Storing Carbon in agricultural soils through a collaborative approach involving farmers, an agrifood company and research

Eric Ceschia, Suzanne Reynders

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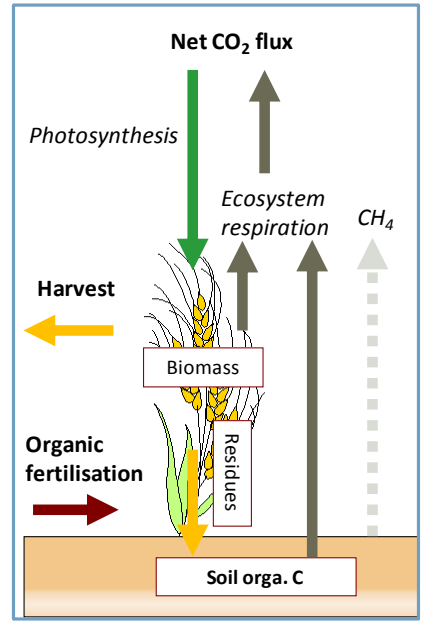
Scaling up Climate Actions in Pacific Small Island Developing States (SIDS)

Enhancing measurement capacities for improved soil carbon and health

May 10th 2022

Carbon budget calculation principles

➢ Represents a change in soil organic C content ➔ objective is to calculate it yearly over large areas (at 10m/plot level) but can be aggregated at rotation/farm scale,



➢ 3 methods (TIERS) with a similar conceptual approach:

C budget = Annual net CO_2 flux – C harvested + Organ. Amend.

TIER 1 (Sentinel)

TIERs 2 & 3 (Sentinel + farmer's data)

➢ Increasing levels of accuracy/complexity:

- TIER 1 (net annual CO_2 fluxes) and TIER 2 (C budget) are based on empirical approaches ➔ can be applied to most temperate crop specie (not rice),

- TIER 3 based on the SAFYE-CO2 model (biomass, yield, CO_2 fluxes) calibrated by high resolution satellite data (e.g. Sentinel 2) ➔ validated on wheat, maize, rapeseed, sunflower, assesses the effect of cover crops & straw management on Soil Organic Carbon storage.

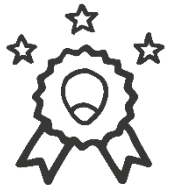
Naturellement popcorn Project

European
popcorn leader

Objectives:

Increase soil fertility through natural process by increasing soil carbon storage (cover crop, no till)

Enabling a higher revenue for farmers reducing their carbon footprint



Meet consumers' and industry's demands for sustainability, climate mitigation and agroecology

Scientific partnership with mutual benefits

Cooperative
250
Farmers

- Rewarding their environmental services such as sustainable carbon storage in their fields
- Benefit of a better societal image

- Co-construction process ensures that the tools meet the user requirements
- Benefit from the data provided by farmers & Nataïs company to improve models

- They advocate for the positive role of farmers in climate mitigation

Research organisations

Agrifood compagny

- Development of soil organic carbon monitoring methods, based on modelling and remote sensing

- Stand out from competitors (selling argument)
- Support local and sustainable production

Monitoring cover crop carbon storage effect

2012 — 2022 — 2024 — 2025

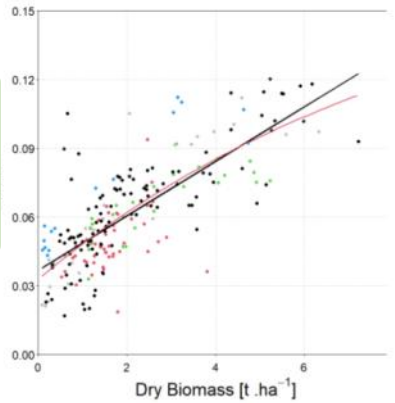
Farmers inquiry

Cover crop: Yes/No

Fixed Bonus paid by Nataïs

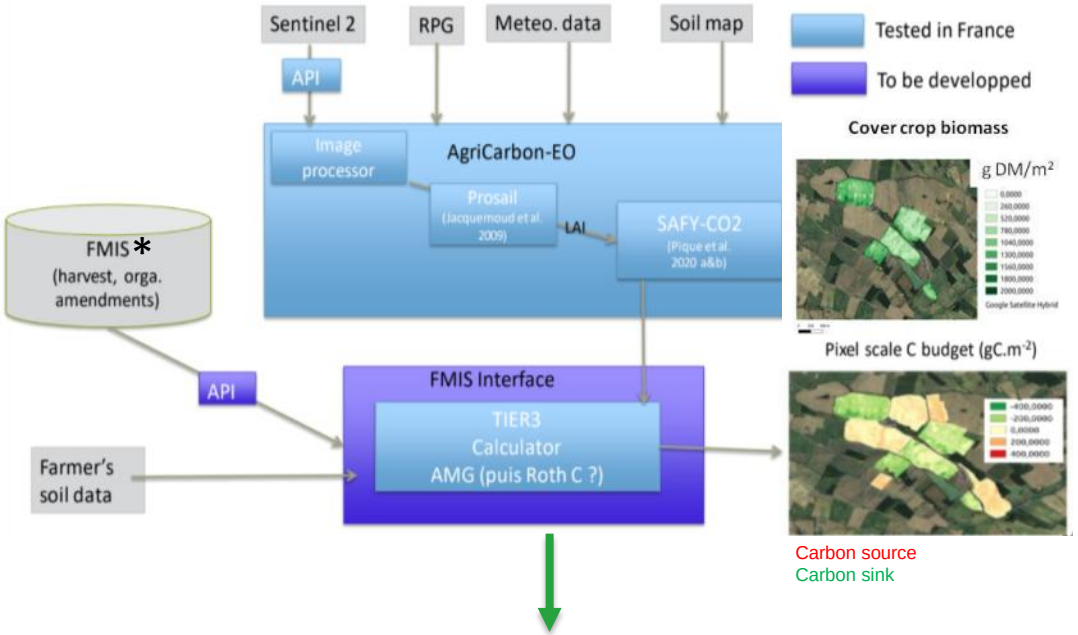
Calculation of biomass using satellite

Empirical relation between vegetation index and biomass



Bonus paid by Nataïs according to additional C storage by cover crops

AgriCarbon-EO chain/SAFY-CO2 model

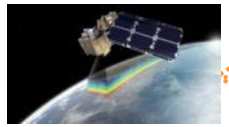


Annual Carbon budget

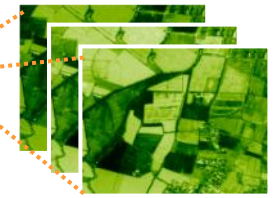
Carbon payment for farmers (➔ international Carbon market)

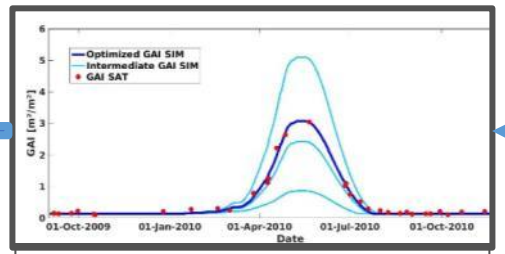
* Farm Management Information System

The SAFY-CO2 modelling approach (TIER 3)



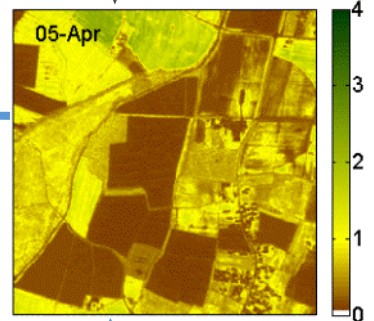
Sentinel 2





Calibration of phenological & photosynthetic efficiency parameters

m^2 leaves/m^2 soil



Crop maps

Crop param

Rg,T°C

Climatic data (e.g., ERA-5)

SAFY-CO_2

Pique et al. (2020 a &b)

Leaf Area Index

Biomass, Yield,

Validation with farmers & regional stat. for yield

International flux stations networks

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

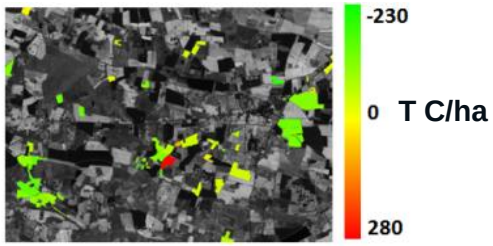
FLUXNET

CO_2 fluxes

C budgets

Farmer's data

Straw export? Organic Fertil ?



Combining high resolution remote sensing data and a simple crop model

The model is forced to reproduce what the satellite « sees »

Few field management data needed ➔ easy to upcale

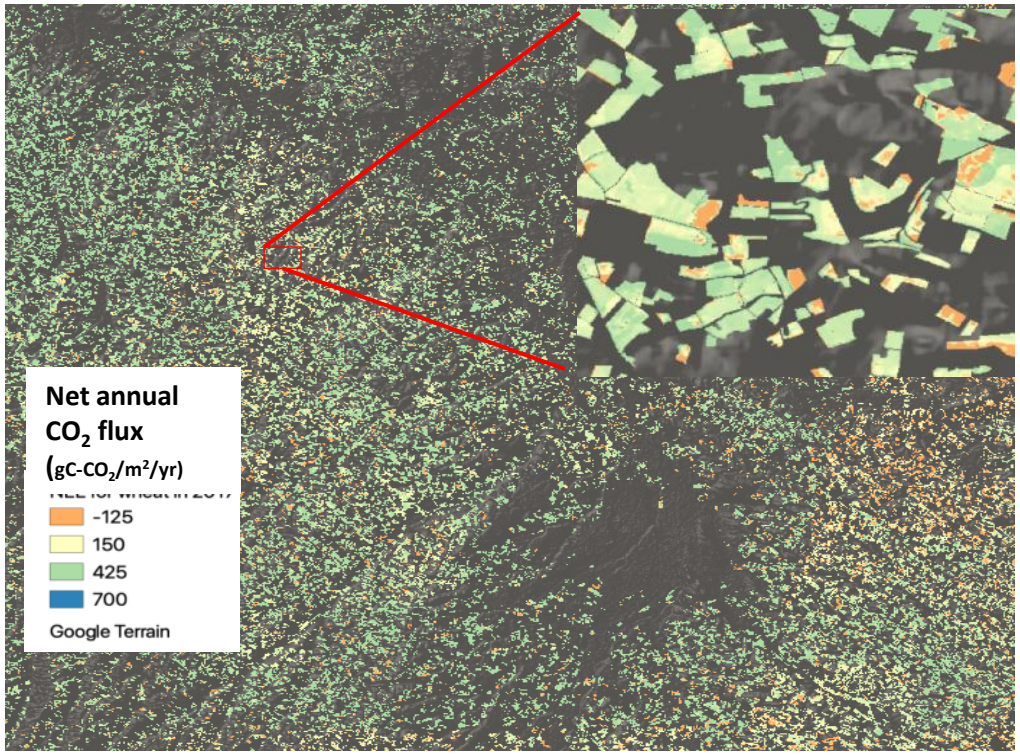
The SAFY-CO2 modelling approach (TIER 3)

AgriCarbon-EO processing chain + SAFYE-CO2 model ➔ large scale, high resolution, uncertainties

CO_2 fixation / soil C storage

CO_2 losses / soil C loss

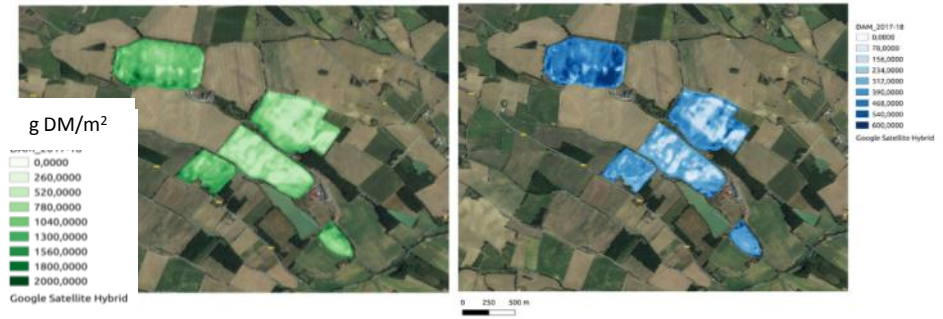
Net annual CO_2 fluxes for 2018 straw cereals in South West France



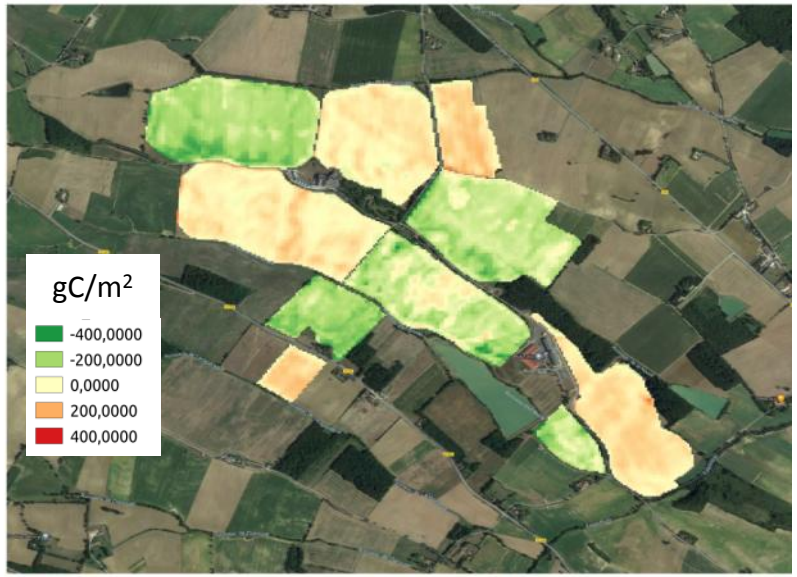
Whole Sentinel 2 Tile (31TCJ)

+ Farmer's data

Cover crop biomass + Uncertainties



Farm C budget map (10m resolution) for cover crop/maize/wheat crop rotations

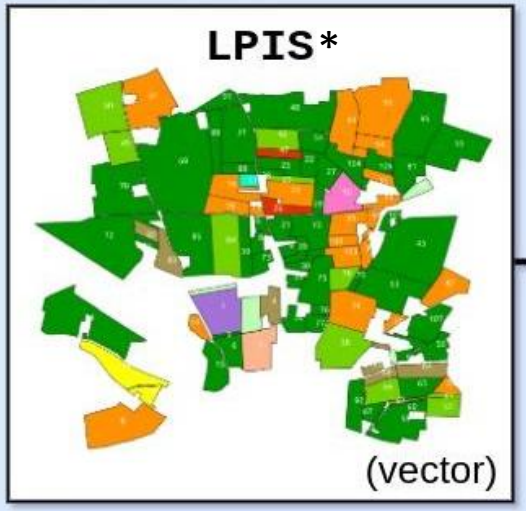


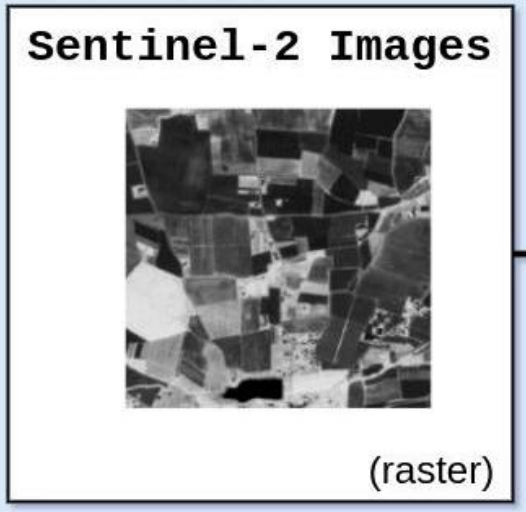
Villeneuve farm (Bézéril)

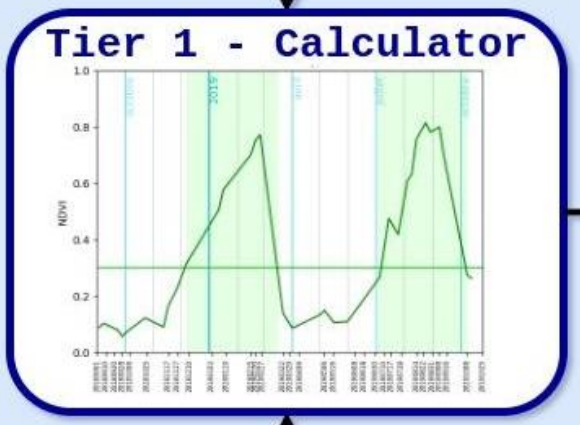
Empirical C budget approach for the European Common Agricultural Policy (TIER 1)

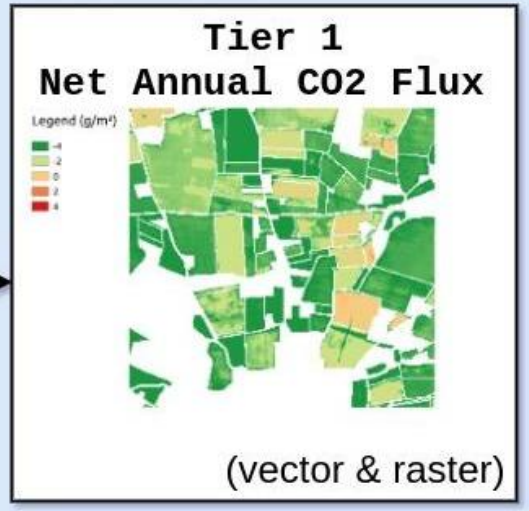
* Land Parcel Identification System (crop map)

Net annual CO_2 flux depends on the number of days of active vegetation



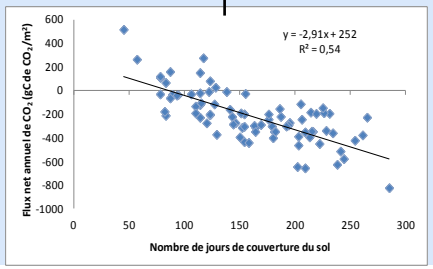






Open tool available at https://gitlab.com/nivaeu/uc1b_tier1_co2

Based on Ceschia et al. (2010)



Cropland sites flux towers

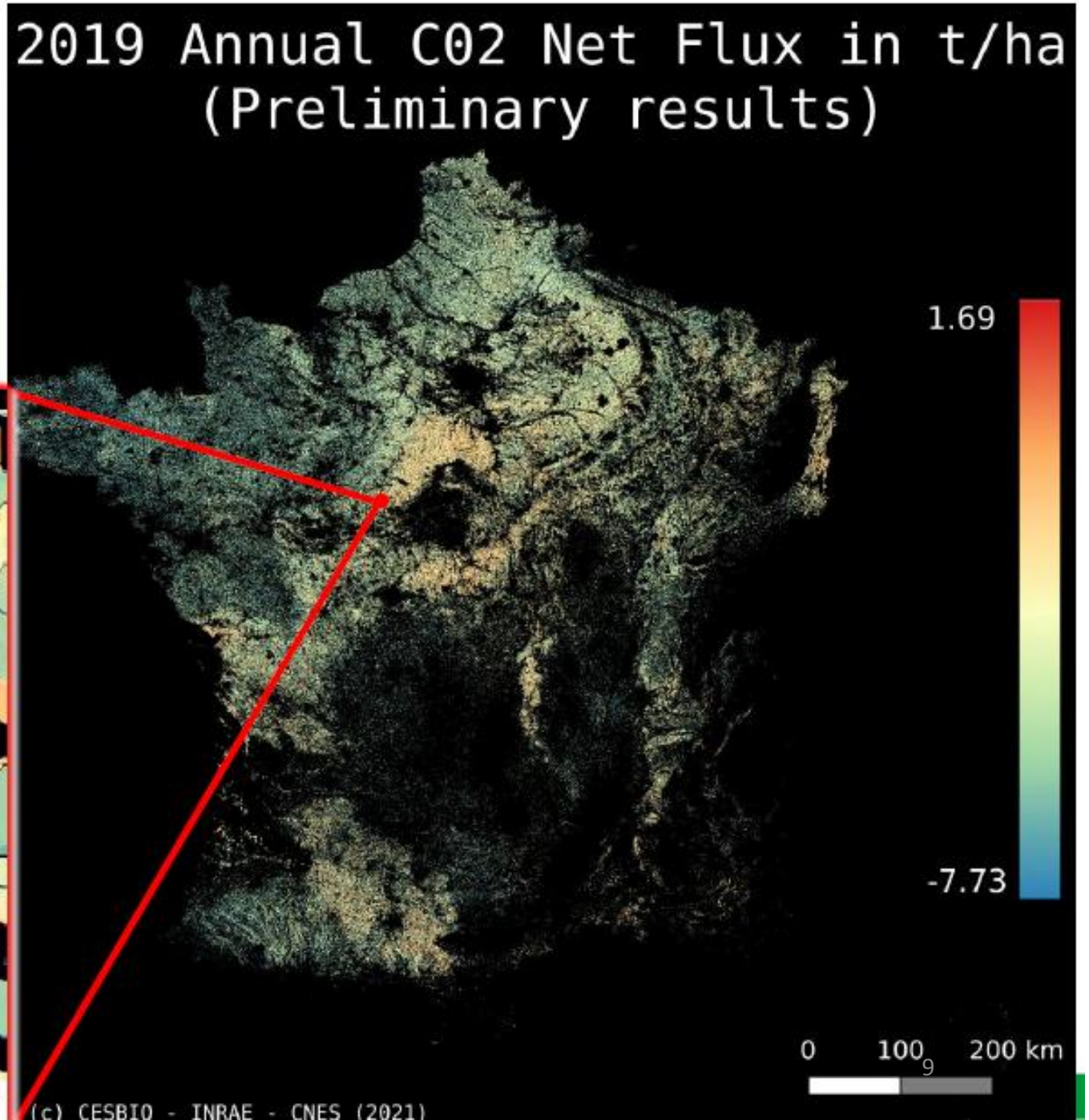
NIVA’S algorithm + Iota2 software

With the support of

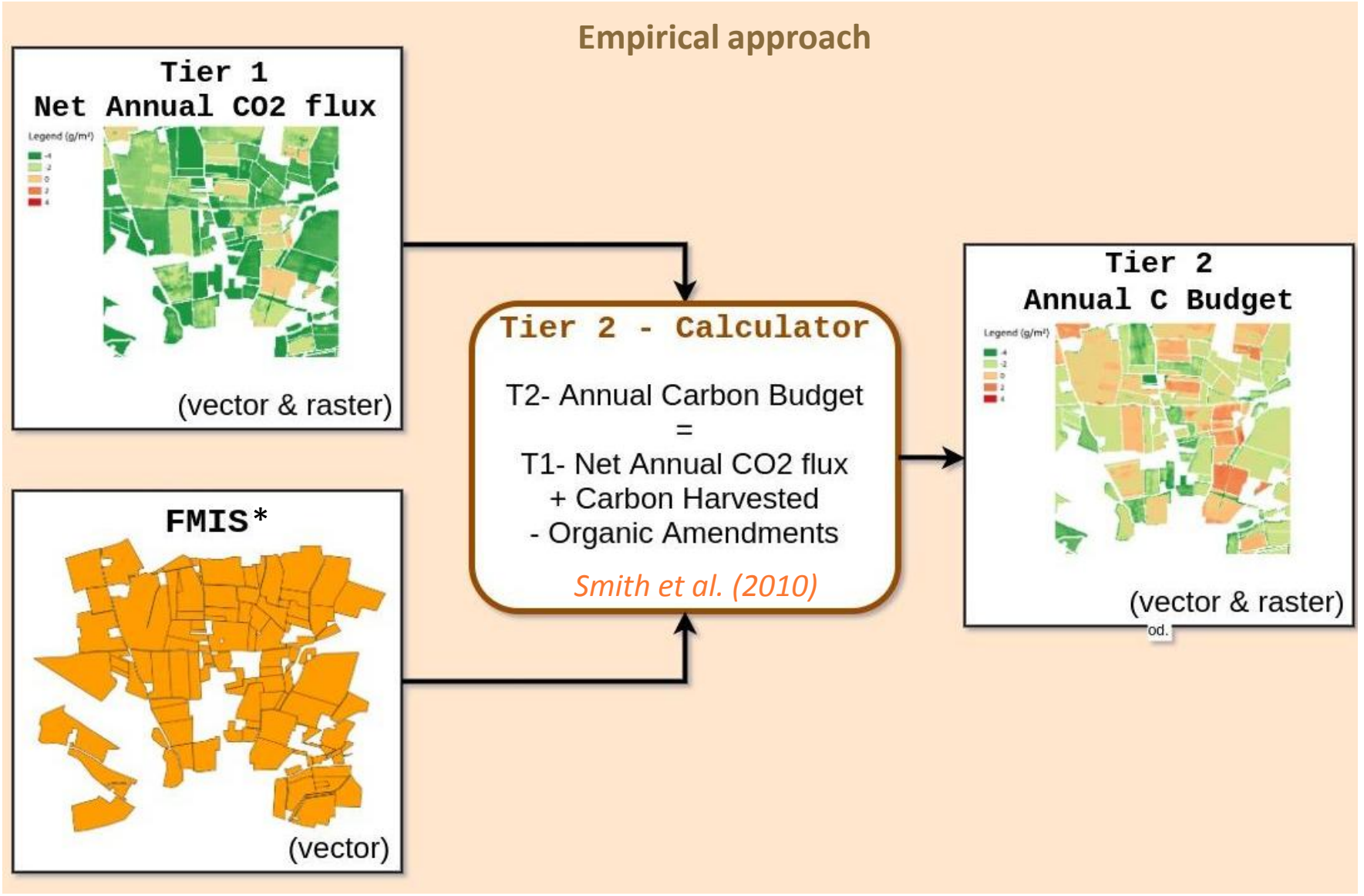
Annual CO_2 fixation

Annual CO_2 losses

France
=
94 Sentinel-2 tiles



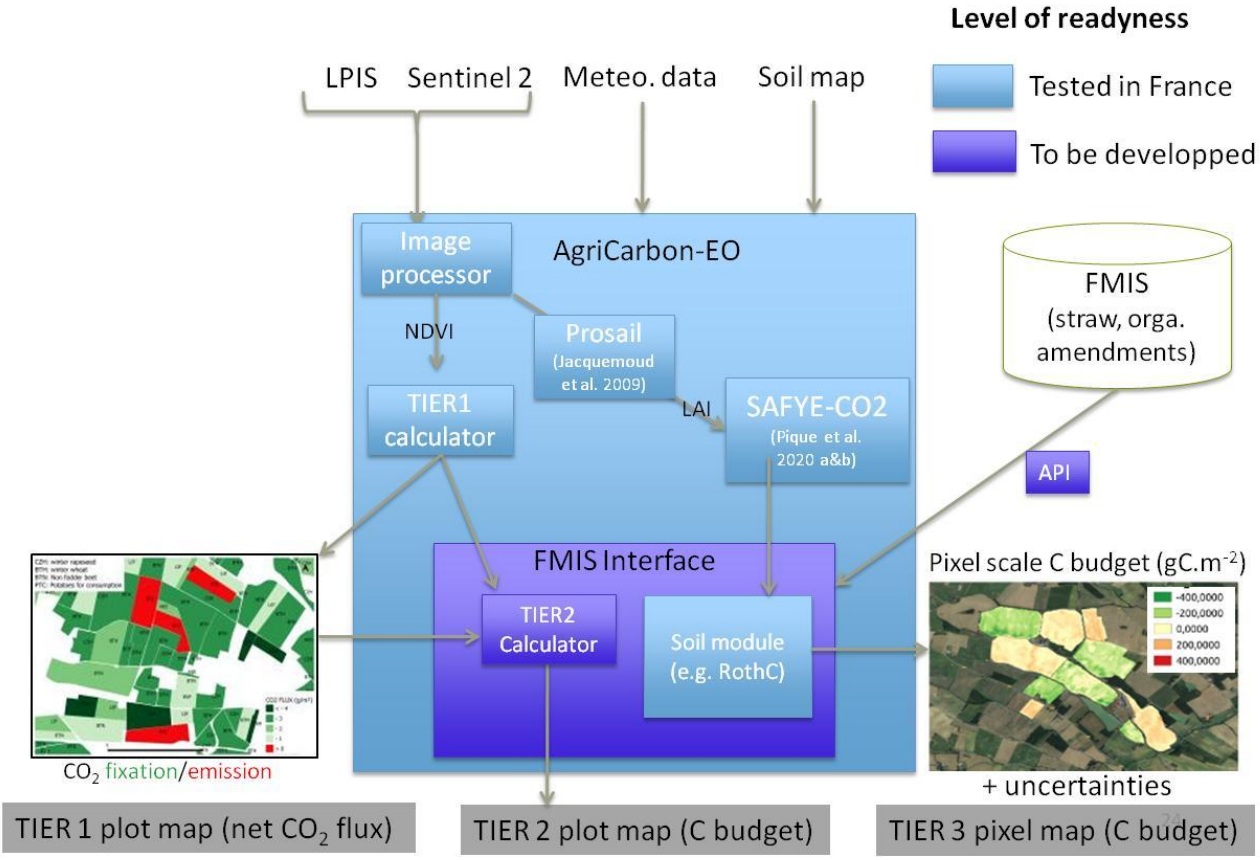
Simplified C budget approach for the European Common Agricultural Policy (TIER 2)



* Farm Management Information System

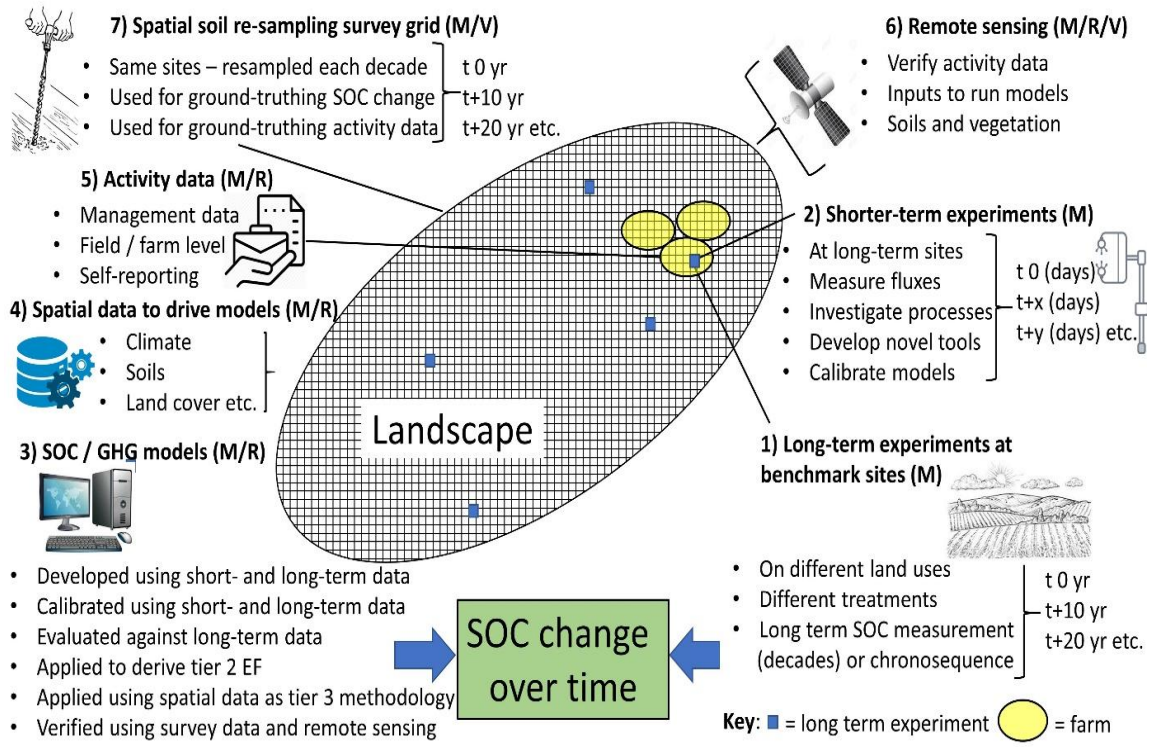
Towards a unified methodological framework ??

➢ A range of tools that will be integrated in AgriCarbon-EO



➢ Compliant with CIRCASA's recommendations for MRV on SOC for agricultural soils

SMITH, SOUSSANA, et al, Global Change Biology 2019



AgriCarbon-EO could prefigure a prototype for a future International Research Consortium on Soil Carbon (see OrCasa in slide 14)

Local/regional adaptations will be needed

The Small Island Developing States specific features

- Small plots ➔ use of higher resolution satellite data (e.g. Planet at 5m) or drones

Pineapple fields in Moorea (French Polynesia)

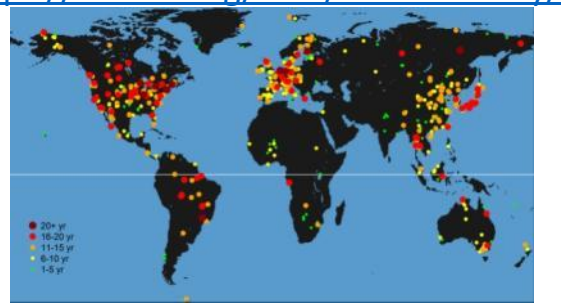
Root crops in Tonga Island

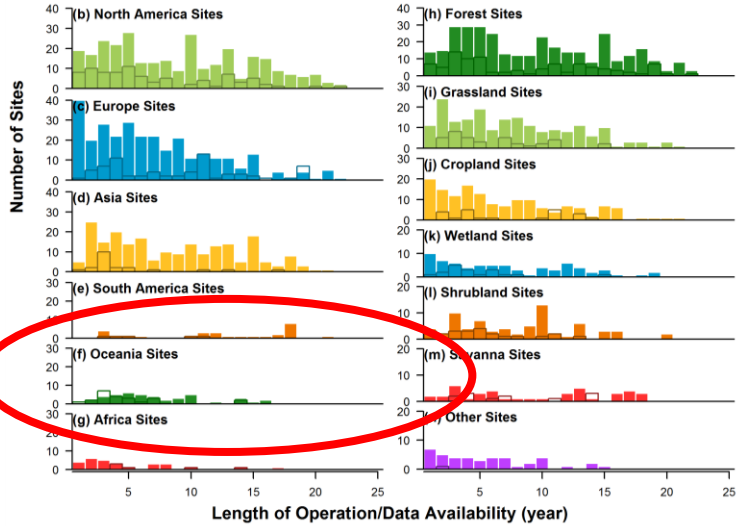
Local/regional adaptations will be needed

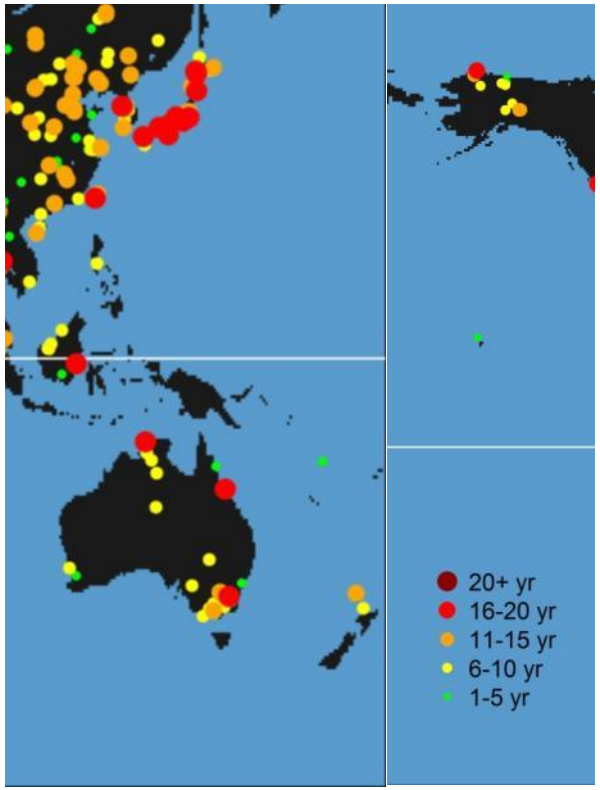
The Small Island Developing States specific features

- Small plots ➔ use of higher resolution satellite data (e.g. Planet at 5m) or drones
- Crop types/soils ➔ Fluxnet network to calibrate/validate TIER 1 & SAFY-CO2 tools

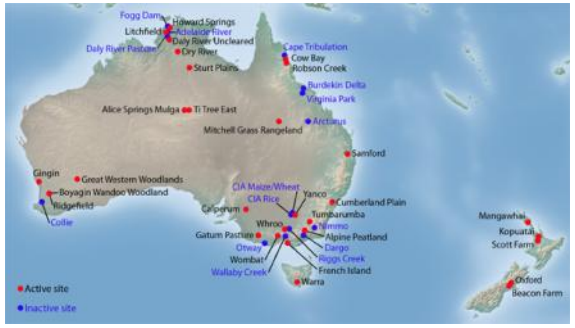
https://fluxnet.org/sites/site-summary/

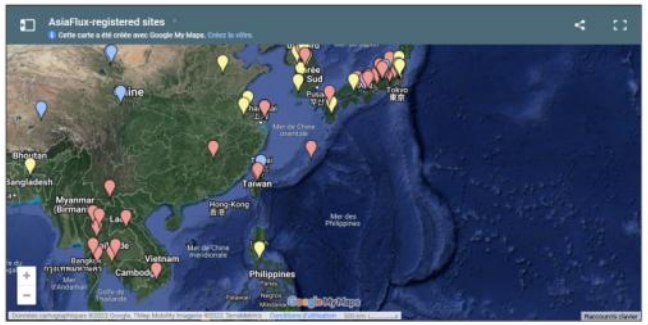






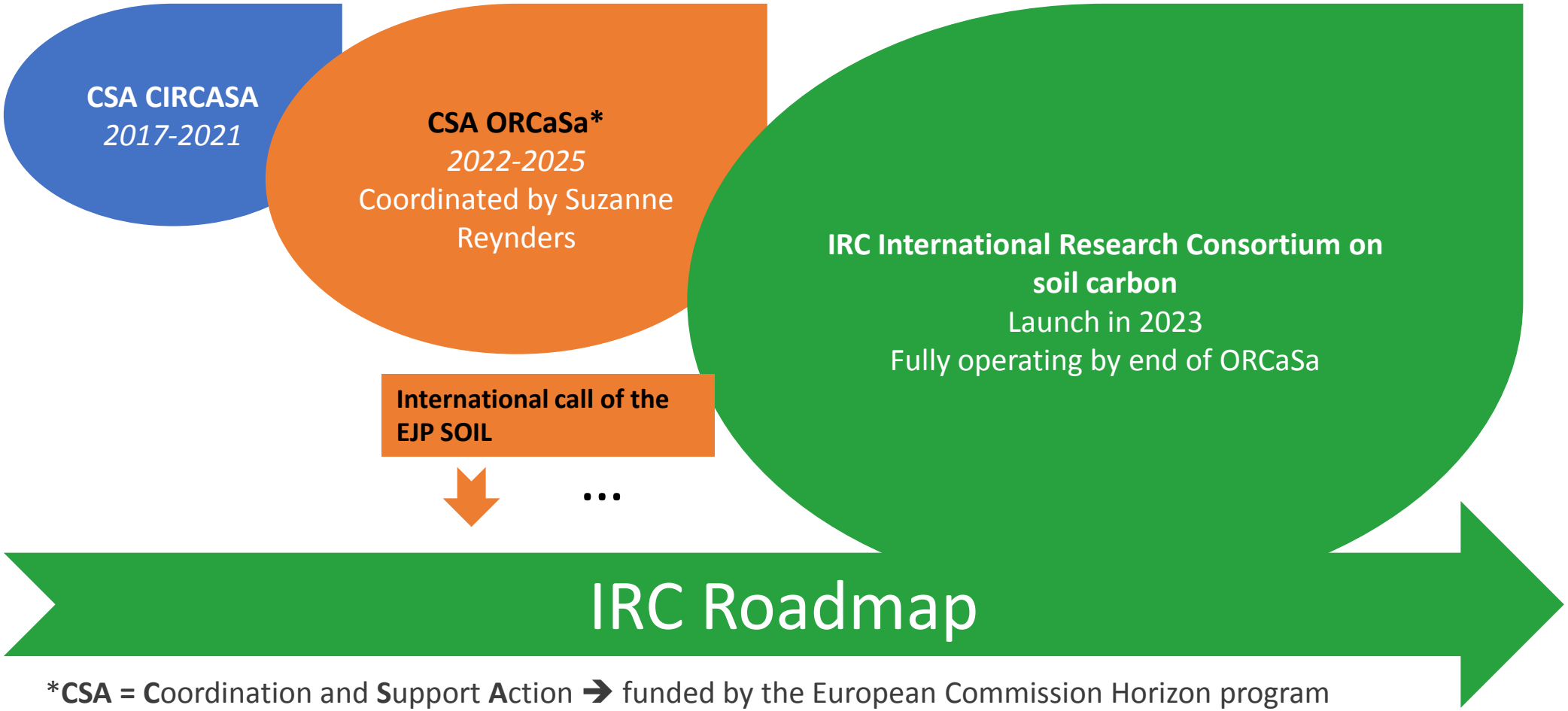
https://www.ozflux.org.au/monitoringsites/index.html





http://asiaflux.net/?page_id=22

Roadmap: from CIRCASA towards a fully operating International Research Consortium (IRC) on Soil Carbon



*CSA = Coordination and Support Action ➔ funded by the European Commission Horizon program
*ORCaSa: Operationalising International Research Cooperation on Soil Carbon (funded by EC)
EJP Soil (European Join Program on Soil) Launches an international call in the coming months

Main Objectives of the International Research Consortium on Soil Carbon

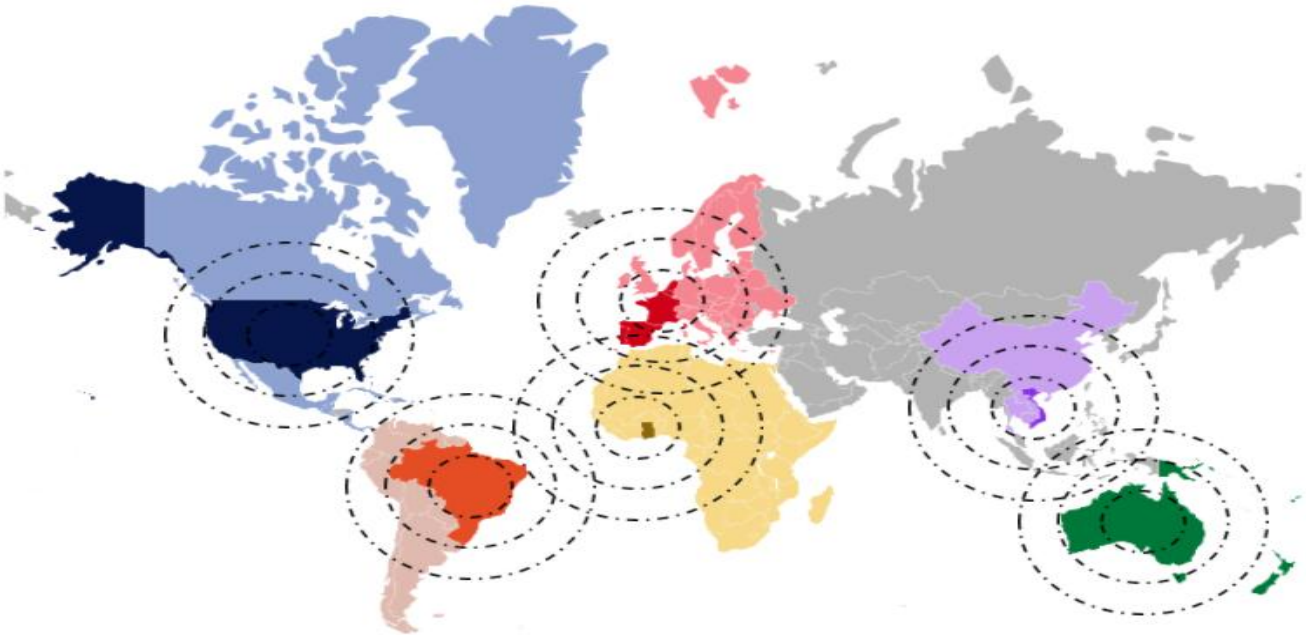
What was done in the last 3 years :

- an initial Strategic Research and Innovation Agenda on agricultural Soils
- an initial community of 100 stakeholders and 500 scientists
- A conceptual methodological framework (Smith et al., 2019) + AgriCarbon-EO MRV prototype (see slide 11)

Next steps for the IRC :

- To **join and coordinate** Europe's research and Innovation **forces** on soil carbon **with those around the globe**
- To create **synergies with existing initiatives** (EJP soil, Soil Health and Food Mission, FAO and GSP …),
- To align international research **cooperation**,
- To facilitate **synergies** between programs,
- To enlarge the **Strategic Research Agenda** to non-agricultural soils & implement it
- To better **share best practices and knowledge** through a **Knowledge Platform**
- To enable **low-cost disruptive monitoring tools (e.g. building on AgriCarbon-EO, NIVA's empirical approaches, regionally validated soil models and observation networks)**

ORCaSa's Regional nodes for the IRC on Soil Carbon



- The French National Research Institute for Agriculture, Food and Environment (INRAE) INRAE
- National Agency for Research (ANR) ANR
- Stichting International Soil Reference and Information Centre (ISRIC) ISRIC
- Vizzuality vizzuality.

- Colorado State University System Colorado State University
- Brazilian Agricultural Research Corporation (EMBRAPA) Embrapa
- Forum for Agricultural Research in Africa (FARA) FARA
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Soils and Fertilizers Research Institute (SFRI)

- Connection with Oceania's Partners are most welcome ☺
- We are willing to enlarge the IRC scope and welcome future IRC General Assembly Members signing a "declaration of intent"
- Find regional partners for developing/adapting/improving our tools

Thanks for your attention !!

Want to know more ? Please contact us:

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- Former PI of the Auradé and Lamasquère ICOS sites
- Former Co-PI of the Spatial Regional Observatory
- PI of the SAFY-CO2 and AgriCarbon-EO platforms
- Specialist in agricultural climate mitigation strategies

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- EIT Climate-KIC governing board member
- PI of EIT C-KIC project carbon farming
- PI of study : recommendations for drafting a low carbon label method and evaluation of business models for carbon farming
- 12 years experience Climate Change and Agriculture