above all an awareness of its benefits and greater involvement of all the scientific and policy makers. The issue of climate change and its impacts on viral diseases may be an axis of reflection on this integrated approach, and Ebola disease is a topical issue.

Our poster presents some examples of North-South collaboration between teams which are fighting together against both climate change and Ebola crisis.

P-4410-04

Localised Climate Smart Agricultural Practices from the Global Permaculture Movement: Examples from the Semi-Arid Little Karoo in the Western Cape Province of South Africa

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A growing global social movement under the banner of permaculture is aimed directly at responding to the effects of climate change and mitigating human impact on our environment, in particular the consequences of unrestrained resource extraction and consumption and non-sustainable agriculture. Permaculture, a conceptual framework that originated in Australia in the 1970s, and now practiced across the globe, provides guidelines for the design of human living environments and the activities that we carry out in those environments. The underlying aim of permaculture design is to create productive anthropogenic landscapes of benefit to both humans and the environments that we inhabit - living and non-living by reducing the negative impacts of our actions through considered design. In the process, the intention is to also have an actively beneficent impact on those environments.

A principal focus in permaculture is the localisation of resilient food production systems which mimic and integrate with local ecologies and ecosystems, and are designed in anticipation of the climatic extremes expected to occur with climate change as well as reduced access to fossil fuels.

This presentation will introduce central approaches to agriculture and food production in the permaculture framework, and draw upon case studies from anthropological fieldwork conducted at a permaculture project located in the semi-desert Succulent Karoo biome of the Western Cape province in South Africa. In particular, the discussion will consider the design methods and technologies that have been employed to provide water and food in a highly degraded landscape of climatic extremes, and in the process contribute towards improved ecological resilience and biodiversity. Examples here include the use of water harvesting earthworks such as keylines, swales and tree pan systems, as well as employing a diverse range of climate specific and resilient productive species grown together to create micro-climates more amenable to food production and human habitation.

Some points that will be considered in this oral presentation are: What is climate smart agriculture? - Some central concerns around climate change and agriculture. What agricultural practice is not smart? What is permaculture? - Case studies of permaculture food production at a semi-arid permaculture in South Africa. How does permaculture address the concerns raised in climate change debates? What lessons can we learn from the permaculture paradigm of climate smart agriculture?

P-4410-05

The Prevalence of HIV/AIDS amongst the Pastoral Communities over Kenya, Uganda, Tanzania and Ethiopia

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The Human Immune Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS) have been identified as a major threat to pastoral communities over East Africa. The regional governments have given little attention to this problem due to the perception that Pastoralisms is economically inefficient and environmentally destructive. The study was carried over Kenya, Ethiopia, Tanzania and Uganda to assess the current state of HIV/AIDS prevalence amongst the pastoral communities using desktop review and expert judgment opinion. In Kenya, about 8million people of Kenyan population depend on pastoralism. In Tanzania the livestock sector contributes about 6.1% to the national Gross Domestic Products (GDP). In Uganda 17% of GDP is accounted for by the sector and about 9% of the national GDP in Ethiopia.

In the pastoral districts the average prevalence of HIV/AIDS amongst the community is estimated at 5.7% with this figure expected to increase. The infection rates are being accelerated by factors related to human rights and gender, socio-cultural environment and lack of HIV/AIDS awareness and stigmatization. The HIV/AIDS is not recognized at policy level as a major problem facing Pastoralisms yet the statistics show increasing population of HIV/AIDS victims.

The communities refuse to admit the presence and impact of HIV/AIDS within their families with high stigma attached to the affected and infected. The number of livestock has been diminishing through sales to pay the medical expenses when the pastoralists are affected. The study recommends for budgetary support and HIV/AIDS campaign amongst the pastoral districts to reduce the stigma and curb the decreasing number of livestock.

P-4410-06

Now You See It

L. Perrin (1)
(1) Lola Perrin, London, United Kingdom

I have spent the last year sourcing and interviewing campaigners, inventors and innovators at the frontline of climate justice and placing their words within a music composition for piano and recorded spoken words. The project is a device to drive population awareness of the issues. Interviewees range from grassroots mitigation experts in Africa to Costa Rican media agitators to campaigners in the Arctic. Please note that as of today, The Guardian newspaper is currently picking up on my work, being released end March 2015. I propose for you a Q&A, to be discussed, following a performance featuring my work - as a musician/layperson/mother of two boys/deeply concerned about our future. I will be situated at a music keyboard/acoustic piano, performing with my artistic, pre-recorded spoken word presentation created from my interviews with major international voices in the climate justice movement, delivered through PA system.

Here follows my press release. I hope to hear back from you: music is an important social device to communicate between expert witnesses and ordinary people and I would like to collaborate with you to create the perfect performance for your vital intiative. I live in London.

TITLE: 'NOW YOU SEE IT'

FOR PIANO AND AN ORCHESTRA OF WORDS RECORDED FROM ACTIVISTS & INNOVATORS AT THE FRONTLINE OF CLIMATE JUSTICE

2 min PROMO https://www.youtube.com/watch?v=EsHnQJQ1A54

Composer: Lola Perrin

Voices: recorded in interviews conducted by Christian Dymond and Lola Perrin

Voices are Marjaun van Aubel, Ben Ayliffe, Guy Battle, Helen Caldicott, Charlotte Du Cann, Seamus Garvey, Natasha Geiling, Peter Gleick, David Helvarg, Jennifer Kingsley, Andreas Mershin, Katiana Murillo, Meena Nallainathan, Margo Perin, Kate Rawles, Carl Safina, Bert Schouwenburg, Joao Talocchi, Abdel Karim Traore, Will Travers, Greg Valerio

Backgrounds of the voices

Greenpeace, Blue Frontier Campaign, Blue Ocean Institute, Pacific Institute, Board of Oceana, Chasing Ice, Smithsonian, Sustainable Business Consultancy, Born Free, If You Love This Planet, IFEX, GMB, Fairtrade, Canadian broadcasting, Latin America media, mitigation in Africa, inventors at MIT and Nottingham University Faculty of Engineering, Transition Free Press, scientists, renewables designer, outdoor philosopher.

Description

Now You See It for piano and an orchestra of words is a new contemporary classical/minimalism/imaginative piano project with a voicescape made from the specially recorded spoken words of international activists and innovators at the frontline of climate justice. The words are responses to Lola Perrin's questions designed to elicit inner meditations on cruelty, beauty, isolation, loss, overcoming difficulty and personal statement. «Such a brilliant idea» (George Monbiot).

Composer statement

«We must all work for Mother Earth right now, it is obvious.» (Nelly Brooke age 85, December 2014)

«We have to stop pressing buttons and expecting things to happen, it's ridiculous.» (Margaret Chalmers age 82, January 2015)

These comments from two elders, and my precious friends, say it better than I can.

P-4410-07

Fiddling while the roof burns? Tales of coal, justice and grassroots opposition to energy boom in Turkey

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What links a local group of activists, struggling with few resources to save their communities from the ills of coal-fired power plants to broader social movements to save the planet from burning? And what, in turn, connects global processes of climate change to local livelihoods' demands for spatial and environmental justice? Climate justice, as Pellow and Park (2009) observe, begins with an acknowledgement of climate injustice and views this problem not as an unfortunate byproduct of climate disruption but as one of its core elements, and one that must be confronted if climate crisis is to halted and reversed. Even though the notion of climate injustice implicates need, care and community, proposals for the Anthropocene remains limited to property rights and market ideas of justice. However climate justice offers a fresh approach which in practice means energy access for those who do not adequate and sustainable access to the services of energy, workplace justice and occupational health for those who produce energy sources and remediative justice those who are affected by the impacts of hydrocarbon burning. This provides a good entry point to investigate the case of Turkey, which has witnessed exacerbating ecological conflicts since 1990s. Economic growth, rapid urbanization and hydrocarbon-dominated energy policy preferences in the past 2 decades placed immense pressure on the socio-ecological systems in Turkey. These pressures often manifested themselves as ecological conflicts due to land use changes, energy production, mining and associated neoliberal legislative changes. At the peak of these conflicts, Gezi protests of 2013 became the landmark of ecological conflicts in framing climate-energy nexus as a matter of (in)justice for and by the most vulnerable communities. Yet failure of the Turkish government to take a binding emissions reduction target as the OECD country with the highest rate of emissions increase since 1990 and its ambiguous position in the global climate regime makes it a curious case. Hence in an attempt to demystify the "energy-hungry nation" idea, this paper focuses on the cases of three local movements (Aliağa, Karabiga and Yalova) against coal-fired power plants, their changing discourses and the national energy planning under climate change in stitching the gap between developmentalism, energy production and defense of rural-urban commons in Turkey.

4411 - Can the Green Economy save the climate?

ORAL PRESENTATIONS

K-4411-01

Green Economy as a Technocratic Concept: Genealogy and Agenda

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In 1972 in Stockholm, the environment was considered as a set of constraints, imposing various biophysical limitations on economic activity. At Rio in 1992, the advent of sustainable development introduced changes in this representation: economic development or growth was considered as possibly compatible with environmental protection. In 2012 at Rio, the Green Economy was supposed to represent a further step in the environment-market reconciliation, since through this notion, the environment was no longer considered as a reality to be taken into account, and even less as a constraint, but rather as an opportunity. Thus, within 40 years, the discourse has moved from the assertion of a fundamental contradiction and the search for a balance between the environment and the economy, to that of potential synergy.

This presentation aims both at tracing a genealogy of the concept of Green Economy and a precise analysis of the moment of its international agenda setting at Rio +20. Our core hypothesis is that the concept of green economy, while conveying a very liberal and economistic worldview, is primarily a technocratic concept that did not stem from the private sector, but that emerged at the interface between academia and international institutions. We also want to analyze the role of the Rio+20 Summit in agenda setting and testing ground for the concept, as a moment of controversy and violent geopolitical confrontation over its definition and vehement criticism on the scope it should be granted.

K-4411-02

CARBON EMISSIONS AND RESOURCE PRODUCTIVITY: Why reviving growth requires a rapid de-carbonization of the global energy system

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Most governments believe that any attempts to reduce their emissions will require giving up on some future economic growth and this has served as the principal barrier to getting global collective action on reducing

the growing risks associated with climate change. This is true despite the fact that numerous economic studies have shown that the future reductions in growth required to keep global surface temperature increases to less than 2 degrees C will be small relative to the overall increases in growth over time. What no one has questioned is whether it is possible to meet the economic growth requirements of a human population on its way to 9.5 billion people in 2050 by using fossil fuels as the primary basis of delivering both stationary and transport energy.

The global economy requires exponential growth to function properly and this, in turn, requires an exponential improvement in overall resource productivity. Resource productivity refers to the efficiency with which all forms of capital (human intellectual, hard assets, and money), energy and natural resources are deployed. There is a growing gap between the increasing levels of resource efficiency now required and the levels which we have been able to achieve. Locating, recovering, transporting, refining, and combusting fossil fuels requires increasing amounts of capital, energy and natural resources. Not only has the resource productivity of fossil fuels been declining for decades but, as energy touches every segment of the global economy, fossil fuels have had a negative impact on global resource productivity as well.

The OECD estimates that global GDP must increase from approximately US$70 trillion today to US$305 trillion by 2050 in order to meet the growing aspirations of an expanding human population. This is an unprecedented level of growth requiring extraordinary improvements in resource productivity. Many large-scale economic activities in operation today are deploying capital, energy and natural resources at levels of resource productivity that will make it nearly impossible to achieve the higher levels of growth now required. The most compelling evidence of this is the waste produced by these activities as waste is the best indicator of resource inefficiency. At 36 billion metric tonnes of carbon dioxide equivalent and growing, the waste produced through the combustion of fossil fuels is the most robust evidence of the least resource productive activity on the planet.

Getting to US$305 trillion is not possible if we continue to rely on fossil fuels as our primary source of delivering useful energy. Fortunately, there are existing and emerging energy technologies, new business models and new models for producing and distributing energy which are capable of delivering the large improvements in resource productivity now required. Furthermore, the level of capital investment required is no more than the amount that would have been deployed to continue using fossil fuels. The old narrative…

"Reducing carbon emissions requires deciding to be a little bit poorer in the future"

is not only out of date but completely inaccurate. The new narrative is…

"Reducing carbon emissions is the only pathway to restoring growth at scale and on time"

K-4411-03

Green economy and its alternatives

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Global environmental policy is increasingly framed by discourses of 'green economy'. Green economy is meant to foster economic growth while decoupling that growth from environmental decline. Its advocates hope that monetary valuation of environmental assets and deficits, economic rationality, and market mechanisms can mute the most ecologically damaging effects of unfettered, globalized capitalism. Some contend that this approach can surmount the North-South conflicts over climate-change liabilities and obligations that have bedeviled environmental negotiations.

To this end, green economy has been advanced as a successor to sustainable development. Its proponents endorse markets in nature as both a conservation strategy and a means to foster economic development in the context of resource scarcities and shrinking ecological space. In this view, international carbon trading would compensate developing countries for the costs of averting GHG emissions and ensuring conservation, while payments for ecosystem services might ease growing conflicts over land and resource rights. Advocates hope that green economy, informed by scientific expertise, can thus position environmental governance above the political fray.

Nevertheless, international climate negotiations remain highly politicized. Some G77 governments reject green economy as likely to undermine their sovereignty and reinforce longstanding patterns of global inequality. Some denounce carbon markets as 'environmental neocolonialism' yet remain dependent on extractivism and fossil-fuel-based growth. In contrast, emerging critiques 'from below' challenge the foundational assumptions of mainstream green economy, extractivism, and the growth imperative.

New peasant and indigenous social movements and their intellectual allies reject the construction of ecological limits as absolute scarcity, focusing less on the finitude of resources and carbon sinks than on the anti-entropic, life-giving relationship among human labor, water, soil, sun, and the activities of other species. They question the implicit equations of development with growth, well-being with consumption, and conservation with market rationality. Instead of growth they speak of buen vivir, sumak kawsay, lek'il kuxlejal, ubuntu, radical ecological democracy, etc. These concepts connote living well and living cooperatively both socially and ecologically.

These visionaries do not exclude trade, much less the reduction of material deprivation, but they reject narrow productivism that is blind to ecological consequences and distributive outcomes. Instead, they pursue endogenous strategies aimed at reduced dependence on external markets and capital, repeasantization, and equitable urban-rural relationships. In place of standardized scientific categories and universally commensurable values, they are informed by relational ontologies: understandings of human-nature linkages that are diverse, dynamic and specific to particular territories, times, and ecosocial systems.

Can such visions and strategies overcome the apparent conflict between the need for greater material well-being and the impoverishing, diversity-destroying results of globalized growth along current trajectories? Given the scope of the climate-change challenge in an unequal world, counter-hegemonic discourses to green economy under the broad headings of buen vivir, mainly in the global South, and degrowth, mainly in the global North, merit our attention.

O-4411-01

Sustainable energy and development in a dichotomous economy: South Africa

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Currently South Africa is ranked amongst the top 20 emitters in terms of global GHG emissions. Energy consumption, which is heavily coal dependent, is expected to grow significantly in the future as the economy grows, and therefore, unless commitments to decrease GHG emissions are prioritised, GHG emissions will increase dramatically in the medium to long term. Energy modeling in the Long Term Mitigation Scenarios showed, for example, a four fold increase in GHG emissions by 2050 under a scenario of Growth Without Constraints (ERC, 2007).

In terms of Economic development and GDP, SA is considered to be an upper middle income country, with a per capita GNI in purchasing power parity terms of 12240$US (World Bank, 2015). However, society in South Africa remains very unequal. The GINI coefficient is 0.69 (StatsSA 2014) and the MDG poverty line of $1.25 (2005ppp) shows that 7.4 percent of South Africans are currently living in extreme poverty, using a poverty line at $2.5 (2005 ppp) per day, this number increases to 29.2% (StatsSA 2013). Lower income households also experience a large degree of energy poverty, despite the high levels of electrification. For example the Department of Energy found that over a third of South African households are energy poor (DOE 2013). Poverty is largely due to high levels of unemployment in the formal sector and low levels of informal sector activity. Using a broad definition of

unemployment which includes all those currently without work that would like to work, 34.6% of South Africans are currently unemployed (StatsSA 2015).

South Africa is committed to a development path which is both inclusive (reducing inequality, unemployment and poverty), and "green" (reducing greenhouse gas emissions and increasing the sustainability of both the production and consumption of energy). Impacting low carbon development aspirations is the heavy reliance of industry and electricity production on coal. Questions currently being grappled with are: how can we decouple GDP growth and coal use in the economy?, encourage more efficient and equitable use of energy and follow a growth path which promotes job creation in sectors that are less energy intensive, thereby lowering emissions. This needs to be done without negatively impacting aspirations for high GDP growth and increased employment, both of which are economic development priorities which underpin current development policies such as the National Development Plan, and the Growth, Employment and Redistribution Plan.

The question for this paper is therefore: What could a sustainable energy future under a scenario of inclusive growth look like for South Africa?

The paper uses a bottom up energy model of South Africa, SATIM, to explore possible energy pathways and deep decarbonisation, looking specifically at the energy needed for the economy and the likely fuel mix and GHG emissions associated with this until 2050. A CGE model is used to assess how close we are to meeting development objectives, and ultimately whether development and decarbonisation can be complimentary objectives.

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O-4411-02

Can "Green Growth" Guide us into a Sustainable Future?

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Prevailing political economy is failing to maintain environmental, social, political and economic coherence. A deep changeover into a new economy is needed "where the acknowledged priority is to sustain human and natural communities" (GTI, 2011: 1). Therefore, it is widely accepted that the current linear so-called "take-make-dispose" economy is not sustainable and that solutions need to be found in order to decrease both the input of limited resources as well as the output of human waste in any form. This paper examines in how far the ideas of „green growth" are capable to cope with this problem since they promise material welfare while reducing the impacts on the environment. Even though the underlying approaches like a „circular economy", "zero-emissions economy" or „Factor x" seem to be desirable, there is reasonable scepticism in how far advances in resource efficiency can ensure a sustainable future while industrialised societies got used to constantly raising living standards. We show that there is an intrinsic contradiction within the desire for "green growth" guiding the way towards a sustainable future.

O-4411-03

Environmental Justice and Conceptions of the Green Economy

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Abstract: Green economy has become one of the most fashionable terms in globalenvironmental public policy discussions and forums. Despite this popularity, and its beingselected as one of the organizing themes of the United Nations Rio?20 Conference inBrazil, June 2012, its prospects as an effective mobilization tool for global environmentalsustainability scholarship and practice remain unclear. A major reason for this is that muchlike its precursor concepts such as environmental sustainability and sustainable development,green economy is a woolly concept, which lends itself to many interpretations. Hence, rather than resolve long-standing controversies, green economy merely reinvigoratesexisting debates over the visions, actors and policies best suited to secure a moresustainable future for all. In this review article, we aim to fill an important gap in scholarshipby suggesting various ways in which green economy may be organized and synthesizedas a concept, and especially in terms of its relationship with the idea of social andenvironmental justice. Accordingly, we offer a systemization of possible interpretations ofgreen economy mapped onto a synthesis of existing typologies of environmental justice.This classification provides the context for future analysis of which, and how, variousnotions of green economy link with various conceptions of justice.

O-4411-04

Greenovation and Sustainable Manufacturing: A Case Study of the Chemical and Pharmaceutical Industry in Nigeria

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Addressing a paucity of research about industrial adoption of green innovation in Africa and, more generally, in tropical developing countries, we examined the Nigerian chemical and pharmaceutical industry as a case study. Qualitative interviews with one hundred and forty upper echelon executives representing thirty five Nigerian firms challenge conventional expectations that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. Our findings suggest a strong positive relationship between green innovation and financial performance and positive relationship between green innovation and sustainable manufacturing of African firms.

O-4411-05

Impacts of mitigation policies on labor markets and welfare

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The increasing need to reduce GHG emissions gives rise to new environmental regulations and market instruments, which present the potential to transform economies over the next decades. Production and consumption patterns are about to experience major changes as the world's carbon emissions must decrease in order to meet safe carbon concentration levels in the atmosphere.

The transition to a low carbon economy offers many opportunities to create green and decent jobs in developing countries, especially in sectors related to renewable energy, sustainable agriculture, forestry and waste management. Meanwhile, sectors like oil and gas, mining and energy-intensive industry may experience significant losses.

Since sectors differ in labor skill requirements and remuneration levels, shifting to this new profile will have major implications for workers among various sectors. To the extent that this affects workers´ income, changes in inequality and poverty levels are expected. In that sense, seeking a fair transition and the preservation of decent jobs is arguably necessary.

This work uses a hybrid Computable General Equilibrium model (IMACLIM-BR) to assess the impacts of mitigation options in various sectors, ranging from AFOLU to waste management, energy and industry sectors. The model is divided in 6 energy sectors, 7 industrial sectors, apart from the agriculture and livestock, transport and services sectors, and represents the Brazilian economy for a 25-year period, from 2005 to 2030.

The household sector is divided in 3 income classes, according to the their total income measured in base-year minimum wages (2005). Household consumption and income levels were calibrated using the 2003 National Household Budget Survey (POF), undertaken by the Brazilian Institute of Geography and Statistics (IBGE). The first income class represents the 16% poorer households, the second the 60% intermediary ones, and the third class represents the 24% richest households.

The long-term scenarios depicted in the study were built through a participative process that engaged more than 70 stakeholders from different areas, including government, private sector, the scientific community and civil society agents. In order to simulate quite ambitious mitigation scenarios, a set of mitigation options was identified, contemplating possibilities in the AFOLU, industrial, transport, residential and services, energy and waste sectors. The inputs provided by the stakeholders and sectorial experts included different mitigation options, investment requirements, GHG abatement potential and marginal abatement costs, among other aspects.

After defining a set of mitigation options, stakeholders were interested in checking what would be the influence of the implementation policy over macroeconomic and social indicators. To assess those effects, two implementation policies were tested - a normative scenario (command and control) and a normative scenario plus a carbon tax (100 US$/tCO2e).

Since several of those options present low and even negative abatement costs, our results show that their implementation do not jeopardize total output and jobs, even though there are winning and losing sectors. For example, jobs in oil, coal and carbon intensive sectors decrease whilst jobs in the biomass and services sectors increase. The former usually employs high-skilled labor, while workers in the latter are usually less skilled and hence poorer. Therefore, the results indicate a greater evolution in poor workers´ income, relative to high-skilled ones, leading to a better income distribution in the long run.

O-4411-06

Low Carbon Economy versus Ecological Civilisation: Polarization and Consensus of China's environmentalism

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China's Climate Strategy proclaims the ultimate objective to transform its economic model towards "green and low carbon development" (lvse ditan fazhan) (China Climate Strategy 2014-2020). This strategy is often equated with the concept of "green growth", which the Chinese government has supported in the UN, mirroring its success in becoming the world's largest manufacturer of green technologies (REN report 2013) and the world's largest "green market" (IGEA, 2014)[1]. Indeed, both concepts emphasise the bottom line requirement that environmental protection may never mean a "growth ban" and on the contrary can be a motor of economic growth (Pan, J. et al, 2010; Jacobs, M. 2013). However, this economic interpretation of sustainability, and the marketization policies it entails, have been challenged, not only internationally, but also within China. In my paper, I brings evidence of this domestic debate and assess the relative importance, within it, of "green growth" as enabler and inhibiter of actions against climate change. Based on an extensive review of Chinese media, NGOs and academic publications, as well as policy documents, I discuss how issues of principle have informed two "low carbon policies": the introduction of carbon markets and the promotion of "low carbon cities" in the 12th Five-Year-Plan (2011-2016). I argue that the rhetoric of "low carbon development" has served mainly to cut through a polarized debate regarding the responsibility for the provision environmental public goods in China. Amongst them, nationalists still view "Low Carbon" as a western plot to contain China's rise (Gou, 2010)[2] and blame foreign capitalists for destroying China's resources and public health for the benefit of western consumers (Wen, Dale, 2015). On the contrary, socialist interpretations of the concept of "ecological civilization" (Shengtai wenming), which was included in the Constitution of the Communist Party in November 2012, target the government as principal agent of change, and reject the focus on economic growth as corrupted and "western" (Yu, Keping, 2003; Pan, Yue, 2007,)[4]. But as implementing successful climate actions in China remains contingent on strong government support, success relies on creative accommodation of the official rhetoric of balancing economic and environmental priorities.

[1] International Green Economy Association guoji lvse jingji xiehui, in their invitation to the first Global Green Technology Conference - China in Beijing on 29-30 January 2015. See http://www.igea-un.org/news/bencandy.php?fid=213&id=3899

[2] Gou's book Low Carbon Plot - China's vital war with the UE and Europe, published in 2010, had a frank success in China and was glossed upon for months on Chinese social media. Gou, Hongyang, (2010), Ditan yinmou; zhongguo yu oumei de shengsi zhilu, Low Carbon Plot - China's vital war with the UE and Europe, Shanxi Edition Publishing (In Chinese)

[3] «The Party must promote all-around economic, political, cultural, social, and ecological progress in accordance with the overall plan for the cause of socialism with Chinese characteristics.»

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O-4411-07

Co-performance: the making of ecological modernization theory and EU climate politics

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Scholars in comparative political science generally acknowledge that the European Union took the lead in issues of environmental protection and in global climate politics in the late 1990s. They attribute the legislative and diplomatic activism of the European Union in environmental issues to the prevalence of ecological modernization beliefs within the European Commission and some Member States heralded as leaders in this domain (Weale 1992; Pridham and Cini 1994; Cini 1995; Hajer 1995; Weale, Pridham et al. 2000). Taking the EU as an example, this contribution aims at questioning the role of norms and beliefs in the development of ambitious climate policy by (supra-)state actors.

We argue that ecological modernization discourse and EU environmental politics co-evolved and co-produced a narrative of environmental performance. This occured through a twofold process: (1) ecological modernization is not only a discourse but a narrative with performative consequences; (2) the evolution of EU climate policy shaped the development of ecological modernization theory. We first explore the intellectual and political context within which the discourse on ecological modernization became an influential narrative in the EU environmental politics. We situate this context in the post-cold war history of transatlantic relations. We then relate discursive affinities between narrative and contingent features in the EU environmental politics. This enables us to disclose how EU environmental politics and the narrative on ecological modernization reinforced and shaped each other. Finally, we explore recent developments in both EU climate policy and ecological modernization theory and ask how they relate to the emergence of the concept of «Green Economy».

4412 - Inequalities, responsibilities and equity in global climate policy

ORAL PRESENTATIONS

K-4412-01

Why We Should Make RICE NICE: The Importance of Intragenerational Inequalities for the Economics of Climate Change

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RICE and leading IAMs focus on aggregate economic growth, which has the effect of downplaying important detrimental effects of climate change on the poorest populations. In this paper we introduce a variant of the RICE model in which income distributions at a sub-regional level are modeled. We call the new model NICE, for Nesting Inequalities, Climate and Economy. By reframing the model with the above income disaggregation (in our case into income quintiles), we strive to address these issues of temporal urgency and intraregional equity more thoroughly.

When the degree of inequality aversion (embodied in the elasticity of marginal utility) is increased in RICE, the prescribed mitigation effort is reduced quite significantly. The underlying reason is the Ramsey equation:

discount rate = pure time preference + inequality aversion x growth rate.

With the positive (and often significant) growth rates of such models, an increase in the elasticity simply leads to more discounting.

However, if inequality aversion is a good reason to discount future damages to wealthier individuals relative to equivalent mitigation costs to the less affluent present, it should also be a good reason to be more concerned about damages (and costs) to poorer individuals than richer individuals, regardless of the time in which they take place.

In NICE sub-regional income distributions are explicitly modeled. We combine these with several point estimates from the literature on the distribution of climate damages across income groups. Once these are incorporated, the picture of the richer future benefiting from the effort of the relatively poor present disappears. We find that for some reasonable damage distributions the poorest income groups in some regions could be worse off than their predecessors even under the low damage estimates from the IAM literature. The effect on the policy prescription is that much more aggressive mitigation is warranted to avoid damaging those vulnerable groups. Furthermore, the effort is increasing in the degree of inequality aversion in the social objective for some damage assumptions.

Explicit incorporation of distributional concerns in the evaluation of a public good such as climate change mitigation can be criticized for making an inefficient use of policy instruments. Ideally, the public good should be provided considering aggregates, and distributional concerns dealt with by more efficient redistributive policies. We consider such a possibility in NICE, and find that the redistributive policies required to substitute for the strong mitigation policy are well beyond what can be considered politically feasible. If income redistribution from rich to poor is performed within regions (with no transfers across regions), an additional 65% marginal tax rate would have to be levied and redistributed in order to alleviate the same (modeled) economic damages to the poor as might be alleviated by the welfare optimal mitigation rate. We also examine transfers between regions. "Overseas" aid from other regions would have to be particularly efficient at targeting only the poor to be an adequate substitute at all, and even so, it would have to be significantly greater than currently accepted levels.

K-4412-02

The climate responsibilities of industrial carbon producers

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Responsibility for climate change lies at the heart of societal debate over actions to address it. The United Nations Framework Convention on Climate Change (UNFCCC) established the principle of «common but differentiated responsibilities» among nations, suggesting that industrialized nations that had produced the greatest share of historic emissions bore particular responsibility for preventing dangerous interference with the climate system.

But climate responsibilities can be distributed in other ways as well. Here, we consider the distinctive responsibilities of the major investor-owned producers of fossil fuels, assessing the actions these companies took and could have taken to act upon the scientific evidence of climate change.

Recently published data show that just 90 entities have produced the fossil energy responsible for 63 percent of the world's industrial emissions of CO2 and methane; of these, 50 are investor-owned companies. As the scientific evidence became clear, many of these companies sought sow doubt about the science linking their products to global warming, and today are seeking new and increasingly carbon-polluting sources of fossil fuels

We conclude that major investor-owned fossil energy companies carry significant responsibility for climate change. It is still possible for these companies to effectively contribute to a solution. Significant progress in reducing emissions and limiting climate change could be achieved if companies 1) unequivocally communicate to the public, shareholders, and policymakers of the climate risks resulting from continued use of their products, and therefore the need for restrictions on greenhouse gas emissions consistent with the 2 °C global temperature target; 2) firmly reject contrary claims by industry trade associations and lobbying groups; and, 3) accelerate their transition to the production of low-carbon energy. Evidence from history strongly suggests that a heightened societal focus on their climate responsibilities may hasten such a transition.

K-4412-03

Equity, Justice, and Security in Global Climate Governance

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Global climate change presents the international community with a seemingly intractable collective action problem. Growing greenhouse gas emissions are projected to raise global temperatures, shift precipitation patterns, and increase extreme weather events. The emerging repercussions of climate changes already underway threaten the livelihoods and security of countries and communities everywhere. Both the drivers and the impacts of transcend traditional state boundaries and governance structures. No single state can counter or avert the impacts of climate change on its own. But any country that moves to reduce its emissions shares the climate benefits with every other nation while bearing the cost of taking action alone. Those states which do nothing to combat climate change can "free ride" on the efforts of those that do. The

UNFCCC has become the global platform for international negotiations to agree and coordinate climate policies among nearly 200 sovereign states. But ongoing debates over the effectiveness and equity of mitigation measures, adaptation, technologies and funding suggest the need for re-evaluation. The future of greenhouse governance depends on innovation towards new type(s) of climate regime. Does the architecture of universal agreement constitute the way forward, or are other channels more suited for climate action? Could the emerging landscape of regional, multi-sectoral, and non-state institutional structures open fruitful potential options and practices for advancing more effective climate governance? Can new governance mechanisms simultaneously ensure climate security and justice, efficiency and accountability, technology innovation and dissemination, or must decision makers and stakeholders inevitably navigate trade-offs between these goals?

In preparation for the 70th anniversary of the United Nations in 2015, The Hague Institute for Global Justice and The Stimson Center have convened a high-level Commission on Global Security, Justice & Governance, to enhance global understanding and capacity and to advance practical recommendations for innovative collaborative action to address critical global challenges such as climate change. Co-chaired by former US Secretary of State Madeleine Albright and former Foreign Minister Ibrahim Gambari of Nigeria, commission members include Yoriko Kawaguchi, former Minister of Foreign Affairs and Minister of the Environment of Japan; Shyam Saran, former Foreign Secretary and chief climate negotiator of India; and Erna Witoelar, Founder of the Indonesian Environmental Forum. The Commission will conclude its report in June 2015. This contribution will provide the opportunity to present and discuss the Commission's analysis and recommendations.

O-4412-01

A novel approach for analysing how equitable and ambitious countries' national policy actions and targets are in the light of the forthcoming Intended National Determined Contributions (INDCs)

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Countries are currently working on preparing measures to conquer climate change at many frontiers. They are developing policies that will lead to emission reductions in the short and medium term, they are considering aspirational long-term targets that provide guidance to policy-makers and stakeholders, and they are preparing submissions to the UNFCCC, in the form of Intended Nationally Determined Contributions (INDCs), committing to legally-binding targets (e.g. emissions reductions below base year) for the post-2020 period. The sum of the initially proposed national actions at a global level so far falls short of what is required to keep global warming below 2 degree above pre-industrial level. More action will be needed and major questions remaining include; which countries are doing their fair share?, which ones are not?, and by how much does each country need to increase their effort?

To answer these questions, global 2 degree-compatible emission pathways have to be broken down to country-level, fair emissions allowances. This can be achieved using effort-sharing methodologies. A wide variety of such approaches exist and their different underlying criteria and assumptions can lead to very different outcomes and a large range of emissions allowances for different countries. Here, we propose a methodology that allows the comprehensive assessment of countries' fair level of effort in a 2-degree world, which integrates the many views put forward by countries and the scientific community, without bias towards specific methodologies.

This methodology builds on previous work for the IPCC Fifth report that gathered and categorized existing effort sharing studies. The categories provided there serve as the basis for our analysis framework as they represent the broad range of possible 'principles' that could be applied to effort sharing. With the goal of extracting a unified benchmark system from the various approaches and categories for countries, we used these 'principles' to develop a framework that enables the rating of countries current level of effort against their fair level of effort. In addition the framework takes account of countries' mitigation potentials and aspects such as finance provided and the conditionality of targets on external parameters. Four categories are introduced that describe the countries' overall effort level: inadequate, medium, sufficient and role model.

Under this proposed framework, the ambition of a large number of countries that have put forward targets so far are rated as inadequate or medium according to the scale developed here. One of the major emitters, China, has pledged to peak emissions no later than 2030. The Climate Action Tracker quantifies resulting emissions of up to 15Gt in 2030, and rates this as inadequate, as only the least stringent effort sharing category is achieved at this level. The currently announced target of the USA of 26 - 28% below 2005 in 2025 results in a rating of medium, meaning that this target is within the range of a number of effort-sharing categories, but the level of ambition would only be sufficient at the global level, if other countries moved into the more ambitious end of their effort sharing ranges. The submitted INDC of the EU of reducing emissions by 40% below 1990 also receives the rating inadequate. Effort sharing approaches demand a stronger change in trends of the EU, in order for it to contribute in a fair manner to the global target.

O-4412-02

Quantifying Development Needs: An energy centered approach to climate justice

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Despite the vast literature on global climate justice, there is a surprising lack of studies that attempt to quantify the emissions impact of basic human development, even though many of these frameworks aim, either implicitly or explicitly, to shield basic human development from the costs of mitigation.[1] Broadly, the literature that frames distributive justice in terms of emissions rights neglects to relate these rights to development needs, making them susceptible as claims of 'hot air'. Proposals that aim to differentiate nations' capacity to mitigate define relatively arbitrary, universal thresholds of exemption,[2] typically in terms of income[3] or emissions, which ignore the heterogeneity in countries' energy sectors, and consequently their mitigation costs.[4] Yet, achieving climate stabilization at 450 ppm or less would significantly restrict global growth in energy, whose sufficiency for even basic development is not known.[5]

This paper presents a new basis for differentiating countries' mitigation responsibilities based neither on emissions rights nor income differences, but directly linking human development needs to greenhouse gas emissions through energy. Drawing on the well-known linkages between energy and human development, this paper presents theoretically and empirically grounded quantification of countries' energy needs for achieving basic human development. Using different indicators of human development (HD), including life expectancy and a composite (new) basic needs indicator, the historical relationship between countries' energy consumption and HD are estimated, and then projected into the future. The methodology also estimates historical decoupling between HD and energy use, so as to account for technological progress. Carbon intensities of energy are then separately projected based on different scenarios of the future, incorporating co-benefits and other future incentives for low-carbon development.

The cumulative emissions budgets for countries, so calculated, provide country-specific estimates of development needs for a universal set of HD standards, which can serve as a basis for deriving countries' mitigation responsibility. The paper discusses how the underlying analysis enables claims of basic development to be incorporated into both country-specific aggregate emissions targets, as well as into sector-specific cross-country mitigation regimes.

This work buildings on a forthcoming publication in Global Environmental Change [6] and presents preliminary ideas from research commencing shortly as part of a European Research Council (ERC) Starting Grant entitled 'Decent Living Energy: energy and emissions thresholds for providing decent living standards to all'.

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O-4412-03

Legal Strategies to Accelerate Climate Action

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Climate change is occurring at a faster pace than the international negotiations to address the problem. In the absence of meaningful progress to reach an ambitious and binding global agreement on climate change, we need new strategies to accelerate climate action. Strategic legal challenges are a powerful tool in effecting transformative change, a tool that groups around the world are already starting to explore.

There are a variety of legal challenges that could be used to hold culpable actors responsible for causing climate-related harms. While the types of legal claims and corresponding evidentiary burdens will vary across jurisdictions, they typically involve a plaintiff with a particularized harm, and a defendant who is responsible and potentially liable for causing that harm. Thus, two primary hurdles in bringing these kinds of claims are identifying those responsible for climate change and connecting their actions to the harms suffered by climate-affected individuals and communities.

Scientific evidence plays a critical role in addressing these hurdles by providing the information needed to identify potential defendants and to link actions to harms (i.e. demonstrating causation). For example, in 2014, the scientific journal Climatic Change published new research that traces nearly two-thirds of all industrial emissions of greenhouse gases to only 90 carbon producing entities (including 50 investor-owned entities). This groundbreaking research provides an identifiable set of defendants whose impact can be quantified at the global level. Coupled with ongoing research to connect specific extreme weather events to the human contribution to greenhouse gas concentrations, the research adds a vital link in the causal chain essential to all successful litigation: connecting the actions of identifiable defendants to the harms suffered by identifiable plaintiffs. Scientific research can also show if climate harms can be redressed and quantify the remedy if the harms cannot be redressed.

This presentation will explore potential legal theories to hold culpable actors, particularly the major carbon producers, responsible for their contributions to climate change and its resulting harms. It will also discuss the importance of integrating scientific research into emerging legal strategies and, conversely, how legal strategies can inform and shape litigation-relevant science.

O-4412-04

Beyond Burden-Sharing: The Potential for Peace and Reconciliation Processes in Climate Equity Debates

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Geopolitical changes combined with the increasing urgency of ambitious climate action have re-opened long-standing debates about equity in the international climate arena. Tensions about historical responsibility have been particularly difficult and have the potential to intensify as climate impacts and losses become more severe, and as developing countries face mounting pressure to take mitigation action. Resolving conflicts about the role of historical responsibility may be necessary to enable a global transition to a regime capable of facilitating the depth of collective action required. This paper presents an alterative to burden-sharing and suggests that a peace and reconciliation approach - in which the focus is on balancing efforts to address historically rooted injustices with a future-oriented collective direction and narrative - may have utility in the climate context.

Although substantial policy experience has been gained through efforts to address other complex conflicts at the interface of historical responsibility and imperatives for new collective futures - such as the transition from apartheid in South Africa - lessons from these processes have not been examined in the climate context. The contexts are profoundly different but international climate policy debates share three key similarities with conflicts in which peace and reconciliation processes have been pursued: a) unavoidable interdependence and mutually harmful consequences of not finding an agreement; b) limited ability to address justice concerns through existing judiciary processes; and c) profound disagreements about how the past and future should relate in a period of transition.

This paper provides an overview of insights from existing peace and reconciliation processes and focuses on the importance of negotiating a balance between addressing historical injustices and moving into a new, collective future. It then illustrates how approaching climate equity from this angle could productively refocus the discussion in particularly important areas for international negotiations, including loss and damage, financial support and capacity building.

4412 - POSTER PRESENTATIONS

P-4412-01

Atmospheric CO2 increase from 1990 to 2010 from emissions traced to major industrial carbon producers

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Financial regulators and shareholders from communities around the world are calling for increased reporting of direct greenhouse gas emissions during production and manufacture by major industrial carbon producers. Requests are also growing for increased disclosure of risks to the infrastructure owned by these entities from climate change consequences. Another approach that has emerged is to account for the emissions traced to 90 major industrial carbon producers (Marland et al., 2011, Heede, 2014). Emissions traced to these producers over the period from 1854 to 2010 were incorporated into an energy-balance, carbon-cycle climate model to assess their relative contribution to atmospheric carbon dioxide and the global mean surface temperature. The UNFCCC was formed in 1988 and 1990 became the reference year for comprehensive reporting by nations for greenhouse gas inventories of emissions. Emissions traced to the 90

major carbon producers account for more than half of the atmospheric CO2 increase in 2010 relative to 1990. The emissions traced to the top major carbon producers will be discussed in terms of the consequences in atmospheric CO2 and global mean surface temperature increase. Such calculations are one factor among many other factors that can inform public discussions as to who may be held accountable to contribute to climate mitigation, adaptation, and compensation for damages.

P-4412-02

The climate-pension deal

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'Reducing carbon emissions is costly for current generations, and only benefits people living in the far future.' Claims like this are common in the popular discourse on climate policy. However, they are mistaken: it is well known that, with overlapping generations, the beneficiaries of climate policies (future generations) can compensate those undertaking the effort (current generations). In other words, there exist climate policies which tackle the externality and leave everybody better off.

What is required for this is a 'climate-pension deal'. Such a deal involves current generations reducing emissions, while pension adjustments shift the benefits of abatement from future generations to the present, as compensation for the abatement costs. This compensation ensures that consumption of the current generations does not fall, and may even increase. In this way current generations are not made worse off, even if they don't live long enough to experience the climate benefits. The counterpart of the pension transfers is lower investment in physical capital: in effect, the portfolio of saving is allocated from (private) physical capital to (public) natural capital.

We characterise the required 'climate-debt deal' which moves society to some Pareto-efficient point. Using an overlapping-generations model, augmented with a climate externality, we assess the intergenerational distributional consequences of Pareto-improving climate policies and compare the fiscal burden due to the required transfers to existing debt and pension burdens. In this way, we assess whether intergenerational compensation is a 'big deal' or not.

We also propose a new framework to assess the distributional consequences of climate policies. Typically, Pareto-efficient points are obtained using a social welfare function. A common choice is the weighted utilitarian sum, often with discount factors as weights. These weights are an opaque device, difficult to relate to the distributional consequences.

We propose an alternative which focuses on the distributional consequences. Efficient climate policy generates a surplus: we employ the idea of intergenerational bargaining over how this surplus is divided between various generations. For example, one Nash bargain would involve the generations splitting the surplus over the business-as-usual outcome evenly amongst themselves. Alternative bargaining outcomes incorporate the effect of sunk investments and split the surplus in favour of future generations, recognizing that full compensation for past investments may not be politically achievable. We present and compare several alternative bargaining notions, all of which share the feature that all generations must benefit from the bargain. We also consider an overlapping generations economy equivalent to the standard infinitely-lived agent economy and compare the results of our intergenerational bargains with those resulting from typical assumptions in the integrated assessment literature.[1]

In addition to assessing the magnitude of the flow of intergenerational compensation involved in Pareto-efficient climate policies, our results imply that the intergenerational distributional effects of climate policy can be corrected for, and are thus a secondary issue compared to questions about the international burden-sharing.

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P-4412-03

Quantification of Effort-Sharing Principles: Policy Choices and Data Uncertainty

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A fundamental principle of the UNFCCC negotiations is that of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC). Operationalizing this principle remains a core challenge in the development of a new international agreement, in part due to the nuances of national circumstances, which cannot be readily resolved without negotiation. However, the scientific and non-governmental community can contribute by providing quantitative interpretations of effort-sharing proposals in terms of emission mitigation targets and financial contributions.

Previous quantifications of burden-sharing proposals differ significantly, and a collation of existing studies identified a wide-range of targets for any individual Party or region (Höhne et al., 2014; IPCC WGIII, 2014). The ranges in reduction targets are partly due to differences in the fundamental underlying principle used to determine the fair-share distribution of emissions. For example, equal cumulative per capita emissions or a convergence toward equal per capita emissions. However, the ranges also result from different choices made in the method of quantification, global target emissions pathway, underlying data, and assumptions regarding future emissions growth and socioeconomic development. These differences in data and key assumptions complicate any comparison of results or understanding of the key factors determining fair-share allowances.

Using the PRIMAP (Potsdam Real-time Integrated Model for probabilistic Assessment of emissions Paths) Emissions Module we generate and assess a suite of effort-sharing scenarios resulting from multiple policy and data options within the Greenhouse Development Rights effort-sharing regime (Baer et al., 2008). The Greenhouse Development Rights regime requires emissions, GDP, and population data projections, and incorporates multiple policy options, thereby providing a consistent framework for comparing these factors. We generate the effort-sharing scenarios using emissions projections from the IPCC AR5 and LIMITS databases, and socioeconomic data from the Shared Socioeconomic Pathways (SSPs) developed for the IPCC 5th Assessment, all downscaled to the national level.

The generated scenarios are assessed in terms of the resulting 2025 and 2030 mitigation targets for individual countries and regions. We identify the key factors that make a quantitative difference in a countries' fair-share mitigation target. Analysis of these factors allows the identification of areas of convergence and divergence from the perspective of different policy options, and the underlying effort-sharing principles.

Using the suite of effort-sharing scenarios, we explore several key policy questions. Including: What is the difference in ambition required for a 1.5°C or 2°C limit in global temperature change? For a given country, does the start year of historical accounting, or the balance of capability and responsibility have a greater impact on the fair-share allocation? What does it mean for 2030 mitigation targets if pre-2020 ambition is not increased? From a quantitative perspective, which of these issues is the most important?

Finally, we highlight how quantification methods can be improved to minimize the impact of data and scenario projection uncertainty on the evaluation of fairly distributed emissions targets.

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P-4412-04

Global Climate Ethics: A View Based on Chinese Philosophy

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The Ethical Factors have been recognized now in the scientific researches on the Climate Change. These researches can be more efficient and effective when studies on economic realities and ethic contexts are involved. Referring the Chinese traditional ethic values, this essay introduces a new Climate Ethic System applicable to inter-nation discussions, with pursuit of "harmony" and the practice of "operation on ranking and grouping". It probes into the assessment principles of Climate Ethics--Equity, Justice and wellbeing based on the explication of the ethic connotations of Equity and Justice in the Climate Protection, and further into the Justice in climate negotiations. As an ethic principle for the international climate negotiations, this essay suggests: all the measures against the Climate Change should keep in line with the social and economic development of all the participating countries, paving the way for the Pareto improvements in each participant while reducing the gaps among them, without depressing the social individuals, which are being poor, deeper into poverty.

P-4412-05

Intergenerational equity under catastrophic climate change

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Climate change raises the issue of intergenerational equity, as catastrophes may unfairly affect some generations. As climate change threatens irreversible and dangerous impacts (IPCC, 2014), possibly leading to economic collapse, the tradeoff is no longer between present and future consumption, but between present consumption and the possible future extinction of civilization (Weitzman, 2009). This paper aims at identifying public policies that can reduce unfairness and strike a compromise between present and future generations when the potential impact of catastrophic climate change on the economy is accounted for. It explores the impact of inequality aversion and the impact of the attitudes towards population size on optimal climate policy when that catastrophic risk is accounted for.

We use an integrated assessment model which simulates the future joint evolution of the economy and the climate. The Response model is a dynamic optimization model (Pottier et al., 2015), which belongs to the tradition of compact integrated assessment models such as DICE. It combines a Ramsey-like macroeconomic module and a climate module, and can be used to determine the optimal climate objective by comparing mitigation costs and avoided climate damages. We account for the risk of extinction due to climate change, first by assuming an exogenous probability of extinction, then by assuming a probability of extinction that depends on the temperature and on the level of economic output. We assume that the states of the world where people are wealthy will show enhanced resilience to climate damages, and will therefore face a lower probability of extinction under a given level of climate damages.

Integrated assessment models can reveal the policy implications of various normative choices through the use of social welfare functions. Ideally, social welfare criteria should (i) account for inequality aversion (it should thus differ from the utilitarian criterion, which does not account for the distribution of utilities), (ii) satisfy the Pareto principle (i.e. it should account for the preferences of individuals) and (iii) be separable (i.e. the situation of past generations should not impact the evaluation). The 'Expected Prioritarian Equally Distributed Equivalent' (Fleurbaey and Zuber, 2014) accounts for the inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

In order to reveal the impact of inequality aversion on optimal climate policy, we consider various isoelastic functions ϕ, which translate the inequality aversion of the social planner, and various isoelastic functions u, which translate the risk aversion of the social planner. Inequality aversion here relates to the average consumption by individual at time t. Preliminary results using Response in the certain case (with no risk of extinction), and using the standard discounted utilitarian criterion, show that the optimal policy (i.e. the timing of optimal abatement) is identical for equal discount rates $r = \rho + \eta g$, whatever the values of the pure time preference rate ρ and the degree of inequality aversion η. In the risky case, the degree of inequality aversion has a significant impact on the optimal climate policy. In order to reveal the impact of the attitudes towards population size N (which refers to the total number of individuals in all generations), welfare is weighted by the population size through αN, which is a bounded increasing sequence of N. In this case, the criterion gives priority to large populations.

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P-4412-06

Attribution of extreme heat events in the western US to emissions sourced from major industrial carbon producers

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There exist highly-vulnerable populations facing detrimental climate impacts within a developed nation like the United States. There is a growing need for accountability for the damages incurred as well as funding for mitigation infrastructure. The concept of responsibility for climate change impacts is central to the United Nations Framework Convention on Climate Change (UNFCCC), and calls for acknowledgement by industrialized nations for their greater share of emissions. However, it has been argued that major industrial carbon producers should recognize the impact of their activities (Heede 2014). Nearly two-thirds of carbon pollution released into the atmosphere can be traced to carbon extracted from the earth by 90 major industrial carbon producers. Recent advances in climate attribution have allowed scientists to link extreme weather events to rising levels of greenhouse gases due to human emissions. Our research uses very large ensembles of regional model simulations to explore the fractional attribution of extreme heat events in the western US to emissions traceable to 90 major industrial carbon producers. The results show that record-setting high temperatures during July in the Central Valley of California were 3 times as likely to occur in the decade of the 2000s compared to a simulated world without industrial anthropogenic greenhouse emissions. The next

phase of the project is to explore the increased risk of heat extremes attributable to major carbon producers.

P-4412-07

The contribution of emissions traced to major carbon producers to changes in meteorological and health risks during extreme events

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Recent studies have shown that ~63% of cumulative, world wide emissions of CO2 have come from only 90 major carbon producers (hereafter, "carbon majors"). Here, we use this result to model a hypothetical climate where the carbon majors never existed.

Specifically, we use a unique modelling capability to perform massive ensembles of climate model simulations ("climateprediction-dot-net: CPDN"), which enables assessment of any changing probabilities of particular meteorological extremes of interest. We use results from a sister study which compares scenarios representing the year 2003 (i) as it actually was (i.e. where both natural and anthropogenic conditions are used to drive the climate model; "scenario 1"), and (ii) as it could have been, if humans had not altered atmospheric gas composition (i.e. with only natural conditions; "scenario 2"). This type of scenario comparison is commonplace in probabilistic event attribution analyses. However, here, we go one step further by considering an intermediate third scenario to address the question: 'how would the frequency of a 2003-like heat wave change if the carbon majors never existed in 2003?' ("scenario 3").

A feature of CPDN is that each global simulation contains a high-resolution "nested" regional climate model centred on Europe. This high-resolution modelling capability allows us to perform much of the analysis at the city level. In our sister study we use Scenario's 1 and 2, and show how heat-related mortality changed over Paris during 2003. In this study, we then discuss the implications for such a change given our Scenario 3, which involves only the 90 carbon majors.

P-4412-08

Distributing the global RCP2.6 emissions: five versions of 'fair' country level allocations

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Current climate negotiations under the United Nations Framework on Climate Change Convention (UNFCCC) aim to limit global warming to 2°C. The distribution of the corresponding greenhouse gas (GHG) mitigation burden amongst countries is a major block in progress toward an international agreement on binding commitments. Scientists and national experts have proposed and quantified several equity principles to distribute the international mitigation burden (Baer, Fieldman, Athanasiou, & Kartha, 2008; BASIC experts, 2011; Jacoby, Babiker, Paltsev, & Reilly, 2008; Nabel et al., 2011). Studies modelling these principles distribute different GHG emissions of diverse global emissions pathways. However, these global emissions pathways may not achieve GHG mitigation at optimal cost and result in different temperature responses making cross-studies comparisons difficult.

The distribution of the annual GHG emissions of a global cost optimal scenario has not yet been compared across a set of approaches representative of the international equity debate. The Fifth Assessment Report of the International Panel on Climate Change (IPCC AR5) introduced the Representative Concentration Pathway 2.6 (RCP2.6), a cost optimal pathway that has a likely (greater than 66%) chance of limiting global warming to 2°C (IPCC, 2013; Meinshausen et al., 2011). The international distributions of the emissions associated with RCP2.6 following different equity principles would provide decision makers with a consistent comparison. What sets of national GHG emission pathways would reflect the proposed equity principles while matching the physical emissions of RCP2.6 at each time step? What would then be the regional and national GHG mitigation targets for 2025 and 2030 according to each effort sharing approach?

The IPCC AR5 presented regional 2030 mitigation targets collated from over forty studies and grouped into five categories according to the distributive justice concepts applied: 'equality', 'equal cumulative per capita', 'responsibility-capability-need', 'capability', and 'staged approaches' (IPCC WGIII, 2014). We model five approaches representative of these five categories using the PRIMAP (Potsdam Real-time Integrated Model for probabilistic Assessment of emissions Paths) Emissions Module (Nabel et al., 2011). Each of these approaches distributes the emissions of RCP2.6 amongst all UNFCCC parties. Consequently, the aggregation of the national emission pathways of each approach matches the emissions of RCP2.6 at each time step. For each approach, pathways are calculated for a range of parameters that account for transition period to the allocation start, historical emissions, historical and projected population data, and GDP projections.

At the next Conference of the Parties (CoP) in December 2015, the international community aims to establish a binding agreement to limit climate warming. Parties to the UNFCCC should announce their Intended Nationally Determined Contributions (INDCs) ideally by March 2015. Our analysis informs the debate on equitable mitigation burden sharing amongst the international community. In particular, it should help decision makers and the public to appreciate the consistency between INDCs and the global goal of limiting warming to 2°C according to the various concepts of equity.

P-4412-09

A Dynamic Intepretation of the Principle of Equity in the Next Climate Change Regime-Equity as a force of gravity

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Equity will play a crucial role in designing the post-2020 climate change policy. The principle of equity is intrinsically tied to sustainable development as an expression of inter and intra generations equity. The next climate agreement has to be felt as equitable in order to be signed by a majority of country states. So far Climate Equity has been interpreted through the principle of Common but Differentiated Responsibilities and Respective Capabilities as encompassed in Art.3 UNFCCC. The current interpretation has brought the so- called firewall between developed and developing countries, where the first are bound to all the emission cuts. In the latest years some developing countries have become major emitters. The current division of mitigation efforts can therefore not be regarded as equitable and should be changed.A dynamic treaty interpretation of the principle of equity could be one way to overcome this division.

This research demonstrates that the concept of equity should be interpreted dynamically because of its own intrinsic dynamism.

Since its early formulation in Art 38 of the ICJ's Statute, equity principle has played a creative role in the public international law. Indeed core international law principles like pacta sunt servanda and unjust enrichment have arisen from equity considerations. In this manner equity acts as a force of gravity, dragging new contents into a treaty. In Climate discourse a dynamic approach to equity would highlight national circumstances rather than responsibility for global warming as a criteria for designing commitments. Equity dynamism calls also for flexibility and variety. The next Climate Agreement should be shaped as a flexible agreement in its contents, settings and outcomes. Mitigation commitments should be tailored to what a country is willing and able to afford. This would bring different commitments to different countries.

This presentation will examine the main emission-reduction schemes proposed, aimed at implementing a dynamic interpretation of the equity principle. It will then analyze which of the features within the proposals the next Climate Change Agreement should include in order to be equitable. To date three approaches- the Global Carbon Budget Approach, the GDRs Framework and the Mutual Recognition Approach- have gathered momentum. Every approach has strengths and weakness from an equity perspective.

P-4412-10

Research on Global Carbon Emission Quotas Allocation in post-Kyoto Era

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Abstract By using the bottom-up and top-down modeling methods, this paper build a global model on quotas allocation. Through simulation, we draw the following four conclusions: (1)due to the difficulties of determining abatement way, benchmark year and proportion of reduction, current global carbon reduction programs exist uncertainty. (2) single principle of quota allocation can not satisfy preferences of all regions, and may even lead to extreme result of quotas allocation. (3) the weighted principle of quota allocation based on controlling the total emissions can be adopted in the future. (4) the weighted principle of quota allocation should cover as many principles of quotas allocation as possible; meanwhile the target of emissions reduction determined by climate negotiations should be replaced by the weight of principles from voting.

4413a - Technology, transformations and capabilities in developing countries

ORAL PRESENTATIONS

K-4413a-01

Building pro-poor, low carbon innovation systems through international and indigenous efforts

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Local innovation capabilities have long been recognised as a key requirement in forging new innovation trajectories and low carbon development pathways. Building on the foundational literature from innovation studies, a swathe of recent research has highlighted the processes through which these have emerged at national levels, in particular in emerging technological nations such as China and India. In most of these cases, indigenous learning processes have led to the build-up of knowledge and capabilities within a usually small subset of elite firms.

At national levels (e.g. in the Chinese and Brazilian cases) the role of central policies and investment from strong development banks has combined with more local efforts to build innovation systems in poorer regions. Relatively few scholars have investigated the governance challenges associated with centralised policies and the sometimes divergent interests of provincial/ regional actors. At international levels, scholars have investigated the potential for collaborative research and development activities as a way of facilitating technology transfer and low carbon innovation.

Informed by some of these insights, international efforts are underway through the UNFCCC to try to provide external support for low carbon innovation of a transformative nature. In particular, the Climate Technology Centre and Network, as well as the Green Climate Fund, which claims transformative ambitions, promise to enhance developing countries' low carbon innovation activities. 'New donor nations' may also play an important role (for example the BRICS bank). These efforts raise a fundamental question, echoing earlier innovation studies work that has pointed to the difficulties of purposive creation of innovation systems that have elsewhere emerged through complex indigenous interactions. How do international (donor) efforts co-ordinate with indigenous processes to foster the emergence of dynamic low carbon innovation systems?

This paper discusses some of the innovation systems literature that can inform our answers to these questions, especially the work of the Latin American school that has highlighted the challenges of implementing policies to build innovation systems that aim to emulate those that have emerged elsewhere. It will link to recent research carried out by the STEPS Centre around low carbon innovation capabilities and the role of 'system builders' in China and Sub-Saharan Africa. Linking this to the wider innovation studies literature raises questions for international processes that aim to foster innovation for alternative trajectories in low and middle-income countries.

O-4413a-01

Facilitating technological change to manage energy and climate challenges in developing countries

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It is well understood that new and improved technologies will play a key role in efforts to address the energy and climate challenges facing developing countries. But a range of resources and capabilities - technical, financial, business, policy, etc. - needs to be marshalled to facilitate the development and/or adaptation of such technologies and their deployment at scale. Drawing examples from India, this talk will illustrate the kinds of resources and capabilities that may be needed for different technologies at different stages of their technology cycle and how these might be brought together in a systematic fashion. In doing so, I will highlight the critical role of "innovation systems operators" in this process, as entities that identify innovation gaps as well as ways to overcome them by bringing together and coordinating relevant actors and expertise, appropriate finance and policy solutions. I will also suggest that such entities are a critical element of the capabilities to manage energy and climate challenges in developing countries where innovation systems often are not well organized.

O-4413a-02

The role of partnerships in enhancing the transfer and diffusion of climate change technologies

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The decision to establish a Technology Mechanism (TM), at the Cancun conference in 2010, was an important milestone in efforts to advance the effective implementation of the technology transfer provisions of the United Nations Framework Convention on Climate Change (UNFCCC). Since then, the two bodies of the TM - the Technology Executive Committee (TEC), more akin to a policy body, and the Climate Technology Centre and Network (CTCN), the Mechanism's operational arm -have begun to carry out their work and activities.

However, the role of partnerships in enhancing the transfer and diffusion of climate change technologies has not received significant attention in the process of the TM's operationalization or in the work programs and activities of both the TEC and CTCN. Yet the mandates of both bodies include provisions to foster such partnerships. For instance, the mandate of the CTCN states that one

of its functions is "facilitating international partnerships among public and private stakeholders to accelerate the innovation and diffusion of environmentally sound technologies to developing country Parties."

At the same time, recent years have witnessed a number of growing partnerships involving public and private entities, particularly in the context of bilateral clean energy and technology cooperation arrangements such as the US-China Renewable Energy Forum. These partnerships also address intellectual property rights (IPRs) in a pragmatic and constructive manner which could provide useful lessons for overcoming the polarized debate on this topic in the context of current climate negotiations.

The objective of this proposal would be to explore how can partnerships contribute to a strengthened TM that could be a possible basis for agreement on a technology package at COP 21 in Paris.

4413b - Environmental policies to enable innovation and transformation

ORAL PRESENTATIONS

K-4413b-01

Environmental policy, multinational firms and green innovation

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This paper investigates the impact of environmental regulation on green innovation in a globalized world, where multinational firms locate production and R&D laboratories across several countries. Using firm-level data on multinational firms conducting green R&D both in developed and developing countries, we find that environmental regulation has a positive impact on clean innovation - in particular in countries where multinational firms face a pollution-haven motive, which is where firms locate their most dirty production processes. In other countries, other factors such as the wages of R&D workers and the country's absorptive capacity in green technologies seem to be more important triggers of clean innovation. Since multinational firms are a major channel for transfering technologies to developing countries, our results have implications for the design of policies aiming to promote the global diffusion of clean technologies.

O-4413b-01

Contextual Factors and Wind Energy Innovation Development ---- Comparing Germany, Denmark, China and India

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Wind energy technology played significant role in response to climate change. Increasing academic studies tried to find the relationship between government support and the technology innovation development path. This research filled the literature gap by decomposing national contextual factors with endogenous wind policy design and implementation elements in the theoretical framework. Checking wind energy development in Denmark, Germany, China and India in the past 30 years, this research found influences coming from political context (i.e. governance structure change, governmental policy making capacity), economic context (i.e. national economic development paradigm), and social context (i.e. social legitimacy) that significantly shaped the national wind innovation path. The paper concluded that accessing wind energy policy required a through study of local context factors. One of the policy implications pointed out that policy and technology dissemination did not necessarily lead to similar innovation path. The paper also called for stable long-term support to wind sector development.

O-4413b-02

Trade flows and knowledge flows: the case of renewable energy generation

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Fostering sustainable growth while addressing climate change concerns entails that energy efficient and carbon free technologies be available and diffuse widely. However, innovation and the ownership of technologies are still concentrated in developed «frontier» countries. Key issues that confront researchers and policy makers alike in both developed and developing countries are (1) understanding the dynamics of knowledge and diffusion in this sector and (2) identify the key policy levers to promote to development and green growth. This will provide insight s on the ability of technologic al progress and technology diffusion to lower the costs associated with climate mitigation while fostering sustainable energy for all. Researchers focusing on the study of diffusion and transfer of energy and climate change related technologies have increasingly resorted to patent data as a proxy of interest. This is due to the wealth of information patents include, the wide coverage in terms of countries and the possibility to classify patent s by technology through the IPC classification. Two are the core assumptions made when using patent data to this end. First, patent citations or cross country patenting informs on the flow of intangible knowledge. Second, a patent application testifies the willingness to protect an idea in a given market and exploit a temporary monopoly of power. Hence, cross country patenting is correlated to some extent with technology production, marketing or licensing. Due to the lack of technical detail in other commonly used proxies such as trade data or R&D investment statistics, patent s have represented so far the best source of information in this respect and have thus been used to study knowledge format ion(Popp 2002 and Verdolini and Galeotti 2011 among others), the role of international and inter-sectoral spillovers (see for example Mariani 2008), the diffusion of cleaner technologies across countries (Hall and Helmers 2013, Bosetti and Verdolini 2013, Dechezlepretre et al. 2011), and issues related to directed technical change from dirty to clean innovation (Aghion et al. 2012). These studies based on patent data resulted in a wealth of policy implications, which, if implement ed, will have long-lasting impacts on economic growth and sustainability. This paper contributes the literature by providing a comparative study of the diffusion of clean technologies focusing on three different proxies, namely patent data (innovation), trade data (transfer) and production of energy from reneweable sources (diffusion). We focus on the sector of renewable electricity production due to two main reasons. First, power production plays a key role for energy security, sustainable growth and climate change (IEA 2010). Due to the willingness to promote economic growth while curbing greenhouse gas emissions and climate change impacts, electricity production is currently a key to most governments' strategies for sustainable development. Second, electricity is a perfect case study because other proxies for technology diffusion and transfer can be identified. We provide two main contributions. First, a thorough description of renewable energy innovation and transfer dynamics worldwide. Second, a validation of the use of patent data as a proxy for technological change, and an analysis of whether such data can substitute or should only complement other proxies of technology transfer. Our analysis comprises both a descriptive approach and a more formal testing of the relation between patent statistics and other diffusion and transfer proxies through an

econometric model. Our contribution is hence to provide a well- rounded assessment of renewable energy knowledge and technology flows across countries. Preliminary results show that trade and patent data provide to some extent similar insights: markets in which patent protection is sought by inventors of a given country are also among the most relevant trade- partners for that country. Moreover, countries where more patents are applied for are also the countries where installed capacity is greater. However, there are cases in which such correspondence does not hold, and hence solely relying on patent statistics might provide biased policy insights.

4413 - POSTER PRESENTATIONS

P-4413-01

Building fuel poverty measurement for the transport sector

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Because of climate change mitigation policies or depleting fossil fuels, fuel prices are expected to rise and an increasing number of households could face difficulties to afford their energy bills, adequately warm their home and achieve their required mobility. If development of fuel poverty measures are necessary to accompany fuel prices rises, their success highly depends on the capacity to identify the population at-risk. Attention has been focused on fuel poverty in the residential sector so far; however traveling by car is another essential energy service for part of the population (Sovacool, 2012). Having too high a fuel spending can induce restriction behaviours and it is particularly problematic when it becomes a barrier to access employment and when it causes social and economic exclusion (Orfeuil, 2004). If an increase in fuel prices will affect more strongly households with the highest motorized mobility needs, here we show that assessing who are those households is not straightforward, and that it calls for the development of a new multidimensional fuel poverty indicator.

Assessing who the households at-risk are is not a simple task for three reasons. First, motorized mobility needs result from multiple factors depending on the geographic, technical and socioeconomic characteristics of households. For example, living in suburban areas requires traveling longer distances to reach central business districts, or driving an old heavy car requires more energy per kilometre than a brand-new compact car. As a result, the fuel spending can vary a lot among the population. Second not only the fuel spending of a household results from a combination of factors, but these factors are often constrained in the short term, such as the residential location, the efficiency of the vehicle owned or access to public transport. As a result, households do not have the same possibilities to act on their daily lives consumption and they might be forced to restriction behaviour. Third, alternatives to car exist. Public transport, walking and cycling are sustainable substitutes to car use, but these alternatives are not equally accessible to households. Those three reasons highlight the fact that households are unequally affected by increasing fuel prices, and it raises public concerns about their impact on the most vulnerable populations.

The choice of fuel poverty indicators is essential because indicators are the basis on which to quantify the extent of the problem, to identify the affected population and to monitor progress of measures (Moore, 2012). To diagnose fuel poverty in the transport sector, the first idea would be to transpose existing indicators used in the domestic sector to the transport sector. The ratio indicator considers a household is fuel poor if its energy spending exceeds a certain share of its disposable income (Boardman, 1991). A more recent measurement approach, introduced by Hills in the UK, consists in identifying households having both high fuel spending and low income (Hills, 2012). However we find these approaches are not satisfactory because they fail to consider the three aspects described above: (1) diverse motorized mobility needs, (2) restriction behaviours, (3) variable capacities to adapt. We develop a new composite indicator that does not solely focus on budgetary aspects but also reflects conditions of mobility. Our composite indicator differentiates three levels of exposition to rising fuel prices. We test this indicator on French data and we find 4,0% of French households are identified at-risks, another 8,3% are vulnerable in their required mobility and another 6,8% are dependents to car. Using a discriminant analysis, we characterize the three identified groups and we find they show different geographic, technical and socioeconomic characteristics. Our results demonstrate using a multi-dimensional fuel poverty indicator is essential to evaluate fuel poverty in the transport sector. High fuel spending, low income but also inadequate conditions of mobility can induce difficulties to achieve one's required mobility, and a comprehensive evaluation of fuel poverty requires an assessment of each dimension. By doing so, the composite indicator brings a new light on which support measures could be developed to insure future climate change mitigation policies are fair and equitable.

P-4413-02

Sustainable energy transformations through innovation-system building

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National systems of innovation (NSIs) provide the contexts within which all processes of technology development, transfer and uptake occur. NSIs are characterised by networks of actors (e.g. firms, universities, research institutes, government departments, NGOs, users), the strength and nature of the links between those actors, their capabilities, and the institutional environments within which they work. Particular technologies, and other innovations, emerge from particular combinations of these elements and their evolution. For example, recent research shows that the rapid adoption of solar lanterns in Kenya can be explained as the result of an emerging solar innovation system that includes an evolving supply chain built over decades, detailed research of users' lighting practices, local - often donor-funded - experimentation with technologies and other innovations (such as finance models), and efforts to establish favourable policies. This Kenyan solar example also suggests that NSIs (including technology or sector-specific innovation systems) can be nurtured to evolve in particular directions, and so understanding how the Kenyan solar and other such cases have developed gives rise to potentially powerful exemplars for how policy interventions can encourage sustainable energy for all.

Taking this NSI perspective, the purpose of this presentation is to outline how international policy interventions such as SE4All, or the UNFCCC's Technology Mechanism, could be enhanced to successfully encourage sustainable energy transformations in developing countries. The presentation will draw on two main strands of academic literature - innovation studies and socio-technical transitions - to explain the theoretical basis for why innovation systems are so important, and what these literatures tell us about how to nurture NSI-building. Examples from the recent research on the Kenyan case noted above, and from others, will be used to illustrate these insights: i.e. how to build actor-networks, capabilities and conducive institutional environments that together can evolve into context-responsive innovation systems. In short, these literatures suggest that policy interventions should focus on achieving four overarching goals:

1. Build networks of diverse stakeholders who work together in projects, programmes and other interventions
2. Foster and share learning from research and experience
3. Promote the development of shared visions amongst stakeholders
4. Support diverse experimentation with technologies and practices

The presentation will finish with a sketch of what architecture could be established to realise these ideas in developing countries. In this regard, two - potentially complementary - proposals will be outlined. One proposal is to strengthen the capacity of national-level institutions - such as National Designated Entities under the Climate Technology Centre and Network - to act as innovation-

system builders. The other proposal is to use technology projects and programmes explicitly to build sustainable energy innovation systems.

P-4413-03

Community energy generation in the UK: the link between ownership of renewable energy developments and social acceptance

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Over the last decade, the UK government has increasingly discussed 'community energy' as a potential option to contribute towards meeting its renewable energy targets. One of the implied, and at times expressly stated, benefits of a community approach is an assumed related reduction in 'public opposition' to new renewable energy developments, which has been seen as slowing the rate of deployment and therefore threatening the realisation of related targets.

The link between ownership and social acceptance is an important research question, which has thus far lacked empirical evidence. The aim of this study is to bridge this gap by investigating three wind farm projects with three different types of ownership: fully community-owned, joint venture and fully private-owned with community benefits. The research will employ a wide range of secondary sources and in-depth interviews with key stakeholders of the wind farm projects and the local community residents.

The presentation will elucidate the impact of each ownership model on social acceptance, which will be considered in the context of other issues known to affect social acceptance e.g. the process of consultation with the community, communications and trust between developers and communities, sense of place from the community, contested impacts, processes of monitoring and perceived level of local benefits. The findings of the study will lead to recommendations for various stakeholder groups including local communities, developers and policy makers.

P-4413-04

Pacific Community Development Through Biofuel from Marine Biomass

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This pilot project based in Fiji with ramifications in Tuvalu and Vanuatu explores the possibilities of developing for Pacific island communities a low-cost, sustainable new source of renewable energy (biogas, or biomethane) from pest marine biomass (invasive algal blooms and coral-destroying crown of thorn starfish) to develop the economy of local communities, create employment, reduce food and fossil fuel imports, reduce greenhouse gas emissions, clean up excess nutrients from sewage treatment plant discharges, and clean up beaches fouled by overabundant and invasive seaweeds. The process provides multiple products simultaneously: energy from biogas, a low-cost alternative to chemical fertilizers, plus the recyclable nutrients remaining after anaerobic digestion. The development of low-cost, efficient anaerobic digesters will empower local communities to produce their own renewable energy source while protecting the environment and improving food security. Currently research is underway at the University of the South Pacific in Fiji with two Master-level students working on the topics of biomethane from seaweeds and crown-of-thorn starfish, respectively. Pilot community-level trials on the conversion of brown seaweeds into biofuel are underway in Tuvalu.

P-4413-05

Local energy and the emergence of the pro-saver

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The publication of the Community Energy Strategy in 2014 indicates increasing recognition of community energy within the UK. Using localised and tacit knowledge, local energy provision allows energy needs to be dealt with at the point of consumption, opening up opportunities for end-users and interest groups to engage in energy production and active consumption, 'pro-sumption', but also the potential to extend this to production and energy saving, 'pro-saving'. Local energy initiatives can combine distributed energy generation, alongside demand reduction and demand side response. The importance of localised energy governance in the UK is highlighted in the Government's recent D3 report. It specifically refers to distributed energy, demand reduction and demand side response at a local level, but also takes into account the role that local government can play in their development. A further landmark enabling more distributed approaches is the Government's Feed-in Tariffs (FiTs), available for renewable energy generation technologies below 5MW. Technological diffusion, combined with an emergence of energy related social innovation and increasing political recognition, is establishing local energy as an alternative to the incumbent energy system. Local energy provides a space for engagement with energy production and consumption at the grassroots level, as well as for local authorities to play a more proactive role in influencing the scale and rapidity of D3 deployment. Often emerging out of community-led renewable energy projects, the initiatives can address issues such as energy prices, fuel poverty and the desire of independence from existing energy utilities.

Based on three case studies, this paper traces the emergence of 'pro-suming' and 'pro-saving' in a UK context. The first case study, South East London Community Energy (SELCE) examines a community energy group that wishes to generate renewable energy "by the community, for the community", for example by installing solar PV panels on public owned buildings such as schools. Their business model is based on income derived from the FiTs and selling electricity at a reduced price. The community group's second original focus, fuel poverty alleviation, however, had to be initially scaled back due to the difficulty of establishing a viable business model based on FiT income. In the second case study Hyde Farm Climate Action Network set out to find solutions for cold and draughty houses in their neighbourhood, which were restricted by conservation area regulations while people in the area had limited funds to do expensive energy efficiency measures. The community group received support from programmes such as ECHO Action and British Gas Green Streets, which allowed them to install renewable energy installations to some of the houses. However, they proceeded to set up their own 'Draught Busting Saturdays' as a way to deal with inefficient houses, address climate change and build community coherence. The Draught Busting Saturday concept proved a popular and an affordable way to improve the energy efficiency, as well as help those who were on low incomes. The third case study provides an example of local authority engagement with fuel poverty alleviation in Southern England. In the summer of 2014, over 150 households were provided with free electricity from solar PV systems installed by their social housing provider, the local authority. The authority paid for the costs of the panels that will eventually be recouped via the FiTs. Any additional revenue generated will be used for energy efficiency work on its social housing stock. The study found that as the households engaged with free energy generation, it also encouraged demand reduction and demand-side responses.

The SELCE case study is an example of 'pro-sumption' as electricity is being used on the site of generation. Their approach provides insights into the difficulty of negotiating what may appear to be a straightforward process in light of continuous scepticism towards decentralised energy. The Hyde Farm case exhibits more 'pro-saving' behaviour emerging out of a grassroots community approach and disillusionment with established energy providers. The Southern England case provides a good example of renewable energy production, consumption and saving – 'pro-saving' – emerging out of a local authority initiative. In our discussion we explore how greater engagement

with distributed energy, demand reduction and demand side response may be fostered through a more facilitatory framework combining technological and social innovation at the local energy scale.

P-4413-06

«ENERGY HAVENS»: TOWARDS A SUSTAINABLE ECONOMIC FUTURE. A study based on the example of Iceland

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There are many concerns on how to enhance environmental policies through participating in the international market with opened borders. For many years already a strong cooperation with countries with lower environmental regulations developed between the United States of America and some Western European countries. This development has brought forward a raise of standards in environmental policies across the world but a big gap still prevails in the regulations between developed and developing countries. Some environmental economists claim that trade flows across countries with different environmental regulations may create the "pollution haven" effect and a "race to the bottom" in environmental standards. Globalization and international cross-border cooperation also play a vital role for international tax regimes. Different fiscal policies in one country influence the economic situation in others, even countries located far away. Companies and individual persons use the possibility of increased capital mobility and choose locations where the tax burden is lower. These locations are called "tax havens". Similar to "pollution havens", "tax havens" can create a "race to the bottom" in the collective tax base. The similarity of this terminology raises the question what makes a country a haven. Since the globalised market is being challenged by an increasing demand for energy and the energy supply is becoming one of the main cost factors in the production process for many industries, the research analysed a new definition of the term "energy havens". The term "energy havens" describes countries which have a big potential of renewable energy creation that can be provided to "power-hungry" consumers/energy-intensive enterprises. This is the aspect which differentiates them from the previously mentioned "pollution havens" because the use of traditional energy sources to offer industries a cheap energy supply would result in the "pollution haven" effect. The exploitation of renewable energy sources has to be feasible and ecologically desirable in order not to cause harm to nature and «pollute» the environment. The main target groups of this thesis are energy-intensive industries and the academic audience whose interest is the future energy market condition. The research conducted focuses on electricity, with production cost as the main factor.

4414 - Leveraging Multi-layered Climate Science-Policy Social Learning and Dialogue for Transformative Solutions: Towards A Proposal to "Decade for Accelerating Climate Dialogue for Action"

ORAL PRESENTATIONS

K-4414-01

Learning for a change! The role and challenges of social learning for climate change adaptation

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Climate change is an additional challenge that arguably we all have to factor into our lives including in local livelihood, local and national government and other decision-making contexts. A commonly heard 'mantra' now is "behaviour change" emerging from a sense of urgency that individuals and societies must 'change' behavour so that we can both mitigate and adapt to climate change. Some seem to argue, for example, that we need well-planned 'dialogue'. But such calls for 'dialogue' and 'change' cannot be made in social vacuums. Issues of power as to 'whose behaviour should change?', 'for what and whose purposes?' and 'who is setting the dialogue agenda?' are some of the issues and questions that need careful consideration. In this paper, the background to social change and learning issues in various contexts is given focusing on developing country contexts. Examples of serious attempts to make inputs in southern Africa, using social learning approaches, are provided in various climate relevant and development areas e.g. water, food and disaster risk reduction. The challenges that arise and possible ways forward are sketched using some emerging evidence from the 'field'.

K-4414-02

Realizing low-carbon Asia based on science-policy interaction through Low Carbon Asia Research Network (LoCARNet)

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Realizing Low Carbon Society (LCS) has become a common understanding of the global community of researchers, policymakers and citizens engaged with the concerns of climate change and sustainable development. LCS gained currency when it was realized that, on the one hand drastic GHG emission cuts necessitating major changes in energy systems and socio-economic structures are essential to prevent dangerous climate change, and on the other hand every country's domestic developmental goals must not be compromised. Attempts to achieve convergence among the multiple goals of global climate change mitigation, national economic development, poverty elimination, sustainable development and environmental protection, have led to the importance of LCS and related paradigms.

The role of Asia is becoming more and more important, considering the rapid economic growth expected in the coming decades and projected doubling of greenhouse gas emissions from 2005 to 2050 if efforts are not made toward achieving LCS. The reduction of emissions in Asia is imperative for transition by 2050 to a worldwide LCS that has halved GHG emissions from 2005 level. Transition to low carbon emissions and low-resource consumption societies, while simultaneously improving the economic standards of living is vital for sustainable development. Asia has many opportunities to realize an LCS by leapfrogging.

We have been engaged in the development of Asia-Pacific Integrated Model (AIM), which assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and avoiding the impacts of climate change. Modeling is essential to understand the future pathways and support policy making processes for transformation to LCS.

Sustained efforts have been made to develop AIM model and transfer it to various Asian countries for developing LCS scenarios in each country over the past two decades. These include science-policy dialogues to implement LCS scenarios. One of important networking activities is Low Carbon Asia Research Network (LoCARNet) which was established in 2012 to formulate and better enable the implementation of science-based policies for low-carbon development in the region. This is expected to become an autonomous researchers' network based on south-south

cooperation in the region in the near future.

Several international research platforms of researchers have already made tremendous contribution to comparative analysis of socio-economic characteristics among different countries and stakeholders. They have developed integrated assessment models for setting de-carbonization future targets and optimal roadmaps, and shared the implementation process in designing collective solutions for national low carbon policies, infrastructure plans, eco-model city designs and industrial transformation processes. During all such collaborative research network activities, analytical methods, simulation models and evaluation indicators have been shared, investigated and refined.

The presentation will provide an overview of various analytical methods and tools used as a common scientific framework in Asia. This will include the integrated future scenario simulation system for a de-carbonization society and development roadmaps to achieve the 2 degree target. The presentation will also provide implementation examples from Asia that showcase transformative actions towards de-carbonization.

K-4414-03

Implementing the long term transition towards Low Carbon Societies

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The work of IPCC and international governments has clearly established the global problem of climate change and identified possible solutions. It makes very clear that achieving a global climate compatible Low Carbon Society entails a «great transition» will change economies and technology and involve all societal groups to work together on coherent long term oriented strategies. This means that societies have to jointly develop long term visions that are able to guide short term oriented interests and activities. Such a venture needs engagement between all societal groups on all levels from local to global. The keynote will highlight the relevance as well as the potentials of collaboratio between sceience and society by highlighting two relevant examples on Global as well as regional levels and by this making clear, what is needed for a global LCS transition.

In 2008 the G8 environment ministers decided to contribute to the global challenge of co-evolution of Low Carbon strategies between policy science and society. Based on a proposal by Japan they decided to create the Low Carbon Scoiety Research Network. A network of science and governments of the G8 together with researchers from developing countries with a purpose to link together national discussions and strategies on LCS and to convey core LCS issues to international policy makers. The network has so far identified a clear international set of issues and was able to convey them into policymakers discussions.

Global approaches, however, need similar ones on other levels. One very intensive example is the climate law and strategy of the German state of North-Rhine Westphalia. This region hosts over 50% of German coal fired power generation and energy intensive industries, but is determined to achieve ambitious climate mitigation. In order to make progress towards the goals and to create a cross-societal movement a broad and long term oriented stakeholder process was implemented that already resulted in a policy program supported by all stakeholder groups.

O-4414-01

A Transformative knowledge network of global youth for combating climate change: an intercultural perspective

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Understanding the societal, economic and environmental issues raised by the climate change at both global and local level calls for the synergy of disciplinary knowledge and cooperation between all stakeholders of international community. It is widely recognized that today's youth will be the first group affected by the consequences of climate change on the socio-economic-environmental biosphere tomorrow, they will and should be the engine of a collective and participatory intelligence that would contribute to concrete proposals for curtailing the accelerated global warming. This requires creating opportunities for expression and exchange between the young citizens from diverse sociocultural backgrounds and interaction with researchers on the state of the climate situation and scientific knowledge on the one hand, and enabling them to discuss possible solutions on the other hand.

The «Global Youth Climate Pact « project gather a multidisciplinary team to build a global intercultural exchange network targeting young people from several countries (e.g. Argentina, Burkina Faso, Brazil, Chile, China, Columbia, France, Guinea, Italy, Nepal, Chad, USA…), known as Transformative knowledge network of global youth (TKNGY) to bridge the knowledge gap between scientists and civil society, i.e. young people engaged in activities for securing global sustainability across the world. The TKNGY platform is established with the purposes of advancing the aggregate knowledge of civil society in particular the Youth for shaping an overall vision and defining feasible local action plan as a contribution to global climate policy.

The project seeks to leverage interdisciplinary knowledge and intercultural experience sharing between Youth in light of carving out a global climate strategy based on bottom-up approach. The network will be conceived as a new source of knowledge pool to facilitate open exchange and dialogue between diverse youth groups as well as with their interactions with global community by harnessing Information and Communications Technology (ICT) and social media. Two "crowdsourcing" tools, an online platform and offline focus groups, are dedicated to gather and share relevant data that will allow local young people to access and improve the scientific knowledge of sustainability and climate change and to develop skills of discernment regarding these issue areas.

The permanent online platform and scheduled offline meetings between young people from different parts of the world will commit to securing sustainable economic growth and to strengthen the solidarity between youth and local communities as well as taking local actions to address climate change. This platform will be constantly enriched and improved through young people's innovative thoughts and ideas within a non homogeneous economic, social and cultural context. It will also lead to the restitution of data on scientific knowledge and analysis of the perception and the proposals of the young students on climate change from an interdisciplinary research perspective. It must be emphasized that the interdisciplinary treatment of a scientific topic is concerned not only with the technological &socioeconomic aspects but also to those related to age, gender and culture.

Multi-dimensional analysis of the first results which will emerge at a meeting gathering all the actors of the project in Toulouse in May 2015 will be the aim of this scientific communication. Results are expected to mark a significant step in enhancing knowledge, training and implementation in addressing scientific questions in regard to climate sustainability. The success calls on global community to bring together knowledge of environmental scientists and social scientists as well as associating engineers and practical know-how by paying a particular attention to intercultural dialogue/understanding, from which a collective intelligence of solutions especially among young people could emerge. The project expects to deliver a «Global Youth Climate Pact « at the Paris COP-21 in Dec 2015 as a result of a series of collaborative work between young students with the support of various international institutions including academia and NGOs as well as regional governments.

O-4414-02

Doing Much More with the Same: Institutional Change and Social Learning for Sustainable Development Outcomes

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Climate change adds considerable uncertainties and complexities to what are already multidimensional development challenges. It is increasingly likely that we are already locked into a two-degree temperature rise, whatever happens to global greenhouse gas emissions even in the near-term. There is ample evidence that the resources needed to deal with the adaptation challenges exceed the resources currently mobilized for it. However, it is not just about resources: the approaches that many of our institutions are taking are failing to address the level of complexity and the cross-scalar nature of the challenges that are triggered by climate change in the context of development. Business as usual is, simply, not fit for purpose. This is becoming increasingly recognised at different levels, from partners on the ground right up to international funding agencies.

In response, a lot of useful practical and theoretical work is being undertaken on the value of learning and reflective practice as a way to bring together different knowledges and to address the multiple dimensions of complex problems, and to take learning beyond the local into much wider networks of practice. Social learning and similar learning based approaches are building a compelling body of evidence on their potential at more localised scales, but we know that the scale of the climate change challenge demands more than isolated community scale actions. Supported by recent scholarship in this area, we argue that the principles emerging from these local-level learning approaches are equally applicable at higher scales, and have the potential to achieve an important shift in thinking across levels. Such work is providing increasing clarity as to what kinds of research, collaboration, and disposition to problem solving are needed to address the levels of complexity and uncertainty we are facing under climate change in a development context.

This need for doing things differently, however, is not yet reflected in most organisations addressing the climate change challenge. This is in part because of the response from organisations funding research for development that place much of the onus on taking transformative change to scale on actors and initiatives working at the «last mile» of planning and practice. While work at this level is critically important, it is not sufficient, and this emphasis sometimes leads to a focus on "silver bullet" technological fixes rather than broader systemic changes.

We need to be seeing the emergence of joined-up learning-oriented models of practice, at all levels. By changing the way our own institutions think about fostering solutions to wicked problems like climate change, we can have a much longer-term impact on how knowledge and action link up in this field. However, this requires social learning or related approaches to instil institutional and organisational change. We currently have very few examples of success at these levels to guide us.

Thus, the Climate Change and Social Learning Initiative has embarked on a process to contribute to a solid evidence base concerning the costs and benefits of social learning in different contexts. This is one of a number of iterative, learning-based approaches that offer a potential avenue for significant change. Jointly with other research for development organisations we are testing a common monitoring and evaluation framework to systematically collect evidence, analyse results and share learning on when and how research initiatives may benefit from social learning-oriented approaches.

The evidence we are building should show tangible proof of the added value of these approaches towards achieving development outcomes. To take things to the required scale, the stakes need to be raised: we need nothing less than a major re-think as to how research for development is used as a vehicle for tackling one of the most complex challenges of our time. To this end, this contribution will conclude with a set of "pathways to transformation" with which we challenge institutions funding and supporting climate change research for development to pursue.

O-4414-03

Systemic and social learning approaches for climate change adaptation: Experiences from transboundary work in Southern Africa

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For climate change adaptation to be successful attention needs to be given to how people might learn to adapt. Theories of social learning enable an exploration of adaptive capacity and how people are learning to deal with climate change amidst a range of other challenges, whilst systemic approaches enable thinking about complex and often unpredictable situations. In South Africa the RESILIM-Olifants project is a multi-year learning approach that is enabling actors at various levels, from households through to catchment management agencies and transboundary organisations to build resilience to climate change in creative ways. Lying at the core of the systemic, social learning process is a collaborative scoping of context and of risk (including climate change) which, when viewed though a systemic lens, helps stakeholders understand change within complex and dynamic environments. Some of the lessons and challenges learnt in this 'creative transdisciplinary endeavor', which is being led by the Association for Water and Rural Development, will be outlined, critiqued and shared.

O-4414-04

Title not communicated

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Abstract not communicated

O-4414-05

China's Emission Pathway towards global 2 degree target: Policies and Scientific Support

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Low carbon development in China is on the purpose for both national sustainable development and global climate change action. For the global climate change target "to hold the increase in global average temperature below 2 °C above preindustrial levels", China need to peak CO2 emission at latest at 2025, and falling into deep cut on CO2 emission, based on the IPCC report(IPCC AR5, 2014). Previous studies on emission scenario shows that it is possible for China to peak CO2 emission by 2030 if strong policies are adopted, and with a relatively high cost. Peaking CO2 emission before 2025 is a very big challenge for China. Modeling study by IPAC on the 2 degree target said it is also still possible for China to peak CO2 emission before 2025, but several pre-condition are needed, including optimazing economy development, further energy efficiency improvement, enhanced renewable energy and nuclear development, CCS etc .

In recent years, China's policy making process moved much faster tan before to tackle climate change issues. Started from 12th Five Year Plan, CO2 intensity target over GDP growth was set up for 2015. And domestic actions including emission trading, low carbon provinces and cities pilot program. The most remarkable achievement is the China-US Joint Announcement on Climate Change, it mentioned about the disire for global 2 degree target, and China set up year to peak CO2 emission, and express that to continue to work to increase ambition over time. Besides this, China's policies on low carbon energy utilization including renewbale energy and nuclear is moving very faster. By 2013, China's newly installed capacity of wind and solar power generation accounts for more then 1/3 of globale total. If put hydro and nuclear power together, China accounts for more than 40% to total newly installed capacity of the world.

In order to support the policy making process, China established a Climate Change Expert Panel for official advise. They relys on large amount of research work to make suggestion. Beside this, there are many workshops and internal meetings to discuss the possible implementation of policies on mitigation of GHG. The policy making on climate change depends much on reserch support. Our researches were adopted in the national peaking year setting, and ETS design. And now we are working on the carbon tax, which is regarded as another significant policy in China.

China also made efforts to promote south-south collaboration. China already leaded several dialog on south-south forum on climate change, and rpovided funding to help other developing countries for capacity building. This will be a direction for China to join international collaboration to help developing countries to respond to climate change.

O-4414-06

Science-policy-stakeholder dialogues about Low Carbon Society: Lessons from the Brazilian Case

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Science-policy-stakeholder dialogues about Low Carbon Society:

Lessons from the Brazilian Case

Achieving a Low Carbon Society entails a «great transition» of economies and technology requiring the involvement and action of different societal groups. This keynote will draw the lessons from a science-policy-stakeholder dialogue about mitigation GHG emission scenarios for Brazil.

A participatory process to discuss the economic and social implications of five mitigation scenarios for Brazil up to 2030 was held from April 2014 to March 2015, coordinated by the Brazilian Forum on Climate Change. It involved a Scenario Building Team (SBT) of 70 members from the government, business sector, non-governmental organizations (from the environmental field and trade unions) and the scientific community. A technical modelling team (TMT) coordinated by the Brazilian member of LCS-RNet (CentroClima/COPPE/UFRJ) has provided scientific support to the process. Upon draft proposals suggested by TMT, SBT selected qualitative storylines of plausible and pertinent futures based upon economic and technological assumptions. TMT has translated these inputs in quantitative projections of key variables depicting economic and GHG emissions, calculated through mathematical models representing the Brazilian economy and technical systems: IMACLIM-BR (CGE macroeconomic model especially designed for long-term GHG emission scenarios building) and sectorial models for energy, land use and forestry, IPPU and waste. The general objective was to design exploratory long-term scenarios, and not forecasts or a normative scenario: the goal was not to supply the most probable nor the most desirable scenario. A comparative analysis between the governmental plan scenario and two additional mitigation scenarios (implemented through two different sets of policy tools) helped to identify key economic and social implications of additional mitigation policies and measures, including the impacts on GDP, inflation, trade balance, employment, income distribution and household consumption across different income classes. The dissemination of the dialogue outcome has provided valuable inputs to the Brazilian society debate on the INDCs submitted to COP21.

This dialogue was part of the MAPS project (Mitigation Action Plans and Scenarios), coordinated by SouthSouthNorth (SSN). Similar participatory processes were adopted in the Long Term Mitigation Scenarios project in South Africa, and in similar dialogues around long-term mitigation scenario in Chile, Colombia and Peru.

Given the huge challenge for developing countries of achieving social and economic development goals through a environmentally sustainable and climate-compatible pathway, science-policy-stakeholder dialogues of this kind about Low Carbon Society may play a valuable role and provide a helpful contribution to a more democratic and enlightened decision-making process.

4414 - POSTER PRESENTATIONS

P-4414-01

Management, hazardous waste treatment and environmental □impact.□

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Improvement of standard living led and will continue to generate a rather big environmental risk, given the significant amount of multiple wastes they produce and depending to the case may be landfilled or treated and recycled. According to their nature and production source, they can be medical, agricultural, municipal, industrial etc. and the protection of human health and ecosystems is much more difficult than years ago. Environmental issues are more diffuse rather than located, subtle than obvious, and involve multiple environmental media (air, water, ground, sediments and biota) rather than a single one.

According to their nature and production source, they can be medical, agricultural, municipal, industrial etc. and the protection of human health and ecosystems is much more difficult than years ago. Environmental issues are more diffuse rather than located, subtle than obvious, and involve multiple environmental media (air, water, ground, sediments and biota) rather than a single one.

Due to their composition and their properties, hazardous wastes such that expired drugs, chemicals, present a real threat to human health and the environment (consequently may have an impact on the climate even if treated), and require a set of appropriate treatments to reduce toxicity risk and contamination, particularly for gathering pathways, transportation, treatment, recycling and disposal. They are considered one of the major environmental and health concerns, and their management requires a capital interest. If untreated, they could reach the water cycle through a variety of routes. They can do after being placed in landfills, such as residues from industrial manufacturing or as unused pharmaceuticals and infiltrate groundwater. It is also possible that effluents from pharmaceutical industries contain occasionally or permanently pharmaceutical residues and can end up in surface water through wastewater treatment process. The primary interest is the risk that contaminated soils and sediments pose to human and ecological receptors, for which rigorous evaluation is essential to make informed decisions and develop effective solutions. Through potential risk they represent, their management requires capital interest. Expired pharmaceuticals and chemicals untreated, can reach the water cycle through a variety of routes and infiltrate groundwater and ending in surface water. Treatment may include production of raw and secondary materials or energy recovery and their management can lead to the valorisation of noblest fraction and treatment of polluting fractional. Recycling and regeneration lead to a recovery of materials such as metals, etc. or by incineration and finally stabilization or landfilling for residues having no more perspective.

As a practical management of hazardous waste, incineration has two attributes: permanently destroy toxic organic compounds contained in the hazardous waste by breaking their chemical bonds and transform their components by reducing or eliminating their toxicity; reduce the amount of hazardous waste by converting the solid and liquid into ashes. The products of incineration are more bottom ash, fly ash, containing toxic organic and inorganic compounds (Satnam Singh et al., 2007). The combustion gases are composed primarily of carbon dioxide and vapour water, and small amounts of carbon monoxide, nitrogen oxides, and low concentrations of organic and inorganic compounds. And like many combustion processes, incineration also produces by-products such as soot particles and other contaminants released in exhaust gases, and leave a residue (bottom ash) of incombustible and partially combusted waste that must be emptied from incinerator chambers and properly disposed. Expired or unused pharmaceuticals are now incinerated in facilities that could meet the highest environmental standards, including treatment of smokes and where releases relating thereto, are a

priori insignificant (RRCSE, 2008). However to date, there are no estimates on all of these issues. We know that climate change is a key environmental issue with major concerns with respect to the rise in global temperature and concomitant direct and indirect implications. Recently, there has been a international momentum to stay within an agreed target of a 2°C increase above the preindustrial global mean temperature, by 2050 (Erika von et al, 2013). Increasing greenhouse gases from anthropogenic activities, carbon dioxide in particular, has been well-established as the major force behind climate change and the warming of the Earth.

P-4414-02

Mind Games: Our (Un)conscious Struggle with Climate Change

H. Berry (1)

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Background/purpose: Some media and academics have proposed that informing the public about the likely (harmful) impacts of climate change will increase psychiatric morbidity, querying whether such community conversations should therefore occur. This study explores whether general population 'worry' about climate change is linked to mental health and wellbeing in Australia.

Methods: Structural equations modelling, cluster analysis and geo-spatial analysis of wave 2 data from the omnibus-style Australian Wellbeing Survey (launched 2013) which includes detailed modules on mental health and wellbeing (SF-36, K10, 'happy feelings', life satisfaction, self-rated health), personality (screen for introversion, conscientiousness, creativitiy), place (e.g., geocoded database, data across the whole continent: metropolitan, rural and remote locations; different climate zones; transport; distance to services; land degradation) and socially-based determinants (e.g., employment, financial circumstances, poverty, marginalisation, household and family structure, relationship status, cultural background, education). Innovatively, the survey includes a 10-item 'climate change knowledge quiz', developed with the Australian Academy of Science, which quantifies un/certainty about climate change science. Participants in Wave 2 (2014) were N~12,000 Australian adults who completed an online or paper survey.

Results: The 2014 survey has just closed and analysis is pending. Initial results indicate that 'worrying' about climate change is not linked to any aspect of wellbeing, except trivially to distress (more distressed people were very slightly more likely than their peers to 'worry' about climate change), but is strongly linked to climate change knowledge and attitudes. In multivariate analysis, these, in turn, are linked, though only trivially, to selected predictor variables: being female, younger, creative and highly-educated. The survey will produce general population and sub-population indicators, notably including often-overlooked groups (e.g., those identifying as LGBTIQA; or living with disabilities; or experiencing marginalisation).

Discussion/conclusion: Mental health problems are the world's leading cause of disability and affect resilience and adaptive capacity. Climate change may harm mental health by, first, damaging local economies (via increased droughts, floods etc, that destroy farms, homes, businesses, infrastructure), harming livelihoods; which, in turn, can undermine social wellbeing and community functioning, key mainstays of good mental health. Uniquely, in the case of mental health and climate change, the threat may also be the solution: local-level community action could help address climate change challenges and also generate mental health co-benefits because it can promote social capital which is powerfully protective of mental health. Engaging the public responsibly in debate about climate change is unlikely to cause psychiatric morbidity and is essential in framing effective local responses.

P-4414-03

Implementing a transformative public transport project in South Africa's urban environment – the case of Cape Town's MyCiTi BRT

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Policy implementation is a major challenge throughout the world. Implementation of mitigation projects in developing countries is particularly complex, as they have to compete with numerous other policy priorities that are perceived as more pressing than climate change mitigation.

The transformation of cities holds huge mitigation potential. In South Africa, cities currently reflect severe inequality in terms of access to opportunities, with urban form and differing levels of mobility amongst citizens, being two major contributing factors. Like other South African cities, Cape Town's urban form was significantly influenced by apartheid policies, which sought to segregate the population, based on race and placed low-income communities, in particular, far from the urban core. This was combined with a strong private car orientation from the 1960s onwards underpinned by substantial investment in roads and highways, which led to low densities and long commuting distances. Thus mobility in South African cities is associated with high emissions per passenger kilometer travelled, and entrenches the levels of inequality across income groups in cities.

The bus rapid transit (BRT) concept was presented to the South African government at a time when traffic congestion was worsening, along with the rise in private vehicle ownership associated with a growing middle class, and was forecast to increase exponentially. There was a realisation that expanding the road network would not alleviate the congestion; instead a sufficiently attractive alternative was required to entice private vehicle users away from their cars. The existing buses and trains were unlikely to induce this shift, but BRT, it was thought, could be such an alternative.

This case study investigates the implementation process of the MyCiTi BRT in Cape Town, and identifies major factors that were influential in bringing about implementation, despite significant obstacles the project had to overcome. Some of these factors include: the role of support from national government, the presence of leadership within government and with stakeholders (especially the minibus taxi industry), the role of the 2010 FIFA World Cup in driving progress at speed, a competent and dedicated project team, and the influence of the industry transition of the minibus taxi industry. Most influential was the unique combination of factors and timing that drove implementation.

It is intended that the findings from this case study will provide insights into how to bring about implementation of transformative actions in difficult circumstances, that achieve multiple objectives, amidst opposition and competing policy goals.

P-4414-04

Industrial sector inspection as a control effort on climate change impacts

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The green economy is defined as an economy that results in reducing environmental risks and ecological scarcities and that aims for sustainable development without degrading the environment. it is closely with ecological but more politically applied focus (Lynn R. Kahle, Eda Gurel Atay Eds 2014). In Cimahi City (located in West Java - Republic of Indonesia), The local government has several facts: (1) approximately 350 industries, located in the southern region of the city, (mostly textiles), are the dominant sector of the city (15% of total area) and home for thousands of employees to earn living. (2) they have been discharged million cubic of wastewater in to a river, every day. (3) Based on the study of Cimahi river water quality, one of the result mentions that the river condition is very polluted. (3) the southern region of the city is densely populated areas (279.854 of 643.548 = 43% of total population of the city) and the lowest elevation areas. (4) rivers and drainage channels are accommodate all types of waste. All these facts lead to «silting of rivers and drainage channels. (5) In south region of the city, industrial zones coexist with densely populated settlements. So if the flood came, hazardous waste water will effect to the

people of South Regioan of Cimahi. Regarding those facts, for the government of cimahi city, green economy is about bridging or unite these two different poles. How to keep the industrial activities because they are "Economic lifeblood of the city" ; but manage their wastewater is also important. The Environment Office Of Cimahi City (KLH) as leading sector have main duty to manage environment issues, try to solve it through a routine program which has been implementing since 2010 until now, called "inspection for industrial sector". One of the output of the program is giving the industry a sanctions which are different one industry to another. Some of them be sanctioned by an obligation to fix their wastewater treatment plant (WWTP). In early 2011, The government of cimahi has issued a sanction for 60 industry. The question is how effective this sanctions improving the environment quality or is there any relation between this program with a better river water quality? Within this papers, writer try to make a simple analysis. Is there any progress? Between industrial waste water quality before and after the sanctions has imposed. Writer believe it does. For example in "X" factory, BOD (biological oxygen demand) concentration in 2013 is 250 mg/l, dropped to 178 mg/l and dropped to 160 mg/l. For another example in "Y" factory BOD concentration in 2013 is 90 mg/l then dropped to 86 mg/l and finally in 2015 dropped to 52 mg/l. Another fact mention there has been an increasing of wastewater treatment plant performance in sanctioned industry. There has been a very noticable change. Its mean that the effort has a significant result to decrease BOD number or in improving a performance of WWTP in industry. The report of inspection program also mentions that all of the sanctioned industry comply with the sanctions and began to make improvements. It means that the program is a collective action between industry and government. In the early year of 2015 the old target and the new target are on their way to be audited by KLH. Writer do believe if this program followed continuously, the environment quality will be better. The conclusion is the green economy for cimahi more than it is defined but how to keep the water in this city, just like the city's name means in the local language, "Cimahi means : a lots of water. And In the end protect and adapt people from climate change impact which is: hazardous flood.

P-4414-05

The New Story: Climate revelations and fantasies of omnipotence

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This contribution concerns the fact that modern science has methodically developed a 'New Story' of how human life came to exist on the earth (Harding, 2006; Hornborg, 2009; Lovelock, 2006; Swimme & Berry, 1992; Weber et al., 1989). This new story points out that humans are an integral part of planetary bio-physical networks and flows, stretching through deep time and space; and that human existence is entirely dependent on and is co-constituted by 'dead' aspects of the Earth such as the atmosphere, the oceans, the land, magnetic fields and solar energy, inter alia.

This story clearly has far-reaching practical, organizational and economic implications (Whiteman & Cooper, 2000; Whiteman, Hope, & Wadhams, 2013), and for many people it also has spiritual implications - because it provides credible and testable (though profoundly incomplete) stories of the existence of life on the Earth (Hanh, 2013). This New Story also has psychological implications in terms of the psychodynamics of power - which is the focus of this contribution.

Why is this relevant to climate change? Progress on climate change is psychologically blocked, and may be unblocked, because of the psychology of power. In his Pulitzer Prize winning book, The Denial of Death, anthropologist Ernest Becker described how the core motivational complex of adult humans is our joy of living - and conversely our fear of death. Becker differentiated between the physical, bodily level - where we are clearly mortal - and the cultural, symbolic level where we can deny death, or at least distract ourselves from inevitable aspects of physical reality. For Becker, human organizational systems and cultures are thus selected which suggest that we are extremely powerful, invincible, or even immortal.

In recent decades a large body of quantitative scientific data has been gathered to support Becker's observation, based on experiments in the branch of psychology called 'Terror Management Theory'. This body of evidence proves that humans associate nature and the body with death, and thus we fear nature; and that symbols and artefacts of power such as money, economic growth, consumer products, technology, organizations and nations give us a deep sense of power and even immortality (Dickinson, 2009; Fritsche & Häfner, 2012).

Our attachment to these human artefacts and systems is stronger than their actual usefulness warrants, because at a deep psychological level they allow us to deny our mortality, to ignore the natural world that sustains us, and to merge in our imagination with anthropogenic systems that may appear to defy physical reality (Arndt & Vess, 2008; Kiehl, 2012). The perceived authority of these financial and cultural systems thus encourages citizens to indulge in psychological 'fantasies of omnipotence', in particular the notion that the economy contains ecology, and the idea that perpetual economic growth is a legitimate goal for countries and for globalized society (Daly, 2014; Ellman & Reppen, 1997; Lothane, 1997; Morante, 2010).

This contribution posits that the power of these salient fantasies of omnipotence is waning in favour of the New Story. As mentioned, the New Story is an evidence-based understanding of the place of humans within the living and non-living flows of the Earth and the cosmos, including the reality of deep time and space (Prigogine, Nicolis, & Babloyantz, 1972; Rifkin & Howard, 1980). This paper proposes that the New Story is more than just a collection of scientific facts and trends - in psychological terms, the New Story has transformational and revelatory potential, because it reverses the normal cultural veneration of fantasies of omnipotence. The revelation of the New Story includes an appreciation that we are not powerless and do not need to fear nature (Searles, 1972).

In a nutshell, the New Story is an encounter with the joy of physical being; and it brings with it an appreciation of the sensitive and contingent nature of human existence (Latour, 1993, 2013). This contribution will discuss the transformative power and practical implications of the New Story, with particular focus on how the New Story may help to create the context for monetary reform and the creation of a sustainable financial system (Benes & Kumhof, 2012; Fiscus, 2013; Georgescu-Roegen, 1971).

P-4414-06

Transformative Potential of the UNFCCC's New Market Mechanism

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There is general agreement that preventing dangerous climate change requires a fundamental transformation of the global economy. For instance, the latest assessment report by the Intergovernmental Panel on Climate Change (IPCC) notes that "The stabilization of greenhouse gas concentrations at low levels requires a fundamental transformation of the energy supply system, including the long-term phase-out of unabated fossil fuel conversion technologies and their substitution by low-GHG alternatives".

The call for transformation has been taken up in international climate policy. The Green Climate Fund (GCF) has been given the mandate to promote a "paradigm shift" and other international funding mechanisms such as the British-German NAMA Facility also demand that activities should contribute to "transformational change". However, public finance, disbursed through the GCF or bilaterally, will not suffice to provide the means of implementation at the levels required to meet the extraordinary challenge ahead. Private funding will have to accompany these public funds in order to spur the necessary investments in sustainable infrastructures worldwide. Market-based mitigation instruments have been proposed by many to leverage such private sector engagement.

A New Market-based Mechanism (NMM) was already defined under the UNFCCC in 2011 in Durban. While further discussions on its design have stalled, it is to be guided by a set of criteria that include inter alia that the NMM should stimulate mitigation across broad segments of the economy, safe-guard environmental integrity, and ensure a net decrease of global greenhouse gas emissions. The EU has called for the NMM to "facilitate

transition towards low carbon economy and attract further international investment".

On this basis, our contribution analyses what the transformative potential of the NMM is in general and how it should be designed in order to maximize this potential? As basis for the discussion, the paper first synthesises how transformation has been defined in scientific literature and existing climate policy initiatives. Based on this synthesis the paper establishes criteria for how to determine transformational impact. Second, the paper examines the transformative potential of market-based instruments on the basis of the EU ETS, so far the largest market-based mitigation instrument in existence. Third, the paper takes stock of the current discussion on the design of the NMM and applies some of the insights from the case study analysis to the case of the NMM. We conclude by translating these insights into policy recommendations for the further consideration of the NMM under the UNFCCC.

P-4414-07

Science Policy dialogue to formulae Low carbon society blueprint of cities in developing countries – The case of Iskandar Malaysia

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Our common future under climate change needs knowledge sharing platform to promote low carbon societies (LCS). It is imperative in long run for developing countries "leapfrogging" to low carbon society to stabilize climate. Fast growing cities in Asia including Malaysia have large potential to leapfrog to low carbon societies by integrating mitigation and adaptation measures in managing urban development infrastructure to cater for the rapid urbanisation and industrialisation. With holistic climate resilient planning, low carbon society blueprint may achieve the co benefit of government objectives to strengthen economic competitiveness and improve quality of life, and its aspiration for promoting green economic growth and greater sustainability.

This presentation outlines the experiences gained and lessons learnt through the multidisciplinary 'Science-to-Action' (S2A) approach to drawing up and mainstreaming the Low Carbon Society Blueprint for Iskandar Malaysia 2025 (LCSBP-IM2025) for implementation in Iskandar Malaysia (IM), a rapidly developing urban region in the southernmost tip of Peninsular Malaysia. This is also in line with the commitment of Malaysian government to the voluntarily reduction pledge in COP15 of carbon emission intensity of GDP by 40% by 2020 based on the 2005 level.

The LCSBP-IM2025 is the outcome of an internationally funded joint research under the SATREPS program that brings together Universiti Teknologi Malaysia (UTM), Kyoto University, Japan's National Institute for Environmental Studies (NIES), Okayama University and the Iskandar Regional Development Authority (IRDA) in a unique 'academia-policymaker' partnership towards crafting a LCS pathway to guide and sustainably manage the projected rapid development in IM in the next 10 years. A methodology has been developed to formulate IM's future LCS scenarios; propose 12 LCS Actions to achieve the LCS scenarios; quantify the GHG emission reduction potential of the proposed LCS Actions with Asia Pacific Integrated Model (AIM models) ; and continuously engage local stakeholders for feedback and opinions in a series of Focus Group Discussions (FGDs).

To ensure effective implementation of S2A, since the Blueprint's launching, the Iskandar Malaysia Actions for a Low Carbon Future was launched, outlining 10 priority projects selected from the LCSBP-IM2025's 281 programs for implementation in IM in the 2013-2015 period; the projects are now in various stages of implementation, yielding real impacts on IM's progression towards it LCS goal.

The project offers valuable lessons especially in terms of advancing scientific research on and, importantly, into real actions LCS into policymaking. These include the importance of having strong highest-level government support; aligning LCS Actions and programs to higher-level development priorities; taking policymakers on-board the research team as active researchers; continuously actively engaging local communities and stakeholders through FGDs; and overcoming 'science-policy gaps' and 'disciplinary gaps' that are bound to arise. Most importantly, the methodology can also be disseminated to other developing countries where implementation of low carbon society policies that will eventually contribute to mitigating global climate change through real cuts in GHG emissions while still achieving a desired level of economic growth.

P-4414-08

A study on the Korean model for greenhouse gas mitigation of livestock industries

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GGIRC of Korea reported Korean agriculture emitted 22 million tons of CO2 eq., which is 0.6% of total emission, 688.7 million ton CO2 eq. in 2012. Korean livestock industries are characterized by the intensified production system and the heavy dependency on the grain imports. Recently Korean livestock industries have been suffering from many problems like feed price increase, animal pandemics, increasing meat imports, and harder control on the environmental problems including GHG emission. In 2010, average Korean consumed about 110 grams of animal meat daily (excluding dairy products, fish, and soybeans), and they love to eat grilled-beef ribs and bacon high in fat. The population of the obese people and the death toll from the circulatory problems have been rising steadily in recent years, which raised the national medical expenses and the import budget of the meat and feed grains. They should tackle on many GHG-related problems of Korean livestock industries collectively, including the obesity, the residue utilization, the clean energy supply, the animal disease control, and the grain import, all of which are inter-related and caused by the human activities.

For GHG mitigation of livestock industries, they should start from the nutrition education programs, which could persuade the people to cut down the fatty meat intake to a recommended level to control the urgent obesity problems, and they have to renew the animal production system urgently to a renewable one, which they could manage the feed supply, and control the animal pandemics and the pollution problems. Korean meat grading system giving the top grade to the heavily marbled meat must be amended to a healthier meat grading system. The import of bacon meat must be taxed on the basis of fat content. The fattening practices of cattle before marketing and the high-grain feeding must be abandoned. Recently probiotic lactic acid bacteria have shown to decrease the intestinal and the rumen gas production as well as the noxious smell of the man and animal feces. More researches are needed for the ruminant yogurt which could decrease GHG emission and enhance the feed efficiencies, which will provide a natural tool to solve the GHG problems of animal industries. The organic residues from livestock operations, food industries, and residences must be collected and digested anaerobically for the production of clean biogas as well as organic fertilizer, which could help the GHG problems, the pollution problems, and the clean energy demands. This concepts for GHG mitigation is hoped to help the nation to decrease the GHG emission from livestock industries and to solve other related problems, like the grain import budget and the national medical expenses. When we consider our history of meat-eating, the dependency on grain import, the obesity problems, and many difficulties of Korean livestock industries, this model for GHG mitigation could be a probable one especially in Korea, which might serve the nation as well as the world then. The methane fermentation is ancient, prevalent, and natural, but I believe we could manage to control GHG problems from livestock operations for our common future.

P-4414-09

Shifting the Epistemology of Gender and Climate Change

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To move the discourse related to gender and climate change beyond the conceptualization of women as a homogenously vulnerable group, we engaged in a social learning experiment that led to the creation of the Gender and Inclusion Toolbox jointly produced by CCAFS, ICRAF and CARE. By documenting the processes used, we were able to observe how changing research power and norms, and shifting incentives through partnerships, were possible despite the complexity of actors and interests involved. We achieved triple-loop-learning, as feedback from scientists and field-testing looped back to re-evaluating and changing modules, methods and practices. Joint learning can happen in planned or unplanned ways, and research interests shifted too autonomously to involve all planned partners, while opportunities to work with others arose. In this sense, the triple-loop-learning that lead to the decision to orient the Toolbox as a development practitioner's resource rather than a purely research resource also led to changes in our partnership needs. As we moved away from expert knowledge and technical language, the assumption that communities have the capacity to shape discourse and also their own development visions took better hold. In this way, the role and sensitization of development practitioners in doing participatory research and social differentiation analysis became of upmost importance in promoting social learning across diverse groups. Shifting the research process to be more participatory and investing in downstream actors can be a critical intervention to improve gender and social differentiation analysis. If development practitioners are not expected to share in responsibility over research outputs, and in many cases have no idea what research objectives and approaches in a study are, conducting gender-sensitive research in particular becomes highly problematic.

P-4414-10

Integrated Assessment Modelling to Enhance Climate Policy Design in Thailand

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In the climate change framework, there is a gap between modeling analyses and policy development. The adoption of national climate policy from modeling analyses depends on several factors. Through policy dialogue on pathways to low emission development, Thailand succeeded to reflect the modeling analysis into actual policy development in its Nationally Appropriate Mitigation Action (NAMA) in 2014. Thailand's scenario studies on NAMA and NAMA roadmap development in the country have been very successful. In COP20, Thailand communicated its mitigation pledge for greenhouse gases (GHG) reduction potential in 2020 to UNFCCC. Thailand experienced in Integrated assessment modelling (IAM) in the climate policy design. In addition, presently Thailand is also employing IAM in designing its Intended Nationally Determined Contribution (INDC) for its GHG reduction potential in 2030. It is clear that the IAM is an effective catalytic role to enhance the policy dialogue. This lesson learnt can be applicable to other regions as a "good practice" of climate policy design; though adaptation is needed to fit local conditions.

P-4414-11

Cross-Cultural Dialogue for Sustainable Develoment ethics

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After investigating Climate Change from a sociological and a cross-cultural perspective, I realized that the problem and the subsequent ecological crisis in which we find ourselves today is, above all, an ethical crisis. My work and research has no higher aspiration than to recapitulate some of the prima facie thoughts on sustainable development ethics to better address the cross-cultural Climate Change Dialogue and negotiations. No doubt the subject is vast, complex, and almost incomprehensible. However, I assume the risk of a disorderly exhibition of ideas because I believe that it better reflects the current state of ethical thinking towards climate change crisis.

The motley collection of ideas presented may seem broad, heterogeneous and little detailed; it is just a hint that obviously is neither finished nor exhaustive. Its purpose is to delineate some of the regulatory requirements, cognitive preconditions and political preconceptions that may be needed for an ecological reorientation of activities and social practices. I am convinced that there is much to think and a lot to work with: it is essential not to fear ridicule and to make continuous proposals, like bottles thrown into the sea.

Along my presentation, the aim of my research and work will not be to make a specialized proposal. On the contrary, after establishing the technical state of the question on climate change, I will devote a few paragraphs to the explanation of a fundamental principle for understanding why we reached this ecological crisis. Thereupon, I will try to demonstrate a central point: the importance of recovering the cross-cultural notion of planning. Finally, and after having presented some past ethical principles that guide present time, I will summarize the central problems and some of the main contributions that ethics can provide on the sustainable development question.

The problem that I will first address in my presentation is simple: to what extent climate change and sustainable development is a social challenge that requires an ethical approach? The fact is that international climate change negotiations are complex, especially because we are talking about different cultures sharing the same problems, but not necessarily sharing the same perspective about its solutions. A first clue is that socially, politically and ethically, we must act on the one factor that multiplies the emission: population. In other words, it's not about «the way» we do things, but about what we do. We will have to expose the cultural roots and understand the cross-cultural idea that mankind is to seek best performances, efficiency and good results.

Whence, we can ask: is there another way of conceiving cross-cultural Climate Change dialogue?

There are no doubts: the problems of climate change comes from the current harmful development program, initiated with the Industrial Revolution. This is when it was born what Tim Jackson (among many others) calls the myth of unlimited growth. Climate change leads this problem to the ethical question of how we have to conduct ourselves with respect to future generations (which, according to the UN, are also a part of humanity). Under the aegis of the idea that we will be able to solve everything in the future, it's been a long time since we are running forward, en "fuite en avant".

To expect that a new cross-cultural conscientiousness is led by the current state of political representation seems nonsense. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity -linked most of the time to the myth of unlimited growth and a conception of men as a free consumer-. But prosperity can not be reduced to the accumulation of material goods. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that encourages work culture, happiness, health, education, long-term planning and that helps to build a renewed confidence on society based on an ideal of diversity and common destiny.

P-4414-12

Development of scientific tools and their application to Asian countries toward low carbon society

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Asia will play an important role to achieve the 2 degree target because the region is expected to witness rapid economic growth during the 21st century. Resulting greenhouse gas emissions are likely to grow rapidly as well if appropriate countermeasures are not taken. In Asia, researchers have been increasingly working together with

a common goal in the development of future scenarios and collective solutions for realizing a low carbon society. Together with several Asian researchers we have been carrying out analyses of the various initiatives with a focus on low carbon society. Based on our integrated assessment model, the Asia-Pacific Integrated Model (AIM), as a common tool of analysis, quantitative visions and roadmaps to achieve the 2 degree target have been investigated, and results shared among researchers in Asia. The researchers in Asian countries have been applying the AIM to analyse low carbon future targets and optimal roadmaps for their countries. They have been sharing results and the implementation process in order to design collective solutions for national low carbon policies, infrastructure plans, eco-model city designs, and industrial transformation characteristics. During all these collaborative research network activities, scientific methods such as analytical techniques, simulation models and evaluation indicators have been shared, investigated and refined. Moreover, these international research platforms have already made tremendous contribution to comparative analysis of socio-economic characteristics among different countries, and to actual policy making process through dialogues between stakeholders and researchers. The purpose of our presentation is to demonstrate, firstly, the structure of the AIM as the integrated future scenario simulation system toward analyzing low carbon society and developing roadmap to achieve 2 degree target. Secondly, we will showcase examples of transformative actions towards low carbon society in some countries. The examples include project designs that lead to green city such as low carbon new city development plan. Thirdly, from our experiences of the interaction between researchers and policymakers, we will show the importance of scientific analysis based policy discussions. Fourth, we will demonstrate the use of monitoring and observation system in order to validate future scenarios for low carbon society and develop roadmap to achieve 2 degree target. Finally, by combining all these efforts, the presentation will highlight Asian example as a reference for rest of the world in regional cooperation, collaborative process of developing integrated tools and common solutions to realize low carbon society.

P-4414-13

Vulnerabilities and threat models on smart grid cyber security: A survey

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When smart grid was inverted, two out of many main purposes were to have self-immune on vulnerabilities and threats posed on it. Lot of thread models have been developed to achieve these purposes on smart grid but up-to-date there is no better achievement [1]. These vulnerabilities and threads are posed by attackers on the building blocks of smart grid like, meters, communication media, billings, electrical transmission, power generators etc [2]. When these components are being maintained, they give loop whole to pose vulnerabilities and threats [2]. These attackers want to analyze plan inadequacy, poor design in components or building block in order to steal identity of end user, conduct deception and divulge sensitive information and data [3]. Most of these vulnerabilities are not clearly known by many researchers, some of them are not listed anywhere [2]. These leads the question that do we have enough threat models to mitigate these vulnerabilities [1]? To answer these questions is to first conduct a survey. Albeit there is no other project that encompasses on vulnerabilities and threat models on smart grid cyber security: A survey.

In this project proposal we will survey, discuss and summarize new threats and vulnerabilities on smart grids cyber security, after that we will survey the current developed threat models or solutions on smart grids cyber security and compare their strengths and weakness. These will be measured by checking if one threat model can mitigate more than three vulnerabilities, table of vulnerabilities and thread models will be provided. After that indication of where improvement will be done in all models is going to be indicated in the conclusion of the paper.

Definition of threat modeling

This is a solution that recognizes a set of vulnerabilities (potential attacks) on a specific product or system and precise how these attacks might be inflicted and the best technique of blocking potential attacks. Threat models are used as input to the creation of test plans and cases [1].

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P-4414-14

Biosphere to Noosphere: Creating People with Planetary Mindset

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More than three decades of collective action towards securing our common future reveals that efforts primarily pegged on scientific stubs alone are inherently incapable of transforming human society into sustainable trajectory. The centrality of social sciences in this endeavor has dawned on mankind. It is unequivocally acknowledged that value enriched education is a non-negotiable prerequisite for sustainable development.

Three out of the five pillars of education (to know, to be and to do), as defined by UNESCO, (Anonymous, 2012) are physical and social embodiments in the Biosphere. They are easy to comprehend, define and achieve. The remaining two pillars (of living together and to transform) are embodiments within Noosphere. They are abstract, difficult to comprehend, express and realize.

Achievements of modern education, based on the former set of pillars are informative, but not transformative. Drawing from the Freudian ice berg analogy of human mind, the authors state that modern education; despite its remarkable achievements in physical and social planes, is deficient in its ability to transform human attitude. It is limited to the conscious part of human mind - tip of the ice berg. Sub conscious interventions transform human attitudes and social behavior.

This paper reaffirms preliminary findings reported previously by the authors on human attitude to sustainable development. Attitude of 750 respondents in Trivandrum, India, spread across all strata of society, towards the notion of sustainable development was evaluated using semantic differential technique (Osgood et al. 1957). It involved asking respondents to independently rate a set of statements on sustainable development using a set of bipolar adjectives on a seven point scale.

Semantic differential analysis reveals information on three dimensions of Evaluation, Potency and Activity. Evaluation assesses whether the respondents' perceive the notion positively or negatively. Potency is concerned with how powerful the topic is for the respondent and activity expresses the respondents' approach to the notion.

Whilst three quarters of respondents evaluated sustainable development positively, hardly two-fifth of them felt the notion had any power and reported any active approach. Both the potency and activity of the notion of sustainable development showed an inverse relation to level of education. This was more pronounced in working women in nuclear family. The results reaffirm the sub-criticality and exposes perceptional flaws of modern education in fostering transformative changes. Figure 1 depicts the threshold required to ensure transformation of human attitude. A numerical solution to the surface plot will provide us a quantitative estimate of efforts needed to make education transformative.

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P-4414-15

«Warming and Greening»: An assessment of farmers' capability to curbing water disasters in Muooni Catchment, Kenya

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In the 16th century B.C. Moses the prophet saw «a burning thornbush» that was not consumed. This account has thrilled many of us for centuries beyond any imagination. Thanks to recent scientific knowledge, which has unveiled similar adaptation to the global warming. Yes, climate change is a threat to life supporting ecosystems, and particularly to forests and freshwater resources. This study puts in motion Moses' account of the "burning thornbush" in an ecosystem similar to that of Mount Hored: the semi-arid and hilly Muooni Catchment of Kenya. The research used rigorous scientific methods and tools to assess vulnerability and capability to curb exposure to hydro-meteorological hazards, social risks and economic misfortunes facing farmers in the course of climate change. The study used innovative and integrated Vulnerability-Capability Assessment (VCA+) techniques for agricultural water adaptation to climate change. Results from the study show without any contradiction that farmers living in Muooni Catchment are mostly vulnerable to drought than flood. This can only be attributed to the high risks of changing hydro-climatic conditions triggered by ill-planned land-use activities and subsequent environmental changes, which are likely linked to the global warming, to sea surface temperature rise, high ocean currents and atmospheric wind pressure occurring in the southern hemisphere, and which are commonly known as El Niño (flood) and La Niña (drought). These factors are well known to impact on the farmland productivity and the sedimentation of water channels. However, it comes out from the analysis that individual farmers' capability to adapt to future disasters will largely depend, not on their endowed capacity (or resources) but on the integration and preparedness of their community to disasters. These factors combined with high investments in water infrastructure, operations and maintenance may lead to water and food security. Farmers hence need to incorporate these drivers, risks and impacts in their decision-making for their future investments and adaptation to environmental changes. This may enhance their capability to manage water resources, land and subsequent institutions thus decreasing their vulnerability to water shortages. Moreover, a green economy has been propounded to be a true paradigm shift from "Business-As-Usual" (BAU) to behaviour change and climate adaptation. This may contribute to preserving our forest and freshwater reserves under the threat of greenhouse gases emission and increasing surface temperatures. All stakeholders are invited to cooperate in environmental conservation through adjustment of their lifestyles and land use activities, owing to uncertain climatic vulnerabilities. Whether acting independently ("autonomous" adaptation programme) or collectively ("planned" adaptation programme), farmers are called to increase their adaptive capacity and ability as a community to respond to climate risks and impacts and take advantage of the benefits arising from a green water economy under «Warming and Greening».

P-4414-16

Obstetrics Risk of HIV infection among women attending antenatal clinic in General Hospital Suleja, Niger State, Nigeria

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Background: Obstetrics risk and practices can lead to the spread of HIV/AIDS. Identifications of such obstetrics risk of HIV infection is a useful step in the prevention of transmission of the virus. Objective: The research sort to determine obstetrics risk of HIV infection in pregnant women attending antenatal clinic in General Hospital Suleja, Niger State. Methods: The researcher conducted a cross-sectional descriptive study of pregnant women attending antenatal clinic in General Hospital Suleja, Niger State between August and December, 2014. Data were collected using structured questionnaire. HIV screening and confirmation was carried out on pregnant women after voluntary counseling. Results: 350 pregnant women were enrolled with a mean age (+or-SD) of 26.8+or-6.4 years. The highest number of HIV infected women was observed in those who had their first coitus between 16 and 20 years. The age at first coitus was significantly related to the HIV infection (P=0.41). Neither parity (P=0.13) nor past history of abortion (P=0.42) was associated with HIV infection. Non of the 41 women who had their last delivery at home had HIV infection compared with 9.8% of the 194 women who delivered in the hospital clinic (P==0.008). 40% of those who had their last delivery in primary health care centre had HIV infection while 22.2% of those who delivered under the care of traditional traditional birth attendant had HIV infection. Conclution: Obstetrics practices mayencourage transmission of HIV infection. This calls for re-examination of the obstetrics practices especially in our primary health care centres in order to prevent transmission of HIV infection.

P-4414-17

Effectuating Humane Societal Transformation through Effective Collaborative Governance - A Holistic System-Cybernetic Model

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In order to ensure reliable governance and control of the Great Transfromation21 (The paradigm for the special kind of change called substitution or creative destruction) Malik is providing the most advanced systems, tools and methods for mastering complexity and ensuring effectiveness.

While in earlier times, societal revolutions were induced by groundbreaking technological innovations, today social technology of system-cybernetic management will revolutionize the functioning of companies, societal organizations and whole countries.

The Malik Governance Systems® - Management operating systems of a new era Management for people and management for organizations are the fields of application of Malik's holistic management and governance systems. These systems create the conditions in which people can effectively transform their own strengths into performance, thus achieve their goals, see meaning in what they are doing and find fulfillment.

The Malik Governance Systems® have unique characteristics that enable people and organizations to overcome any management challenge. The Syntegration® methodology is at the heart of the transformative power - a highly innovative social technology for profound change. It increases the performance of any organization immensely.

During a Syntegration the knowledge of a large group of people is effectively combined. Executives around the world apply it for developing solutions to their most complex challenges and for simultaneously achieving strong commitment and fast implementation. The basic model for the functioning of Syntegrations is the most complex platonic solid, the icosahedron and its geometrical-mathematical properties. These determine the logic of the communication linkage of large groups of people.

The Syntegration approach allows highly complex challenges, often interlinked across the whole organization or even across sectors of society to be mastered quickly, effectively, cheaply and holistically. This requires the simultaneous collaboration of all the specialists who, when networked together, have the necessary knowledge to find solutions for the problems.

The results of the Syntegration include the following two effects: on the one hand, it leads to innovative solutions by releasing the existing creative intelligence in the system, and by making full use of all available knowledge. On the other hand, the hierarchy-free participation of all those involved mobilizes the social engagement required

for efficient, accurate and speedy implementation. The effectiveness and speed of this method are much higher than with conventional methods. It works without the periods of inactivity, which usually occur at big events, and with a precision hitherto regarded as impossible in change management.

The Syntegration method proved its high level of efficiency and reliability in more than six hundred applications across society in Businesses (e.g. Food, Energy and Automotive), Science (e.g. Helmholtz-Institute and German Cancer Research Center), GOV (e.g. Cities, Higher Education and HealthCare) and clusters of same (e.g. SolarValley, an internationally established cluster of photovoltaics (PV)).

P-4414-18

The Economics of Mitigating Climate Change: Factors Usually Neglected

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There are many problems with the traditional use of integrated assessment models for the purpose of quantifying the net economic impacts in the very long run of mitigating climate change. First, the modeling teams almost completely ignore uncertainty both as it affects the models, the estimation of parameters, and the input assumptions. Second, reasonably broad ranges of sensitivity analyses are never performed. Third, the discount rates assumed are very high. Fourth, the role of enhanced energy and resource efficiency is usually underestimated. Fifth, the models do not typically allow for transformative scenarios whereby past trends can be radically altered. Sixth, live style changes are typically ignored which could facilitate mitigation efforts and policies. Seventh, new laws and regulations for mitigation are usually ignored. Eighth, policies such a increasing the role of mass transportation are usually ignored, in part because most integrated assessment models can not model changes in transportation modes for either passengers or freight. Ninth, the impact of reducing income inequality between and within nations on the potential for mitigating climate change is ignored. Finally, the absolute amount of investment needed to mitigate climate change is usually dramatically underestimated, and issues related to how such large investments could be financed on a sustainable basis are often excluded from research papers on the long-run economics of mitigating climate change.

P-4414-19

The Sustainable Energy Utility as a transformative solution to 'utility 2.0'

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Economic development decision-making criteria throughout the 20th century relied heavily on economic optimality as a chief guiding principle in the design of energy, technology, markets, and policy. Proposals to redefine energy progress on sustainability principles gives rise to an emerging 21st century sustainability paradigm revolving around commons-based economics and long-term ecological viability. An existing operational expression of the new paradigm - the Sustainable Energy Utility (SEU) [1],[2] - is analyzed as a practical means to arrive at the New Economics and New Policy which might guide the energy sector under a 21st century sustainability paradigm. The SEU is compared and tested against other candidates for 'utility 2.0', most notably the Energy Service Utility in order to establish the transformative potential of the SEU application.

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P-4414-20

Strengthening Nomadic Herders' Traditional User Groups for Sustainable rangeland management in Mongolia

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Nomadic livestock herding has been the livelihood of many Mongolians for centuries. For countless generations, herders have lived in harmony with the fragile and sensitive ecological systems of the semi- arid and arid rangelands which make up 80 per cent of the country's total land area. Rotational grazing between four seasonal rangelands and water access combined with the balancing of livestock numbers to suit the carrying capacity enabled rangelands to regenerate, as did the setting aside of reserve areas for use during emergencies and natural disasters. These have been the core practices of nomadic herding that have ensured long-term environmental sustainability.

At the start of the transition period, there was a rapid increase in the number of "new herders" - many of whom were former State employees who had lost their jobs and turned to herding as a means to support themselves and their families. Since then, the number of herder families has doubled, as has the number of livestock. The use of public rangelands, however, has remained unregulated and they can be used by anyone. This has had a number of negative consequences: Chaotic and opportunistic behaviour in rangeland use at the expense of traditional herding norms and practices, encouraging herders to increase animal numbers without regard for quality; and discouraging an ownership mentality and impeding the initiatives of herders and local governments, providing opportunities for local elites to secure exclusive rights to productive rangelands, which generates inequality and endangers the sustainable foundation of herders' livelihoods.

In the mid-2000s, the Mongolian government began to take measures to address the problem and to ensure the proper use of public rangelands, with the first Land Law enacted in 2006. Under the Land Law, herder families with shared access to seasonal rangelands and organised on a voluntary basis to collectively manage the land are able to negotiate Land Use Agreements with local authorities. To ensure more effective implementation of the Land Law, the government adopted an annual local land-management planning methodology in which local governments are required each year to draft rangeland use plans, to be implemented and monitored with the participation of the herding community. Despite this initiative, the implementation of the Land Law and the planning methodology has proved to be insufficient, largely due to poor capacity at the local government level and inconsistent government policy resulting from increasing conflicts of interest that favour the issuing of mining licences on former rangelands. In addition, raising awareness and capacity development at the level of herder households is a time-consuming task.

Since 2008, the Green Gold Project, in cooperation with local governments, has supported herders' traditional user groups - Pasture User Groups (PUGs) - in order to develop the capacities needed to collectively develop and implement grazing plans and regulate the use of common seasonal rangelands. In the intervening years, about 1000 PUGs have been supported. By September 2014, about 400 of those PUGs had negotiated land-use agreements with local authorities based on collective rangeland use plans and the adoption of internal regulations. In those soums where herder families have become organised and have adopted collective rangeland use plans and regulations, the implementation of annual soum land-management planning has become more feasible. The division of responsibilities between herders and local governments in managing rotational grazing, stocking rates and the management of hay-making and reserve areas has become clearer and is thus better implemented and monitored. At present, PUG Land Use Agreements are the only legal documents assuring herders of their traditional user rights to their rangelands.

P-4414-21

Our Common Future, Our Common Global. Approaches from an educational experience towards collective action

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"…When we understand how much we depend on nature then we will start this huge cultural change we need to be more sustainable…" Antonio Tironi Silva, Young Scientists Network Conference, Villa Vigoni, Italy, 2014 (Video available at www.icsu.org)

A common future under climate change will need deep behavioural changes. We need to learn more about threats and risks, to reduce vulnerabilities, to increase our capacities to adapt to global environmental changes, and to reduce our pressure on the environment. We need to sustainably live under uncertainty within a complex human-nature world.

We can think about climate change as a major threat to humans and nature, a threat to our common future, a tragedy of our global commons. Despite quite strong, short term global actions are required if we are to avoid this and other threats to and from global environmental changes, equally strong but long term individual and collective behavioural changes will be necessary.

This presentation is about an educational experience aimed at fostering behavioural changes at the individual level and towards collective action. We present results from a local experience through formal education at the National University of Rio Cuarto in Argentina. An ongoing Project (PRODEC*) which aims at introducing environmental issues within all discipline curricula at our University based on the premise that most of our students are those future professionals and educators that at different levels and within different spaces will have the opportunity and hard challenge to foster that huge cultural change we need to sustain life on Earth.

The Project started in 2013 with the integration of professors from different disciplines, within the social and natural sciences, interested in an interdisciplinary approach to global environmental changes and challenges through formal education. The Project has been associated to a request from the Humanities school at our University and nurtured from the demand of a Secondary school with a trajectory in "education for the environment". To date, four workshops have taken place: one with undergraduate students from our University; one with students for primary education; and the other two, with students from first years of secondary school. In all cases, each workshop was structured in three phases: a) an oral presentation accompanied by allusive photographs, pictures and diagrams to the presented global environmental threats and challenges; b) the development of competitive and cooperative games; and, c) a space for creativity from group productions (posters made by students) related to what has been experienced, followed by a fifteen minutes presentation by group. Each workshop started with an impersonal individual written inquiry about their expectations for the workshop and ended with another individual appreciation on what has been experienced, in a written form.

Main results from these participative dynamic experiences may be summarized as follows: a) all students show themselves eager to learn more about what is going on at Planetary scale concerning the relationship human-environment; b) there is a widespread willingness to reconnect to nature -i.e. through different activities within and outside the University; and, c) there is a kind of widespread happiness when discovering the possibilities to solve problems through collective action.

To date, these experiences have allowed our working team to increase our expectations on introducing environmental issues within all discipline curricula at our University through this type of workshop activities, even we have not been able to assess the extent to which these activities may have transformed students behaviour yet.

* PRODEC Team: Rached S; Aguilar Mansilla F; Echenique H; Tello D; De Luca N

P-4414-22

Dynamic of agricultural innovations diffusion in Burkina Faso

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This study highlights the factors determining the spread of agricultural innovations for water harvesting since the drastic effects of drought 70s in Burkina Faso. These innovations include zaï, stone bunds, bunds land, half-moons, mulching and grass strips. A survey of 629 farmers revealed that farmers fall into five categories which are the pioneer, early, latecomer, late and non-adopters. After four decades of diffusion (1974-2013) the rate is estimated at 69.3% for stone bunds, 49.1% for zaï, 26.2% for grass strips and less than 10% for half-moons, bunds land and mulching. The multinomial logit model showed that the climatic conditions in the Sahel zone, age and perception of increased dry spells of farm households promoted the spread of these innovations. However, the low level of organization and access to agricultural services were the major constraints to their adoption.

4415a - Urban policies for Accessibility, Mobility and Informal settlements in the Global South to cope with Climate Change: Emerging Issues, Innovations and Opportunities

ORAL PRESENTATIONS

K-4415a-01

Urban form, mobility and greenhouse gas emission in African cities: the case of Yaoundé

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Short summary: (max 15 lines)

This contribution using the city of Yaoundé with a mono centric spatial form, as a case study, aims to show how accessibility is created through the link between urban form and transport services.

The main finding of the estimation is that CO2 emissions is linked to mobility practices associated to distance covered. Consequently, urban form and mobility planning in Yaoundé are not CO2 neutral. The mono centric spatial form of the city of Yaoundé with a spatial concentration of services and economic activities, low residential density likely induces high level of travel demand. Associated with high emission of greenhouse gas services, induces high level of CO2 emissions. The main policy herald should be the necessity to insist on putting in place an integrated land used and mobility plan with a specific focus on non-motorized facilities and mass transit solutions.

Full abstract: (max 34 lines)

Urban sprawl and mobility are currently becoming an important concern in developed countries with the principal challenge being the reduction of greenhouse gas emissions. Nonetheless, in sub-Saharan Africa where household's motorization rate is still weak, the main issue appears to be adequate transportation. This communication aims at shading light on integrated land use and mobility planning actions with a focus on reducing vehicle emissions, introducing clean fuel and clean vehicle technologies, improving fuel economy and reducing CO2 emissions.

Estimates by Godard (2002) for some cities in Africa indicate that CO2 emissions rate is weaker than certain capital cities in Europe. However, studies by CERTU and STC (2002), redone by Duprez (2002), highlight the interest of this question by comparing greenhouse gas pollution between buses and business associated with small size low cost vehicles in Abidjan. Results indicate that, those taxis reject more CO2 emissions than minibuses and buses.

This contribution using the city of Yaoundé with a mono centric spatial form, as a case study, aims to show how accessibility is created through the link between urban form and transport services. The aim of the paper is to evaluate accessibility policies by measuring the consequences of urban sprawl on the production of greenhouse gas emission, within the context of an African cities experiencing growth, where mass transit has not been adopted as a pertinent solution for urban displacement. Using data from the third Cameroon household consumption survey (2007) and the urban displacement Plan for Yaoundé (2010) describing mobility is realized by individuals on a daily and weekly basis, the study estimates the rate of CO2 emission according to characteristics associated to displacement as well as urban form.

The main finding of the estimation is that CO2 emissions is linked to mobility practices associated to distance covered. Consequently, urban form and mobility planning in Yaoundé are not CO2 neutral. The mono centric spatial form of the city of Yaoundé with a spatial concentration of services and economic activities, low residential density likely induces high level of travel demand. Associated with high emission of greenhouse gas services, induces high level of CO2 emissions. The main policy herald should be the necessity to insist on putting in place an integrated land used and mobility plan with a specific focus on non-motorized facilities and mass transit solutions.

K-4415a-02

The EASI (Enable, Avoid, Shift, Improve) concept: a climate-friendly policy framework to ensure accessibility and sustainable mobility in urban areas of developing countries

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The objective of this presentation is to discuss the results of a major study recently carried out under the aegis of the SSATP on the basis of which a new approach to sustainable urban transport in developping countries, the EASI (Enable, Avoid, Shift, Improve) concept, was developed. The SSATP is the Africa Transport Program, administered by the World Bank and funded by various bilateral and multilateral donors. The SSATP is the main donor supported African fund dedicated to knowledge creation and capacity building in the transport sector.

The study took place in 2013-14 and focused on African cities. Although specific to the African context, the study's findings and recommendations apply to most developing countries particularly those with low to medium GDP per capita. The study's goal was, first, to identify through a bottom-up approach the key constraints to the efficiency of urban mobility systems and accessibility in Africa, including the cities' ability to reduce green house gas (GHG) emissions and to adapt to potential extreme climatic events, and, second, to present priority policy measures needed to address these constraints. The study is based on a systematic and thorough data collection effort of a scope never carried out before. Twenty cities (metropolitan areas in fact) were selected for the data collection. A detailed set of information in eleven domains was collected for each city in the same format.

The key weaknesses that were identified were the following: (i) inadequate governance systems, although there was a lot of variability in this among the cities; (ii) little progress with respect to land-use planning and control and their integration with the development of mobility systems; (iii) insufficient system optimization of the various transport modes; (iv) unplanned development of informal, environmentally unsound, small public transport providers; (v) serious deficiencies in the design of infrastructure and in its operation and maintenance; (vi) high level of traffic accidents; and (vii) neglect for the environmental impact of transport and the resilience of cities. A major consequence of these weaknesses is that urban growth produces much greater GHG emissions in the transport sector in Africa than it needs to do. The presentation will examine in particular the relationships between two indices developed during the study to assess the level of governance achieved by the cities as well as their performance vis à vis mobility and accessibility, and, indirectly climate change.

The presentation will then discuss the key elements of the policy framework needed to address the above issues. It will show that the ASI (Avoid, Shift, Improve) conceptual framework formulated about ten years ago to structure public action mostly in developed countries is fully relevant to African and developing world cities as long as it is adapted to the particular context of these cities. This requires that special emphasis be given to the future urban form and future infrastructure networks (including their resilience) in the "Avoid" actions, to an integrated and inclusive multimodal mobility strategy focused on non motorized transport and low cost public transport in the "Shift" actions, and to more efficient traffic and vehicles in the "Improve" actions.

The presentation will also emphasize that, for public action to take place and be effective, it is essential to establish a competent and responsible governance framework for urban transport in Africa, which will lead the transformation effort in conjunction with all stakeholders, therefore to add a set of "Enable" actions. This framework should be capable of anticipating needs, guiding action, and ensuring integrated management and development of urban transport systems. It would include the adoption of a national urban transport strategy, the adequate allocation of public responsibilities at the metropolitan level, the setting up of metropolitan transport agencies in the large cities, the fast development of human resources, the sustainable increase of financing flows to urban transport, the continuous participation of civil society in the development of urban transport systems, and the involvement of the private sector in the provision of transport infrastructure and services.

K-4415a-03

Urban Agenda for Climate Change- Meeting the mobility needs of urban poor

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India is at the doorstep of rapid urbanisation. The process of urbanisation is contributed by migration of population, with diverse socio-economic and cultural backgrounds, to cities. One common aspiration they all come with is-quality of life. Although cities contribute to more than two-third of total GDP, the flow back for city improvement is very meagre. City infrastructure is getting overstressed with the added burden of migrants. City is unable to meet the demand of migrants for housing, urban services, employment and social security.The result is islands of disparity and social divide between different segments of population on the basis of origin, socio-economic fabric and religion.

Ove the years, many attempts have been made to integrate population living in various clusters of the city. Inclusive planning is a tool, which provides opportunities for the residents to plan for their social, physical, cultural and socio-economic needs. Urban transport is an improtant entry point towards acheiving the objective of inclusive planning, for the simple reason that it cuts across all the sectors and population. Mobility is directly linked to interaction of various stakeholders, which is a precondition for generation of GDP. Mobility also consumes large resources and leads to high levels of carbon footprints.

This session would look into various planning imperatives pertaining to urban transport, with an objective of making a city 'inclusive' and environment friendly. Discussions

would focus on formulating strategies to make transport accessible to the urban poor, with an objective of reducing carbon footprints. Tools like integrated transport network, last mile connectivity, transport demand management, transport oriented development, transport pricing etc would be illustrated to demonstrate their adaptability in meeting the needs of urban poor in the making of inclusive and carbon neutral cities.

O-4415a-01

Sustainable Urban Mobility Plans: a local approach for national mitigation actions

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In European countries, Sustainable Urban Mobility Plans (SUMP) have shown how much they could be a powerfull approach to define urban transport policies that combine the multiplicity of transport modes and their actors.

In its international review, the European Conference of Ministers of Transport (ECMT, 2002) highlighted the principal barriers to effective SUMP development as poor policy integration and coordination, counterproductive institutional roles, unsupportive regulatory frameworks, weaknesses in pricing, poor data quality and quantity, limited public support and lack of political resolve.

Thanks to Nationally Appropriate Mitigation Actions (NAMA) there is an interesting potential to develop mitigation policies in developing countries by combining local urban transport planning and national policies.

The concept of the NAMA – Nationally Appropriate Mitigation Action – emerged in December 2007 during the 13th session of the Conference of the Parties in Bali (COP13) and it was detailed in the Cancun agreement in 2010. NAMAs are voluntary measures taken by developing countries – and registered by the UNFCCC – to reduce their GHG emissions. Not only do they cover investments that directly reduce GHG emissions, they also cover investment projects and programmes, as well as sector-based or national policies to reduce emissions in the medium and long term.

They must refer to a real-time situation and show the expected reductions in GHG emissions using MRV methodology (Measure, Report, Verify) to quantify the impact of the measures taken. But they have also to report on co-benefices such as accessibility improvments, congestion reduction, air quality, road safety, public health, etc.

By using a national MRV (Measure, Report, Verify) methodology, the local authorities could monitor and evaluate the impact of their mobility policies within a SUMP process, but their effort could also be encouraged at the national level, by national support and appropriated legislative framework before being submitted to the UNFCCC secretariat.

Such Vertical NAMAs in the urban transport sector could certainly facilitate sustainable urban developpement in developping countries and give to urban transport a transformational role for cities.

O-4415a-02

Transforming a Megacity: Climate Change Adaptation and Mitigation in Jakarta

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Recently, Jakarta has been selected as a city with the worst traffic jam in the world. As among the largest urban areas in the world, the city suffers various urban problems on extreme levels. In 2010, it has 771 traffic congestion points and 11,185 l/s water supply deficit. It is also struck by flood every year. Flood does not only come from the upstream areas but also from the sea. Some of its northern coastal areas experience rapid land subsidence with 7.5 cm/year on average. It is predicted that if nothing be done, water from the sea will go up into the heart of the city in less than 50 years. The rapid urban population growth in Indonesia, especially in Greater Jakarta, makes the problems in the future worsening.

The 5th Assessment Report describes how urban areas are strongly related to the climate change. It contributes significantly to CO2 emissions. Urban form and transport infrastructure, as well as density and mixed use of land use are strongly related to GHG emissions. They also have a strong link to the level of efficiency in the use of energy.

This paper explains how the Indonesian government addresses those problems, their strategies and to what extent they already implement such efforts. Do they handle it in a comprehensive manner? Wich efforts can be considered as climate change mitigation, adaptation and both? Such questions will be answered here.

The central government of Indonesia comes up with the concept of Green City, not only for Jakarta but also for other Indonesian big cities. The concept requires that a city in Indonesia needs to focus in improving the condition of its eight elements, namely Green Planning, Green Open Space, Green Waste, Green Energy, Green Water, Green Transportation, Green Building and Green Community.

In the case of applying the concept, the government is on the way of mainstreaming climate change into spatial planning. In the case of Jakarta, it tries to cope with the increasing number of motorized vehicles on the roads and the worsening traffic congestion by improving the public transport condition through the development of Bus Rapid Transit (BRT) and Mass Rapid Transit (MRT). The government also tries to connect the improvement of that public transport network with the densification of land use and the application of mixed use by implementing the transit oriented development (TOD) concept.

As for the problem of land subsidence and the sea level rise, the government has a plan to build the so called Giant Sea Wall, which can protect the coast of Jakarta and to be functioned as raw water storage. In addition, Jakarta is also increasing the size of its green open space. It may reduce the flood and at the same time cooling the city's temperature. Therefore, Jakarta is and will be experiencing a big transformation in order to overcome its problems as well as ways of climate change mitigation and adaptation.

O-4415a-03

Comparative resilience process of Asian river / coastal cities faced with hydraulic crisis

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The Asian coastal or river cities are already subject to very high stresses in their urban development. They have most often expanded behind the bank of the rivers or on the coastal areas with dikes and embankments on the river floodplains. So they are very vulnerable to natural disasters such as flooding and sea level rise.

For example, in Phnom Penh, infrastructures of protection against flooding (i.e. drainage network in the city center and large peripheral dikes) have been rebuilt only after the great flood of 1996. They have been badly damaged during the Khmer rouge regime.

In Bangkok Metropolitan Area (BMA), despite the many evacuation canals and pumping stations, major floods occur almost every year. The floods of 2011 have caused new developments in order to protect the inner city and industrial areas north of the capital.

Recently, in Phnom Penh and Bangkok, speculative projects to private investors reject in the outskirts of cities the poorest populations. The consequences are social, but also environmental. Firstly the peripheral areas, in contrast to the city center, having no embankments, are prone to flooding, with no proper drainage systems. Secondly the proliferation of high-rise towers worsens the process of subsidence and flooding vulnerability of cities. How to be resilient without being sustainable?

So we propose to compare the resilience to hydraulic crises of these river/coastal Asian cities, as well as actors and tools used in each case for the implementation of priority actions identified at the conference of Hyogo in 2005 (HFA 2005-2015). They gradually incorporate into their planning instructions to promote risk reduction, under pressure guidelines and international actors such as United Nations, the World Bank and NGO.

4415b - Transformative solutions for urban sustainability governance: Multi-level government and cross-sectoral collaboration for efficient climate action

ORAL PRESENTATIONS

K-4415b-01

Transformative solutions for urban sustainability governance: Multi-level government and cross-sectoral collaboration for effective and efficient climate action

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In this session we will focus on transformative solutions for urban sustainability governance. After more than two decades of attempting to address climate change and broader sustainability challenges through a global regime, progress has been largely incremental and piecemeal. Despite a rich theoretical tradition that increasingly addresses the normative issues in global environmental governance, and considers the crucial role of non-state actors, the application of this theory to practice often retains a biophysical or managerial lens rather than a deeply normative or socio-political one. Transformative actions are emerging, however, that may deepen resilience and trigger effective climate change adaptation and mitigation. These actions are particularly abundant at the urban scale, drawing upon novel constellations of actors, resources, and engagement strategies.

Responding to the global environmental challenge requires a deepened understanding of how urban areas relate with the environment and how they transform it. New areas of research are needed that explore the dynamics of urbanization, including the globalization of urban lifestyles and diets, which must take into account urban complexities and urban resilience for refurbished governance and urban transformations.

Collaborative engagement that includes non-state actors, non-governmental networks and civil society provides a deeper and better understanding of the complexity that comes with bridging human and biophysical dimensions of environmental policy, including social-ecological dynamics, in order to bring about sustainable development in urban contexts. This requires a shift in thinking within governance that embodies transformative pathways - with the international tools in hand (i.e., MRV regulation, transparent reporting of climate action), as well as deeper engagement with a variety of stakeholders to help build a meaningful, legitimate, and ultimately effective mode of "urban sustainability governance."

To this end, this panel brings together key scholars and leading experts on local government climate action to propose new insights into participatory, inclusive action that engages non-state actors.

The session proposed will be focused on urban environments (cities) and their climate action transformations. Examples of successful transformative dynamics and solutions tested in and demonstrated by cities will be highlighted. The session includes new insights into community-based action research on climate change; guiding principles in governance at multiple scales for efficient urban transformations; the drivers of unsustainable development paths; collective action with involvement of diverse knowledge-and-power domains and multi-stakeholder engagement towards creating transformative pathways at the local level; and approaches to standardized, transparent emissions reporting.

O-4415b-01

Urbanisation, sustainability and transformation - from local decisions to global goals

B. Webb (1) ; X. Bai (2) ; M. Stafford-Smith (3)
(1) Australian National University, Fenner School of Enviornment and Society, Canberra, Australia; (2) Australian National University, Canberra, Australia; (3) Climate Adaptation Flagship - CSIRO, Black Mountain, Australia

Urbanisation with its attendant resource and social pressures is an increasingly dominant feature of development. Substantial research addresses sustainable urban development. However, whilst there are important attempts at integration, from a 'whole of systems' perspective much of the research has been partial and fragmented. Understandably public and private sector decision makers find it difficult to encompass the full range of issues, whilst also facing a range of risks and uncertainties (including, but not only, climate change).

With much of the growth in urbanisation still to come, there is a window of opportunity to address the complex and multi-level issues from the local, regional and national decision-makers perspective. At the same time development of the UN Sustainable Development Goals, many directly relevant to urban directions, provide an overall context to address the many trade-offs and synergies faced in practice by urban decision-makers.

The presentation describes an initiative currently under development to use a wide range of Asian and Australasian urban case studies to systematically investigate:

- the extent of two-way interactions between urbanisation and sustainable development goals at local, regional and global levels
- identification and analysis of the most critical trade-offs and synergies that need to be addressed by urban decision makers at local, regional and national levels if they are to achieve sustainable, equitable, inclusive and resilient development
- the preconditions and mechanisms for cities to achieve the transitional and transformational change necessary to address the above issues
- the extent to which the key choices, trade-offs and synergies, and the transformational preconditions identified, can be related to various urban characteristics and typologies; this to better understand the potential for (and limitations in) transferability of insights, learning, practices and strategies.

It is crucial to reveal and understand these key inter-linkages, which are not always apparent, but can present both challenges (unintended outcomes or even derailment of an intervention) and opportunities (identifying the leverage points for generating and realising co-benefits). The initiative will aim to provide practical integrated cross-sector guidance to urban decision-makers at various levels, on the key strategic issues and choices they face, and relevant to their context. It also aims to develop underpinning scientific insights including a robust set of frameworks that will facilitate understanding and analysis of the impacts of various urbanisation choices and futures, at multiple levels of analysis, and so contribute more generally to future research methodology and practice.

The approach to be taken to the initiative includes analysis through research and stakeholder partnerships and collaborations with a diversity of case study cities and scales to be included; trans/inter-disciplinary approaches including knowledge co-design/development with stakeholders, recognising that multiple decision makers and other stakeholders need to be engaged to reflect the initiative's decision-centred approach; viewing cities as

complex emergent socio-ecological systems with many possible future urban pathways which need to encompass incremental and transitional as well as transformational change.

Whilst the initial case study focus is on Asia and Australasia the approaches and findings will draw on and contribute to broader international initiatives, including Future Earth.

O-4415b-02

Urban transitions

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(1) Dutch Research Institute for Transitions, Rotterdam, Netherlands

Urban transformati¬ons are complex and shockwise processes of change cocreated by formal and informal types of governance. This presentati¬ons draws from the experiences with urban transi¬tion labs to reflect upon the dynamics of urban sustainability transi¬tions, its inherent poli-cal dimension and their governance. Ci¬ties are the breeding ground for transformati¬ve changes. Not only are ci¬ties confronted directly with the impacts of unsustainability, they are also the contexts in which the high density of actors, technologies, capital and knowledge leads to experimentati¬on and social innovati¬on. This presentati¬on will build upon transiti¬on studies to reflect on the mechanisms, dynamics and patterns underlying the complex and shockwise process of urban sustainability transi¬tions. One of the features of such urban transi¬tions is that they are inherently poli¬tical: new forms of agency and governance challenge mainstream thoughts, structures and cultures to create space for transforma¬tion. It will introduce the idea of governance panarchy in this contexts: the emerging contexts in which different actors at different levels develop informal and formal governance structures to address specific complex problems. These range from local coopera¬ves to public-private partnerships, ci¬zen juries, par¬cipatory planning and social entrepreneurship. Urban transiti¬on management takes this emerging context as the basis for developing the meta-governance framework of urban transiti¬on labs.

O-4415b-03

Driving change through effective local climate action, collaboration and integrated solutions

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Setting the scene for inclusive and decisive global climate regime is not done in an isolated manner. Transformative climate action requires multi-level government and cross-sectoral collaboration for ensuring low-emission, climate-resilient development in the urban world.

Local Governments can have significant impacts on local markets and on the large-scale delivery of low emission development technologies and practices, through their mandates and different roles as policy maker, regulator, service provider and consumer (procurement processes).

This presentation focuses on the change system which is being implemented by ICLEI – Local Governments for Sustainability* and other local government networks, from the definition of a common global vision and strategy that enables the recognition, engagement, and empowerment of local and subnational governments, to the main methodologies and tools used for the collaborative identification of transformative pathways at local level. Results are presented and key barriers and opportunities are identified and discussed.

This presentation also explores the different processes, methodologies and tools ICLEI uses to identify the local unique context and priorities, and catalyze broader engagement from different actors, including the business community, to foster the development of long-term Low Emissions development Strategies (LEDS) and design and implementation of low-carbon projects and programs which are adequate to the local needs. A Measurement, Reporting and Verification framework of local climate action is also addressed, by using globally-recognized methodologies for consistency, comparison and aggregation across different entities and initiatives. Transparent reporting of local climate data is essential to ensure the credibility and empowerment of local governments as partners in the global climate regime.

As conclusion from the multiple initiatives analyzed, collaborative engagement emerges as enabler for the sharing of best practices, vertical-integration of policies and investment plans across multi- levels of government, mainstreaming low-carbon strategies into all sectors of urban planning and development, and fast-tracking climate action.

(*ICLEI – Local Governments for Sustainability is an international association of Local Governments which has more than 1000 members in 86 countries.)

O-4415b-04

Sustainability governance: the role of entrepreneurs in triggering transformative development pathway shifts

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Sustainability transitions are fluid and multi-faceted phenomena, and may be characterized by multiple 'false starts,' punctuated equilibria, and contradictory pressures (such as a shifting political landscape and economic stressors). Many of these transitions are taking place at very small, community-based scales, and are driven by grassroots or bottom-up initiatives. While the idiosyncrasies of a particular urban context may strain our capacity to garner lessons that apply to other cities, social learning is a crucial dimension of accelerated sustainability transitions. In particular, cases of established leadership and innovative responses to sustainability challenges provide important insights into the roots, enabling factors, and various pathways that sustainability transitions might follow.

Despite increasingly frequent engagement with large corporate partners, cities rarely have the capacity to meaningfully engage with the abundant variety of small businesses that contribute much of the innovation necessary for a transition to low carbon, resilient communities. These entrepreneurs are often characterized by the ability to rapidly take advantage of opportunities that others might view as risks, and create the 'radical novelties' that are central to sustainability transitions. In this talk, I explore the role that entrepreneurs in general, but small businesses in particular, can play in sustainability transitions. I investigate novel mechanisms that are emerging that might contribute to more effective governance of this group of non-state actors, and the potential that a multi-level governance approach might have to accelerate innovation.

4415 – POSTER PRESENTATIONS

P-4415-01

Mitigating Climate Change Through Managing Urban Mobility and Urban Form

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Some researches have emphasized that travel patterns and their impacts on the environment are strongly related to the urban form. It is also believed that the private automobile has been the primary cause of the expansion of cities. However, in fact, they affect each other. The urban form affects the travel pattern, and the suburbanisation is also the cause of the changes in the socio-economic context of urban life that are also responsible for the growth in car ownership.

The high-energy consumption of transport in low-density cities has become a matter of growing concern. The threat of long-term climate changes due to greenhouse gases have sharpened the awareness that present energy prices

do not nearly cover the environmental and social costs of energy use. However, there have been some suggestions to respond to this challenge. The majority of them follow the hypothesis that the energy use of urban transport is a direct function of population density and suggest a return to mixed-use, compact urban form.

Nevertheless, such researches on developing countries are still limited. Do they bring a similar conclusion? Using Bandung Metropolitan Area (BMA) as the case study, this paper tries to investigate how the urban form affects travel patterns in Indonesia's metropolitan areas. BMA is the second largest metropolitan area in Indonesia, it has more than 7 millions inhabitants in which about 67,7% of them live in the urban area. Thus, it can be predicted that it generates a significant level of urban mobility, which in turn may lower the environment condition.

This paper discovers the impacts of the urban form on the travel pattern. It tries to explain to what extent the urban form affects the travel pattern and how it is strongly related to urban environment especially through the air pollution factor.

P-4415-02

Integration of adaptation to climate change within the design process of urban planning projects : new tool(s) and new methodology(ies)

M. Colombert (1) ; M. Gantois, (2) ; L. Jacquet, (3) ; A. Leseur, (4) ; G. Meunier, (3) ; H. Nassopoulos, (1) ; JL. Salagnac, (5)
(1) Ecole des Ingénieurs de la Ville de Paris, Paris, France; (2) City of paris, Paris, France; (3) EGIS Concept / ELIOTH, Montreuil, France; (4) CDC Climat, Paris, France; (5) CSTB, Desh, Champs-sur-Marne, France

During the ADAPTATIO project, partners have reflected on the means available to address in the design of development projects the issue of adaptation to climate change in relation with mitigation. For this, the adaptation has been defined in terms of two key resources for tomorrow - water and energy - and on the economic evaluation of these two intakes. Exploring contrasted possible futures was privileged to show the consequences, including economic, of those choices. Solutions to act on the building envelope, on equipment and on the immediate environment of the buildings were identified. Each solution has an investment cost, operating and maintenance costs, and a very specific lifetime.

Thereafter, the reflections in common with professional urban development have led to two conclusions. Firstly, the adaptation does not appear to the specifications of ongoing and planned projects. The project and the daily monitoring are already very complex. The consideration of climate change during project is not easy due to the uncertainty regarding the intensity of future climate change. Secondly, this relative lack of interest on adaptation, due to the significance of the operational aspects of the conduct of operations, however, is accompanied by a curiosity to have elements of appreciation regarding the magnitude and urgency to set up adaptation measures.

Premièrement, l'adaptation ne figure pas au cahier des charges des projets en cours ou projetés à court terme, dont le déroulé et le suivi au quotidien se révèlent déjà très complexes. L'incertitude autour de l'intensité des futurs changements climatiques ne facilitent pas leur prise en considération lors des projets.

The tools developed within the project ADAPTATIO, including the «toolbox», intend to propose an answer to the needs of professionals. This toolbox processes the results of simulation software to the scale of the building on the one hand (CLIM'ELIOTH. Ecodesign tool developed by Egis Concept and addressing energy issues and comfort of buildings), to the neighborhood level on the other hand (ENVI-MET: simulation tool on urban comfort particularly taking into account the evapotranspiration of vegetation phenomena). This software uses meteorological data for 2050-2100 provided by Meteonorm. The toolbox also includes economic data regarding the costs of energy and water to the same time periods as for the climate. This tool enables meeting the wishes of professionals to have synthetic indicators on the qualification of indoor and outdoor comfort at the neighborhood level. The associated costs are also accessible. ADAPTATIO toolbox is able to raise awareness of professionals regarding the issues due to a new climate. Particular attention has been paid to the interface that further tests will lead to improvement. Its current limits are to require a complete new data entry (geometry and description of buildings and their environment) to analyze a new neighborhood.

The ADAPTATIO objective was however achieved: to make possible an exploration by professionals on the incidence of future climate on water consumption and energy of a group of buildings actually made in the ZAC Tolbiac. It is all about creating the conditions for an exchange without pretending to replace the detailed study and simulation tools operationally mobilized by the actors of urban development. The maturity of the concept of adaptation and reflections on its close ties with mitigation still seems inadequate given the analysis of research on these topics. It seems therefore necessary to continue the maturation and ADAPTATIO toolbox may help. The project has also attracted the rich exchanges at workshops and public meetings about the economic aspects of adaptation. Some steps have been taken in connection with the professional practices to facilitate the exchange between economists and practitioners about the economic and financial implications of adaptation. However the long-term outlook for costs (energy and water) is difficult to understand.

P-4415-03

CLIMATE CHANGE ADAPTATION AND RESILIENCE IN CITIES: An Analysis of the Living Community Challenge Certification

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Adaptation and resilience are emerging as key components to the paradigm shift needed in urban planning to deal with the super wicked problems of climate change and resource depletion that characterize the urban reality of the early XXIst century. However, the lack of emphasis on the examination of governance from a practical perspective is stunting the transfer of academic ideas to actual interventions and hindering the timely implementation of solutions. My presentation addresses these issues by analyzing the newly released Living Community Challenge (LCC) certification system as a conceptual framework in guiding interventions for adaptation and resilience in cities.

The presentation will be separated into four sections: 1- characterization of principal parameters in resilience and adaptation, 2- synthesis of currently applied methodologies, 3- identification of recognized barriers in adaptation interventions 4- and analysis of the LCC certification as a regulatory tool. Specifically, in the first section, I will be performing an epistemological analysis of the fundamental concepts of climate change adaptation within the context of urban planning processes. Second, I will provide a summary of current methodologies used in adaptation experiments, as well as, juxtaposing these methodologies against theoretical processes proposed by many leading thinkers in the field of adaptation planning. I will discuss the involvement of these processes in strategic program development, especially as pertaining to the importance of the multi-level governance frameworks and the transmission of information in institutional learning. The use of innovative ideas such as experimentation, market-based approaches and maintenance management will be addressed. An examination of the obstacles encountered in applying climate change sensitive modifications to regulatory aspects in cities and their related projects will examine the prevailing barriers accompanying legitimacy/power struggles and the characteristics of policy development coupled with super wicked problems.

Finally, the LCC certification system will be juxtaposed against the theoretical groundwork identified in the first three sections to establish connections between the processes described in adaptation management and the potential for real-life application in order to meet adaptation and resilience goals. The presentation will answer the following questions: Does the LCC certification meet adaptation and resilience parameters in its scope and implementation? How does the certification system measure against current methodologies applied in existing experimentation? Does the tool provide a structure which enables well-recognized barriers to be surmounted more easily or does it create potential negative feedbacks hampering its use?

As the urgency for climate change adaptation in cities increases, the need for tools which can guide practitioners in uncharted waters will become pressing. This analysis of the Living Community Challenge (LCC) examines the system within the framework of academic theory on adaptation and resilience, in order to facilitate community approaches to sustainability and resilience.

P-4415-04

Livable Urban Futures - Process and Way Forward for Urban within Future Earth

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The complexity of urban systems and the global sustainability challenges that we face require inter- and transdisciplinary research that combines context sensitive regional and global approaches to inform and challenge solutions. Although traditions of addressing urban complexities have long existed in the social sciences, humanities, engineering, and natural sciences, we have barely scratched the surface in our efforts to understand many crosscutting issues. A lack of interdisciplinary and co-produced research on the interactions and feedbacks between urbanization, urban areas and global environmental change (GEC) profoundly limits the potential to intentionally shift development pathways through planned governmental and nongovernmental actions.

Sponsored by the Science and Technology Alliance for Global Sustainability, the global research platform, Future Earth represents a new opportunity to rethink how GEC research is organized to encourage interdisciplinarity, and how it can better connect science with policy in order to offer solutions to today's grand sustainability challenges. Future Earth recently published its 2014 Strategic Research Agenda naming 'urban' as one of its priority research areas. With this changing global research landscape, a number of urban research and practice communities are currently interested in new opportunities for enriched collaboration and for expanding and enhancing the 'urban' research agenda under the Future Earth framework. There is a lot of fertile ground for innovative research to promote linkages across established or rapidly emerging areas of urban and environmental research and the Future Earth research themes.

In February 2014 and March 2015, Scoping Meetings were held in London, UK and Boulder, CO, USA that brought together representatives of different regions, disciplinary backgrounds and inter- and non-governmental organizations to begin conversations on the gaps and future needs for urban research as well as the necessary components for the design of a new urban interdisciplinary initiative.

The purpose of this presentation is to share the outcomes of the two workshops and the overall process that has been set in motion by the Urbanization and Global Environmental Change (UGEC) Project along with many other partners known as the Future Earth Urban Platform (FEUP) Working Group. This Working Group is leading the transition of the urban agenda within Future Earth through: a) the establishment of urban flagship activities and b) the design of an urban platform for facilitating interdisciplinary research coordination and co-design with urban stakeholders and practitioners. The goals for this session is to openly communicate this process of the urban transition into Future Earth and how it can better facilitate research and practice related to urban options for and limits to the transformation towards global sustainability; to offer pathways for the engagement of new communities of urban researchers, practitioners, and others; and receive input and feedback from the session participants on the process and platform design.

P-4415-05

Qualitative Scenario Building for Post-carbon Cities

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This contribution presents the results from interactions with representatives in 10 cities of different sizes, located across Europe, aimed at the development of local visions and scenarios for transitioning to become post-carbon by 2050. Findings are based on experiences from the European Union funded project Post-Carbon Cities of Tomorrow (POCACITO), which aims at the development of an evidence-based roadmap for post-carbon European cities in 2050.

By means of holding local workshops in a participatory case study approach, the foresight exercise is conducted using a two-step methodology, consisting of vision building and back casting exercises. Both exercises have a strong focus on the inclusion of stakeholders. The use of a participatory approach, where the people whose futures are being discussed are the key actors of the process, can improve the relevance, consistency, and hence usefulness of scenarios. Creative brainstorming is employed to induce stakeholders to first envision the future of their city, and then develop qualitative scenarios describing how the transition to reach their post-carbon vision might be possible. Obstacles and opportunities that might be encountered along the way are identified, and actions needed to meet future goals are highlighted. The case study cities include Barcelona, Copenhagen/Malmö, Istanbul, Lisbon, Litoměřice, Milan/Turin, Rostock, and Zagreb.

Initial results from 6 out of 10 case study cities show similar elements in the local strategies that have been proposed by local stakeholders, focusing primarily on urban projects for energy efficiency and the transition to non- fossil energy resources. The specific mix of strategies envisaged in these fields for each city depends both on different points of departure with regards to local governance (greater or smaller financial autonomy, extension of the municipal jurisdiction, etc.), and in part on specific local economic issues (development of economic sectors and/or generic aims of development). Under the prospect of urban sustainability, consideration is also given to thematic areas like consumption, as most visions contain "circular economy" as an aim, related to waste but also to energy generation. Further to "classic" urban issues in the transition to become a post-carbon city, some visions contain, for instance, a more or less generic prospective on local economic development and social inclusion. Additional analysis will be conducted to identify if the different city characteristics influence the set of actions, obstacles, opportunities, and milestones proposed during the workshops. Moreover, the actions proposed during the participatory exercise will be compared to the existing urban plans for carbon reduction. The objective of this analysis is to identify if the participatory approach provides tangible advantages.

The great homogeneity of the initial results and the high rate of correspondence to issues considered in the international debate on post-carbon transitions can be interpreted as a sort of bottom-up confirmation for these arguments. However, it can also be seen as a result of a relatively high-level of uniformity in the composition of stakeholder groups across the local case study workshops, raising the question of how visions and scenarios might be described in a forum not composed mainly by "educated middle-class representatives".

P-4415-06

Reimagining Civic Technologies for the Urban Poor in Indian Cities

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Introduction: People-centred economic transformation will play an important role in realizing inclusive and sustainable development in an increasingly urbanizing world. UN member states have therefore accorded a central place to "Make cities and human settlements inclusive, safe, resilient and sustainable" as Goal 11 on the "road to dignity" in the December Synthesis report of the Secretary-General on the post-2015 sustainable development agenda. According to UN-Habitat, the UN agency for human settlements, around 33% of the urban population in the developing world in 2012 were living in slums. Urbanization in India, like in other low and middle-income developing countries, has been characterized by

environmental degradation, deepening economic divide and rampant proliferation of slum settlements that house close to 100 million urban poor in 640 cities and towns. Slum dwellers have a poor quality of life as they are deprived of access to basic services in the area of water and sanitation, electric power, street lights, healthcare and education. Slum settlements have also been reported to have become breeding grounds for criminal incidents and other unlawful activities thus jeopardizing public safety in the neighbourhood. Moreover, greater exposure to adverse environmental conditions in the form of polluted water and air, makes the slum inhabitants particularly vulnerable to the adverse impacts of climate change.

Problem: The poor and disadvantaged slum dwellers suffer from a persistent digital and financial exclusion that prevents the fruits of Indian's economic growth from truly percolating to them. However, in spite of the rapidly deteriorating living standards of the urban poor, most government programs have paid little attention to their plight. For example, Government of India has recently embarked on an ambitious multi-year program to create 100 smart cities with an investment of over USD 1 Billion every year. The proposed initiative aims to harness the power of technology to create profound changes in how cities operate and to deliver more effective governance to their residents. While the smart city program has a strong focus on increased competitiveness and economic growth through technology-driven urban improvements, the challenges faced by slum settlements are not sufficiently emphasized. The National Optical Fiber Network (NOFN), is Government of India's largest nation-wide optical network initiative that aims to extend broadband connectivity to 600 million rural citizens of India across 2.5 lakh village offices in the country by 2017. Once again, the initiative fails to address the needs of the urban poor in slum communities since it's primarily focused on the empowerment of rural masses through broadband Internet.

Uni-Fi Architecture: In this paper, we present and discuss a universal and cost-effective broadband network architecture called "Uni-Fi" that is geared towards advancing the needs of slum dwellers in Indian cities through superior service provisioning, improved governance and a better quality of life. Each Uni-Fi node in a slum community comprises three key components: i) Wireless Streetlights with integrated cameras for public lighting, broadband delivery and remote surveillance by public safety agencies, ii) Community Kiosks that serve as broadband training centres and single-window facilitation units for government welfare schemes for low-income slum dwellers, iii) eCommerce/Deals platforms that list and sell daily-use items and other services at deep discounts to them. Uni-Fi nodes in a city are networked and managed centrally with an easy-to-use, drag-and-drop interface for transferring relevant municipal content to these devices.

Methodology and Results: A detailed techno-economic analysis was carried out to quantify and compare direct and indirect benefits of the Uni-Fi approach with competing multi-layer overlay options for varying network scales, ranging from 100 to 1000-node networks. The study observed a reduction in total cost of network ownership in the range of 30-60% for Uni-Fi over 5 years, besides accruing multiple socio-economic benefits to the state. Uni-Fi is being currently rolled out as a six-month pilot across 5 slum areas in Bangalore city in Karnataka state for proof-of-concept testing and further architectural refinements prior to scale-up.

P-4415-07

Adapting cities to climate change : a systemic modelling approach

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To answer the climate change challenge, all states have to reduce their greenhouse gas emissions, but also to adopt adaptation measures to limit the negative impacts of global warming on the population, the economy and the environment. The question arises especially for cities.

Because of complex interactions between climate change, the evolution of cities and its inhabitants, studying adaptation strategies for cities requires a strong interdisciplinary approach involving urban planners, building engineers, and researchers in architecture, meteorology, climate, economy, and social sciences.

Our four-step methodology consists firstly of defining interdisciplinary scenarios at several scales influencing the city evolution; secondly of simulating long term city evolution based on socio-economic and land-use models; thirdly of calculating impacts with physical models, and finally of calculating the indicators quantifying the impacts and evaluating the adaptation strategies.

Interdisciplinary systemic modelling performs well to evaluate several adaptation strategies for a very broad range of topics. Some of the results obtained for the agglomeration of Paris through our interdisciplinary research projects VURCA and MUSCADE will be discussed:

A finding is that urban planning strategies may have unexpected influence on city expansion when considered on the very long term of the climate change. Another is that the combine effect of global warming and UHI can lead in the future to larger energy consumption in summer than in winter.

Indeed, air-conditioning will probably be necessary in 2100, because of expected stronger, and longer, heat waves. Limiting the UHI intensity allows for energy savings, and hence contributes to climate change mitigation. Adaptation strategies exist to limit air-conditioning use, both in time and intensity.

Analysis of several vegetation strategies, at several spatial and planning scales (from agricultural practices in the city surroundings to urban trees and green-roofs) have been performed and evaluated. Architectural choices also allow to reduce the UHI. Finally, inhabitants' use and practices seem to be an efficient lever to reduce energy consumption in buildings and its impact on the urban climate.

P-4415-08

How do we Create and Build Knowledge Partnerships for Cities?: The Urban Climate Change Research Network (UCCRN) ARC3-2

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The objective of this presentation is to introduce the Urban Climate Change Research Network (UCCRN), and to foster a dialogue between global experts and local policy leaders regarding latest scientific findings and action areas on cities and climate change.

Climate change mitigation and adaptation are areas of high priority action in the urban context. These are often dealt with as separate issues in academic research, international climate talks, as well as national and local policy-making -- leading to a situation where these focus areas often compete for funding and for decision-makers' attention. The session will discuss the main challenges and potential of cities to integrate climate change adaptation and mitigation actions.

This presentation will introduce the UCCRN and present initial findings from the Second UCCRN Assessment Report on Climate Change and Cities (ARC3-2), concerning interelationships between adaptation and mitigation in cities. Synergies, conflicts and trade-offs between adaptation and mitigation will be analyzed and discussed across scales. The session will illustrate the need and importance of building a robust climate knowledge base in cities to support them in developing climate change actions strategies to address both climate adaptation and mitigation in an integrated manner.

The objective of the UCCRN is to bring together experts

working on global-scale, climate change and cities assessments in order to simultaneously present state-of-the-art knowledge on how cities are responding to climate change and to define emerging opportunities and challenges to the effective placement of this knowledge in the hands of local stakeholders and decision-makers.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, represents a four-year effort by 100+ scholars from over 50 cities in both developing and developed countries, and is the first-ever global, interdisciplinary, cross-regional, science-based assessment to address climate risks, adaptation, mitigation, and policy mechanisms relevant to cities.

The UCCRN is now working towards launching the next installment in this ongoing series, the Second UCCRN Assessment Report on Climate Change and Cities (ARC3-2). This session will present a 'First Look' at the ARC3-2 Report, which has been submitted to Cambridge University Press. The ARC3-2 Report is scheduled to be launched at COP21 in Paris.

The content and format of the ARC3-2 report has been based on several scoping session dialogues held at international conferences, inviting thoughts and reflections from urban and climate change scholars, city practitioners, and stakeholders. It has also taken into account survey feedback from ARC3 users and city officials. This discussion will highlight UCCRN's approach to knowledge creation and the status and next steps for ARC3-2.

The presentation will comprise of an introduction by the Co-Editors of the ARC3-2, its new topics and novel perspectives. It will present the main thrust of the Report and the analytical challenges of the main sections of ARC3-2, and will outline the content, analytical breath and anticipated challenges in building the main sections of the report, including: Interdisciplinary methods and tools to analyze cross-cutting processes driving climate change and sustainable development; climate science and disaster risk management; urban infrastructure; urban ecosystems; and governance, policy and finance. It will also include details on the UCCRN Regional Hubs in Paris, Rio, and Durban, to be launched at COP21. Through this regional participation, the audience will be able to grasp key regional priorities addressed in ARC3-2, with concrete examples of relevant analytical and policy cases. It will also discuss innovations for analyzing, reporting and communicating scientific progress in this field. This includes a short briefing on how ARC3-2 is building a storing communication platform (i.e., a Case Study Docking Station) to improve access to information by policy makers, academics and practioners.

P-4415-09

Transforming the Urban Fabric to a Solar City: Market, Finance, and Policy Factors for Infrastructure-Scale PV Deployment in Amsterdam, London, Munich, New York, Seoul, and Tokyo

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A significant and sustained transition to a renewable energy future required to avoid further climate change continues to elude societies. Meanwhile, cities play an increasingly important role as they have propelled themselves onto the global climate change stage and have engaged in polycentric networks. To achieve substantial energy transformation while capturing the dynamic and important role reserved for the world's cities, this article reconsiders finance-policy-market interactions by positioning the build-out of a particular renewable energy technology, photovoltaic (PV) energy, as a commitment to infrastructure-scale development. The concept of the so-called 'solar city' [1] is analyzed where large-scale deployment of urban PV essentially transforms the urban fabric into an urban renewable energy power plant as the strategy utilizes the vast rooftop real estate available in all cities. More specifically, a capital market strategy to finance the infrastructure-scale implementation of urban PV is evaluated for six case study cities that have taken up active global roles - Amsterdam, London, Munich, New York City, Seoul, and Tokyo. The paper makes clear the substantial potential of the solar city concept in each location and outlines a practical financing strategy to realize the potential.

[1] Byrne, J., Taminiau, J., Kurdgelashvili, L., & Kim, K. (2015). A review of the solar city concept and methods to assess rooftop solar electric potential, with an illustrative application to the city of Seoul. Renewable and Sustainable Energy Reviews, 830-844. doi:http://dx.doi.org/10.1016/j.rser.2014.08.023

4417 - Transforming Society and Science for Sustainability – Addressing Challenges in Transdisciplinary Research

ORAL PRESENTATIONS

K-4417-01

Social Transformations towards Sustainability – needs and opportunities for transformative, transdisciplinary science

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Research on global environmental change and sustainability increasingly goes hand-in-hand with calls for deep social change, and yet we know very little about how real and enduring social transformation comes about and how – if at all – it can or should be initiated, fostered or steered. 'Transformations towards Sustainability' is one of the three major thematic lines of activity of Future Earth, the new international hub coordinating research on global environmental change and sustainability, along with 'Dynamic Planet' and 'Global Sustainable Development'. As a direct contribution to this initiative, the International Social Science Council recently launched a research programme on Transformations to Sustainability in the first significant global effort to address knowledge gaps around social transformation.

Both Future Earth and the Transformations to Sustainability Programme are committed to a new approach to research for sustainability. Science as usual is not going to be successful in addressing climate change or other environmental challenges. Change is needed, and urgently, in how we do science, if we want to help accelerate transitions to a sustainable and just world. A transformations approach to sustainability research demands integrated, solutions-oriented science that takes account of the complexity of the challenges: research that involves the appropriate scientific disciplines, from social sciences and humanities to natural sciences and engineering; which focuses on specific problems in specific places; and crucially, which engages with society in its many dimensions in identifying the challenges, framing the research questions, designing and implementing the research, interpreting the findings and disseminating and using the results.

However, integrated, transdisciplinary research involving multiple stakeholders and places is difficult and done in various ways with varying results by different communities of practice. We need now to go beyond enumerating the challenges, obstacles or even successes, to pull together and learn from what we know about transdisciplinary research to enhance its quality and usefulness more generally.

O-4417-01

Stakeholder based science in transition research – challenges and opportunities

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The clean energy transition – based on the findings of the IPCC and others– is a highly political issue. It touches the way how society and especially the economy is organized, but also requires change on a personal and community level. Powerful interests of all status quo advocates are at stake and there exists not at all a consensus on how to transform and where to transform to. Hence, research on possible decarbonization pathways is a tricky issue that led researchers to involve stakeholders more strongly in the scientific process. Reasons behind this are (at least) twofold: First, engaging stakeholders more actively can facilitate access to issue-specific insider information that helps tackle scientific uncertainty and consequently improve the research process. Second, such involvement is perceived by the scientific community as a way to increase the influence of research on decision-making in political and economic arenas. However, these developments challenge the classical way scientific research is carried out and raise the question of "objectiveness" and value- and interest-driven research results.

We use the case of clean energy transition in Germany and Europe to systematize and discuss arguments for and against stakeholder based science and put them in a meta-scientific context. By doing so, we tackle the following questions: What kind of knowledge can be generated from stakeholder dialogues involving actors with varying degrees of influence in society and how can it be used? Which are the limitations of the so called co-production of knowledge? How can researchers coordinate and evaluate the influence that stakeholders have on their research process? What kind of trade-offs exist in the way research involves stakeholders and what implications do different approaches have for the science-policy interface? Our discussion paper thus investigates the influence of stakeholder based science on research «validity» and «objectivity», and its effects on research processes.

O-4417-02

Transforming Science to meet Society's Needs - The Social Footprint Laboratory

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A quiet revolution is taking place that began a decade ago on a small Pacific island. A group of trans disciplinary academics had gathered to enjoy the sun, great company and discuss the how they could share data in a way that would be scalable and replicable. The data would be based on the trade in the world economy, and have detailed sets of environmental accounts for countries globally. When these data sets were all used together, the impact could be transformational. Complex global problems, such as understanding indicators of climate change, could be modelled and scenario tested. Academics from across the world could contribute and upload environmental and economic data, to be used with a multi-regional input-output database. The database and user friendly interface has now been uploaded to a cloud based platform. In 2014 this idyll dream came to fruition in the form of the Australian Industrial Ecology Virtual Laboratory (IELab). The IELab is transformational in bringing together academics, early career researchers, and users to better understand the environmental impacts of consumption, production and trade.

Now that the lessons have been learned for environmental data using economic modelling, researchers are developing a network to establish the global Social Footprint Laboratory (SFL). Where the IELab can be used to model carbon, energy and water footprints, the SFL will model social footprints such as labour or inequality. Social footprints are already being used to demonstrate the inequality in trade between countries, the 'Master/Servant' relationships between producing and consuming nations, and the embedded social impacts such as accidents and even workplace deaths associated with production. The development of indicators in the SFL will provide a focus on basic needs and the capacity to engage local stakeholders to define and model relevant indicators for transformational change for social sustainability, as well as develop networks for data collection, sharing and use. The power and innovation of the project is to enhance and extend the existing economic and environmental data and structures of the IELab, with the critical social data and indicators required to identify, guide and monitor changes towards sustainability.

The development of these cloud based tools will bring together users such as governments, businesses, non-government organisations (NGO's), academic research institutions and international institutions worldwide to start to understand the drivers of globally and locally complex problems such as climate change and inequality. The SFL, when developed, will also help to monitor multidimensional progress against social, environmental and economic goals such as the UN Post 2015 Sustainable Development goals. An important part of the process of developing the SFL will be bringing together users to form a network and creating the knowledge links essential for transformational change. This network will complement the existing Asia-Pacific Research and Training Network on Trade (ARTNeT), which is an open network of research and academic institutions and think-tanks in the Asia-Pacific region, currently coordinated through UN ESCAP in Bangkok. Even without the virtual laboratory, the establishment of such a global network concerned with the collection, use and dissemination of social impact data will be transformational. The case studies developed as part of this project will also add to the transformational change through demonstration to the different user groups of how the data in the SFL can be applied.

Existing data sets on social indicators such as employment, income, poverty and child labour have already been used with the multi-regional input-output databases, in both the IELab and the Social Hotspots Database, proving viability of this project. A transformational aspect of this project will be in bringing together early career researchers in developing countries to gather the data and involving end users with the development of the tool.

This paper will present the transformational work on the IE Lab, giving examples of studies this work has enabled early career researchers to conduct and publish and share practical experiences of building a virtual laboratory in Australia and scaling it to a global capacity. It will also outline the proposed SFL project and network as part of the Transformation to Sustainability Programme, and showcase some of the social footprinting studies conducted to date and how this multidisciplinary work can contribute to solutions oriented research on climate change.

O-4417-03

FEAST (Food: Engaging in Action for Sustainable Transformation): Building a Transformative Knowledge Network

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With academic and community partners in Mexico, Brazil, Kenya, Canada, the United States, and the European Union, the FEAST (Food: Engaging in Action for Sustainable Transformation) social economy of food network focuses on co-creating and sharing knowledge about innovative, community-scale solutions to the interrelated challenges of climate change, poverty, and food insecurity. We take as our starting point practical initiatives that have demonstrated potential to improve access to healthy food, build resilient communities, and contribute to transformation to more sustainable food production and consumption practices. These include: promoting new as well as traditional climate-smart production techniques; building community capacity to engage in agroecology and

agroforestry; facilitating increased access to traditional foods, particularly in Indigenous communities; developing appropriate alternative markets for ecological products; and, implementing participatory governance systems, for example for organic certification.

By analyzing and developing connectivity amongst projects such as these, our transdisciplinary network of scholars and practitioners aims to increase the scope of their transformative potential. Specifically, our objectives are to: 1) Use a social economy of food as a lever to explore socially just, economically robust, and ecologically regenerative sustainable opportunities for communities in the Global South that would increase their ability to address the interrelated challenges of climate change, poverty, and food insecurity; 2) Build direct person-to-person (or community-to-community) knowledge flows that enable citizens in the Global North to better understand the impacts of climate change, poverty and food insecurity in communities of the Global South, and also build solidarity amongst communities in the Global South that are confronting these challenges; 3) Create a networked learning community to facilitate the exchange of knowledge regarding concrete examples of innovative, community-scale solutions to the problems of climate change, poverty and food insecurity; and 4) Use this knowledge-network as a platform to extend knowledge sharing to other communities. This learning community would highlight the co-creation of knowledge between South and North and between academic and community partners, and be facilitated in a way that empowers traditionally marginalized communities. It would also enhance the capacity of researchers/scientists - particularly emerging scholars - to analyze household and community-level adaptation strategies, and inform climate-smart policies.

The proposed paper will highlight some of the advances that have been made to date by FEAST network partners working at the regional scale to address climate change, poverty, and food insecurity, particularly for marginalized populations including women, youth, Indigenous communities, and smallholder farmers. It will also outline how the development of a robust transdisciplinary knowledge network creates opportunities to increase the transformative potential of existing regional work.

O-4417-04

Strengthening collaboration for transformation to sustainability in research and education at universities

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To be able to respond to grand societal challenges such as climate change, it is necessary for universities and other research organisations to recognise and act upon their responsibility as both educators and generators of knowledge. An effective contribution of science to societal transformation requires an adaptation of teaching and research activities and intensified collaboration and networking. Equally important is that science opens up to civil society and improves interactions with decision makers. Inter- and trans-disciplinary approaches can help expedite the necessary dialog on all levels. "Responsible Science" is the catch word used to address these changes - but what needs to be done? What are best practice examples from different academic cultures? How can universities and other research institutions cooperate to speed up the necessary change?

Increasingly science is becoming aware of and acting upon this responsibility. In Austria e.g. over 240 scientists have collaborated to jointly create the first Austrian Panel on Climate Change (APCC) report, mimicking in form, structure and process the assessment reports of the Intergovernmental Panel on Climate Change. The leading climate research institutions have founded the Climate Change Centre Austria (CCCA), which coordinates activities of and facilitates exchange between the climate science community. Recently a number of major universities created the Alliance of Sustainable Universities in Austria that is working on implementing the necessary transformation in teaching, research, on-campus and in societal outreach and exchange activities. In 2014, this alliance e.g. completed a research project on climate friendly research and managed to implement sustainability strategies on the regulatory level as part of mandatory performance agreements with the Austrian Ministry of Science and Research.

In this contribution we will discuss experiences, particularly on barriers and leverage points and potentially transferable "catalysing mechanisms" for "science and research in transition".

Although these activities have many positive effects, a fundamental issue still persists: Currently the academic system is geared towards achievements within the scientific community such as e.g. SCI publications, disciplinary oriented research and education, scientific oriented third-party funding, etc. However, responsibility toward society means dealing with the challenges society faces rather than investigating issues which promise to be lucrative either financially or in terms of scientific 'standing'. Sustainability science and education with its inter and trans-disciplinary research, exchange and dissemination of knowledge and engagement in collaboration and networking activities of the kinds mentioned above are often not rewarded and hence are difficult to prioritise in a publish-or-perish system.

Universities and the scientific system at large can play and must play a leading and visionary role toward the solution of the climate crisis and other grand societal challenges. However this will mean considerable changes to the current academic system, supplementing systems of evaluation and rewards in order to enable science to answer the pressing questions of our times and engage in the type of education, collaboration, networking and exchange, which is so crucial if we are to achieve the necessary transformation to a post-carbon, sustainable society.

O-4417-05

Networked co-design for trans-national sustainability-oriented innovation systems

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This paper presents initial findings from a co-design process involving 'transformation platforms' in six different high, middle and low-income countries as part of the 'Constructing Pathways to Sustainability' network. In each case, co-design workshops were hosted in order to bring stakeholders together around challenges that linked to climate change, including sustainable cities, sustainable agricultural and food systems and low carbon energy. In all cases the host institution convened a mix of academic scientists and knowledge partners in order to analyse the locally-defined problem and explore alternative pathways serving environmental sustainability and social justice objectives.

The paper will focus in particular on the examples from China and Africa, which primarily address the challenge of low carbon transitions that serve the needs of the poor. In each case, local innovations were identified that related to solar photovoltaic technologies, and participants discussed the problem of enabling access among poorer communities. Whilst innovation policies in China are clearly succeeding in the competitive production of low-cost PV panels, primarily for export, the uptake of PV in poor rural areas remains relatively slow. Participants identified the need to move away from technology-focused approaches to expanding energy access towards bottom-up approaches that also integrate concerns embodied in a new central government focus on poverty reduction, seen for example in the State Council's new policies on rural participation.

In the African case, participants discussed the utility of solar home systems (SHSs) and biomass in providing energy services to off-grid communities. Of particular interest to this paper is the development of novel payment mechanisms for solar energy, utilising mobile phone systems, that have been pioneered in Kenya. Interestingly, these are being recombined with solar PV hardware imported from China to produce a (socio-technical) system with potential to enable low carbon transitions that serve the needs of the poor.

The networked approach to co-design enabled the pairing of the China and Africa cases, offering opportunities to explore linkages and mutual learning across continents

that can – together – contribute to transnational (low carbon) sustainability-oriented innovation systems. The paper ends with a proposal to take forward these initial findings through continued work at the levels of the local transformation platforms and across the international transformative knowledge network.

O-4417-06

Collaborative political ecology: Mapping movements to leave oil in the soil with and for Environmental Justice Organizations

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This paper presents the results of the collaborative work on climate justice undertaken in the EJOLT (Environmental Justice Organizations Liabilities and Trade) EU fp7 project through the presentation and analysis of over 300 cases of conflicts over fossil fuel extraction and infrastructure as documented in the Atlas of Environmental Justice (www.ejatlas.org).

The Global Atlas of Environmental Justice (www.ejatlas.org) is a collaborative project that draws on activist knowledge to document social conflict over the environment. Ecological conflicts are defined as: "mobilizations by local communities, social movements and EJOs against particular economic activities (or state policies), in which concerns about current or future negative environmental impacts are an important part of the grievances, along with social, psychological and political impacts."

The Global Atlas of Environmental Justice currently documents over 1400 such ecological conflicts displayed on an online interactive map. Each conflict contains around 100 fields including activity type and commodity, actors, quantitative data, degree of violence, forms of action, outcomes and perception of success, among others. Over 250,000 users have opened over 1 million pages of the atlas in the last year since it has been public.

The atlas one one hand serves to document, making visible, and support the struggle for environmental justice (EJ), with the ultimate goal of empowering movements and activists, and increasing the recognition and legitimacy of research done by environmental justice organizations. It also serves as an important activist resource for information sharing and networking.

Scientifically it contributes to a form of 'statistical political ecology', and the development of a system whereby a large number of environmental conflicts can be described, analyzed, and compared across geographies and thematic issues and across spatial and temporal scales. The global nature of the atlas enhances the study of transnational spatial patterns of environmental and economic risks and impacts and their connections through commodity and financial flows that cannot be gained except at broader geographic and political scales.

The EJatlas is part of a new wave of initiatives that use geo-spatial information and new spatial media to advance, legitimate and secure political claims (Elwood and Leszcynski 2012). Through these "knowledge politics" individuals and institutions leverage digital spatial data and spatial technologies in negotiating social, political, and economic processes. The process of co-production of knowledge in producing the EJatlas is thus a contribution to transcending the expert/amateur or expert/grassroot activist dichotomy, while creating a new spatial knowledge politics and contributing to a collaborative political ecology.

After an explaination of the methodology of the EJatlas process the paper will present results from a comparative survey of the 300+ cases related to climate justice and fossil fuel extraction in the EJatlas with an emphasis on the following lines of enquiry: 1) The increasingly interlinked nature of place-based mobilizations over fossil fuel extraction and their articulation with global climate activist movements 2) The growth in conflicts over new technologies such as hydraulic fracturing and how citizen science is created and knowledge difused and transmitted between locations 3) the use of increasingly contentious and disruptive forms of resistance to fossil fuel expansion such as blockades in some regions 3) Transformative cases in the atlas that demonstrate how communities resisting fossil fuel extraction are presenting innovative governance mechanisms to leave oil in the soil and move towards energy sovereignty and post-extractivism.

O-4417-07

The Role of Young Scientists in Advancing Knowledge and Informing Decisions in a Changing Climate

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Young scientists are passionate about addressing the climate challenge, and this community is increasingly being recognized for its leadership and contributions to international climate science and policy efforts. Processes such as the Intergovernmental Panel on Climate Change and the U.S. National Climate Assessment are making explicit efforts to include early-career scientists. Young scientists play critical roles in advancing the understanding of climate change, developing mitigation and adaptation solutions, and informing societal decisions that enhance sustainability in the face of climate change. Doing so often requires early-career researchers to work across traditional disciplinary boundaries throughout the process of discovery. In addition, many young scientists regularly engage with the public and with decision makers, such as resource managers, local officials, urban planners, and stakeholders, through their work. For such emerging leaders, metrics of professional success should therefore reflect not only new contributions to knowledge but also the tangible benefits that those insights bring to society. Despite progress in meaningfully integrating young scientists as leaders in the climate-science community, institutional barriers often hinder early-career researcher engagement both with the scientific community and with stakeholders. This talk will discuss opportunities and challenges facing young scientists working on transdisciplinary projects to inform sustainability solutions in a changing climate. In particular, organizations such as the Global Young Academy provide critical opportunities for mobilizing and empowering early-career scientists to become the leaders of tomorrow's climate science and policy efforts.

4417 – POSTER PRESENTATIONS

P-4417-01

Three perspectives on global energy transitions and the promise of inter-disciplinary dialogue

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Human's use of energy in the 21st century could result in the collapse of the global climate, persistent poverty, and international conflicts over access to increasingly scarce resources. Alternative energy scenarios portray climate stabilization, universal access to modern energy, and strong global cooperation. Yet our knowledge of what political forces could trigger sustainable global energy pathways is still scarce and fragmented. Three distinct scientific disciplines strive to explain the driving forces behind the evolution of energy systems. Energy-economy models base their explanations on equilibrium between growing energy demand and supply constrained by resource scarcity and cost-optimization by rational actors. Technology studies analyze emergence and diffusion of energy technologies across socio-technical systems stressing innovation, performance and non-linearity. Political economy focuses on interests, ideas and institutions that impede or promote certain types of energy systems. Due to their diverse historic origins and different disciplinary roots, these scientific fields rarely communicate or cooperate. This paper outlines a transdisciplinary research agenda involving the three perspectives on energy transitions. It subsequently uses several examples from developing, developed and emerging countries to illustrate how a meaningful scientific dialogue between these fields could help to understand and guide sustainable energy transformations.

P-4417-02

"¿Post-normal research networks?: Rethinking the production of interdisciplinary and transectorial knowledge"

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This presentation aims to reflect about the epistemological implications of knowledge production in the frame of international collaborative research networks on climate and its social impacts. The way in which climate change knowledge is produced in the frame of international interdisciplinary networks and integrated into social actor's ´practices is a complex process where a numerous of factors intervene: knowledge production conditions, sociopolitical, environmental and socio-structural settings (macroeconomics, social structure, etc.), among others. An effective appropriation of expert knowledge by social actors and politicians requires not only methodological tools with the ability to integrate these factors within a dynamic of knowledge co-production, but also an analysis of the social field concerned in order to understand in which historic- political thread is this trying to get involved. This analysis is not related to a techno-methodologic matter but it summons to a political economy of knowledge. The challenges this epistemological perspective opens express both in the social as the scientific field and on the design of public policies. Basing in our own experience as social sciences researchers in two different climate research networks of this kind, our objective is not to present a social network analysis but to analyze the dynamics of this research networks as an apparatus (Foucault, 1977), whose ambition is to produce a "governance" response to climate change problem. These apparatuss are generally organized in a three-part logic: pluridisciplinary (diverse interdisciplinary interactions inside network´s working groups), multilocation (interaction among diverse academic institutions and countries) and transectoriality (interaction between researchers and society actors).

This work is organized in five sections. In the first one, we introduce and describe our networks of interest, as well as the ethnographic approach we have applied to study this research apparatuss. In second section, we present a brief description of the historic construction and management dynamics of scientific production on the extensive areas of post-normal concern, and we analyze the structure and logics of these networking research apparatus. Then, interdisciplinary dynamics is analyzed in the third section, showing how different disciplinary approaches, theoretical frameworks and concepts are engaged with the aim of legitimizing this network apparatus three-part logic. In the fourth section we analyze transectorial collaboration, describing its dynamics, the way stakeholders, policy makers and local communities are conceived by researchers, and discuss the possibilities of climate knowledge appropriation. Finally, we present our conclusions reflecting on the epistemological implications of these apparatus considering the role of global political-scientific agenda in the construction of climate change problematic, the hegemony of the techno scientific logic, and the relevance of political dimension for the creation of alternative responses facing the challenges and interests of our globalized world.

P-4417-03

Artisticc: An Art and Science Integration Project to Enquire into Community Level Adaptation to Climate Change

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The purpose of this paper is to present the Belmon Forum «Adaptation Research a Transdisciplinary community and policy centered appoach» (ARTisticc) project. ARTisticc's goal is to apply innovative standardized transdisciplinary art and science integrative approaches to foster robust, socially, culturally and scientifically, community centred adaptation to climate change. The approach used in the project is based on the strong understanding that adaptation is: (a) still «a concept of uncertain form"; (b) a concept dealing with uncertainty; (c) a concept that calls for an analysis that goes beyond the traditional disciplinary organization of science, and; (d) an unconventional process in the realm of science and policy integration.

The project is centered on case studies in France, Greenland, Russia, India, Canada, Alaska, and Senegal. In every site we jointly develop artwork while we analyzie how natural science, essentially climate sciences can be used in order to better adapt in the future, how society adapt to current changes and how memories of past adaptations frames current and future processes.

Artforms are mobilized in order to share scientific results with local communities and policy makers, this in a way that respects cultural specificities while empowering stakeholders, ARTISTICC translates these "real life experiments" into stories and artwork that are meaningful to those aff ected by climate change.

The scientific results and the culturally mediated productions will thereafter be used in order to co-construct, with NGOs and policy makers, policy briefs, i.e. robust and scientifically legitimate policy recommendations regarding coastal adaptation. This co-construction process will be in itself analysed with the goal of increasing arts and science's performative functions in the universe of evidence-based policy making.

The project involves scientists from natural sciences, the social sciences and the humanities, as well as artists from the performing arts (playwriters, film directors) as well as the visual arts (photographs, designers, sculptor) working in France, Senegal, India, Russia, Greenland, Alaska, and Canada.

P-4417-04

Science and art together

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For decades worldwide scientists rely considerable efforts to bring to the world and particularly to decision makers of the planet, all the knowledge that allow us to understand the causes of global warming, and its predictable and irreversible consequences on the environment and on the balance of the world. In other words, thanks to science, we have for a long time and especially today, sufficient dates to take necessary decisions and measures. Despite this, greenhouse gas emissions have risen, and on the contrary, nothing has been done to effectively fight against global warming. It seems that knowledge is not enough to raise awareness, create responsibility and encourage ethical behavior in front of the current climate crisis. Would it be because conscience, responsibility and ethics are not only forged with scientific or rational considerations? It is undoubtedly an urgent need to enrich and strengthen the contribution of science with other forms of perception and understanding of the world in order to go further in this thought. To understand and internalize what is at stake in environmental and climate issues, we should perhaps call upon our sensitivity and our emotional intelligence. This could probably help us to understand better what science tells us, because what we live and experience don't just have a rational explanation. This would bring us, among other things, to develop our empathy, carry us to change the way we see and understand our relationship to life, to ourselves and to someone other than Me. This Other than me is plural and singular, he surrounds us and expects from us another way to coexist and live on this planet. We must be able to pass to the other side of the mirror, to go beyond the immediacy of things, to really understand what is our place and responsibility in the community of the livings. Among the possibilities that are available in order to succeed in this passage, the better of them is probably art. Indeed, it could best go along with science to bring us further in the process of evolution of our awareness, our understanding of reality and our way of being in the world. In the creative process of art, logos and sensitivity merge together and the result offers to our senses stimulates our mind, sharpens our perception, our vision widens and expands our critical and analytical skills. In this paper we try to show, with ongoing experiments, how this collaboration between science and art can happen. How, while working together, they can create a new perception and a new understanding of environmental and climate issues and in the end, how this alliance and this merger can contribute to the development of awareness and willingness into order to act in responsible ways.

4418a - Information for decision-making - How to engage in future thinking or plan for the long term

ORAL PRESENTATIONS

K-4418a-01

Decision-relevant science for water security: An iterative process for targeting and evaluating impacts of watershed investments

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Nature-based solutions are increasingly recognized as viable strategies to address major challenges for human development in areas such as water security, disaster risk mitigation, infrastructure development, and sustainable agriculture. Such strategies have the potential to provide adaptive solutions to changing climate conditions by encouraging ecosystem-based adaptive management and community participation. In the realm of water security, protecting and restoring nature to regulate the quantity and quality of water flows is increasingly viewed as a cost-effective and complementary strategy to engineered approaches. Broadly termed Investments in Watershed Services (IWS), these projects typically invest in the conservation of source watersheds to secure clean water for downstream communities. Recent studies show the potential for IWS to provide a positive return-on-investment for water resource goals, to generate additional environmental and social co-benefits, and to be a strategy that can adapt, potentially more so than engineered solutions, as climate conditions change. In 2013, there were an estimated 345 active IWS programs globally and an annual investment totaling $12.3 billion (www.forest-trends.org/dir/sowi_2014/). Yet, despite its exponential growth over the past two decades, IWS remains a relatively small-scale, often one-off strategy in particular locations, which contrasts with the widespread use of engineered solutions.

We argue that a key barrier limiting the scope of IWS is that tools and guidance to bridge the science-to-practice gap are less well developed - tools to help practitioners understand if, where, and how well IWS will work. A recent plethora of reports and decision support tools highlight for cities, regional authorities, and corporate actors the risks that they face due to dependence on water resources (e.g., Ecolab and Trucost's Water Risk Monetizer and WWF's Water Risk Filter). However these tools largely focus on the "risk" component of the water security equation. To effectively mainstream IWS, decision makers need science that addresses the "opportunity" component of the equation - the degree to which improved watershed management activities can mitigate risk. Combining risk and opportunity information enables decision makers to quantify the scope for IWS and to identify actionable solutions that are specific to the decision context. Such decision support would allow policymakers to target natural capital investments towards programs (at global/regional scales) or projects (at local scales) that promote IWS where it has the highest potential to be a cost-effective intervention. We will showcase several tools and methods developed by The Natural Capital Project - in collaboration with various NGO, academic and policy partners - in support of IWS programs in 7 countries across Latin America, India and Kenya. Our experiences illustrate the importance of co-producing ecosystem services information as part of an iterative research-application process, for 1) targeting investments based on ecosystem services outcomes, 2) addressing uncertainties around drivers of change (including climate change), and 3) monitoring and impact evaluation. Delivering more resource-efficient and transferable science will allow decision-makers to evaluate where IWS is, and critically is not, likely to be an effective and robust institutional mechanism to achieve water security goals in the face of climate change.

K-4418a-02

School Earth Care Centre: A Communication and Decision Support System for Community Level Weather, Climate, and Environmental Services

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Development of a weather, climate and environment service system requires scientific and technological development including development of understanding and knowledge regarding enhanced observational needs. To create an "intelligent and wise" rural community secondary schools can do a lot. Schools have the scope for fostering scientific, human and technological resources required for making people aware and resilient to threats and impacts of climate change through appropriate science and technology communication.

School Earth Care Centres (ECC) catalyzed by the Natural Resource Data Management System (NRDMS) of Department of Science and Technology (DST), Government of India is an approach to establish a bridge between the community and educational institutes for catering community level climate and weather services through generating water & weather related data, preparing maps and sharing it with the stake holders.

In 2007-12 ECC have been established in 75 schools of West Bengal, India representing each geoclimatic, socio economic and demographic situations. A state level NGO had been engaged to act as the central resource agency and a communication link between the expert community and the rural institutions. The ECC schools have been provided with weather instruments, soil and water monitoring kit and a kit for map making. Necessary orientation, hands on training workshops were held in each ECC school involving stake holders from the teachers, students, farmers and the community. Development of methods for efficiently making use of weather and water databases and implementation of user-relevant approaches for evaluating the quality and benefits of products and services are considered to be the end product.

This paper discusses the model in terms of formation process, tasks and results that have been measured in terms of development of awareness, knowledge, motivation, sharing and participation. While analyzing the overall success indicators of the model it is observed that rural schools in backward and disaster prone areas showed a higher level of competency and motivation. It has also been observed that development of ownership of the data and making wise use of it resulted into a more resilient society in those areas.

This paper argues that the scientific effort is reliant on extensive sharing of capabilities and knowledge where educational institutions and other stakeholders can play as a key factor for comprehensive services system development. Such a framework is essential in developing countries, allowing weather and environmental data generated and provided by the local institutions to the service of the local community at the grass root level.

O-4418a-01

Personal adaptation: discussions, decisions and planning

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Decisions that will be effective to manage the impacts

of climate change that are now unavoidable will need to account for ongoing instability in social, economic and environmental systems. Commonly examined barriers in accounting for progressive climate impacts include: disbelief in aspects of climate change processes; lack of understanding of the impacts; poor access to relevant and credible information; and a felt need for greater certainty. Professionals who exchange climate change knowledge in research, policy, and practice will have overcome many, if not most, of these barriers through training and experience. Barriers that affect even these professionals are personal reactions to envisioning the future such as: emotive responses; lack of facility in future thinking; and subjective assessments of perceived risks and capacity. This paper draws on interviews that inquire into personal adaptation discussions and planning by Canadians and Australians. Participants have professional expertise and regular high-level communications regarding climate change with colleagues and the public. The interviews and this paper focus on a different sphere: discussions by these same professionals with family and friends. Key improvements in interpersonal discussions of climate change adaptation decisions and planning identified in the research include the need to: connect concern for mitigation of climate change to adaptation to climate impacts; think beyond unpleasant possibilities and envision future life affected by climate change; and foster skills for greater cooperation in education and planning. Even among this highly educated group there was difficulty in imagining changes in society in the climate of the future, especially among those who do not tend to engage in future thinking or plan for the long term. This has implications for our understanding of individual factors in climate adaptation decision processes that may affect the wider society over time. Further study with people from other nations, professions and culture groups would broaden understanding of personal factors in adaptation decision-making.

O-4418a-02

Synthesis centers: an essential tool in our complex, data-rich future

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Climate change presents a challenge to traditional scientific practices of disciplinary focus and the well-established research pathway. Understanding and responding to global climate change requires the integration of an abundance of information over many disciplinary fields and from many different organisations, with the added urgency of needing rapid answers and applications. Synthesis centers provide a unique environment for harnessing knowledge and expertise to catalyse discovery through cross-disciplinary working collaborations. Supported scientific synthesis—the integration of disparate theories, methods, and data across disciplines, professional sectors, and scales—has been proved to provide general, robust scientific explanations and evidence-based solutions across the social, economic and scientific realms. We contend that providing a synthesis intervention is a necessary, even mandatory, requirement for humanity to properly address critical climate change challenges.

More than a dozen synthesis centers now exist across Europe, North America, Asia and Australia. These centers bring discipline-specific experts together for blocks of time to stimulate cross-sectoral creative thinking and insight. The synthesis center approach is a vital tool to achieve collective action and transformative solutions. It offers something rare: participation based on a collective interest to deliver outcomes, and distraction-free, supported time and space for groups to totally immerse themselves in a question. A common tool provided by all synthesis centers is the technological support to analyse and synthesise diverse and disparate datasets.

Each synthesis center reflects the imperatives uppermost in its own country, and has developed a unique approach and expertise relevant to its mandate. Some centers emphasise the earth sciences, some the application of mathematics to biology, some natural resource management, social science and science policy, some the dynamics of marine and terrestrial ecosystems, inter alia. Conservatively, the Centers together have been instrumental in bringing more than 25 singular disciplines together to work in unique trans-disciplinary combinations to address complex problems. The Centers have amassed large networks of people and provide the necessary infrastructure and skills to support them to collaborate. As a group, newly formed into the International Synthesis Consortium (www.synthesis-consortium.org), these centers provide a powerful tool across the whole range of disciplines and geographies needed for innovative solution-oriented thinking around the effects of climate change.

4418b - Information for decision making - Improve availability, access and use of information

ORAL PRESENTATIONS

K-4418b-01

Enhancing National Climate Services for Development in Africa

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Timely and appropriate climate information could play a critical role in national development planning; helping policy and decision makers to better manage climate risks and maximize opportunities. Available and decision-relevant climate information on the past climate, recent trends, likely future trajectories, anomalies and associated impacts is a prerequisite for climate-informed decision making. Unfortunately, climate information is not widely used in Africa to make development decisions. This is mainly because useful information is often not available or, if it does exist, is inaccessible to those that need it most.

The ENACTS (Enhancing National Climate Services) initiative is an ambitious effort to simultaneously improve the availability, access and use of climate information by working directly with National Meteorological and Hydrological Services (NMHS). It enables the NMHS to provide enhanced services by overcoming the challenges of data quality, availability and access - while at the same time fostering stakeholder engagement and use. The new spatially and temporally complete ENACTS data products allow for characterization of climate risks at a local scale, and potentially offer a low-cost, high impact opportunity to support applications and research. ENACTS has so far been implemented in Ethiopia, Madagascar, Tanzania, Rwanda and The Gambia at national levels, and at regional level for the CILSS countries (West African Sahel).

O-4418b-01

Assessing climate change vulnerability of species: best practice guidelines for conservation practitioners

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For effective climate change adaptation planning, conservation practitioners must consider how their areas and species of concern are likely to be impacted by climate change. At present, however, they face a burgeoning scientific literature describing a wide variety of methods for assessing species' vulnerability to climate change, each with its own strengths and limitations. Based on inputs spanning the conservation science and practitioner communities, along with broad literature review, the IUCN Species Survival Commission's Climate Change Specialist Group has developed guidance for selecting and applying methods for assessing species' vulnerability to climate change.

The best practice guidelines outline commonly used approaches for assessing species' climate change vulnerability namely correlative (niche-based), mechanistic and trait-based approaches. They guide users to clearly define the scope and objectives of their assessments, and to identify and evaluate their available data, technical, expertise, time and financial resources. With the aid of a decision framework, users match their objectives with appropriate methods, and then identify those for which they have sufficient resources. The guidelines also include sections on selection and appropriate use of climate and biological data, selecting temporal and spatial scales, and working with uncertainty, knowledge gaps and indirect climate change impacts. They present overarching principles, ideas for communicating assessment results, and a broad range of case studies demonstrating how the guidelines can be applied.

This presentation provides an overview of the new best practice guidelines for assessing species' vulnerability to climate change and familiarizes attendees with steps for making sound and defensible decisions on method choice. Through the guidelines we hope to make climate change vulnerability assessment more accessible to the conservation practitioner community, thereby providing the best possible foundation for climate change adaptation planning.

O-4418b-02

The experience of the Brazilian Climate and Health Observatory

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Gathering and analyzing data on climate and health, as well as information on socioeconomic and environmental factors, is essential for planning actions to adapt to and mitigate climate change. In view of the complexity of the processes involved between global environmental and climate change and its effects on health, it is essential to bring together and analyze data in such a way as to provide society, government agencies and the media with information on these changes. To achieve this follow-up, a set of data on the dimensions of the climate, environment, population and health is required. The Brazilian Climate and Health Observatory project is making information on climate and health available through an internet page (www.climasaude.icict.fiocruz.br) where data from different origins can be accessed on a common platform. This technology is innovative in that it allows users to make consultations that simultaneously use distributed data, i.e. data generated and maintained by different institutions. The Information Technology and the information content were agreed between the participating institutions, researchers and representatives of government and civil society in workshops during which a consensual platform was agreed among data producers and data users.An initial assessment of the possible impacts of climate changes on health was made by a group of public health researchers, resulting on a list of climate-sensitive diseases (Barcellos, 2009). Vector-borne diseases, respiratory and cardiovascular diseases, water-borne diseases and a variety of health problems resulting from prolonged drought or floods, such as hunger and infant mortality, were selected to be monitored by the Observatory.The debate on climate change drivers, its impact on public health and adaptation actions needs to be a democratic process that allows participation by different social actors, with guidance towards motivating present-day changes with short, medium and long-term repercussions. In the Observatory project, participation is proposed as a path leading to integration between citizens, researchers and public health administrators so as to enable manifestations towards and interactions with other individuals within the community, develop reflective discussions and propose new ways of comprehending the process of climate change. Citizens, even if without links to any institution, can feed the Observatory with information on extreme climatic events and new data giving warnings about the population's health conditions, by means of the "Live Database". The intention with this database is to allow insertion and publication of georeferenced information in the formats of text, images or external links. In addition, comments on news items or research conducted under coordination from the Observatory are encouraged. The Observatory's various workshops held in different regions of the country have included participation from organizations within local and national civil society.Furthermore, the project has acted as a means of assembling researchers interested in the debate on the effects of climate change on health. Recent occurrences of extreme events, such as the torrential rainfall on the coastal mountain range of the state of Rio de Janeiro, the fluctuations in river levels in the Amazon region and the intensification of vegetation burning in the arc of deforestation, have raised awareness among researchers and citizens regarding the need for preventive action to reduce the impact of climate-related natural disasters. On the other hand, the long-term and indirect effects of climate change on health, such as expansion of the incidence of vector-borne diseases, remain little studied by researchers. This makes it difficult to bring citizens into the debate on the long-term effects of climate change and the possible measures to adapt to these changes. The results from studies under development at the sentinel sites have shown how climatic factors influence the transmission of water-borne diseases in Manaus; how atmospheric pollution associated with vegetation burning influences respiratory diseases in the states of Rondônia and Mato Grosso (Carmo, 2010); and how rainfall and temperatures affect vector-borne diseases like dengue (Lowe, 2012). These studies may promote of debate on the effects of climate change on health, and on the role of the healthcare services, within the Brazilian National Health System, in reducing these impacts.

O-4418b-03

The Global Island Database as a strategic asset for island biodiversity issues

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The Global Island Database (GID) targets the five themes important for islands, as identified by the Convention on Biological Diversity (CBD/UNEP), namely biodiversity, climate change, invasive species, pollution and sustainability. It aims to provide a geographical and environmental strategic tool to define priority in island biodiversity issues, including assessment and protection, at a global scale. As such, it does not replace regional, national or local GIS databases but it comes in synergy with them in a macrobiological perspective. GID aims to be a GIS networking platform for international collaboration, noticeably for the Global Islands Partnership (GLISPA).

Some pioneering works were initiated in the 90ies in the scope of providing global information on islands before GIS and the WEB became available [1] [2]. The initiative of making available an online version of GID was supported by GLISPA, the UNEP/WCMC and the Italian Government during the CBD CoP9 2008 in Bonn. The first version of Global Island Database (GID) was officially announced at the UN Commission on Sustainable Development SIDS Special Day of celebrations on 10 May 2010 in New York. The further versions were updated at the initiative of the WCMC and includes specific tools for interactive functionalities to users, as for instance the GID validation tools [3]. It allows edition and validation of spatial and attribute information for any islands including those not referenced in GID. It is an example of on-line participative science whose purpose is to improve and update the spatial accuracy and associated information relating to islands or islets whatever the size.

The GID present version takes account of more than 180,000 islands including all the 116,103 islands greater than 0.06 km² from New-Guinea (783,408 km²) down to the islet of Gemini close to the shore of Elba (0.06 km²). Each island received a specific international island coding (IIC) and refers to attributes on geographical names, location, planimetry, human occupations, climatology, and topography (Table 1).

This GIS asset is not only allows the visualisation of data relevant for islands but also provides added value through contextual information, data analyses and potential biodiversity indicators for the various stakeholders requiring homogenous information for comparison purposes and prioritizing funding and actions. It is one of the tools which is urgently required to get over the present «island data gap» facing SIDS and countries with islands, as stated by macro ecologists: «We found that environmental characteristics were harder to determine for islands because they are not well represented in most global environmental data sets" [4]. It is also worth noting that the UN Under-Secretary General and UNEP Executive Director, Achim Steiner said: "High quality databases are crucial for addressing both the threats to biodiversity and economically important ecosystems. The importance of GID for island nations cannot be over stated, and is long overdue"[5].

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O-4418b-04

Quantifying the changing shape of local climate

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Climate is intrinsically a distribution and changing climate a change in distribution. Adaptation decisions and individual's perceptions of climate change are influenced by changes in thresholds in these distributions. Different decisions are impacted by different thresholds but in most cases the relevant distributions are those experienced at local scales. To understand the impact of climate change on practical decisions requires us to quantify how local climatic distributions are changing shape. Such information also substantially affects how climate change can be communicated and made relevant.

Changes in the shape of local climatic distributions are influenced by global and large scale (synoptic) changes in the earth system but are mediated by local / meso-scale circumstances. It is not clear to what extent it is possible given current technology and model limitations, to predict such changes multiple decades in the future. However, it is now beginning to be possible to identify changes in the shape of local climate from observational timeseries in some locations. Such changes provide crucial information which can help decision makers optimise decisions for the climate of today by putting them in the context of the fine detail (geographic and distributional) information from recent decades. It also provides a baseline of climate change against which future projections can be put into context.

Here we will present such analyses showing the changing shape of European climatic distributions in terms of changing probabilities and changing decision-relevant thresholds. The process could be automated by climate services providers to generate output tailored to the needs and vulnerabilities of individuals and organisations. Challenges in the statistical interpretation of the data will be highlighted and a means of identifying robust aspects will be presented. Results will be shown from two recent papers which address local temperature distributions, and work-in-progress on changes in precipitation distributions. The analytical process can be seen as transforming direct weather observations into observations of climate change.

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4418 - POSTER PRESENTATIONS

P-4418-01

Outlook for Integration between some African Countries (Egypt, Libya, Sudan and South Sudan as Case Study)

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Often considered by developed countries to developing countries as the countries lagging behind in everything, and deal with it as representing store of natural resources, which you can get from the developed countries to their raw materials cheaply and then send to the factories to

return as producers full industrialization of the African market with densities high population to sell at very high prices, which has purchased raw materials.

In spite of the financial aid provided by the developed countries of the African countries are often consumed to feed those poor people and African countries remain waiting for food aid from rich countries, which give barely enough to eat.

In spite of the large number of economic programs and development provided by developed countries to developing countries and least developed countries, we did not find programs that seek to technology transfer, albeit a relative, so that they can African countries to adopt serious programs aimed at building an industrial base, economic and promising those countries, and did not seek the developed countries to Technology Settling in African countries, but all their quest to remain African countries representing the trunk filled with raw materials needed by developed countries as well as Africa remains the most hungry market for the purchase of products from European countries and the United States.

Therefore, the integration between African countries all or some of a director and the sanctuary of the problem, which is no way to solve it, but by African-African cooperation between the countries of the African continent, and here we are trying to shed some light on the possibility of integration between some African countries which are similar in many circumstances and can of through integration together to build an economic base is good, and I've dealt with here, the possibility of integration in the future, between Egypt and Libya, Sudan and South Sudan, as we talked about earlier attempt (1969/70-1971), to build this integration between the same countries before the secession of Sudan and the announcement of the south as an independent state, but that attempt has failed, and call on the African parties and leaders of those countries free to study the reasons for the failure of the previous attempt integration, and looking to the new leadership at these countries to try again and get rid of all the challenges and barriers to get success of the next attempt.

P-4418-02

Population Vulnerability and Adaptation to Climate Change in Large Metropolitan Areas: a Brazilian Perspective

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The rapid urbanization process in Brazil and the consolidation of large metropolitan areas have created important challenges for public policies. This process has been "incomplete" in the sense that population and urban growth have occurred without the corresponding investments in urban infrastructure and reduction of poverty and inequality. These problems assume a new momentum with the potential impacts of climate changes in Brazil regarding, in particular, extreme rainy and dry seasons, health endemics (such as dengue fever and respiratory diseases), urban disasters and water scarcity. The main purpose of this paper is to discuss a pilot research project and its corresponding conceptual and methodological framework to identify and assess population vulnerability to climate change in large Brazilian cities in the next decades. This pilot project is being developed as a key activity of the Rede Clima - the Brazilian Network for Research on Global Climate Changes from the Brazilian Ministry of Science, Technology, and Innovation. The main mission of Rede Clima is to generate and disseminate knowledge about the causes, effects, and adaptation mechanisms related to climate change in Brazil and consequently inform public policies. We will discuss the key features of the pilot research which will focus on the three largest metropolitan areas of Brazil - São Paulo, Rio de Janeiro, and Belo Horizonte. The main methodological feature involves the use of a mixed methods evaluation (MME), which combines primary data collection on perceptions and attitudes of population towards potential climate impacts, as well as other primary and secondary data, which allow measuring intra-urban population vulnerability. This information will help us to assess profiles of population vulnerability at finer urban scales and develop alternative scenarios for adaptation policies in Brazil, as well as to improve tools for the dissemination of information and knowledge on adaptation to climate change to urban population and stakeholders. Finally, we will discuss how the research project will provide us a base for the creation of a monitoring system of the human dimensions of vulnerability and adaptation to climate change in the large Brazilian cities.

P-4418-03

Observatories for Climate Change monitoring : Local vs Global approaches

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Introduction: Eco-sociosystems are all impacted by Climate Change. The future of humanity depends upon the adequacy of analyses related to such systems. Several views prevail, some within a local approach and others which take a more global view. These views are used in ascending or descending approaches. The aim of the article is to show a) how «local» and «global» are inseparable to preserve both the stability of the system as a whole and global equity ; b) and how the two methods should be continuously confronted to each other. We capitalize here on the conceptual expertise built during programmes aimed at the implementation of specific devices (scientific observatories for the acquisition and monitoring of socio-environmental phenomena).

System: Facing Climate Change, we will first assume a) that we consider the system emerging from «Earth-human interactions» (further on named System Earth) as an integrated (eco-socio)system, even though we are quite aware that some kind of ecosystem would further exist, regardless of climate change, while this may not be the case for mankind ; b) that System Earth is a complex system, where natural and anthropogenic processes occur ; c) that humanity (all of mankind) should aim, for a sustainable future, at maintaining a relatively steady state (holocen like) for Earth System. As a system, System Earth has a structure with biophysical and human components and a functioning, the output of which may (partly or as a whole) be considered as adequate to social expectations. More generally, this may result in the concept of sustainable services. System Earth is a whole, consisting of elements, organized altogether in some more or less connected subsystems. Climate is one of these subsystems, which in turn consists of biophysical components. In addition, human interactions with this subsystem are key-points for studies and discussions : «How and to what extent do anthropogenic processes interfere with the climate subsystem ?». The impacts of these interactions (in either ways) and relevant management measures for control / regulation represent the core problem. Hence the importance of the choice of disaggregation (choice of categories and scales*) of System Earth into subsystems and the taking into account of existing connections between these subsystems. The spatial projection of the disaggregation of System Earth should help to better assess the proposed management measures with respect to their ratio efficiency / equity in populations involved in efforts for a better management of System Earth.

Observatory: For several years, we have built expertise on long-term environmental monitoring observatories for «Desertification» (ROSELT/OSS and REPSAHEL/OSS). This leads us to define the concept of «Scientific Observatory», which relies on a rigorous and scientific approach in order to observe the dynamics of systems. Because, even in science, work is often sectorial, the challenge in such observatories is to develop interdisciplinarity so that it becomes possible to share the best definition of theoretical models (of the observed system(s)) as well as methods for observation and analysis. If the observatory is to answer the question «How and to what extent do anthropogenic processes interfere with climate subsystem ?», it has to comply with two objectives in its local observation devices: a) gather information for power the global climate model, b) gain information on the local territorial system and measure its viability, especially when management measures related to Climate Change have been incorporated. Assuming that, as regards the climate system, the theoretical model is at the global level**, one of the challenges is to translate the question of society in a scientific issue and in local models consistent, with respect

to the given holistic ontology, with the global model. Such a network of observatories should be the tool of decision support for governance at both global and local scales.

Conclusion: Let's stop trying to save the planet (it does not care) and save humanity instead. Our proposal makes a Plea for the implementation of a network of perennial observatories ; as a part of governance processes, this would provide a powerful support for decision making, both at a global and local scale.

* : Continental, national, climatic areas, economic areas

**More than 20 computer prediction models are currently operated

P-4418-04

Vulnerability Sourcebook: Integrated and participatory vulnerability assessments support adaptation planning and evaluation

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Decision making on effective adaptation policies and actions depends on a sound assessment of adaptation needs and the identification of the most promising approaches. This requires information on types and extents of climate change impacts, existing vulnerability patterns, related adaptive capacities and already implemented measures. The assessment, in addition, has to be realized in a participatory manner in order to take into account all existing knowledge (technical, scientific, local experiences), allow common decision making on key factors and needs, and achieve the sensitization and political will that are later on needed for the planning, financing and implementation of adaptation activities.

A tool that has been explicitly put forward at international level for this purpose are vulnerability assessments. Due to the variety of vulnerability definitions and methodologies to assess it, German International Cooperation GIZ commissioned the development of standardized methods and tools allowing a better comparability of results across sectors and regions. The Vulnerability Sourcebook, published in 2014, is a practical guideline that can be applied to support cross-sectoral, integrated and collaborative adaptation planning across different levels, especially in the context of the National Adaptation Plan processes (NAPs). Moreover, it is conceived for the Monitoring and Evaluation of adaptation as well.

The Vulnerability Sourcebook comprises eight modules and an annex that provide practical guidance on how to conduct standardized vulnerability assessments. Its application in in Bolivia, Pakistan, Burundi and Mozambique demonstrated that it can make a valuable contribution to collaborative and integrated adaptation planning and the M&E of adaptation. It combines outcome- and process-oriented perspectives and provides very detailed decision support.

The presentation will outline the tool itself and describe the results of the various application experiences, which concern national level as well as decentralized and community-based processes. The presentation will then stress how the different results have been used for concrete adaptation planning and implementation. These experiences serve also to discuss the different perspectives of various stakeholders and the demand-side aspects on decision support in climate adaptation.

P-4418-05

Ethno-malacology in mangrove ecosystems: integrating local and scientific knowledge to assess socio-ecological variability and coastal change

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Ecosystems and societies face major emerging challenges as climate change and ecological services degradation. Nowadays, linking local knowledge and global science in multi-scale assessments is at the heart of international debates. Although, ecological monitoring approaches to assess coastal change have improved considerably during the last decade, many projects still fail at incorporating local knowledge on the conception of the master plan and the analysis of the collected data. Participatory monitoring methods and assessments protocols of coastal change, especially relative to climate change, are generally based on informing the local community what to observe and how to do it, rather than understanding their own perception of ecosystem change and integrating it to the analysis. For providing a strong interface between science-policy-society on climate change issues, these local perceptions and actions for adaptation cannot be overlooked. There is a real need to develop an in-depth reflection on local knowledge and know-how and on interdisciplinary methods to integrate them in the pool of data information for decision-making.

In the search for indicators to monitor and assess coastal change while combining local and scientific knowledge, mollusks appear to be particularly interesting for setting a constructive and interactive dialogue between scientists and local villagers. In the one hand, the cumulative and complex bodies of knowledge of shellfish gathers include accurate knowledge of mollusks diversity, habitat and distribution, as well as, detail knowledge on marine environment characteristics and coastal socio-ecological change. In the other hand, for scientists, mollusks are considered to be performant indicators of ecosystem quality and physico-chemical change. Furthermore, their ubiquitous nature and broad distribution make mollusks particularly suitable for geographical large scale surveys.

Shell harvesting was found to be an important subsistence activity in Indonesia and Papua New Guinea. Though, shellfish might be considered to be of secondary importance in the overall diet of coastal societies, it plays a crucial role supplying proteins when faced with environmental fluctuation and seasonal inequalities. In the current context of global and rapid coastal change, shell gatherers can provide thus valuable views, knowledge and observations related to the dynamics of mollusks assemblages and population change within highly sensitive and productive ecosystems as mangroves are coral reefs.

By combining anthropological, geographical (human geography and remote sensing) and ecological approaches, the aim of this communication is 1) to describe the development of ethno-malacological research - considering ecological, cultural and scientific representations - in two different contexts, 2) to examine the applicability of local knowledge in climate and coastal change monitoring and assessment, and 3) to propose participatory ethno-ecological methods and criteria for enhancing local participation in coastal and climate change assessment. Our presentation will be based on research program and fieldworks that are at different steps of realization in Asia and Oceania and will present potential sites for undertaking further comparative research.

P-4418-06

The IRI Data Library: Decision-Making Tool for Climate and Health

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Public health professionals are increasingly concerned about the potential impact of climate variability and change on health outcomes. Protecting public health from climate requires new working relationships between the public health sector and the providers of climate data and information. The Climate Information for Public Health Action initiative at the International Research Institute for Climate and Society (IRI) is designed to increase the public health community's capacity to understand, use and demand appropriate climate data and climate information to mitigate the public health impacts of the climate. Significant challenges to building the capacity of health professionals to use climate information in research and decision-making include the difficulties experienced by many in accessing relevant and timely quality controlled data and information in formats that can be readily incorporated into specific analysis with other data sources. We present here the capacities of the IRI climate and

health map room and show how we have used it to build an integrated knowledge system in the support of the use of climate and environmental information in climate-sensitive decision-making with respect to vector-borne diseases.

P-4418-07

The application of multi-criteria decision analysis in exploring the co-benefits of climate mitigation technologies and scenarios

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The MAPS Programme (www.mapsprogramme.org) supports developing countries in long term planning to reduce greenhouse gas emissions. The Programme combines an extensive stakeholder consultation process with deep quantitative research to provide defensible results that have buy-in from a wide range of stakeholders. These results are then used for long-term greenhouse mitigation planning and policy setting. The Programme is currently active in Peru, Brazil, Colombia and Chile, with preliminary planning activities already having been conducted in a number of African countries.

What has become evident through the projects already implemented in Latin America, as well as ongoing related work in India, is that mitigation planning cannot be conducted in isolation of the consideration to trade-offs related to co-benefits for and negative impacts of mitigation actions on society and the environment. Such co-benefits and impacts include those relating to poverty alleviation, human health, water demand, employment and air quality. In some countries, such as India, the co-benefits concept is inverted, with the salient issue being the mitigation co-benefits of development actions, leading to a formulation of "multiple objectives". However conceptualized, however, there is limited knowledge and experience in how broader development considerations can be incorporated into mitigation planning or vice versa. A particular challenge is the long time horizons that need to be considered in this context, as well as giving due weighting to the multiple developmental challenges facing the target countries.

The discipline of multi-criteria decision analysis (MCDA) has developed a wide range of tools and methodologies that are well suited to problems that require concurrent consideration of a range of impacts. These include tools that allow for identification of a suitable set of criteria for measuring impacts, quantifying performance of alternatives which do not have natural measurement scales, and for exploring trade-offs in situations with multiple decision makers and sometimes conflicting priorities.

This paper provides a taxonomy of the types of problems and challenges in the climate mitigation space that may be approached using MCDA. These include assessing the co-benefits of individual mitigation options, combining of mitigation options into scenarios, and interpreting the results of modeling of following particular emission trajectories. It then goes on to describe the key components that underpin analysis of problems using an MCDA framework, which fall broadly into the areas of problem structuring and problem analysis. The paper will then highlight two examples of the key errors that are often made in co-benefits analysis - notably use of rating scales and weighting, using relevant examples. Finally, the key limitations of MCDA will be described - notably the time required to conduct a proper engagement exercise and the complexity of the analysis (and hence challenges with communication of results).

Acknowledgements:

This work has been conducted under the MAPS Programme (www.mapsprogramme.org) with funding for Children's Investment Fund Foundation (www.ciff.org). Some of the thinking that underpins this work was developed during a 3 day workshop on the use of MCDA in co-benefits analysis and hence was informed by participants at this workshop. Individuals who participated were: Hernan Blanco, Navroz Dubash, Matthias Ehrgott, Jose Rui Figueira, Marta Torres-Gunfaus, Radhika Kosla, Francisco Molina, Ana María Rojas Méndez, Britta Rennkamp, Serban Scrieciu, Ashok Sreenivas, Theodor Stewart, Tanya Visser and Harald Winkler

P-4418-08

Foreseeing the evolution of the expertise on climate: some thoughts from the French Association on Disaster Risk Reduction

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The French Association for Disaster Risk Reduction (AFPCN), formerly the French Committee for the International Decade for Natural Disaster Risk Reduction (UN-IDNDR), is a multidisciplinary platform that aims to strengthen the coherency of public policies on disaster risk reduction. One of AFPCN working groups focuses on the risks associated with climate change. At the occasion of the release of the fifth IPCC report, the group re-examined the organisation of IPCC expertise and brainstormed on how it could evolve in the future. This thinking process was based on a review of the existing academic literature and on interviews undertaken with top climate scientists (with the support of the French Academy of Science, IPSL, LEGOS or CEA) and the IPCC focal point (former and actual) in France. A preliminary report was written, sent off to the public authorities and disseminated to the wider public at the occasion of a study day on July, 9th 2014. Since then, the team has continued to follow up on AR5 results and several study days are scheduled in 2015, aimed at further discussing, enlarging and strengthening its views.

In this contribution, we propose to communicate the results of this integrative thinking process with the willing of nourishing the science-policy dialogue on what could be a more efficient articulation between research, expertise and decision regarding to climatic issues. IPCC is a unique experience: first, because of its international dimension; second, because it occupies a specific position at the crossroad between science and policy. Evaluating the advantages and the limits of its organisation is key to foresee the evolution of the climatic expertise in the future.

Our analysis focuses on the difficulty to transfer the disparate knowledge of fundamental research, which is organised in specialised disciplines, to build a coherent expert narrative. Today, each of the three working groups of IPCC has a relatively wide field of knowledge to cover and build on a variety of research communities from atmospheric to solid earth sciences, from socio-economy to political science. Each discipline is confronted to different constraints in terms of observational, modelling or conceptual thinking - differences that are not anecdotic but are heritages of different cultural scientific background as well as of the complexity of the real world. The question is whether and how these differences can be accounted for while building a relevant expert narrative. We propose to explore three key steps: 1) the articulation of the working groups, 2) the treatment and communication of uncertainty, 3) the process of successive summarization done from the report to the technical summaries to the Summary for Policy Makers. On that basis we propose leads for amelioration and adaptation for compliance to the needs of the new agreement that is emerging from Copenhagen, Cancun, Lima and will be adopted in Paris.

As we are particularly interested in public policies on adaptation and mitigation, we tend to suggest bigger changes than the ones adopted by IPCC last February. The idea of transferring the expertise on impacts from WGII to WGI seems particularly relevant to us. Additionally, we would suggest developing more works combining adaptation and mitigation. The trend that has led IPCC to produce ever-bigger reports corresponds to a somewhat inductive view of science. In addition to a large expertise on climate change, it would be important to allow for more focussed works to be undertaken at a variety of scales, involving a greater variety of scientific disciplines and with the contributions from a greater variety of stakeholders (notably the civil society). Workshops and seminars could be organised at the level of the United Nation that could help identifying the research questions to be covered up

in order to answer to the future expertise needs. The scale at which climatic risks, adaptation and mitigation solutions can be thought together in an applicable manner is the scale at which decisions can be taken and applied. Working at a well-thought scale on well-designed questions, and with relevant groups of stakeholders, could allow approaching the challenges associated by climate change in a more readable manner. On the side of public policies, it also seems important to explicit more clearly the interplay between science and policy while going from the large expert reports to the short SPMs.

P-4418-09

Towards a scalable architecture for climate adaptation services: illustration of challenges through future coastal flooding assessments

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As climate is changing, more applied information on its impacts is required to inform adaptation planning. It is a fact that during the last decade, the amount of information relevant for climate change impact assessment has grown drastically. This can be particularly illustrated in coastal areas, where a most important recent development has been the delivery of precise and accurate topography obtained by LiDAR at regional to national scales. However, these developments have not led to easier assessment of coastal climate change impacts. This is due to (1) the complexity of coastal models that also depend on local natural changes and anthropogenic actions and (2) the difficulty to actually use such large and complex datasets. This raises the following questions: can such complex and heterogeneous datasets be used for an efficient communication of future flooding affected by sea-level rise and climate change? How to communicate the related uncertainties? What infrastructure is needed to support the development of such services?

One of the major challenges in the design of this class of information system is to tackle both the volume and the heterogeneity of the data required to build relevant climate services. Contributions from wingspan projects (Copernicus, EarthCube, EPOS), have demonstrated the feasibility of such architecture. The scalability of the components lying at the heart of these global systems is therefore critical in order to handle large data sets, to integrate complex coastal models and also to deliver near real-time quantitative flooding scenarios. We will therefore discuss several issues related to data architecture at large scale, on-the-fly (geo)-processing capabilities, management of asynchronous workflows and data diffusion strategies in the context of international standards such as INSPIRE (Infrastructure for Spatial Information in Europe).

We finally describe a prototype of web service to quickly communicate spatial information on future flooding along the French coastal zones that takes into account the related uncertainties. We believe that our flexible architecture, mainly reusing off-the-shelf components is able to improve both complex scenarios analysis for experts and dissemination of these future coastal changes to the general public.

P-4418-10

Science-policy interfaces for climate change adaptation in Vietnam: A Case Study of Quy Nhon City

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Climate science has improved more than ever in the human history. With continuous research at national and international levels, more accurate knowledge of climate change - scenarios, models, data and case studies - is being produced. This body of knowledge has crucial role to resolve challenges raised by climate change - sea level rise, severe weather events, extreme temperature, etc. - through mitigation and adaptation measures in policies and plans. But in reality, it is almost impossible to reach on common consensus on use of these scientific knowledge in policy process because the policy choices are so context dependent (Prewitt, Schwandt, & Straf, 2012). Therefore, the role of climate science research is not straightforward on addressing challenges of climate change in plans and policies. In case of climate change adaptation, the use of this knowledge is even more complex because adaptation bears more pragmatic and immediate values than mitigation in the policy processes. But it is quite pressing to improve interfaces between science and policy to effectively adapt with current and future problems posed by climate change; especially among rapidly developing countries where the urbanization and economic growth is surmount. There is very little research exploring science-policy interfaces for effective climate change adaptation in plans and policies in the context of developing countries. This research tries to address this gap using case study of Quy Nhon city of Central Vietnam; where almost all effects of climate change - sea level rise, temperature change, change in precipitation, drought events - are predicted. Studies have shown that Vietnam is 5th most exposed nation to the impacts of climate change where 7 - 12 typhoons make landfall annually. It is also one of the most rapidly transforming countries - economically and socially - in Asia. It has strong institutional and bureaucratic set up for policy formation and implementation as well as for scientific research of climate change. Using more than 30 interviews at Central and at Provincial level among policy makers, climate scientists, policy implementing agencies, and local political as well as community representatives; this research attempts to identify a pragmatic approach of science-policy interface for climate change adaptation. Major contribution of this research is methodological - to propose an appropriate approach of better interaction between scientific researches and policy processes to adapt with climate change among vulnerable communities in developing nations; where the formal mechanism of policy implementation are not adequate.

P-4418-11

Sharing skills and needs between providers and users of climate information to enable decision making based on science: lessons from the Northern Adriatic case study

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The growing evidence in support of an anthropogenic influence on Earth's climate, and the need to cope with the expected impacts of climate change on socio-ecological systems call for a closer dialogue between climate scientists, and the large community of climate information users.

The research described here is focused on an interactive process designed to bridge the gap between climate information providers (i.e. climate scientists) and climate information users (i.e. decision makers belonging to public institutions). Bridging this gap means designing a two-way communication, so that mutual learning occurs. Main objective of this research is to analyse the need of climate information for the integrated assessment of climate change impacts on the coastal zone of the Northern Adriatic Sea. The Northern Adriatic coastal zone is considered to be particularly vulnerable to several climate-related phenomena, including, among others, heavy rainfall events, pluvial flood, sea-level rise, causing potentially high damages to coastal eco-systems and urban areas (e.g., acqua alta in the Venice Lagoon). The work reported in this article (conducted within the framework of the EU-funded CLIM-RUN project) focuses on the set up of a participatory process designed to understand end-users' needs, engaging representatives from both the scientific and local stakeholders communities. The process was facilitated by the Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) acting as a "boundary organization".

End-users of climate information were selected among representatives of those public institutions having a

specific mandate for Integrated Coastal Zone Management (ICZM). End-users' involvement and discussion allowed, since the preliminary phases of the iterative process, to identify which were the end-users' needs: (1) data to support land-use planning, (2) data with greater resolution and longer time series, (3) data on climate impacts and risks, (4) precipitation patterns to improve irrigation, (5) sea level rise and tides to plan ahead both agriculture and Venice defences, (6) climate variations and extreme events, (7) seasonal trend for tidal waves, and (8) hydraulic risk. End-users selected extreme events as the most important climate variables needed, because they are necessary for the development of flood early warning systems, for urban planning, and for Integrated Coastal Zone Management. Based on all needs expressed climate variables were listed in a table and climate products were designed.

Three climate products addressing some of the highest priority needs identified by local end-users were selected. Specifically, climate experts decided to focus on 1) short-term (2020-205) projections of sea-level rise; 2) seasonal predictions of extreme rainfall events; 3) long-term regional projections of climate extremes (including heat waves, dry spells and heavy rainfall events). Additionally, two risk products were developed: 4) Sea level rise inundation risk maps for the low-lying coastal areas of Veneto and Friuli-Venezia Giulia regions; and 5) Pluvial flood risk maps for the urban territory of the municipality of Venice.

We can conclude that the dialogue between end-users and climate scientists is still at an early stage, and there are objective difficulties in clearly identifying a common ground where scientifically robust climate information can be effectively translated into a usable product by the end-users community. However, more than lack of information the problem seems to be, nowadays, lack of integration of climate information into the decision making process.

P-4418-12

Transforming Science: The Process and Performance of Scientific Synthesis

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Transforming science is a term meant to be understood in two senses. In one sense it means changing the way science is organized and done; in another sense it means producing science that may transform what we know and can do. Achieving transformative solutions to sustainability challenges will require transforming science in both senses of the term: we will need new forms of scientific knowledge and inquiry, and will need scientists to organize and collaborate in new ways to produce such knowledge. Synthesis centers offer promising possibilities for transformations of both sorts, achieved through intense and focused collaboration across academic fields and across the sectors of science and public policy. This talk describes the inner workings of two organizations that promote scientific synthesis, analyzing their structures and consequent patterns of interaction to understand why they work well and to draw lessons for the design and operation of other such centers. To do so we measure collaborative process in new ways - using sociometric sensors - and analyze substantive output using a topic models of publications from synthesis centers and a reference corpus of articles from cognate fields. We summarize our findings in a model of intellectual fusion that captures the principal dynamics of the process.

P-4418-13

Towards more consistent assessments of country-level impacts of climate change

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Vulnerability and impacts assessments contribute evidence to shape and support action to tackle climate change at various levels. However, there is currently no international process for presenting information about climate impacts consistently at the national level. The lack of consistency means it is hard to compare results from different assessments and different countries, and it can be challenging to attempt a synthesis at the country level, given absences of common approaches, preferred timescales, descriptions of sectors, etc. International cooperation on cross-border impacts can be especially challenging when assessments in different countries lack consistency or transparency in respect of assumptions and methods.

The level of ambition for national assessments is constrained by multiple factors within countries, including research budgets, technical capacity, data availability at appropriate spatial and temporal scales, political priorities, and uncertainty over best practice methods. Approaches to country-level climate impacts, vulnerability and risk assessments span a spectrum including top-down modelling of impacts in sectors, expert synthesis, and bottom-up stakeholder-led risk aggregation and prioritisation. Even within individual countries, preferred approaches for national assessments have evolved over time.

Previous studies have shown that greater consistency in the assessment and communication of climate impacts and vulnerabilities at a country level is both possible and desirable. The UNEP-UK Country level impacts of climate change (CLICC) project is now addressing this. It is facilitating the co-creation of a common process with a range of countries to enable them to present their own climate change impacts and risks in a more standardised way. The CLICC initiative aims to establish a long-term process supported and coordinated at the international level, rather than simply to deliver a one-off suite of information products.

Participating countries represent a range of economic development and geographies. Some of the benefits identified by countries during consultations include: (1) more effective information-sharing on climate impacts, leading to enhanced collaborative research and action, especially in relation to trans-boundary impacts; (2) expansion of common capabilities in scientific assessment and building capacity of national systems for climate assessment; (3) generation of good practice and collective learning, through improved transparency around methods, assumptions, data sources and limitations in assessing impacts; (4) consolidation of existing studies and findings within countries, also contributing to a more detailed picture of the global risks from climate change; (5) country-led contributions to the evidence base for provision of support to countries lacking in technical or financial capacity, or approaching their limits of adaptation.

This conference presentation will provide an overview of the achievements of the CLICC project so far, including the results of consultation with more than 30 countries. It will explain the principles that CLICC has established to engage successfully with the needs of multiple countries addressing multiple impacts in distinctive contexts. These include:

- Maintaining country control over content and communication of their impacts information
- Maximising inclusivity regardless of countries' current capacities
- Minimising the burden and avoiding parallel institutions or obligations
- Promoting good practice, enabling quality control and signposting research needs

CLICC has considered both qualitative and quantitative formats to achieve greater consistency in the communication of results, and the importance of metadata has been underlined. We will present the CLICC options

currently in development, showing how they fit with other common approaches and requirements on countries. We will explain how the outcomes from CLICC support better decision-making at national and international levels. Finally, we will foster discussion around CLICC's longer-term aspirations, exploring how the sustainability of this initiative may be achieved through international support and coordination, leading up to COP21 negotiations and beyond.

P-4418-14

Multi-model, multi-method, information for decision making

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Despite continual advances in our understanding of the climate system and climate change, continual increases in complexity of earth system models, and continual developments in both dynamical and statistical downscaling methods, decision makers continue to be presented with a diversity of contradicting and often highly uncertain information regarding potential changes in climate with respect to their decision context. Added to this is the increasing complexity of the information needs of decision makers as they consider a range of time scales, spatial scales, and complex system interactions in their day to day and long term strategic decision making. Urban centers, particularly in developing nations face severe resource constraints, and yet stand out at key points of risk and vulnerability under future climate due to rapid urbanisation, pressure of natural resources, and critical limitations on governance and administration.

It is therefore crtiical that the most robust and, critically, defensible, information is available to decision makers and that this information is made available that facilitate co-production of knowlege, rather than just supply of knowledge. This is a significant challenge. This paper presents some initial work being done at the University of Cape Town, South Africa. The focus drawing out defensible scale and context appropriate information from a diversity of global climate models (CMIP5), regional dynamical downscaling (CORDEX) and regional statistical downscaling (CORDEX-ESD). The method presented allows for rapid and continual exploration of the diversity of information and so facilitates co-production. The approach allows for the specification of certain characteristics of the information required (variables, and multi-variate characteristcs, spatial scales, temporal scales and time horizons, etc.) and uses these requirements to interrogate the diversity of source data and signals in such a way as to extract the most defensible messages.

It is explicitely acknkowleged that the resultant messages may still contain contradicitons, and that some levels of uncertainty due to natural variability or model inadquecy is irruducible given the available data.

P-4418-15

Climate induced environmental domain change: informing conservation decision making in KwaZulu-Natal, South Africa

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Climate change is having marked influences on species range distributions, ecosystem composition and phenology. This raises questions as to the effectiveness of current conservation strategies and conservation planning, the central tenets of which are representivity and persistence of species. Conservation planning is currently based on static spatial plans which do not adequately account for dynamic threats such as climate change and thus cannot ensure the persistence of species. KwaZulu-Natal, a province occurring on the eastern seaboard of South Africa, occurs in one of the biodiversity hotspots of the world. This high diversity and the paucity of species specific information make it impracticable to develop individual climate adaptation responses for all species. We propose a method to incorporate climate-dynamic environmental domains into conservation strategies. The environmental domains are identified using specific environmental correlates of floristic composition in the province, which were temperature, soil base status and precipitation variables. The environmental domains represent the metaphorical stage of the province whilst recognising that species constituting the diversity may change through time. This offers an approach to conserve diversity under current and future climates. Current domain locations were mapped by identifying their positions in a multi-dimensional environmental space using a non-hierarchical, iterative k-means clustering algorithm. Their future locations were explored using an ensemble of six different dynamically downscaled Coupled Global Climate Models based on the A2 emission scenario. The HadCM2 and GFDL2.1 models represented the extreme ranges of the models. Domains occurring in savanna biomes increase at the expense of domains occurring in the grassland biomes. This has significant negative consequences for the species rich grasslands. Euclidean distances were used to determine the magnitude of change in each environmental domain. The magnitude of change models identify areas of greatest and least stability for each future climate projection, and represent areas of changed climatic conditions or edaphic disjunctions. Species with specific soil requirements may not be able to track changing climatic conditions. Using the identified environmental domain and magnitude of change maps, a vulnerability framework was developed to inform appropriate conservation actions to mitigate climate change impacts on biodiversity. The framework incorporated climatic stability and habitat loss which is another major global change factor in the province. The mean magnitude of change expected in each domain formed the third dimension of the framework which indicates the potential velocity of change in each domain. The study explicitly links floristic pattern and climate variability and provides useful insights to facilitate conservation decision making for climate change.

P-4418-16

Building a Climate Information Platform for Europe

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In association with the new European space programme (Copernicus), the European Commission is promoting the development of a climate information platform which should supply comprehensive, reliable and consistent information for stakeholders.

The FP7 project "Climate Information Portal for Copernicus" (CLIPC) is developing a demonstration portal for the Copernicus Climate Change Service (C3S). This project is one of a suite of FP7 research activities which are administratively independent of Copernicus, focussed on creating the technical and scientific building blocks needed for the service. There are dozens, if not hundreds, of climate portals already offering a variety of products to a confused user community. It would be unwise to seek to replace all this creative activity with a single portal - instead CLIPC is designing a portal to make distributed resources more accessible through flexible discovery systems. CLIPC needs to deliver more than a directory of resources: resources need to be presented in common protocols so that users can access multiple datasets.

More information about the project objectives is available at www.clipc.eu. The gulf between the climate science communities and the end user communities is a central challenge being addressed in the project. It is important to understand that there is significant diversity and multiple communication barriers within these two sets of communities as well as between them. The CLIPC services must presentation will provide a review of progress towards this ambitious goal, through a discussion of user requirements activities, an overview of the proposed architecture, work on assessing and adjusting model biasses, and a discussion of the climate impact indicators which will be provided through the portal. When looking at the usability of data for the various users, CLIPC will implement a set of services functioning as a "knowledge base" supplying information to users about the data, including definitions of terminology used, quality of datasets, versioning, and user annotations.

P-4418-17

Cooperation on climate change under economic linkages - How the inclusion of macroeconomic effects affects stability of a global climate coalition

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Game-theoretic models of international cooperation on climate change come to very different results regarding the stability of the grand coalition of all countries, depending on the stability concept used. In particular, the core stability concept produces an encouraging result that does not seem to be supported by reality. However, current implementations of this model are based on the assumption that a country's consumption loss due to emission abatement measures only depends on the country's domestic emissions. This approach neglects international macroeconomic effects of emission reduction measures, such as technology spillovers or changes in fossil fuel prices. We extend the game-theoretic model based on the core stability concept by introducing these effects into the model. The computable general equilibrium model DART and damage functions from the RICE model are used to quantify the theoretical model. Contrary to the classical model, we find that the core of the resulting cooperative game is empty and no stable global agreement exists. This is mainly due to fossil fuel exporting countries, which are negatively affected by lower fossil fuel prices resulting from global emission reduction measures. Also, other countries do not have a sufficient incentive to compensate fossil fuel exporters for their participation in a global agreement, because the gains of further cooperation are small. We also find that, if damages from climate change are assumed to be high, countries with comparatively low projected damages are a hindrance to global cooperation. Our results point to two alternative ways forward in the climate negotiations. The first option calls for a «coalition of the willing» to compensate blocking countries, mainly fossil fuel exporters, for participation in a global agreement. As we found that no stable global agreement exists, such compensation would not be rational, if the decision is based purely on a benefit-cost analysis of GHG abatement. However, if other arguments such as fairness principles are taken into account, the necessary compensation might be justifiable. The second option calls for the «coalition of the willing» to abandon the UNFCCC process and to try to consummate an agreement among this coalition. This option could come close to the environmental effectiveness of the grand coalition.

P-4418-18

Development of an interactive, multi-objective decision support system in South Africa

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Climate change, and the decisions to be made regarding the management thereof, is inherently complex and multi-faceted. However, in the complex world we live in, it is but one of many complexities - there are many other essential systems and pivotal issues with which it interacts. Going forward, decisions will not be based on the traditional decision criterion of cost alone, nor should it be based on a single criterion (which ignores the knock-on impacts of a decision in terms of other criteria). To be defensible and responsible, decision makers need to be cognisant of the full extent of their decision's impacts before making a final decision. Myopic decision support systems often, inadvertently, do more harm than good in the long run. Multi-objective decision support has been developed to try and overcome this problem.

Generally, a country's energy generation and consumption is a key driver of its greenhouse gas emissions. The TIMES model generator, a widely used country-wide energy planning tool, was developed as part of the IEA Energy Technology Systems Analysis Program, an international community which uses long term energy scenarios to conduct in-depth energy and environmental analyses. The TIMES model generator combines two different, but complementary, systematic approaches to modelling energy: a technical engineering approach and an economic approach. It is a technology rich, bottom-up model generator, which uses linear-programming to produce a least-cost energy system, optimised according to a number of user constraints, over medium to long-term time horizons. In a nutshell, TIMES is used for the exploration of possible energy futures based on contrasted scenarios. The model makes equipment investment decisions and operating, primary energy supply, and energy trade decisions, by region. This outputs an optimal mix of technologies and fuels at each period, together with the associated emissions to meet the demand. The model uses scenarios to do what if analysis, and does not optimise for anything other than costs.

The first part of this presentation chronicles the conversion of SATIM, a South African calibrated version of TIMES, from a cost only to a bi-objective (initially) and multi-objective (ultimately) optimisation model. The practicalities of such a conversion, along with the obstacles encountered and ways to surmount said obstacles, are discussed. This conversion was part of a MAPS South Africa initiative to create a multi-objective energy sector planning model for South Africa. The benefit of having such a model is the ability to study trade-offs and to provide more rich data for decision makers. The second part of the presentation will demonstrate and elaborate on the enrichment of data outputs thanks to the expanded model.

The end goal of this modelling work is to convert the South African linked energy and economic model (a combination of SATIM and a South African economic (CGE) model) into a multi-objective optimisation framework. Adding the economic framework opens the scope for a wealth of economic and social considerations to be included in the objectives, broadening the reach of the model in terms of decision support and stakeholder representation. Further to this, true multi-objective decision support cannot happen in isolation from decision makers, who have insight into the problem and are able to specify preference information related to the objectives considered and the different solution alternatives. It is, thus, proposed to incorporate interactive modelling techniques in the model formulation. Interactive modelling is a constructive process where, while learning, the decision maker is building a conviction of what is possible and confronting this knowledge with his or her preferences, which are also evolving. The presentation will conclude with an overview of the proposed methodology for the development and implementation of such a large scale, complex model. Ideally, advice and constructive feedback on this proposed plan will be elicited during or after this presentation.

P-4418-19

Communicating uncertainties of future coastal impacts for decision making

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As sea-level rises, coastal hazards and risks such as extreme flooding or erosion are changing. For accurate assessments, several factors must be considered, such as the variability of sea-level rise and storm surge patterns. We proceed to a global sensitivity analysis of future coastal impacts of sea-level rise, in order to provide quantitative insight into the relative importance of contributing uncertainties over the coming decades. The method is applied for typical coastal settings of high- and low-energy coasts. Storm surge propagation processes, then sea-level variability, and, later, global sea-level rise scenarios become successively important source of uncertainties over the 21st century. This defines research priorities that depend on the target period of interest. On the long term, scenarios RCP 6.0 and 8.0 challenge local capacities of adaptation for the considered sites. For decision makers concerned with adaptation to climate change in coastal areas, this approach provides quantitative insight into three key issues related to: (1) the timeliness of coastal adaptation planning (2) the identification of periods by which rising sea-levels cause rapid obsolescence of regular adaptation measures (3) the constraints imposed by different future climate change scenarios for long-term adaptation planning.

P-4418-20

Climate services for adaptation to climate change in a developing country: case studies from South Africa and Burkina Faso

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Background and objectives: Adaptation to climate change (CC) is an issue growing rapidly, one reason being the observation and projection of negative impacts highly challenging human societies and ecosystems. Amongst barriers to adaptation, the lack of useful and understandable climate information is regularly emphasized. Many initiatives to implement climate services have emerged in recent years to respond to this need, especially in developing countries. According to the World Meteorological Organization, climate services aim to « provide climate information in a way that assists decision making by individuals and organizations ». My PhD project has a multidisciplinary nature and aims to understand whether, and if so in what ways, climate services may represent a first step towards the development of adaptation strategies at the local level. This research is based on a bottom-up approach, and has for main hypothesis that using climate services for the development of adaptation strategies requires to meet certain criteria (as relevance, access, legitimacy, equity, integration) associated with a participatory approach for the construction of information, taking into account contextual aspects of vulnerability to CC. More specifically, the focus is on the interactions between climate services providers, users and final beneficiaries for one part; and the communication tools used to broadcast the information for the other part. I pursue this way the goal to analyze the degree of consistency between the "supply" and "demand" in terms of climate information, both for content and communication structures, and therefore understand whether CS can be a first step towards adaptation to CC. This may serve to formulate recommendations or alternatives in order to improve the reconciliation between the bottom and the top on that matter.

Methods: The methodology (that will be described in more details in the poster) will be applied to two case studies. The first one is South Africa (1), in the province of Western Cap, where a multidisciplinary research center at the University of Cap Town acts as climate service and collaborates with public local stakeholders. The second one is Burkina Faso (2), where two climate services projects are currently being implemented targetting adaptation in rural communities. Both countries present a high degree of vulnerability to climate change, although different internal contexts influence the distribution of adaptive capacities and social vulnerability. I first want to highlight internal logics coming from the building of climate services at the level of suppliers (scientists) and users (administration and technical agents involved) of climate services; then identify demands from final beneficiaries (local public stakeholders and rural farmers in our case studies) through qualitative investigations carried out locally. Data will be collected by means of semi-structured interviews (for all actors) and participatory workshop (for beneficiaries). The selection of those key stakeholders will be a crucial point of the research, and particular attention will be given to what some authors have called « weak » or « absent » stakeholders, traditionnaly excluded from participating in consultation/decision making processes. The understanding of contextual factors forging social vulnerability to CC, as well as interactions between all actors involved in building climate services, will be two major points of attention in this project.

Results : I will present early results from the analysis of a field research planned for April 2015 in South Africa (case study 1) as well as highlights about adaptation to climate change in Burkina Faso (case study 2) on the basis of a previous field research conducted in this country in 2012. I also intend to present a simplified typology of climate adaptation services in Africa. This PhD project is in its first year, research is then on-going and new points may be included later on.

P-4418-21

Land use changes and emissions from deforestation in Guatemala: advances and challenges to prepare this Central American country for REDD+

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In spite of the fact that Guatemala is consistently listed as one of the most vulnerable countries to climate change, adaptation needs and gaps have not been the focus of governmental and non-governmental organizations dealing with climate change issues. Rather, most of the work on climate change for the last 15 years has focused on capitalizing on the potential for income from international sources derived from carbon-offset projects, first as part of the Clean Develop Mechanism CDM and more recently as part of avoided deforestation initiatives.

Our research group has accompanied this process for the last 15 years and this paper will present the most important advances in terms of producing the hard data needed to show recent deforestation and reforestation trends in the country, as well as advances in defining the governance system required to implement the National Strategy Against Deforestation which is the basis for REDD+ initiatives in the country.

We first discuss forest cover change information for Guatemala, where we observe a steady drop in the net deforestation rate from a high value of 1.7% measured for the period 1991-2001, to 1.3% for 2001-2006, to 1.0% for 2006-2010. This drop is not a result of a drop in the gross amount of cleared forest. Rather, it is a result of an increase in the forest regenerated, which includes new plantations and forest regenerating after disturbances such as fires and as secondary growth in abandoned agricultural fields. This is in part the result of a successful incentive program by the central government both for large and small holders (PINFOR and PINPEP), which provides monetary incentives for people and communities who plant new forests or preserve existing forest cover. Ironically, these programs have not been able to generate a single carbon credit because of problems demonstrating additionality.

In terms of the governance needed to reduce deforestation and to generate marketable carbon credits, this paper describes various significant advances in recent years. A climate change law was passed in 2013, which mandates the implementation of a series of policies to reduce and compensate emissions from sectors such as energy, industry and transportation. It includes some provisions to create a national registry for carbon-offset projects, which could set the basis for the development of an internal carbon trading system.

Beyond these national initiatives, many sectors within the country, including several government offices, are very actively pursuing the development and implementation of REDD+ initiatives to attract international investments. We will describe some of the governing issues under discussion, particularly the intergovernmental coordination needed to implement a proper Monitoring, Reporting and Verification (MRV) system and the discussions around the fair distribution of potential income from avoided deforestation projects in protected areas between the communities implementing the activities to reduce deforestation and the central government who is the legal owner of the land and therefore of the carbon credits to be generated. This of course has been a difficult issue to negotiate, which has resulted in tension between the communities and the central government.

Many of these issues and challenges are typical of situations encountered in developing countries around the world that have been pursuing the elusive goal of bringing in enough funding to reduce or stop their deforestation problems. Unfortunately, even after many years of work, international markets for carbon credits appear to be unreachable to communities in need of funds to improve their adapting capacites. National carbon markets may prove to be a more feasible solution.

P-4418-22

Controlling environmentally-related diseases outbreaks: support of remote sensing, modeling and knowledge integration

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Recently, in their fifth report on the impacts of climate change (CC), IPCC experts highlight 6 major challenges that will face humanity (IPCC, 2014). The fifth one concerns the impact of global warming on health with a modification of the geography of diseases due to changes in climate. Indeed, in certain areas, CC is going to deeply modify the environment (for example land use, water accessibility, natural habitats) and the links between environment and human health are multiple, complex and multiscale. For example, environment plays an important role on the dynamic of vector-borne diseases since it can modify the distribution of the vectors, and affects interactions between human-vector and vector-pathogen.

In addition to environmental changes, health inequalities are determined by unequal health provision, unequal access (health care coverage, travelling time) and unequal use (related to: socio-economic difficulties, risk perception, risk behaviors). These complex relationships between a changing environment, societies and health are major issues for policy makers.

In this context, gathering and analysing data on climate and health, as well as information on socioeconomic and environmental factors, is essential for planning actions. For this purpose, remotely-sensed data are increasingly available in a very short time (few days) at high spectral (from radar to blue), spatial (<5m) and temporal (daily or weekly) resolutions. The access to such data is promising to improve models and response. Recent advances in information and communication sciences and knowledge engineering could advantageously assist the implementation of spatial data infrastructures. Such infrastructures should handle highly heterogeneous and distributed data while allowing to formalize multidisciplinary knowledge.

In this contribution we propose an integrated solution for assessing the impacts of the CC on Environmentally-Related Infectious Diseases that can be broken up into four sub topics:

- aggregation of high quality multidisciplinary in-situ and permanent monitoring spatial information related to environment (including climate), human (socio-economics...), diseases (blurred georeferenced cases to respect anonymity);
- formalization of knowledge and reasoning to facilitate contextual interpretation, data integration and dissemination;
- use of mathematical models to investigate epidemiological dynamics and associated risks linking diseases occurrences with factors related to environment and human activities at different scales (regional to local);
- production of indicators for assessing social and environmental changes and predicting the spatio-temporal evolution of the epidemiological patterns.

These transformative solutions are useful to mitigate the effects of CC (vector spread control, epidemics forecast and control), to target appropriate actions, to reduce the costs related to improvement in people's health and to facilitate the dissemination of information to health stakeholders, society, government agencies and media.

We describe several ongoing works which partly contribute to reach these objectives: i) New-Caledonia: --spatial risk modelling, 6 months ahead forecast of dengue epidemics and evolution of dengue dynamics up to year 2100--, ii) French Guiana/Brazil: catalog of multi-thematic spatialized data related to the transborder area between French Guiana and Brazil, portal of a future malaria sentinel site of the Brazilian observatory on climate and health, iii) Mayotte and La Réunion: surveys to investigate the inequalities and choices that drive the use of health care; development of a method to spatially anonymize georeferenced individual data, and iv) Madagascar: early warning system for forecasting malaria outbreaks. We also situate this project within the worldwide initiatives context.

We analyse the benefits of such an approach but also the related obstacles (e.g. data sharing) and technical issues (e.g. multiscaling, complex modelling).

P-4418-23

Robust technological and emission trajectories for long-term stabilization targets with an energy-environment model

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In order to inform decision makers and to evaluate climate policies, the use of integrated assessment models (IAMs) is now widespread and common. These models are in particular used to identify promising technological pathways (Labriet et al., 2009), to evaluate various climate policies (Hu et al., 2012) or to assess the impact of policy measures on resource exhaustion (McGlade & Ekins, 2015).

Climate change being a recent and complicated field of research, the last decade brings multiple answers regarding the climate system evolution but raises also a lot of new questions that still need to be addressed by physicists and climate scientists. The imperfect knowledge of global warming mechanisms and the large variety of IAMs lead the model users to reach conclusions sometimes very different.

This lack of robustness across models leads some economists to disregard the use of IAMs. Pyndick (2013) states that considering the numerous uncertainties surrounding the climate system behavior or the impacts of climate change on economic aspects and the inability of IAMs to consider very low probability/catastrophic outcomes events, the IAM-based analysis of climate policy creates "a perception of knowledge and precision that is illusory and misleading". Hence, it seems absolutely necessary to make uncertainty a core feature of long-term, climate related policy analysis and to identify relevant techniques to solve large-scale problems contaminated with "massive data uncertainty".

Motivation Stochastic optimization (SO), sensitivity analysis and deterministic multi-scenario analysis have been applied to tackle this uncertainty issue. SO allows to endogenize uncertainty and to provide an explicit hedging strategy while the other methods stay deterministic. One drawback of SO is that it requires to know the probability distribution of the uncertain parameter which is not always possible. Another drawback of all these methods is that they become rapidly intractable as problems grow in size.

In this work, we introduce an alternative way to tackle uncertainty in energy system models. We rely on robust optimization (Ben-Tal et al, 2009) to make many model parameters simultaneously uncertain. So far, this technique has been scarcely used in energy modeling (Babonneau et al, 2012). We focus on the climate system modeling because of it is large uncertainties and the numerous criticisms it faces.

Methodology In this study, we use the TIAM-World model (Loulou, 2008) that relies on the TIMES paradigm. Often used to analyse climate change policies or objectives, this model contains a climate module inspired by the DICE model. Using robust optimization techniques, we assess the impact of the climate system parameter uncertainty on energy transition pathways under climate constraints. Unlike other studies (Syri et al., 2008, Labriet et al., 2015); we consider all the climate system parameters. This is of primary importance since (i) parameters and outcomes of climate models are all inherently uncertain (parametric uncertainty) and (ii) the simplified models at stake summarize in a (sometimes linear) few equations phenomena that are by nature complex and non linear, so that structural uncertainty is also a major issue.

Given the non linearity of the climate module in the parameters, we had to implement a two-level master-subproblem algorithm in order to solve the non-linear problem apart from the classical Times one. We run this constraint-generation algorithm for various values of the uncertainty budget (which represents the number of climate parameters allowed to deviate from theirnominal values) and for several levels of the temperature constraint.

Results and discussion The use of robust optimization techniques allows us to identify economic energy transition pathways under climate constraints for which the outcome scenarios remain relevant for any realization of the climate parameters. In this sense, scenarios/transition pathways are made robust. In particular, we show that adverse combinations of climate parameters include not only the expected climate sensitivity, but also carbon cycle parameters, which directly impact the quantity of atmospheric carbon. Moreover, we compute robust emissions trajectories, and examine how the strategies are spread across regions - especially between oil producing and non-producing regions.

P-4418-24

Information Technology in management of social-economical estimation of the flood affects and water quality in the Central Asia

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The aspects of water allocation between the countries of Central Asia are considered from the point of view of river drain ecology. For the decision of ecological problems, the creation of Interstate Water Quality Control Commission of Transboundary Rivers is offered in the region.

Water relations between Central Asia republics during the Soviet Union time were regulated by "Complex Use and Protection of Water Resources Schemes" in Amudarya and Syrdarya basins. The main purpose of working out basin "Schemes" was to define real volumes situated within the Amudarya and Syrdarya basins and available for using water resources. It was also providing their fair allocation among region republics, meeting all the water users' interests. It should be noticed, that the number of important aspects were not considered and included in "Schemes", for the situation has greatly changed after 1980 (years of the last "Schemes" specification and completion of hydraulic range composition). Mainly it concerns the ecologic acquirements and sanitarian clears thrown into rivers and channels. Overusing basin water in irrigational lands planned as maximum use by "Scheme" resulted in exhausting water resources and appearing new problems. They are:

- Deterioration of ecological condition sometimes leading to ecological disaster in downstream of rivers of Aral Sea Basin;

- Great pollution of river water with pesticides, herbicides, other harmful elements and increasing of water mineralization.

Among all the regions of Tajikistan 93 % of territory that borrow mountains in the Zarafshon River Basin the formation of floods is observed most often (almost 7% of the total across Tajikistan) and their average number in a year reaches 150. More than 300 thousand inhabitants live in the Zarafshon River Basin located in the Ajni and Penjikent regional centers. The local population is affected almost annually with great economic losses.Nowadays one of the most polluted rivers of Central Asia is Zarafshon River. The capacity of this water is changed under the influence of collector drainage water of irrigating basin zone and wastewater of Samarqand, Kattakurgan, Navoy, and Bukhara cities. Mineralization of water exceeds from origin to estuary from 0.27-0.30g/l to 1.5-1.6 g/l.

It gives the ground to hope, that the problem of contamination and ascending of a degree of water arteries mineralization can be solved with the same success by creating (similar ICWC) Interstate Coordination Water Quality Commission (ICWQC). Structural subdividing "The interstate experts" unite the leading technicians in evaluating the quality and composition of waters from all five states of Central Asia. The main function of this body is to compare the republican experts' information about water composition and to solve disputable questions by carrying out the independent expert appraisals of water quality of Transboundary Rivers. ICWQC Secretary appoints the stuff and sets terms of power of the interstate experts. In Information Center established in each country of Central Asia the water quality control statistics in industrial, agricultural, municipal sectors and Hydroposts are gathered, generalized and systematized. Thus, the data concerning water arteries quality from each country come to Analytical Center of ICWQC.

It should be noted that after reaching the complete transparence of relative composition and quality of all water arteries in Central Asia the next stage is the development of mechanisms to encourage and take measures to the states polluting water environment. These problems together with other questions should be studied in ICWQC Secretariat for considering at Meeting of Central Asia Heads of Governments.

P-4418-25

Balancing Short- and Long-lived Climate Pollutant Mitigation: Clearer Metrics are Critical

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Any effective program to address climate change must reflect a well-balanced effort to reduce emissions among a suite of climate pollutants, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), various fluorocarbons (e.g. HFCs), and black carbon, as their radiative effects and atmospheric longevities vary by orders of magnitude. However, confusion among policy makers about how to attain the optimum balance required to achieve the desired climate benefits has increased dramatically in recent years, in large part because of the way in which climate metrics, Global Warming Potentials (GWPs), are reported in the scientific literature. This confusion is particularly evident in the public and political debate over the expansion of natural gas production in the United States and its use to replace coal in the generation of electricity. Understanding the climate impacts associated with this fuel switching over time is an important and unnecessary source of acrimony. We propose a simple change in the convention used in reporting GWPs that we believe would significantly reduce confusion about the implications of a host of policy decisions. Rather than picking a single time period over which to report the cumulative radiative forcing caused by an emission, typically 20 years (GWP20) or 100 years (GWP100), we propose that the scientific community adopt the convention of reporting climate impacts as a slashed pair: GWP20/GWP100, much the way systolic and diastolic blood pressures are reported together. This framing will help to clarify short- and long-term temporal tradeoffs that are at the heart of much of the confusion.

P-4418-26

Surpassing cognitive barriers for an international climate agreement: Communication matters

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Individual perceptions of climate change should matter for the design of an international climate agreement and domestic climate policy. Especially responses to uncertainty will determine whether one can gain support for climate policy, let alone for an agreement. Communication of its magnificence is vital to garner just this. This paper addresses the individual mind and how it reflects the interests of various actors, be it governments, businesses or international organizations, by focusing on similar cognitive barriers. Using the existing literature on behavioural decision-making, two cognitive barriers that seem to get in the way of a desired climate agreement are highlighted: positive illusion and interpreting behaviour in a self-serving manner. Positive illusions serve as a necessary buffer for human beings in dealing with

negative information about potentially disastrous future developments. In the context of climate change, unrealistic optimism and the illusion of control stand in the way of climate policy. This can explain an array of behavioural responses between various actors. For instance, the reason for climate scepticism; or the overreliance on technological solutions without needing to change individual behaviour. With regard to the second cognitive feature, it is in human nature to behave in a self-interested manner, more so when facing limited resources such as food security, oil and clean air. The agreement should be communicated in a way that does not instill such perceptions but instead should focus on the numerous co-benefits of climate mitigation policy. For example, the results of the 2015 agreement are designed to go into effect well into the future with many possible co-benefits. This gives time for preparation and advancement of domestic climate policy. The United Nations Framework Convention on Climate Change (UNFCCC) has even launched a pre-2020 workplan to raise mitigation ambition by highlighting the benefits of action. Nevertheless, the agreement/climate policy is frequently viewed as costly whilst inflicting unwanted immediate self-anxieties that end up blocking such imperative policies unnecessarily. Thus communication which pays attention to words used influences expectations and information processed cognitively by a person.

The paper ends with solutions and tentative proposals on steering such biases so as to foster support for an agreement. Key questions from the behavioural decision-making perspective are elaborated along with its contribution and important implications to the ever evolving trans-disciplinary framework in tackling barriers towards an international climate agreement.

P-4418-27

An integrated framework for climate vulnerability, and natural hazards & risks assessment at the local scale - and its potential for regional upscaling

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The Indian Himalayan Region (IHR) as many other (mountain) regions worldwide, is facing important challenges in view of coping with adverse effects of climatic changes. In order to address adaptation needs and reduce the vulnerability of the communities living in potentially affected regions, the Indian Government under its National Mission on Sustaining Himalayan Ecosystem (NMSHE) is targeting an integrated vulnerability and risk & hazards assessment encompassing the 12 Indian Himalayan States. The assessment will serve as an important basis for prioritizing, planning and implementing adaptation measures at State/ sub-national level.

The Indian Himalayas Climate Adaptation Programme (IHCAP) of the Swiss Agency for Development and Cooperation SDC, being implemented in partnership with Department of Science and Technology (DST), Government of India is actively supporting these efforts through scientific and technical knowledge cooperation between Swiss and Indian scientific institutions. A first step includes the development and implementation of an integrated and comprehensive framework for climate vulnerability and natural hazard and risk assessment in a pilot region of the IHR. Kullu district in Himachal Pradesh, India, has been identified as climate hotspot and as such represents an ideal pilot region.

The framework for Kullu is based on the latest concept of vulnerability, hazards and disaster risks from the Intergovernmental Panel on Climate Change (IPCC; AR5, SREX). Specific joint Indo-Swiss collaborative studies are in progress in Kullu covering thematic themes such as climate, cryosphere, floods, agriculture, perception, tourism, forestry and biodiversity. Fundamental for integrated vulnerability assessments is a common baseline and thus particular care was addressed to the definition and agreement for a common time window and homogenous datasets (climate, socio-economic, environmental) for all studies conducted within the framework. With regard to the time window, the baseline refers ideally to a relevant time horizon of their livelihood and must span a climatological period of preferably 30 years (WMO standard). For Kullu, the time window 1981-2010 was chosen.

In this contribution, we present the framework for the Kullu region, related results from specific thematic studies and discuss in particular the potential and limitations of the upscaling processes towards a common framework for integrated vulnerability and risks & hazards assessment for the IHR.

P-4418-28

Integrating Research and Practice - What Climate Service can learn from other Fields

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Climate change and its widespread impacts are a challenge for both science and society. To find sustainable solutions and develop adaptation strategies, a transdisciplinary approach to this challenge is needed. Climate service is bridging the gap between climate research and practice. This integrated research relies on intense communication between various players in science, politics, economics and administration. So - by nature - climate service is transdisciplinary.

Some fields now have a tradition of integrating practice partners, but so far, there is hardly any integration of knowledge and experiences on the meta-level. Rather, the terminology, concepts and references that are used are very divers. Neither theoretical insights nor empirical case studies on transdisciplinary communication in different fields have so far been systematically reviewed.

To evaluate in how far climate service can benefit from existing approaches to transdisciplinarity, a literature review has been carried out. Its aim was to better understand definitions, approaches, methods, and barriers over the different fields of context. Following Stauffacher et al. (2008), different levels of practitioners' involvement were identified. The presentation will both, sum up the results of the literature review and the outcomes of a recent conference, which collected experiences from scientists and practitioners from a wide range of disciplines and practice fields. From this experiences and good-practice-examples the workshop, held in November 2014, aimed to deduce success factors and quality criteria in transdisciplinary dialogues.

On the basis of both review and conference data, the integration of research and practice is looked at in a range of contexts, such as public health, environment protection, sustainability, and climate change. A special focus lies on aspects of social-ecological research and stakeholder engagement in climate change adaptation.

P-4418-29

Maning Risks? Early Warning Systems for Climate Related Hazards

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Early warning systems are a tool with which to minimize risks posed by climate related hazards. Although great strides have been made in developing early warning systems most deal with one hazard, only provide short-term warnings and do not reach the most vulnerable. This presentation will review research results of the United Nations Environment Programme (UNEP)'s CLIM-WARN project. The project has sought to identify how

governments can better communicate risks by designing multi-hazard early warning systems that deliver actionable warnings across timescales. Household surveys and focus group discussions were conducted in 36 communities in Kenya, Ghana and Burkina Faso in order to identify relevant climate related hazards and early warning communication options. Preliminary results show significant variability in risks and needs within countries. Here there is critical need for advanced warning so that adaptive measures can be taken. Some regions have limited access to information through TV or SMS. Here traditional institutions, such as chiefs and meteorological extension officers, will be critical for warning delivery. In contrast, in urban areas mobile phones may be an effective way to deliver warnings and spread information about risks. Communities should be involved in early warning system design so appropriate communication channels, and trusted groups, are used to deliver warnings. There is a need for flexible early warning systems that address community specific needs and deliver broad information about risks. Information disseminated through early warning systems should not only include details of hazards, but also short -term response options and long-term adaptation options, thus increasing both capabilities and response options.

P-4418-30

Water Related Disaster Risk Reduction (DRR) Management Strategies in the United States: Climate Adaptation to Floods and Storm Surges

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Water resources planning and management has evolved in the United States through several distinct stages over the past two centuries, transitioning from a concern for inland waterways transportation to single purpose flood control and finally to multiple purpose large reservoirs. Disaster risk reduction (DRR) - both economic and loss of life - were always the main goals of these strategies, as an integral part of a US Federal system that presents major challenges to coordinating water resources development and DRR, at both the watershed level and metropolitan area scales. Equally, the underlying and inherent climate-based components of risk and uncertainty comprised the scientific basis of assessment and evaluation of management strategies.

The relative performance of existing flood protection systems of three recent disasters are presented; Hurricane Katrina (2005), Superstorm Sandy (2012) and the Mississippi River flood (2011). The cases revealed new vulnerabilities and weaknesses in the US DRR responses and planning, while contrasting the relative successes of long term, strategic DRR planning and investments in the case of the Mississippi River and Tributaries system.

Today, the underpinning of DRR in the US is risk-based decision making, which is distinct from traditional water resources multi-objective decision making. This new paradigm maximizes social well-being, public safety and risk-reduction strategies for the local populace, subject to numerous environmental constraints (and preferred solutions), leading to what could be termed 'sustainable development'.

The new 'risk-informed decision making' culture is far more complex. It is based on risk-cost comparisons and tradeoffs among various options. It engages the affected public. This evaluation approach requires a great deal more complex and technically sophisticated information and attention of the public - not just the analysts and decision makers. As a consequence, the public is also asked to bear more of the residual risks and costs, without often fully understanding the consequences.

OVERALL LESSONS LEARNED FROM THE THREE RECENT MEGA-DISASTERS

a. Disaster risk reduction comprises a special category of flood management, as it connotes extremely large events, with catastrophic human consequences and national level economic impacts.

b. Conceptually, federal systems should be able to deal effectively with such events, but a series of recent disastrous floods and storm surges in the US has exposed some of the weaknesses in the response of federally-based disaster management systems.

c. Risk-based decision making at the local level is neither replicable nor uniform. It is not at all clear, whether a collection of loosely connected local solutions, with varying degrees of risk and uncertainty, can guarantee either robustness or resilience. The recent responses to Katrina and Superstorm Sandy reinforce that public confusion.

d. Residual risk is almost always underestimated because it is difficult to quantify a cascading series of highly interdependent measures, each of which has its own reliability characteristics and risk of failure.

e. A flood protection system is a collection of fragmented measures, including new building codes, zoning ordinances, and structural measures that are implemented over a long period of time and loosely coordinated by multiple authorities. This comprises the definition of a 'brittle system'.

f. Because people bear the risks, their involvement in choosing risk and participation in the tough operational decisions made during the process of planning for mitigation of potential events is critical to the health of a democratic system

P-4418-31

Climaps.eu an Online Platform for Informing Decision-Making

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In our contribution we will present the platform Climaps.eu: a digital atlas providing data, visualizations and commentaries about climate adaptation debate.

This atlas is addressed to climate experts (negotiators, NGOs and companies concerned by global warming, journalists...) and engaged citizens. It employs advanced digital methods to deploy the complexity of adaptation discussions and information design to make such complexity legible.

Climaps contains 33 issue-maps, each focusing on one adaptation issue and providing:

- an interactive visualization;
- a discussion of the map and the findings that it discloses;
- a description of the protocol through which the map has been created;
- the data on which the map is based and the code employed to treat them.

Climaps.eu has been produced by the EU-funded project EMAPS (www.emapsproject.com) as the largest experiment tempted so far with the method of 'controversy mapping'. Controversy mapping is a research technique developed in the field of Sciences and Technology Studies to deal with the growing intricacy of socio-technical debates. Instead of mourning such complexity, it aims to equip engaged citizens with tools to navigate through expert disagreement. Instead of lamenting the fragmentation of society, it aims to facilitate the emergence of heterogeneous discussion forums.

A few examples of the Climaps.eu findings that we will discuss in our presentation:

Adaptation and mitigation in the UNFCCC

Analyzing the Earth Negotiation Bulletin, we identified the main discussion in the UN Convention on Climate Change, traced their visibility over time and the countries engaged with them. Adaptation and mitigation, we concluded, have different places in the UNFCCC. Mitigation constitutes the main object of the convention, is present everywhere in its conversation and structures the articulation of the debate. Adaptation, on the contrary, appears as a group of specific discussions and has a limited though central place in the negotiations. Although, adaptation is present from the beginning in UN conferences (in particular the question of its funding), an 'adaptation turn' is visible from 2004 with

the rise of the questions of vulnerability and of climate change impacts.

cfr: http://climaps.eu/#!/narrative/mitigation-and-adaptation-in-the-unfccc-debates

The geopolitics of adaptation expenditure

Using RioMarkers coding we extracted from the OECD Official Development Assistance the bilateral adaptation funding and visualized it in a way that allows comparing how the distribution of aid varies between these countries. We compared not only the amounts committed by donor countries, but also their preferred policy areas, the concentration of their aid, their favored recipient countries and closest UNFCCC recipient groupings. Some donors appear to specialize in particular policy areas: for example, Japan is best at funding disaster reduction; France water management; Spain government and civil society; UK biodiversity and Germany agriculture. Some countries concentrate their aid more among policy areas and recipient countries (EU, Denmark) than others (Spain, Italy, Ireland), which could suggest a more planned approach to adaptation aid.

cfr. http://climaps.eu/#!/narrative/the-geopolitics-of-adaptation-expenditure

Who deserve to be funded

We have compared the priorities of bilateral and multilateral adaptation funders with different ways of assessing vulnerability. Using Germanwatch, DARA and Gain vulnerability indices, as well as the Human Development index, we explored possible correlations between the amount of money allocated to a country and the degree to which it could be said to be climate vulnerable. We found both positive and negative correlations. In general, development oriented indices correlate more with adaptation funding, providing evidence that adaptation and development are closely connected. We have also tried to find out, where vulnerability indices are mentioned and we found that climate specific vulnerability indices are rarely used by actors in the UNFCCC process, but widely cited in the new media.

cfr. http://climaps.eu/#!/narrative/who-deserves-to-be-funded

P-4418-32

An Integrated GIS-Based Climate Change Model to Assess Sustainable Development Scenarios

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Climate change and its impact are serious issues that scientist and engineers are involving with. It is believed that human activities contribute to the Earth's climate change significantly and the change is tremendously rapid. A reliable methodology to predict the climate change is modeling. Climate change models aim to improve the understanding of Earth's climate by focusing on scientific analysis of the governing sets of processes that describe the climate over different conditions; evaluate strong methods to obtain higher spatial resolution for projections of climate change; and detect uncertainties in climate predications by real simulating.

On the other hand, sustainable development needs a bright image of the future. Sustainability cannot be achieved without regulating and controlling human activities. Regulations and policies come within different scenarios that are acceptable internationally. Models can predict the future conditions based on various scenarios.

This research proposes an integrated GIS-based climate change modeling methodology than can use different climate scenarios. Its easy-to-use method helps the policy makers and decision support systems to see what will happen in the future by applying a certain scenario in a short time. It also helps the users to visualize the results with a good spatial resolution in order to choose the best policy. The proposed methodology is believed to be first of its kind as it is run very fast and has a simple interface, yet with powerful background.

4419 - Climate science in the public sphere. Media coverage and communication devices analysis for effective policy implementation

ORAL PRESENTATIONS

O-4419-01

Climate change journalism - communicating the science

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The MediaClimate network presents the results of TV and newspaper representation of the IPCC AR5 reports in a large number of countries, analyzing the differing levels of attention and frames emerging when journalists in a variety of national contexts report on the latest results from climate scientists. To what extent are the carefully formulated scientific concepts, such as uncertainty, probability and degrees of likelihood present in the journalistic texts? Which voices are quoted, which genres are salient, and which recommendations are made by editors and journalists? To what extent are the IPCC results and recommendations related to peoples' everyday experiences investigated in the media? Which challenges in reporting on a global scientific endeavour may be traced, and what are the perspectives for a more cosmopolitan (globally oriented) journalism?

O-4419-02

Advancing climate mitigation efforts through dialogue with the Australian Public

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There is no doubt the politicisation of climate change discussions in Australia have severely impacted the coordination of Australia's mitigation actions. Despite the lack of proactive action at the political level, many of the Australian public are concerned about climate change and its impact, but are at a loss as to what might be the best actions for them to take as part of the response to climate change. To help facilitate greater understanding of the portfolio of mitigation options, and raise awareness of actions that can be taken at the individual and community level, a number of engagement and dialogue opportunities have been undertaken. This paper will present the research findings from a range of activities that have been utilised to engaged with lay publics across Australia. As a result of this work we have been able to inform policy makers of public preferences, bring about a reduction in participant footprints and understand in more detail the Australian public's preferences for engagement on the topic. Processes used vary from kitchen table discussions; to large group processes – of up to 100 people in the room; citizens' panels and interactive survey tools. The results

generally confirm that the Australian public are concerned about action on climate change, tend to have a preference for renewable energy, but lack in-depth knowledge on the range of low carbon energy technologies.

O-4419-03

Building a vision for a low carbon society in France with non-violent communication methods, result from the R&Dialogue europe-pean project

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As organisations and governments working towards the energy transition broaden their focus to include a large spectrum of society, they need processes capable of building deep understanding out of the diverse backgrounds, perspectives, and judgements oftheir stakeholders. Several countries have initiated large-scale social dialogues on the energy transition, demonstrating the difficulties inherent in implementing a genuinedialogue and integrating it into the democratic process.

This communication presents the results of the R&Dialogue project in France, a research-action to implement dialogue at the regional, the national and local levels using renewed tools to improve the practice of democracy.

O-4419-04

How to rethink the Science-Societies debate about climate change?

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The question of climate change is increasingly drawing consensus among the scientific community. However, there is an obvious and continuous lack of dialog between scientists and stakeholders (institutions and civil society). How can we foster debate on climate issues between academics, decision-makers and the citizens of the World?

Such a dialog is impaired in different ways. We will focus on some of those that are particularly pregnant and will propose mechanisms to address them. The first one lies in polemics and controversies related to uncertainties in the scientific knowledge and the way they are accounted for and communicated. Pascal Maugis will show how uncertainties should be reported in order to go beyond them and eventually make them an opportunity for enlighted and shared decision making for the management of the risks induced by climate change.

Second, «citizen science» about the climate issues remain isolated, weakly coordinated and for the most part unknown to the general public. Moreover, social demands vary a lot, addressing for example educational issues, adaptation measures or public debates. Because the climatologists who intervene in the public space are at the frontier between science, expertise for territorial policies and political strategies, they bear contradictory constrains. This may result in uneffective - or even counter-productive - discourses. Lionel Scotto d'Appolonia will analyse such situations using the example of climate controversies. This suggests to strenghten the path towards participatory science : A new form of the «Palaver Tree» (L'Arbres à Palabres in french). Inspired by African tradition, the palaver tree is a meeting place where villagers « freely » discuss social and political problems. Its modernized form, scientifically enriched by Human and Social Sciences, will be explained.

Finally, participatory citizen expertize and science have met several success. Sylvie Blangy will present one such success story on tourism adaptation in Québec.

This presentation is set-up and facilitated by the PARCS (Participatory Action Research and Citizen Sciences) research working group: a group including 50 scientists and NGO members from diverse research fields. The objective of PARCS is to synchronize various initiatives of «citizen science» about the climate issues. The PARCS group is conceived as a field-laboratory to explore new ways to question Science-Society relationships, by putting into synergy all demands and initiatives from citizens and institutions. The «palaver tree» is one of its three research axes.

4419 - POSTER PRESENTATIONS

P-4419-01

Dialogue among stakeholders for climate risk management strategies

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Climate risk management in long-term and in global scale is a key topic in this century to achieve global sustainability. Therefore, we need to develop risk management strategy to encounter problems caused by climate change. However, climate risk management is still controversial and complicated issue especially in developed countries. One reason is that there are various issues and stakeholders (SHs) play various roles in the society and relationship among them are very complicated. In order to provide arena of discussion for SHs, it is extremely important to provide appropriate scientific knowledge for all SHs in an easy-to-use manner with an understanding of the actual social context.

"ICA-RUS", Integrated Climate Analysis - Risks, Uncertainties and Society, a research project funded by the Ministry of the Environment, Japan, in order to deliver scientific findings to SHs and to develop climate risk management strategy for various sectors in Japan. From this project, we organized SH dialogue for communicating and developing a framework of climate risk management. We set two objectives; framing climate risk management problems and understanding SHs' needs. Framing problems is expected to extract agenda, to develop a framework of relationships among perspectives and values, and to understand key factors to influence on problems. Understanding SHs' needs is to know these three points; what kinds of information sources they would like to use for judgment, how scientists should deliver information for the society and what they expected scientists and different SHs to do for contributing to the better consequences of climate risk management in the future.

This SH dialogue can contribute to develop global strategy and stimulate comprehensive and active discussion in the society. However, conventional methods of interview and discussion are not effective for uncertainty relationship with SHs and issues. In addition, people are not familiar with expressing their opinions to others in public in Japan and many Asian countries. People also feel non-experts should not talk about issues. In Asian culture, we need to reform and integrate methods for supporting participants to express their views even in front of experts. Thus, we have designed a triangulation approach for the dialogue and its analysis.

The SH dialogue contains three steps: information sharing from experts, in-depth interview, and focus group discussion. This step by step approach encourage participants to join dialogue actively gradually. We also collected relatively small number of people (4-5 people in a group) as focus group than conventional manner. This helps everyone get opportunity and reason to utter in a group. We chose SHs from those who are involved in global climate talks and related activities. The structure of dialogue is divided in two sections; current perspectives in a semi-structured group interview and long-term strategy in an interactive focus group discussion. In the dialogue, we observed group dynamism became active gradually.

From the dialogue records, we made verbatim transcriptions. We analyzed it by the qualitative research method for understanding key categories or points. To utilize all utterance and to integrate the quantitative research methods, content analysis was also adopted to

transcriptions. We give attention to "real voice" deeply but also to comparison analysis and integration in an easy-to-understand manner. Therefore, we can share findings from a multilateral perspectives.

From these triangulation approach, we discussed key categories and related SHs of climate risk management, like international governance, mechanism of decision-making, communication, future vision and so on.

Multiple research design seems to be an effective way for framing complicated issues and setting agenda from it. This diversity of choices in findings is expected to invigorate discussions in the society.

P-4419-02

A linguistic analysis of IPCC Summaries and its coverage in scientific and popular media

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The Intergovernmental Panel on Climate Change (IPCC) Summary for Policymakers (SPM) is the most widely read section of IPCC reports and the main springboard for the communication of its assessment reports. Its findings should be communicated in a way that can be understood by a non-scientific audience. Existing studies have focused on the way in which IPCC probabilistic statements are interpreted, and on the discursive construction of the IPCC in national newspapers, including the influence of grammatical and word choices. We have undertaken a linguistic analysis of SPMs and related scientific and popular media coverage on the launch of each IPCC assessment report from 1990 to 2014. We employ widely-established sentiment analysis tools and readability metrics to explore the extent to which information published by the IPCC differs from the presentation of respective findings in the popular and scientific media within this time-frame. IPCC SPMs clearly stand out in terms of low readability, which has remained relatively constant despite the IPCC's efforts to consolidate and readjust its communications policy. In contrast, scientific and broadsheet newspaper coverage has become increasingly readable and emotive. Our findings reveal easy gains that could be achieved in making SPMs more accessible for non-scientific audiences.

P-4419-03

Young Voices: Developing narratives for engaging young people on climate change

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Young people are in a unique position as they face the reality of a changing climate:

potentially they are best-placed to push for and define the long-term societal response to climate change, yet they are also the most vulnerable to the legacy of decisions made by older generations. Young voices are not prominent in the climate change discourse, and engagement with climate change among this crucial demographic is in many ways limited.

In this presentation, we will report the findings from a series of qualitative 'narrative workshops' involving 36 young adults in the UK during May/June 2014. The research found that young people see climate change as a problem for the here and now and respond positively to messages that frame climate change as a contemporary concern requiring an immediate response. However, young people sometimes find it difficult to talk about climate change with their peers because of a perception that it comes with a certain stigma and is 'uncool', or preachy to do so.

Most participants were either unaware or uninterested in the idea of organised climate change scepticism, suggesting that campaigns to counteract science-based scepticism will not be particularly useful for this audience. Debating solutions - rather than the science - was identified as a much higher priority. Some commonly used climate advocacy phrases (such as '2 degrees' or 'managing climate risks') were either unfamiliar or unpopular with the young people we engaged. Participants were receptive to the idea of protecting the 'things they love' from climate change, but to avoid trivialising the issue, felt that it was important to always make the link between the 'everyday' and the 'bigger picture', joining the dots between the personal and the political.

We will present and discuss these and other key findings, and explore the implications for developing narratives to engage young people more effectively in future initiatives.

P-4419-04

Communicating Climate Change to the General Public and Policy Makers

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The results of polling surveys, academic literature, and practitioner field work in communications suggest that the work of communicating climate science should be calibrated in a strategic manner against the mind-set and experience of audiences, the larger landscape of communications by all voices that construct the public narrative, a clear theory of change, and a clear understanding of the goal of science communicators. Scientists are highly sought after communicators in pubic discussion on climate change - but that dynamic is driven more by the high regard and trust the public places in scientists when discussing a controversial issue than any public interest in taking a deep dive into the science. Polling in the context of climate change communications is best used as a road map, illustrating audience mindset, not as a compass heading indicating direction of travel. Support for climate protection in the general public is often a mile wide but only an inch deep. One barrier is the impression of climate change as a distant and future threat. Extreme weather offers a teachable moment addressing a key misperceptions regarding climate change. Another issue is the analog of smog that audiences bring to their understanding of carbon pollution. Another compounding problem is the self-identification by the audience of bad actors. The experience of science communications on tobacco control offers a helpful soltution here. Action on climate change requires what sociologists call «hot cognition,» a story element that goes beyond the physical science of climate change. Principles for effective climate science communication include: tell us what you know (not what you don't know) and choose metaphors that not only illustrate the science but highlight the signifiance of the situation. The bathtub metaphor for carbon sinks and sources is one example of a techically correct metaphor that often sends the wrong message. Scientists can leverage their validating authority to affirm the basic climate science narrative that speaks to the interests of the general public and policy makers, a narrative that centers on the salience of the science for public policy, not on the physics or chemistry of the science. The narrative is centered on five key points:

- Climate change is happening, right here, right now.
- We're causing it.
- Scientists agree about this.
- We can fix it.
- We can't wait, the problem is locking in now.

P-4419-05

Climate Communication: Bringing It All Together

R. Mccarthy (1)
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When it comes to matters of global importance a wide view is needed.

This talk brings together independent studies in the fields of communication, media, phsychology, lingustics

and the physical sciences to identify the optimum way forward for climate communication. Recommendations as to how climate communications could be improved have been made by various institutions, but as of yet no multi-disciplanary, or multiple-institution strategy has been unveiled. This talk is designed to bridge that gap and work to bring disciplines together.

An analysis of opinion polls and the reporting of the detail of climate matters primarilly in European and American newsapers — including the provision of renewable energy generation— indicate equallly a 'will' to address climate issues and a 'dis-satisfaction' at current action.

The talk specialises in analysing these divides but with a particular and focused experience in lingustics. The scientific language uses words in a different way to 'regular' english. This talk asks what we can learn from a very proficient use of the english language. The issues of conveying clear messages around climate variabilty and change transcends these boundaries.

This lecture looks at these lingustic, societal, and scientific issues, drawing them togther to make a cohesive way forward.

P-4419-06

Has Political Action On Global Warming in the United States Been Forestalled by Gangsters? A Historical Analysis

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Action behind the scenes to hide and sabotage climate change awareness is pervasive, especially in English speaking countries such as the United States, Australia, and Canada. Causes include fossil fuel influence on mainstream media, as well as educational institutions and government agencies.

This fossil fuel campaign, abetted by corporate sectors such as banking and construction, is well organized and financed. Global warming activists are relatively underfunded and poorly represented in American media. We propose a historical analysis employing biting satire in order to correct this situation.

The author achieved prior success in this regard through his Climate Villains series, published in Alternet and Buffalo Beast, and republished in over 40 internet magazines. Actors such as the Koch Brothers and media puppets like George Will and Lord Moncton were portrayed in biting satirical fashion. The author has also published serious research pieces in Energy Future and Climate Progress.

The proposed article for Paris is being written at present, and will employ the gangster metaphor, along with examples from European history. Examples will come from the 14th and 17th centuries, periods of difficult climactic conditions that led to large areas of Europe being controlled by armed bands of mercenaries. Consequences included disregard for any laws or social norms, as these «companies» of armed thugs sacked towns, raped and pillaged, and sold their services to the highest bidder. These companies were often employed by heads of state, or religious leaders such as Cardinal Richilieu.

We are seeing gangsters take control of the United States, using political leaders as proxies. Included are control of media messaging via corporate advertisers, and placing puppets on courts and in local political offices. Violence is routinely employed, as in American bombing campaigns in the Middle East, assassination of reporters, and intimidation of political opponents. These actions are mostly employed by Republican Party political operatives, acting on instructions from fossil fuel and banking firms, but Democrats are also often complicit. Evidence can be seen in the majority support of the Keystone Pipeline in the US Senate, where 63 Senators insist on allowing a pipeline that could devastate aquifers, will increase GHG emissions, and provide no significant job growth or increase in US oil supply. The end products, too dirty to meet US standards, will be shipped to the Latin American market.

The beneficiaries of the pipeline are the Koch Brothers, the largest owners of Tar Sands operations, and the owners of the refineries in Texas where the Tar Sands oil will be shipped. Their net worth of approximately $100 billion US has enabled this level of political control. Estimates of their reported cash contributions to political puppets have exceeded $1 billion US, with dark money contributions possible.

I propose to use historical analogies, and make recent comparisons to American gangsters of Sicilian origin. This portrayal will be illustrated by Ian Murphy of Buffalo Beast, whose satirical art work is among the best in the world. Koch, Tillerson of Exxon, and Boyce of Peabody Energy (a coal company) will be drawn in expensive Italian suits, similar to what is worn by actors in shows such as Boardwalk Empire and The Godfather series. Along with the satirical drawings will be detailed summaries of their criminal activities. These fossil fuel executives have killed far more people through pollution and greenhouse gas emissions than any Sicilian mob ever did, and evidence will be cited to support this assertion.

The analogy is based on evidence, but somewhat imperfect. The goal is to reach a wide popular audience, establishing the gangster meme and illustrating how it plays out in considerable detail. By illustrating financial ties, including degradation of education and media reporting, we propose to put pressure on bad actors in the United States and elsewhere.

4420a - How to price carbon for industry?

ORAL PRESENTATIONS

O-4420a-01

Session Number 4402b - Carbon Pricing

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The EU Emissions Trading System is the EUs flagship climate policy, establishing since 2005 a carbon market across Europe with more than 12,000 plants in 31 countries regulated at present. With industry responsible for a large share of global carbon emissions, carbon pricing is seen as a central policy instrument for industry's transformation towards more energy and material efficiency and for unleashing innovation processes. We will discuss what effect the carbon price had to date on industry.

We discuss the results of a research paper that uses comprehensive firm and plant level data for more than 4,500 French manufacturing firms. It examines the economic and environmental impact of the EU ETS. Our results suggest that ETS regulated manufacturing plants in France reduced emissions by an average of 15-20%, a significant amount. The most marked reduction in emissions occurs following Phase II of the EU ETS in 2008, though there is some evidence of emissions reductions occurring during Phase I (2005-2007). Further investigation provides evidence that while these emission reductions do not arise from reallocation within the firm there is some evidence that these reductions are, at least in part, the result of outsourcing carbon-intensive production.

We also discuss recent research investigating the relative intensity of knowledge spillovers in clean and dirty technologies. In addition, a recently published paper by one of the co-contributors and his coauthor shows that the EU ETS has increased low-carbon innovation among regulated firms by as much as 10%, while not crowding out patenting for other technologies.

Together, these provide a robust basis for discussion of the impacts of carbon pricing, on emissions, economic performance and innovation by firms.

O-4420a-02

Assessment of Allowance Mechanism in China's Carbon Trading Pilots

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Due to its rapid economic expansion over the last decade, China has become the world's largest energy consumer and greenhouse gases (GHGs) emitter. With growing resources and environmental constrains domestically and the need for meeting international commitment to GHGs abatement, China's National Development and Reform Commission (NDRC)launched a series of local carbon cap-and-trade pilots in seven provinces and cities including Shenzhen, Beijing, Tianjin, Shanghai, Chongqing, Guangdong, and Hubei, each of which has started its operation between 2013 and 2014.

In this paper, we examines the allowance mechanism of China's pilots from two aspects, one is the allowance allocation, and the other is the allowance distribution and make comparisons in the two aspects with EU Emissions Trading System (EU ETS) and CA CAT. Allocation determines how the carbon emission cap on the total number of emission allowances is set and how emission allowances are allocated among covered entities within the cap. Allowance distribution deals with distribution of allocated allowances to all covered entities as well as dynamic allowance management in post-distribution.

China's carbon trading pilots formed its unique allocation mechanism, which includes the following four characteristics: rigid cap combined with elastic structure, historical emissions method combined with benchmarking, free distribution combined with the auction, pre allocation combined with post adjustment. However, due to the short preparation time and lack of sufficient emissions data, there are many problems in the pilot design of the allocation mechanism, such as the loose cap, whipping the fast ox, double counting, and too small proportion of benchmarking and auction.

O-4420a-03

Emission Trading Scheme and competiveness:the tricky equation of free allocation for the EU ETS through to 2030

E. Alberola (1) ; M. Jalard (1)
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One of the central debates surrounding the design of the European Union Emissions Trading Scheme is the approach to address carbon leakage concerns. In preparation of its phase 4, new design settings proposals of the European Commission in January 2014 have revived the debate. Based on the European Commission's communication on the 2030 Energy and Climate framework, in October 2014, the European Council approved a new target to reduce CO2 emissions by 43% in EU ETS sectors by 2030 in addition to the implementation of a market instrument for stability. These two measures are likely to induce the emergence of a more robust carbon price signal, and the Council committed to the continuation of free allocation for industry after 2020.

From 2005 to 2012, all installations were eligible for free allowances which were allocated using installations' historical CO2 emissions data. Since 2013, free allowances have been allocated according to EU harmonized rules on the basis of benchmarks (carbon intensity target) and historical production levels. These have been adjusted by a coefficient of exposure to the risk of carbon leakage and finally adjusted to the free allocation cap by a Cross Sectorial Correction Factor (CSCF). In this new context, the paper assesses the robustness of the expansion of the 2020 mechanism to define free allocations by 2030 regarding three criteria. Firstly, free allocations are assumed to mitigate carbon leakage risks efficiently and sustainably; secondly to minimize sectorial distortions; and thirdly to maintain the environmental and economic efficiency.

In a first section, based on a literature review and on estimations from industry data, the paper examines the phase III experiences which provide useful insight into the necessary considerations for phase IV of the EU ETS. Then, in the second section, the paper presents three modeling scenario to define the amount of free allocation for the European industry: a scenario of the expansion of the 2020 mechanism by 2030, a scenario with the output based mechanism and three alternative scenarios based on the output based mechanism with additional measures to mitigate the uncertainty of an ex-post adjustment.

We conclude that, by extending the current mechanism, the amount of free allowances remains higher than the free allowance cap, which should mechanically decrease from roughly 800 million in 2013 to 500 million by 2030. It would thus be necessary to gradually reduce the amount of freely allocated allowances using a Cross Sectorial Correction Factor (CSCF) from 94% in 2013 to 82% by 2020 and 66% by 2030. The implementation of the output based allocation, based on actual industrial production (rather than historical), using up to date benchmarks in line with technological progress, would induce an annual correction coefficient of 71% in 2030. However, depending on the annual aggregate activity level, a new uncertainty would arise concerning the value of the CSCF coefficient. According to our estimates, this coefficient would be comprised between 62% and 82% in 2030, which would imply an uncertainty on the net carbon cost of the magnitude of 10% of the added value in the cement sector and 6% for in the steel sector, under the assumption of a 30€/tCO2 price.

There are three potential avenues which can be explored to mitigate this uncertainty and facilitate investment in low carbon technologies. Firstly, a reserve of free allowances could be established to offset yearly deficit / surplus between free allowances cap and the quantity of freely allocated allowances. Secondly, by removing the free allowances cap, the need to apply the correction factor is eliminated. However, this may reduce the amount of auctioned allowances, which was already decreased by the market stability reserve (MSR). Finally, the definition of a more targeted list of sectors at risk of carbon leakages could reduce the number of free allowances by identifying and gradually allocating allowances according to sectors exposure. This would deem it unnecessary to apply the correction factor, and therefore eliminate all associated uncertainty. The method of dynamic allocation combined with a more targeted list would thus be an adequate solution to the tricky equation of free allocation through to 2030.

O-4420a-04

Energy market regulation and leakage: implications for industry

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Electricity markets are crucial for addressing climate change. Electricity generation accounts for vast amounts of greenhouse gas emissions and electricity costs are an important concern for industries and thus a prominent topic in leakage discussions. This contribution focuses on electricity leakage (the avoidance of emission costs when generating electricity through relocation or importation) and its implications for industry. Following a comparative economic and a legal analysis it highlights 1) the carbon pricing implications for industry in terms of incentives for innovation and investments and 2) compare different regulatory approaches in various emissions trading systems such as e.g. the EU ETS, RGGI, and Korea.

O-4420a-05

Inclusion of Consumption in Carbon Pricing Systems

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Climate protection is a global challenge that all countries have a common but differentiated responsibility to address. The UNFCCC Lima outcome reconfirmed that pricing carbon remains important. However, not all governments are willing to commit to targets of equal stringency. Moreover, countries may have different views on the choice of policy mix. Some countries may put a stronger emphasis on the carbon price and see a higher

carbon price in the policy mix whereas other countries may make more use of other regulatory instruments. Carbon prices may thus continue to differ over longer time horizons. Without additional measures, this difference in the carbon price threatens a shift in production volumes to regions with lower carbon prices, which would undermine the effectiveness of carbon pricing.

Carbon leakage protection measures have therefore been and most likely will continue to be taken that complement carbon pricing in the production of carbon intensive materials. As leakage protection measures , all emission trading mechanisms thus offer free allowance allocation and all carbon tax schemes have implemented some exemptions for materials production. As a result, the carbon price signal is largely eliminated for mitigation opportunities in the materials sector other than efficiency improvements within the primary production process. In our studies of the cement and steel sector we found that only 10 to 20% of emission reduction potential exists through further efficiency improvements. The majority of future mitigation opportunities are linked to break-through technologies, the use of higher value products and thus lower weight and carbon intensity, alternative materials and more tailored use of materials. Thus the current approach to leakage protection cannot support the realization of the majority of mitigation options in these sectors. The reform options for leakage protection currently discussed for the European Union Emissions Trading System (EU ETS), dynamic allocation and abandoning the linear adjustment factor, would further reinforce this effect and undermine incentives for mitigation along the value chain. This puts at risk the low-carbon transformation of our economies because materials production comprises the largest share of industrial emissions.

Hence for post 2020 a new philosophy for leakage protection is necessary. We therefore propose to introduce a scheme (Inclusion of Consumption) for high-carbon commodities that:

1. continues to ensure leakage protection by (benchmark based) free allowance allocation or corresponding tax exemptions
2. includes the domestic consumption of selected carbon intensive materials in carbon pricing schemes.

The scheme, which would replicate systems that are already in place for the consumption of electricity in emission trading mechanisms of Chinese provinces and the Republic of Korea, would thereby restore the carbon price signal for the value chain which is broken where leakage protection motivates free allocation or tax exemptions. Thus the carbon price could contribute to set the incentives necessary for a low-carbon transformation of production and use of carbon intensive commodities.

4420b - What role of carbon pricing in a post Paris world?

ORAL PRESENTATIONS

K-4420b-01

Carbon price in a long-term, normative perspective

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This paper describes the use of an integrated assessment model to derive a (shadow) carbon price for government policymaking, including the current status of the SCCO2, ways that governments should periodically revise the SCCO2, potential improvements to the SCCO2 to encompass impacts by sectors, and the potential diffusion of standard SCCO2-type measures around the world.

K-4420b-02

"Carbon pricing in the United States: Markets and prices in the new national and international regimes"

J. Wiener (1)
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This presentation will be part of Session 000110 - «What role of carbon pricing» (A Creti), which will itself be part of the Topic on «Emissions Trading» as a form of «Collective Action toward Transformative Solutions,» featuring several related presentations on the evolving carbon markets in Europe, the United States, and elsewhere, as they build toward an effective and efficient new international regime.

This presentation will focus on the United States and Canada. First, it will assess the development of sub-national carbon markets among key US member states, including the «RGGI» emissions trading program among northeastern states and the California emissions trading program, and the links from some of these sub-national programs to carbon markets in other jurisdictions such as Quebec and Ontario, Canada. Second, the presentation will explain the new national program («Clean Power Plan») being advanced by the US Environmental Protection Agency (EPA) under the US Clean Air Act, section 111(d), including its current status (scheduled to be issued in final form during the summer of 2015), its legal basis, its economic efficiency, and the legal and policy challenges it may face. Third, the presentation will discuss how these North American carbon markets -- especially the EPA 111(d) national «Clean Power Plan» -- may contribute to action at the international level, including the Intended Nationally Determined Contribution (INDC) of the United States, along with other countries' INDCs to be presented at COP 21 in Paris in December 2015. It will discuss the potential for linking the evolving carbon markets in the US to those in Europe, China, and others, and it will consider the role of these developing carbon markets in the longer-term evolution of an effective and efficient international climate change regime. Fourth, the presentation will address the development of a carbon price for government policymaking through the US government's «Social Cost of Carbon» (SCC) measure, including the current status of the SCC, ways that governments should periodically revise the SCC, potential improvements to the SCC to encompass a broader array of impacts, and potential diffusion of SCC-type measures around the world.

This presentation will draw on the author's prior work in publications such as IPCC 2014, 5th Assessment Report, Working Group III, chapter on «International Cooperation» (of which J.B. Wiener was a co-author); W.A. Pizer et al., «Using and Improving the Social Cost of Carbon,» in Science (5 December 2014) (J.B. Wiener is a co-author); J. B. Wiener, «Property and Prices to Protect the Planet,» in Duke Journal of Comparative & International Law (2009); R.B. Stewart & J.B. Wiener, Reconstructing Climate Policy (2003); J.B. Wiener, «Global Environmental Regulation,» in Yale Law Journal (1999); and the author's experience helping to negotiate the UN Framework Convention on Climate Change (FCCC) in 1989-92.

O-4420b-01

Contours of carbon pricing: factors influencing 'optimal' developments over space and time

M. Grubb (1) ; K. Neuhoff (2) ; JC. Hourcade (3) ; JF. Mercure (4) ; P. Salas, (4)
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This paper summarises the main economic reasons why carbon prices are likely to, and should, differ between regions, and key factors that would affect the optimal trajectory over time in ways that diverge from a simple formulation based on an estimated social cost of carbon. We illustrate the generic discussion of some issues in space and time variance of carbon pricing with reference to key earlier works respectively on international welfare dimensions of carbon pricing, and the results of models with different dynamic specifications.

It is widely assumed in economic studies that the optimal approach to carbon pricing is a single global carbon price, reflecting the 'social cost of carbon', which should rise over time to reflect the assume cost or constraint. We first detail the assumptions under which this would be true and show these to be highly restrictive (and indeed implausible), which is one of the reasons why nothing like this is observed in practice. At the same time, industrial expectations of long-run carbon price trajectory are crucial to efficient investment, so developing a common understanding of desirable contours of carbon pricing over space and time is central.

Reasons why a common global carbon price is not welfare-efficient include those articulated by Chichilnisky and Heal in the 1990s, with reference to international inequalities; we add some specific real-world illustrations. We then analyse reasons why even in an equal world, factors of expectations, inertia, uncertainty and evolutionary economic considerations (including the combination of innovation and infrastructure in different sectors) may all create reasons why the locally optimal carbon price may be larger than the estimated SCC, illustrating with respect to varied published models with different dynamics specifications.

We build upon this work in three ways. First, conceptually, we link some of the existing modelling literature to the framework of different domains of economics processes in Grubb, Hourcade and Neuhoff (2014), notably the Second and Third domain processes of markets and innovation respectively, and highlight implications in terms of the relationship between these economic processes and corresponding policies. Second, we present results from a simplified model which to illustrate some aggregate influences and potential magnitudes of these effects, comparing results from other aggregate global models.

Finally, we discuss how interactions between the various factors should inform understanding of the desirable "contours" of carbon price development over space and time. In particular we illustrate some implications for the debate on linking emissions trading systems, in terms of the need for exchange rate mechanisms which can help to both support equitable development of investment and returns, and help to foster the processes of regional transformations.

O-4420b-02

Price formation in the EU ETS: politics or abatment-related fundamentals? Policy implications

G. Grosjean (1) ; N. Koch, (2) ; O. Edenhofer (1) ; S. Fuss (2)
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First, we analyze empirically the drivers of the carbon price between 2008 and 2013 in the world's largest cap-and-trade system - the EU ETS. We provide evidence that the market fundamentals such as the economic crisis, the development of renewables and the use of international credits explain only a small share of price variation during the period.

Secondly, we investigate how and to what extent allowance prices respond to regulatory news. Capitalizing on an event study method that incorporates a highly flexible econometric technique, we isolate and quantify the news-implied price response to 28 hand-collected announcements about the time profile of EU ETS supply schedules that took place between 2008 and 2014. The induced price reaction gives an instantaneous feedback onhow market participants view the evolution of cap stringency in the light of a particular policy announcement. Our findings suggest a high responsiveness of the cap-and-trade market to political events. We provide strong evidence that the backloading decision process caused substantial pricedeclines. The event-induced negative drifts evolve gradually as market participant's faith in the political support for backloading is shaken in the light of severe decisional bottlenecks in the lengthy legislativeprocess. In addition, we document positive price reactions to the announcement of the 2020 and 2030 policy packages, while news related to the 2050 roadmap either did not affect allowance prices orinduced negative price drifts. These results point to an underappreciated feature of cap-and-tradeprograms: with temporarily non-binding periodic cap, market perceptions will dominate priceformation. If a relaxation of cap schedules in the future is expected, the current allowance price drops significantly, irrespective of whether the contemplated change actually happens.

Thirdly and following our findings, regulatory instruments to stabilize expectations in the market and induce sufficient investment in low-carbon technologies are compared. This includes both price and quantity adjustment mechanisms as well as institutional reform such as delegation to an independent carbon central bank.

O-4420b-03

Extending carbon pricing with the expansion of the ETS scope: the road transport sector moving towards the EU ETS?

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One of the central debates surrounding the design of Emissions Trading Scheme is the question of its sectorial scope and its potential progressive expansion. In the context of the increasing development of emissions trading schemes all around the world beyond 2015, sharing the experience of implemented emissions trading schemes could be useful for other governments which should involve or would like to be involved in the implementation of this carbon policy.

In Europe, the Emissions Trading Scheme (EU ETS) covers energy and industry sectors. However, Since 2005, there have been several extensions of the EU ETS: new states, sector (domestic aviation) and gases. In the context of the EU ETS reform and in its first report on the EU ETS functioning in November 2012, the European Commissions suggested to constraint energy related CO2 emissions in sectors currently outside the EU ETS by for instance including fuel consumption in other sectors. In the 2030 Energy and Climate framework, the European Commission introduced namely the potential avenue beyond 2020 to introduce new sectors in the coverage such as road transport or buildings sectors. Beyond the overall revision of the EU ETS directive, the road transport sector can be included in the EU ETS via the opt-in provision which gives Member States the option of introducing, voluntarily and unilaterally, new GHG or new sectors. Denmark is the first European State to express, in September 2014, its wish to include the road transport sector in its national Emissions Trading scheme (ETS) target.

Based on this policy context, the paper deals with the introduction of the road transport in the EU ETS. In a first section, the paper examines the future trends of CO2 emissions from road transport in Europe by 2030 by modeling technology deployment in passenger and heavy duty car parks in two main regions in Europe (EU15 and EU13).

In a second section, the paper investigates what lessons could be drawn for the European Union from the experience of others ETS. Since the implementation of the EU ETS in 2005, other emissions trading schemes have been developed but only a small number include or envisage including road transport within their scope. The New Zealand includes the road transport in 2008 and California and Quebec's emissions trading schemes cover transport fuels suppliers and importers since 2015. The analysis reveals two main design lessons: in all cases, the emission trading scheme is a complementary measure adding to other sectorial policies and credit offsets play a key role to mitigate compliance costs.

Then, the third section analyses what would be institutional and economic impacts of the introduction of the European road transport in the EU ETS. Based on modeling results from three different general equilibrium models, the paper reveals that the EU road transport sector is not likely to be included in the EU ETS by 2030. First, we conclude that the new burden sharing after the road transport inclusion would be supported mainly by the power sector. Secondly, the CO2 price would increase sharply revealing higher compliance costs without the potential opportunity to use offsets credits. Thirdly, the new higher carbon price with the road transport in the EU ETS would be too low to trigger structural changes in the sector towards the deployment of low-carbon technologies or behaviors.

O-4420b-04

Linked domestic CDM: A proposed climate architecture

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Three dominant issues have historically plagued climate negotiations: how to bypass issues of sovereignty, generate sufficient climate finance, and establish an agreement that is inclusive of the current major polluters. Despite the highly contested nature of the Clean Development Mechanism (CDM) under the Kyoto Protocol, it provides policy makers with a starting point for the formation of new climate policy architecture. This research proposes the integration of CDM, as hosted by each state and therefore under their jurisdiction, into a linked climate policy architecture. A linked domestic CDM system would allow for Certifiable Emission Reductions to be earned through the implementation of domestic projects or projects hosted in other states. These Certifiable Emission Reductions can act as a unique climate currency for each state. This research questions how a linked domestic CDM system would be structured in a climate finance context, specifically analysing how Certifiable Emission Reductions would operate and interact as a climate currency. From this research, we conclude that fixed exchange rates are more stable than flexible exchange rates in a climate currency framework. Fixed Exchange Rates reduce losses of capital (owing to uncertainty in the markets) and the prominence of asymmetric spatial price transmission associated with fiat Certifiable Emission Reductions prices. To encourage co-operation between developing and developed countries, it is recommended that a combination of currency area theory and trade blocs be implemented as opposed to a currency union. Currency areas are the most viable option as they maintain that the CDM is under the control of the state and retains a level of stability as individual state Certifiable Emission Reductions prices are fixed to the same price. Even though this research forms the basis for a new climate policy architecture, the overall effectiveness of the policy will be determined by the selection of appropriate discount schemes, increased participation and agreement by states, and most significantly, political will.

O-4420b-05

Linking Up Emissions Trading Schemes: Lessons, Risks and Challenges

S. Quemin (1) ; R. Trotignon (2) ; B. Solier (2)
(1) Climate Economics Chair & Paris-Dauphine University, Paris, France; (2) Climate Economics Chair, Paris, France

This presentation will come after contributions about design and functioning issues of carbon markets in Europe, the U.S. and China.

Following these presentations, it's appear clearly that the fragmentation of carbon markets in the world is reflected by the wide range of regional designs, among which discrepancies regarding flexibility rules and dynamic price management mechanisms are particularly salient.

Although on the face of it inter-ETS linkage looks appealing, impediments to linking could arise from these discrepancies. This raises the twofold issue of whether to engage in linkage given the risks and challenges involved; and of how to link up ETSs given such discrepancies and how these could be overcome by gradual alignment.

Regarding the why-link side of the question, much can be gained by flipping it upside down and rather addressing the potential sacrifice from not linking. We identify determinants and key convening features of past linkages and investigate the question of how to make linkage more attractive and induce further cooperation.

On the how-to-link side of the question, we discuss what we identify as impediments to linkage and how these can be remedied. Such relative concepts as linkability or compatibility are discussed in light of a comparative analysis of schemes' design features (whom would it be better/easier to link with). Different linking path scenarios are then reviewed, namely case-by-case or bilateral regulation, definition of model rules for regional partnership, globally networked ETS, etc.

This discussion draws on current experience, that is determinants of observed linkage agreements.

4420 - POSTER PRESENTATIONS

P-4420-01

An analysis of climate policies which include compensation mechanisms to preserve the competitiveness of the French industry

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(1) Centre International de Recherche sur l'Environnement et le Développement, Paris, France

The aim of this presentation is to explore tax arrangements that can help to reduce the negative aspects of the application of carbon tax through objectives comprising equity, competitiveness and better efficiency.

This will be done by comparing the impacts of different strategies on various macroeconomic indicators, and through analysis of the corresponding distributive effects on energy-intensive sectors, as well as on households with different levels of income.

Each strategy offers different options to recycle the carbon tax revenue, in situations when it is applied unilaterally to the French economy.

We use the IMACLIM-S France computable general equilibrium model designed for comparative static exercises. It represents an open-French economy, distinguishing four categories of agents (households, businesses, government and «the rest-of-world»). The description of the production system distinguishes the energy sectors, as well as energy-intensive sectors, and a composite remainder of the economy.

IMACLIM is a «hybrid» model. It is based on input-output tables of the national accounts previously harmonized with the energy statistic information to obtain a consistent framework for the study of environmental issues. This harmonization effort between energy balance and national accounts provides an accurate description of energy volumes traded directly through their physical flow. Furthermore, the distribution of income and the structure of public finances are detailed without disrupting the overall consistency, reconciling the microeconomic data from household surveys with macroeconomic statistics.

The model is based on a set of economic parameters on which «various beliefs» are expressed, and from which we must conduct systematic sensitivity tests: (i) the adjustment of energy consumption levels in response to signal prices, (ii) the response of wages to changes in unemployment, (iii) the effectiveness of alternative methods on public finance management, (iv) the effects of price competitiveness, by observing the response of changes in production costs in France with the rest-of-world, exogenous to the model.

The version of the model is calibrated by data of the year 2010.

The critical point of a carbon tax reform is to contain the spread of a higher energy costs on production costs, increases that ultimately affect the purchasing power of households and affects the international competitiveness of firms.

The combination of a carbon tax with structural policies to support growth (lower social contributions) does not reduce the unequal effects of taxes. To reconcile equity, employment and activity level, it seems essential to combine these policies with specific compensation mechanisms according to household income levels, and to the exposure of energy-intensive sectors to international competitiveness.

Thanks to the sectorial and household disaggregation described by the latest version of the model, we consider various revenue-recycling schemes that better preserve altogether economic efficiency, equity and competitiveness.

The joint analysis of the distributive impacts across sectors,

the distributive impacts between households, and their macroeconomic feedbacks on the rest of the economy, and of several environmental policy proposals highlight possible trade-offs for maximizing global consumption, reducing unemployment, reducing inequalities, and protecting exposed sectors.

The analysis framework allows the design of a reform resulting from inevitable trade-offs between redistribution, competitiveness and aggregate impacts on activity and employment.

P-4420-02

How carbon pricing can foster collective solutions

S. Qi (1)

(1) Wuhan University, Economica and Management School, Wuhan, China

China made great decision to reduce its carbon emission based on Cap and trade mechanism.China began its ETS pilots in five cities and two provinces which controls 20 percent of China's carbon emission since 2011 and will start its national carbon market in 2016 based on the experiences of the seven ETS pilots. As the current biggest emitter, China's ambitious action to reduce its emission by market oriented policy will influence our globle emission reduction heavily and will be one of the important driver to getting the internatinoal climate agreement in the COP in Paris in this year. Therefore, we will firstly compare the policy features and the effect of the seven ETS pilots in China. Then,we will forecast how to step into a united national carbon market based on the seven ETS pilots. Finally,we will analyse the significance of China's ETS pilots to China, emerging economies and even the globle carbon market and emission reduction.

P-4420-03

«Carbon pricing and markets in the United States: Constructing the new national and international regimes»

J. Wiener (1)

(1) Duke University, Nicholas School of the Environment, Durham, United States of America

This presentation will be part of the Session on «Emissions Trading» as a form of «Collective Action toward Transformative Solutions,» featuring several related presentations on the evolving carbon markets in Europe, the United States, and elsewhere, as they build toward an effective and efficient new international regime. This presentation will focus on the United States and Canada. First, it will assess the development of sub-national carbon markets among key US member states, including the «RGGI» emissions trading program among northeastern states and the California emissions trading program, and the links from some of these sub-national programs to carbon markets in other jurisdictions such as Quebec and Ontario, Canada. Second, the presentation will explain the new national program («Clean Power Plan») being advanced by the US Environmental Protection Agency (EPA) under the US Clean Air Act, section 111(d), including its current status (scheduled to be issued in final form during the summer of 2015), its legal basis, its economic efficiency, and the challenges it may face. Third, the presentation will discuss how these North American carbon markets -- especially the EPA 111(d) national «Clean Power Plan» -- may contribute to action at the international level, including the Intended Nationally Determined Contribution (INDC) of the United States along with other countries' INDCs to be presented at COP 21 in Paris in December 2015. It will discuss the potential for linking the evolving carbon markets in the US to those in Europe, China, and others, and it will consider the role of these developing carbon markets in the longer-term evolution of an effective and efficient international climate change regime. Fourth, the presentation will address the development of a carbon price for government policymaking through the US government's «Social Cost of Carbon» (SCC) measure, including the current status of the SCC, ways that governments should periodically revise the SCC, potential improvements to the SCC to encompass a broader array of impacts, and potential diffusion of SCC-type measures around the world. This presentation will draw on the author's prior work in publications such as IPCC 2014, 5th Assessment Report, Working Group III, chapter on «International Cooperation» (of which J.B. Wiener was a co-author); W.A. Pizer et al., «Using and Improving the Social Cost of Carbon,» in Science (5 December 2014) (J.B. Wiener is a co-author); J. B. Wiener, «Property and Prices to Protect the Planet,» in Duke Journal of Comparative & International Law (2009); R.B. Stewart & J.B. Wiener, Reconstructing Climate Policy (2003); J.B. Wiener, «Global Environmental Regulation,» in Yale Law Journal (1999); and the author's experience helping to negotiate the UN Framework Convention on Climate Change (FCCC) in 1989-92.

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