Improving biodiversity monitoring coupling remote sensing and biodiversity data

Sandra Luque

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IMPROVING BIODIVERSITY MONITORING COUPLING REMOTE SENSING AND BIODIVERSITY DATA

Sandra Luque

INRAE National Research Institute on Agriculture, Food & the Environment,
Unit TETIS *Land, environment, remote sensing and spatial information, Montpellier France*

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TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

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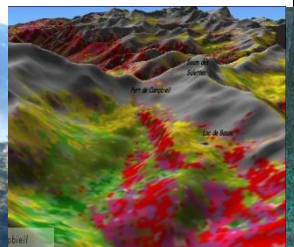
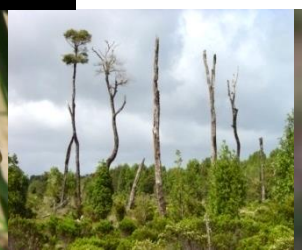
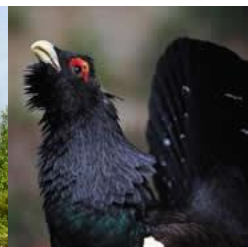
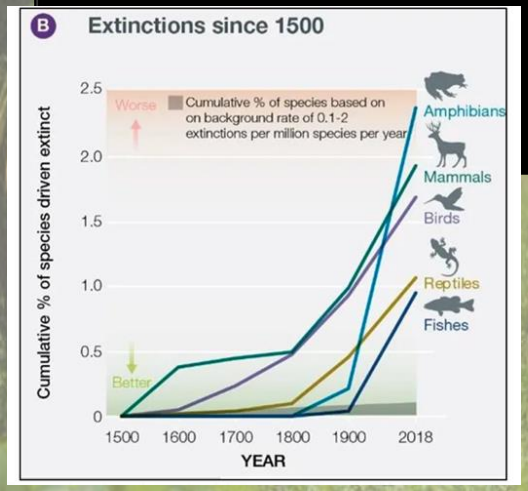




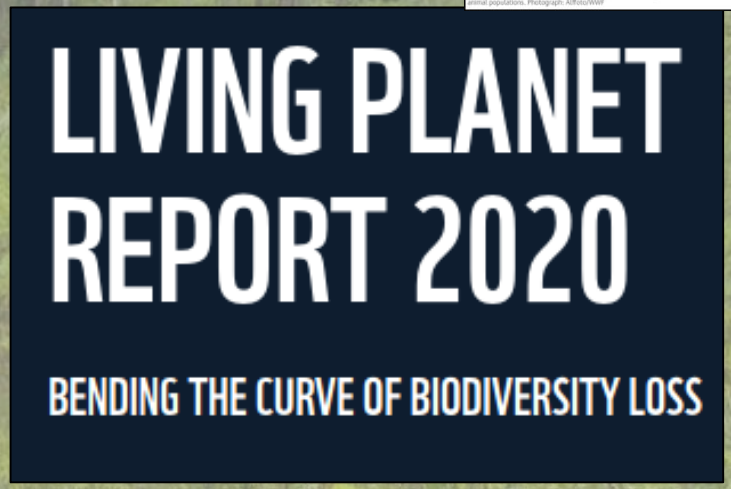



Cop 15 à Kunming



Global biodiversity loss is on the rise (IPBES 2019)

Biodiversity loss risks 'ecological meltdown'



The latest in WWF's flagship research series, the Living Planet Report, shows that our planet's wildlife populations have now plummeted by 68% since 1970

"All the News That's Fit to Print"

The New York Times

Late Edition
Today, clouds and sunshine, afternoon showers or thunderstorms, high 74. **Tonight**, cloudy, showers, 53. **Tomorrow**, partly sunny, cooler, high 66. Weather map, Page B16.

VOL. CLXVIII ... No. 58,320 © 2019 The New York Times Company NEW YORK, TUESDAY, MAY 7, 2019 $3.00

Wildlife Facing Extinction Risk All Over Globe

U.S. ADVISERS SAY CHINA IS RENEGING

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)

Media Release

(Cliquez ici pour le texte en Français)

- Summary for Policymakers, photos, 'B-roll', other media resources: bit.ly/IPBESReport
- Media launch webcast live from #IPBES7 (Paris, France): bit.ly/IPBESWebcast starts at 1p.m. (Paris time – CEST) / 7 a.m. (US EDT) / noon (London – BST)
- For interviews: media@ipbes.net or French: +33 62520-0281 English: +1-416-878-8712 or +1- 415-290-5516 or +49- 176-2538-2223 (After 7 May: +49-152-3830-0667

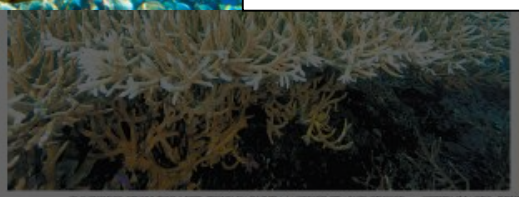
Nature's Dangerous Decline 'Unprecedented'
Species Extinction Rates 'Accelerating'

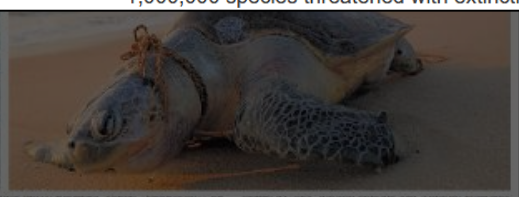
Current global response insufficient;
'Transformative changes' needed to restore and protect nature;
Opposition from vested interests can be overcome for public good

Most comprehensive assessment of its kind;
1,000,000 species threatened with extinction

in biodiversity across the globe and the dangers that creates for human civilization. A summary of its findings, which was approved by representatives from the United States and 131 other countries, was released Monday in Paris. The full report is set to be published this year.

Its conclusions are stark. In most major land habitats, from





CLOCKWISE FROM TOP LEFT: TONY KARUMBA/AGENCE FRANCE-PRESSE — GETTY IMAGES; BRUNO KELLY/REUTERS; SOREN ANDERSSON/A.F.P. — GETTY IMAGES; JURGEN FREUND/NPL/MINDEN PICTURES

more significant concessions from Beijing.

Mr. Trump, angry that China is retreating from its commitments just as the sides appeared to be nearing a deal and confident the American economy can handle a continuation of the trade war, will increase tariffs on $200 billion worth of Chinese goods on Friday morning, his top advisers said.

Convention on Biological Diversity

Global Policy Goals and Biodiversity Targets

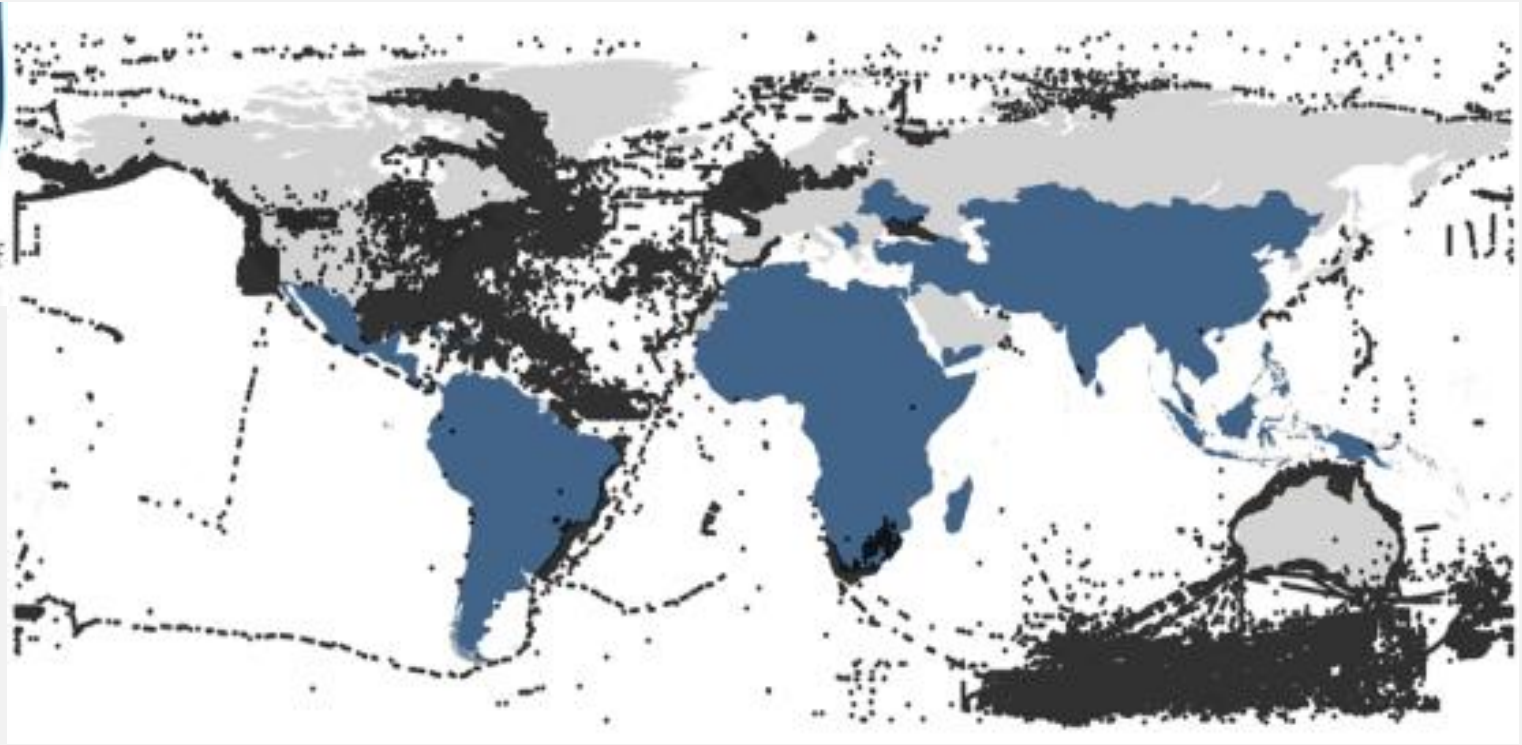
- **Emerging and ambitious policy targets are being proposed to address the impact of biodiversity loss and climate change**
- **Scientific evidence can underpin environmental policies**

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

RESTORE OUR FUTURE
BONN CHALLENGE

BIG DATA to answer conservation needs

University of St Andrews

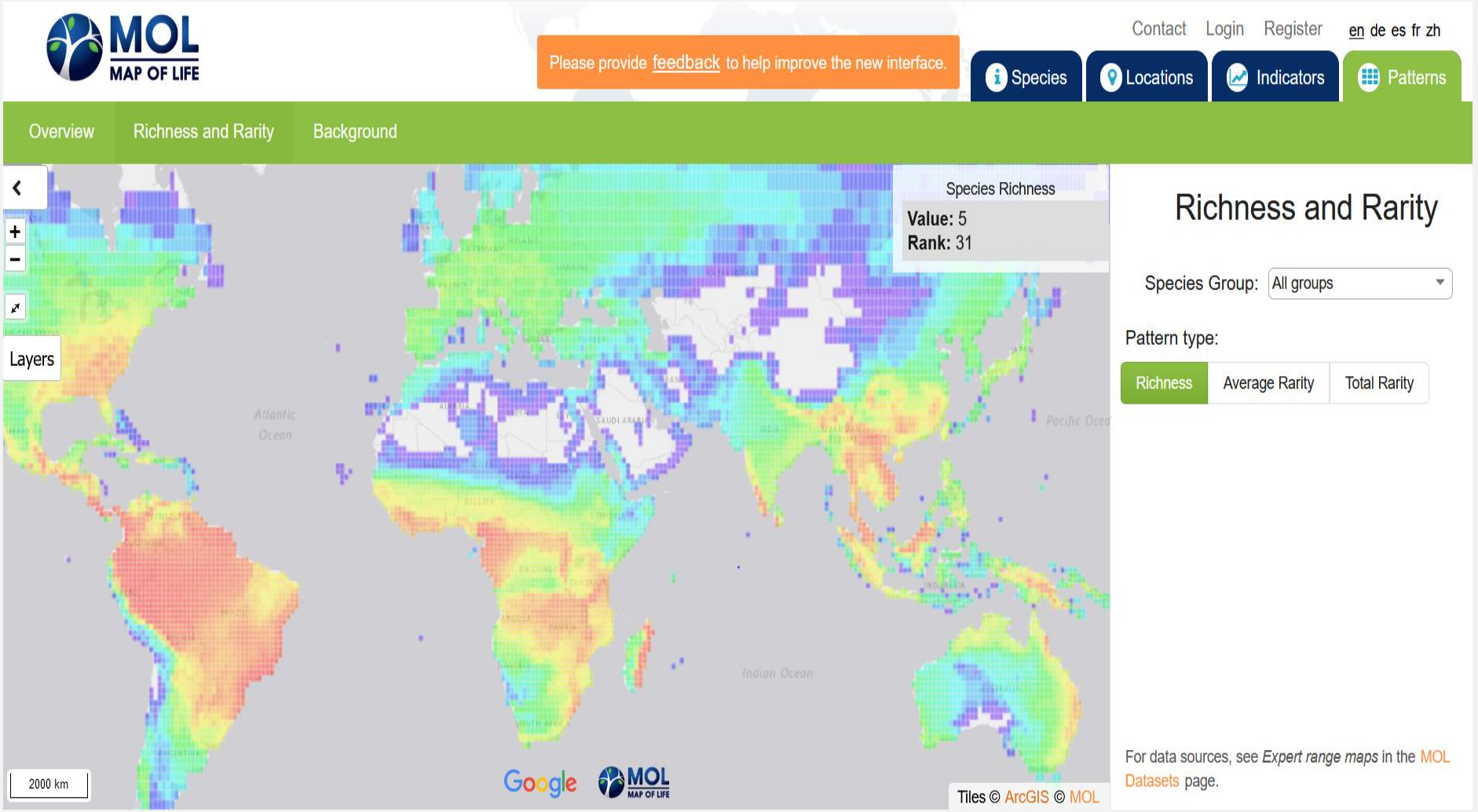


BioTIME database contains c. 12 million records, nearly 50,000 species and 124 unique years from locations across the globe (black dots) (600 thousand distinct geographic locations and is representative of over 20 biomes, occurring over 6 different climatic zones)

BioTIME follows the guiding principles of FAIR data (Findable, Accessible, Interoperable, Re-usable).

Coupling temporal big data with spatio-temporal remote sensing data to study biotic homogenization and patterns of change across gradients of anthropogenic pressures

What do we know about biodiversity?



Several latest studies working with large global database of different nature, -have been contesting- that such loss is actually occurring in particular at local scales in nature (Vellend et al 2013, Dornelas et al 2014 ; Elahi et al. 2015; Newbold et al 2015). Nevertheless, land-use change due to human pressures is recognized as the main driver of global biodiversity degradation – still the relative impact on species turnover (β-diversity) across multiple spatial scales remains unclear

SEARCH DATASETS | 43,100 RESULTS

> 43,000 DATASETS

ENCE CHECKLIST SAMPLING EVENT METADATA

DOWNLOAD AS TSV

GBIF Backbone Taxonomy

Checklist dataset

The GBIF Backbone Taxonomy is a single, synthetic management classification with the goal of covering all names GBIF is dealing with. It's the taxonomic backbone that allows GBIF to integrate…

Published by GBIF Secretariat

6 783 300 records | 77 citations

Catalogue of Life Checklist

Checklist dataset

The Catalogue of Life is an assembly of expert-based global species checklists with the aim to build a comprehensive catalogue of all known species of organisms on Earth. Continuous progress is made t…

Published by The Catalogue of Life Partnership

4 675 779 records | 7 citations

NCBI Taxonomy

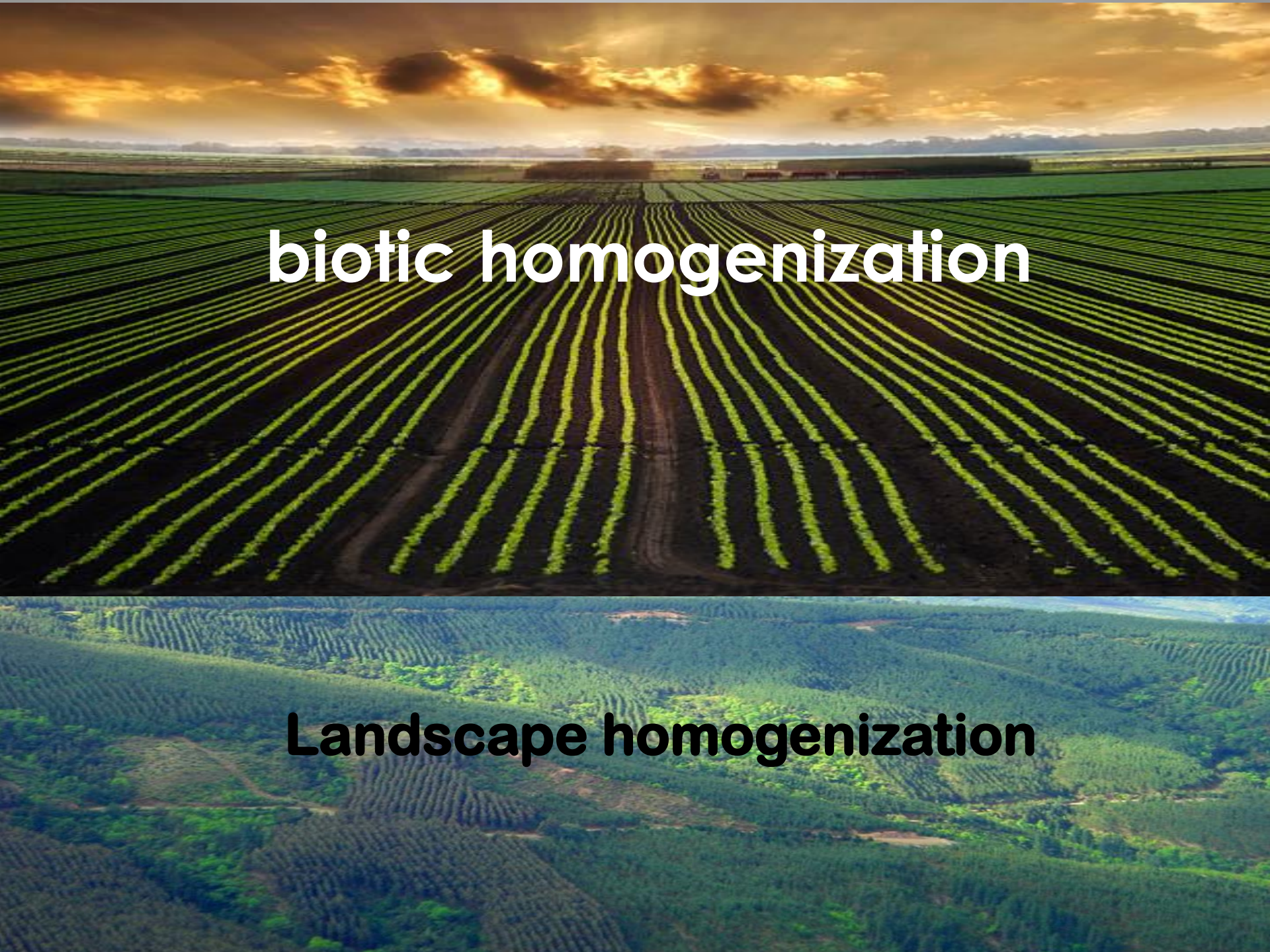
Checklist dataset

The NCBI taxonomy database is not a primary source for taxonomic or phylogenetic information. Furthermore, the database does not follow a single taxonomic treatise but rather attempts to incorporate p…

Published by National Center for Biotechnology Information (NCBI)

3 348 623 records | 2 citations

- **The tropics lost 11.1 million hectares of tree cover in 2021 (new data from the University of Maryland and available on Global Forest Watch 2022)**
  - **3.75 million hectares of loss that occurred within tropical primary rainforests — areas of critical importance for carbon storage and biodiversity**


biotic homogenization
Landscape homogenization

Measuring Forest Biodiversity Status and Changes Globally

Samantha L. L. Hill[1,2*†], Andy Arnell[1†], Calum Maney[1], Stuart H. M. Butchart[3,4], Craig Hilton-Taylor[5], Carolyn Ciciarelli[6], Crystal Davis[6], Eric Dinerstein[7], Andy Pur… and Neil D. Burgess[1,4,8]

[1] UN Environment World Conservation Monitoring Centre (UNEP-WCMC), Cambridge, United Kingdom, [2] Departm… Sciences, The Natural History Museum, London, United Kingdom, [3] BirdLife International, The David Attenborough… Cambridge, United Kingdom, [4] Department of Zoology, University of Cambridge, Cambridge, United Kingdom, [5] I… Species Programme, Cambridge, United Kingdom, [6] WRI, Washington, DC, United States, [7] RESOLVE, Washingt… United States, [8] Department of Life Sciences, Imperial College London, Ascot, United Kingdom, [9] CMEC, Universi… Copenhagen, Copenhagen, Denmark

Hill et al, Frontiers in Forests and Global Conservation 2019

Review

How Can Remote Sensing Help Monitor Tropical Moist Forest Degradation?—A Systematic Review

Chloé Dupuis *, Philippe Lejeune, Adrien Michez and Adeline Fayolle

TERRA Teaching and Research Centre (Forest is Life), Gembloux Agro-Bio Tech, University of Liege, Passage des Déportés n°2 5030 Gembloux, Belgium; p.lejeune@uliege.be (P.L.); adrien.michez@uliege.be (A.M.); adeline.fayolle@uliege.be (A.F.)

* Correspondence: chloe.dupuis@uliege.be

Dupuis et al, Remote Sensing 2020

ELSEVIER

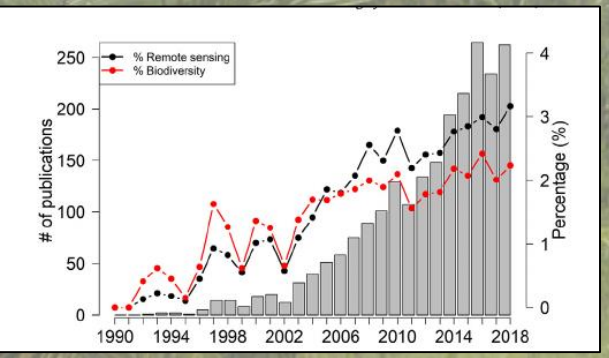
Ecological Informatics

Volume 61, March 2021, 101195

From local spectral species to global spectral communities: A benchmark for ecosystem diversity estimate by remote sensing

Duccio Rocchini [a, b], Nicole Salvatori [c, d], Carl Beierkuhnlein [e], Alessandro Chiarucci [a], Florian de Boissieu [f], Michael Förster [g], Carol X. Garzon-Lopez [h], Thomas W. Gillespie [i], Heidi C. Hauffe [j], Kate S. He [k], Birgit Kleinschmit [g], Jonathan Lenoir [l], Marco Malavasi [b], Vítězslav Moudrý [b], Harini Nagendra [m], Davnah Payne [n], Petra Šímová [b], Michele Torresani [o, q] … Jean-Baptiste Féret [f]

Rocchini et al, Ecological Informatics 2021

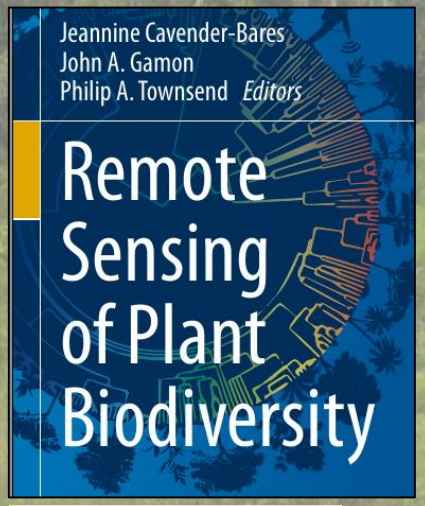


Remote sensing of terrestrial plant biodiversity

Ran Wang[a,*], John A. Gamon[a,b,c]

[a] Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G 2E3, Canada
[b] Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9, Canada
[c] School of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583, USA

Wang and Gamon, Remote Sensing of the Environment 2019



Cavender-Bares et al, Springer 2020

Applied Vegetation Science

Conservation, restoration and survey of plant communities

IAVS

SPECIAL FEATURE: REMOTE SENSING | Open Access

Which optical traits enable an estimation of tree species diversity based on the Spectral Variation Hypothesis?

Michele Torresani, Hannes Feilhauer, Duccio Rocchini, Jean-Baptiste Féret, Marc Zebisch, Giustino Tonon

First published: 29 April 2021 | https://doi.org/10.1111/avsc.12586

Torresani et al, Applied Vegetation Science 2021

Biodiversity monitoring is critical to understand how to mitigate mass extinction

- **Biodiversity is multidimensional**
- **There is no unique indicator to describe or monitor biodiversity**

→Group on Earth Observations Biodiversity Observation Network (GEO BON) aims at improving the availability of biodiversity change data to decision makers and scientists in support of policy

GEO BON

A global system of harmonized observations is needed to inform scientists and policy-makers.

ECOLOGY

Essential Biodiversity Variables

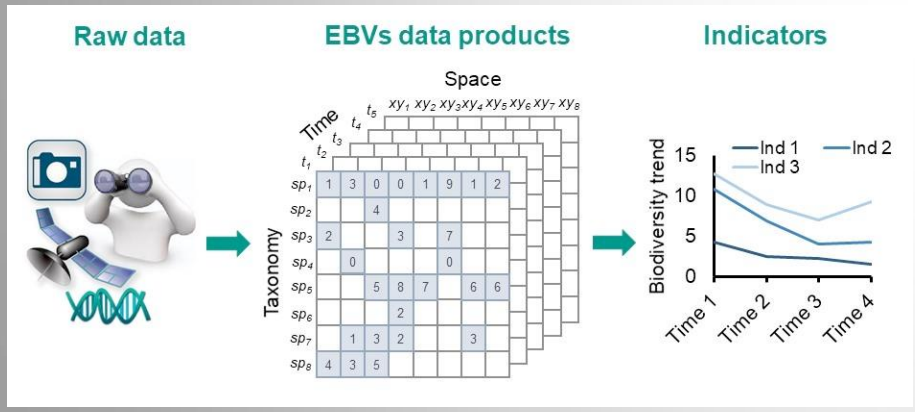
H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3] M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11] D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19] M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25] J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

Pereira *et al.*, *Science*, 339(277-278), 2013.

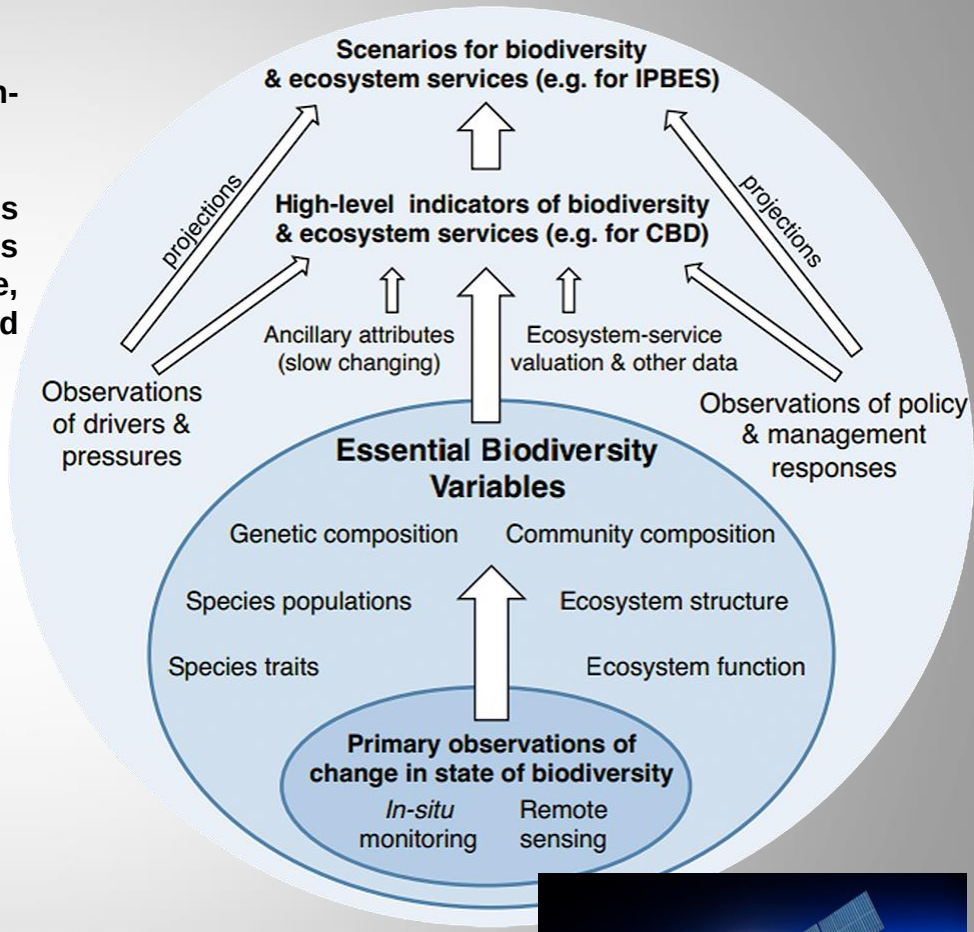
How can we reliably measure and monitor the state of biodiversity at various spatial scales?

Integrated efforts are needed to consolidate data from in-situ and remote sensing.

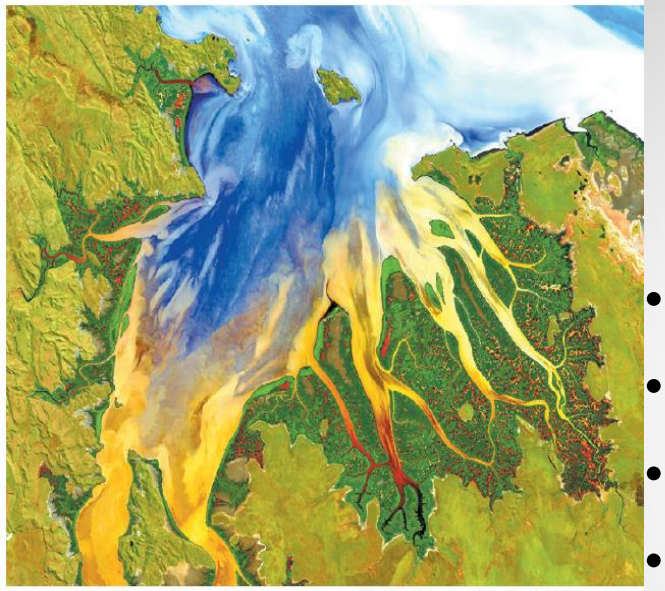
The concept of essential biodiversity variables (EBVs) is currently gaining momentum as a framework to address this research and operational need in order to prioritize, integrate, and consolidate biodiversity observations and monitoring programs worldwide.



https://www.biomac.org/research/themes/7/global_biodiversity_change.html



Remote sensing as a key data source for biodiversity monitoring



Estuary sediment and vegetation patterns in Australia, captured by NASA's Landsat 8 satellite in 2013.

Agree on biodiversity metrics to track from space

Ecologists and space agencies must forge a global monitoring strategy, say **Andrew K. Skidmore**, **Nathalie Pettorelli** and colleagues.

Earth observation appropriate to provide information for the monitoring of biodiversity

'RS enabled EBVs'

- **Regional / global monitoring**
- **Cost effective**
- **Coupling with global modeling tools**
- **Combined with *in situ* observation networks**

Very active domain of research, boosted by increased RS data availibility (including LandSat & Copernicus)

13

Skidmore *et al. 2015*, *Nature*, 523(7561)

Operationalization Biodiversity mapping with satellite data

Received: 22 September 2017 | Accepted: 11 November 2017
DOI: 10.1111/2041-210X.12941

IMPROVING BIODIVERSITY MONITORING USING SATELLITE REMOTE SENSING

Methods in Ecology and Evolution

Measuring β-diversity by remote sensing: A challenge for biodiversity monitoring

Duccio Rocchini[1,2,3] | Sandra Luque[4] | Nathalie Pettorelli[5] | Lucy Bastin[6] | Daniel Doktor[7] | Nicolò Faedi[3,8] | Hannes Feilhauer[9] | Jean-Baptiste Féret[4] | Giles M. Foody[10] | Yoni Gavish[11] | Sergio Godinho[12] | William E. Kunin[13] | Angela Lausch[7] | Pedro J. Leitão[14,15] | Matteo Marcantonio[16] | Markus Neteler[17] | Carlo Ricotta[18] | Sebastian Schmidtlein[19] | Petteri Vihervaara[20] | Martin Wegmann[21] | Harini Nagendra[22]

Remote Sensing in Ecology and Conservation
Open Access

ZSL LET'S WORK FOR WILDLIFE

REVIEW

Satellite remote sensing to monitor species diversity: potential and pitfalls

Duccio Rocchini[1], Doreen S. Boyd[2], Jean-Baptiste Féret[3], Giles M. Foody[2], Kate S. He[4], Angela Lausch[5], Harini Nagendra[6], Martin Wegmann[7] & Nathalie Pettorelli[8]

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

ELSEVIER

Short Communication

Measuring Rao's Q diversity index from remote sensing: An open source solution

Duccio Rocchini [a,*,1], Matteo Marcantonio [a,b,1], Carlo Ricotta [c]

Available online at www.sciencedirect.com
ScienceDirect
Remote Sensing of Environment 111 (2007) 423–434

Remote Sensing of Environment

www.elsevier.com/locate/rse

Effects of spatial and spectral resolution in estimating ecosystem α-diversity by satellite imagery

Duccio Rocchini *

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

ELSEVIER

On the use of binary partition trees for the tree crown segmentation of tropical rainforest hyperspectral images

G. Tochon [a,b,*], J.B. Féret [b,c], S. Valero [c], R.E. Martin [b], D.E. Knapp [b], P. Salembier [d], J. Chanussot [a,e], G.P. Asner [b]

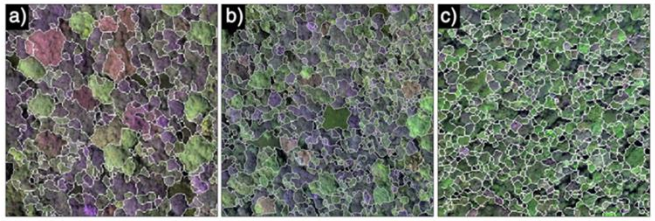


Fig. 10. Visual results obtained when using mean shift clustering, PC selection without PC # 1 and size threshold of 1200 for Hawaii (a, b) and 150 for Panama (c).

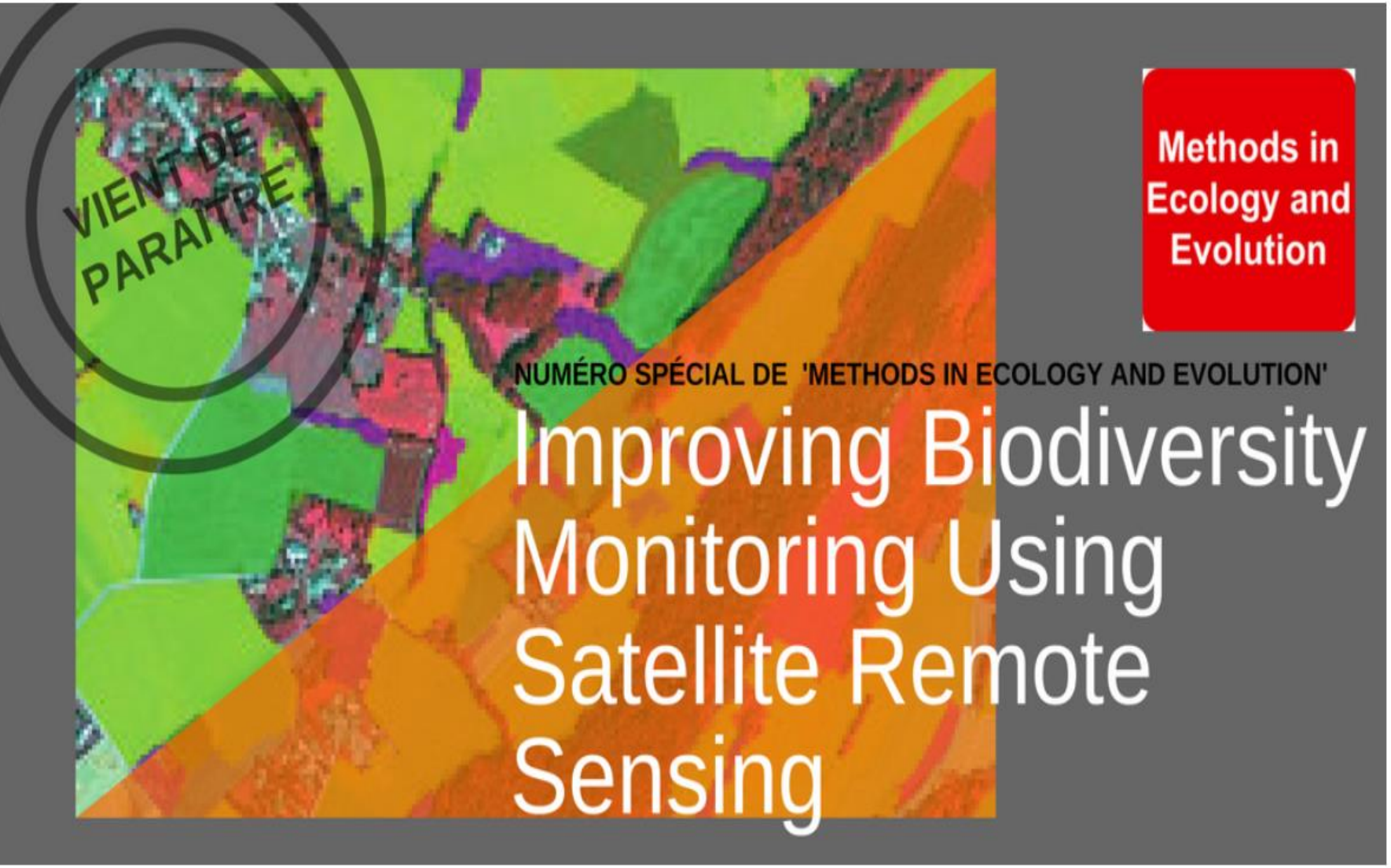
remote sensing

MDPI

Article

Realistic Forest Stand Reconstruction from Terrestrial LiDAR for Radiative Transfer Modelling

Kim Calders [1,2,3,*], Niall Origo [1,2], Andrew Burt [2], Mathias Disney [2,4], Joanne Nightingale [1], Pasi Raumonen [5], Markku Åkerblom [5], Yadvinder Malhi [6] and Philip Lewis [2,4]



Improving biodiversity monitoring using satellite remote sensing to provide solutions towards the 2030 conservation targets
Sandra Luque | Nathalie Pettorelli | Petteri Vihervaara | Martin Wegmann. (2018)

Methods in Ecology and Evolution BRITISH ECOLOGICAL SOCIETY

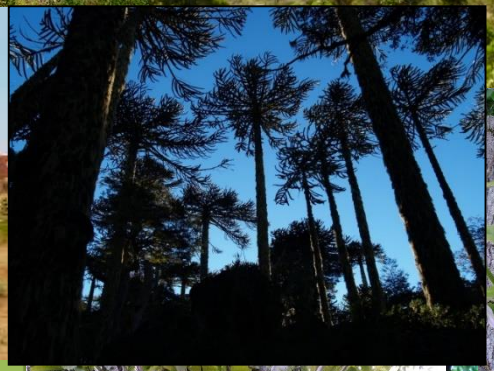
Over-arching research goals

- Innovation & technology for improved biodiversity monitoring coupling in situ data & RS
- Other types of data should be considered for application of methods for diversity mapping based on spectral heterogeneity
- Operational methods & tools to be linked to policies for improvement of public awareness and cost-effective management of biodiversity
- Using a mixture of remote sensing and field based data requires ecologists and remote sensing experts to collaborate closely to make the best use of the newest remote sensing capabilities and modelling approaches

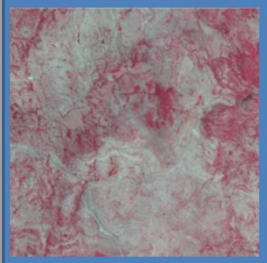


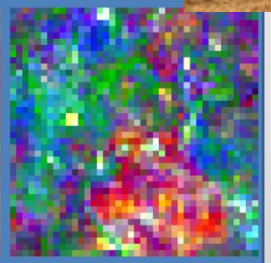

Thank you

Jean Baptiste Féret, Eric Chraibi, Maxime Lenormand, Samuel Alleaume

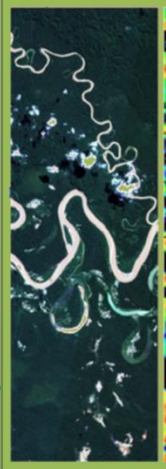


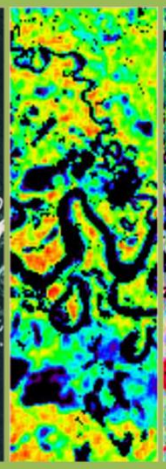
Mediterranean ecosystems:
Characterizing openness of vegetati

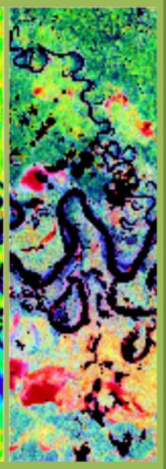




Tropical ecosystems:
Mapping taxonomic diversity & species communities







Alpine ecosystems:
Mapping habitats based on floristic inventory