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To cite this version:

Eric Ceschia, Jean-François Soussana. Monitoring Reporting and Verification issues and technologies for decision makers in the context of carbon sequestration : towards a MRV operational system for soil Carbon monitoring. 26th Conference of Parties, side event 7.G.4, "Agriculture, land use, forestry", United Nations, Aug 2021, Glasgow (Ecosse), United Kingdom. pp.1-13. hal-04221994v2

HAL Id: hal-04221994
https://hal.inrae.fr/hal-04221994v2

Submitted on 29 Sep 2023

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Monitoring Reporting and Verification issues and technologies for decision makers in the context of carbon sequestration : towards a MRV operational system for soil Carbon monitoring

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COP 26 side event 7.G.4, “Agriculture, land use, forestry”, 8th November 2021

Context

- Growing international interest in better managing soils to increase soil organic carbon (SOC) → contribute to climate change mitigation, enhance resilience to climate change and to underpin food security (e.g. '4p1000' initiative, FAO's Global assessment of SOC sequestration potential programme),

- Yet, changes in SOC content of soils are difficult to measure → key barrier to implementing programmes to increase SOC at large scale,

→ Need for credible and reliable measurement/monitoring, reporting and verification (MRV) platforms, both for national reporting (NDCs) and for emissions trading.

Current MRV systems & limitations

- Most operational MRV systems allowing national scale quantification are based on in-situ soil sampling networks (reference approach) but heterogeneous protocols (+ uncertainties), low sampling frequency (5-10 yr), expensive, not exhaustive (not all plots monitored)

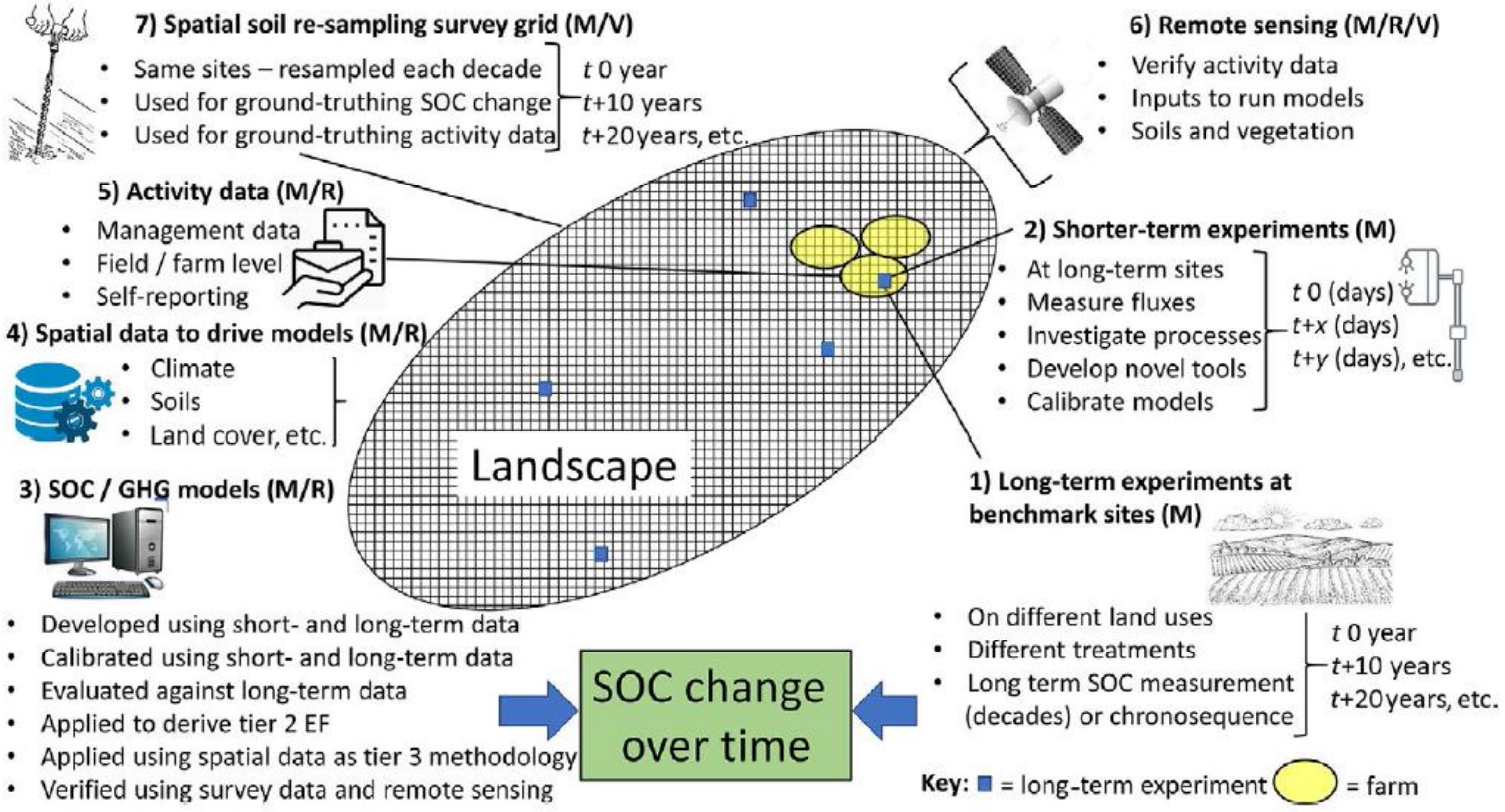
➔ issue for attributing SOC stock changes to specific driver and concerning the suitability of using those networks for monitoring absolute SOC stock changes and for international negotiations,

- On the other hand, for a range of applications (agri-environmental monitoring for the CAP, carbon market…) the development of MRV methods and tools based on the plot scale annual estimation of the C balance and its components (e.g. photosynthesis, biomass inputs to the soil…) is needed.

- Other approaches like soil modeling approaches, direct estimates by remote sensing… have their pros and cons (cost of implementation, operationnality, accuracy, accessibility of the data), and some are easier to implement at large scale than others; also they are rather complementary and to some extend the weakness of one approach can be compensated by the others.

Need for a new & harmonised international MRV framework for Soil Carbon

➔ CIRCASA (Smith, Soussana et al., 2019) proposed to combine a range of approaches and suggested a common theoretical framework for MRV at global scale.



How to implement such a MRV framework ?

- Many bricks already exist (e.g. COMET-Farm (US) and SIMEOS-AMG (France) as modeling tools for soil C budget and GHG inventories at farm level, international flux tower networks, new generation of high spatial & temporal resolution satellite missions ➔ biomass estimates…),

- …but need to define an integrated methodological MRV framework and develop tools having:

  - large acceptability & adapted to a large range of stackeholders,

  - meeting the highest scientific standards,

  - the possibility of large scale application (or even global) with comparable/identical protocols/systems of observation (e.g. earth observation),

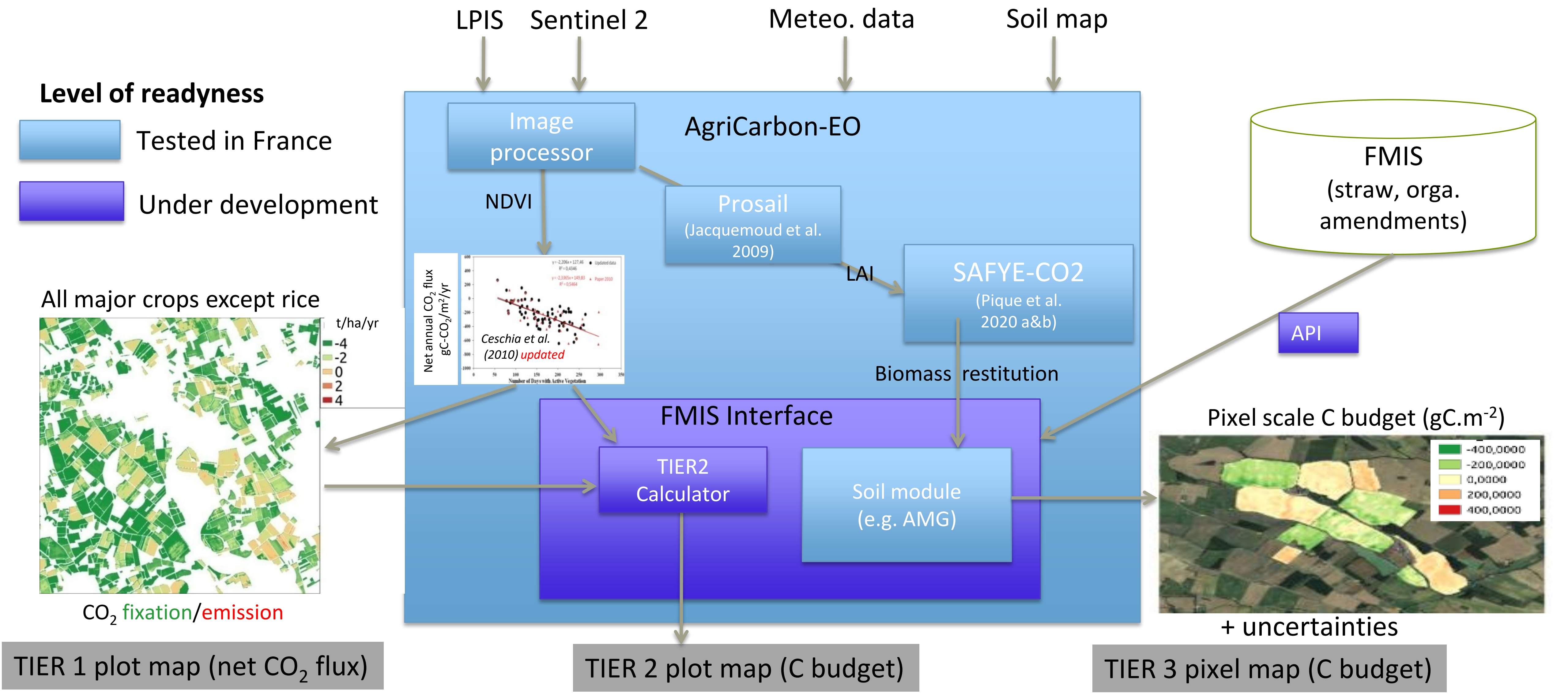
  - at low cost of implementation,

  - adaptative, with several levels of complexity depending on the context of application (e.g. availlability of input data…) ➔ TIERs with TIER 1 being applied everywhere.

- Some MRV prototypes are under development : FiON (Finland), AgriCarbon-EO (France) ➔ NIVA NEW IACS VISION IN ACTION and Soil Carbon Farming (eit Climate-KIC Climate-KIC is supported by the EIT, a body of the European Union).

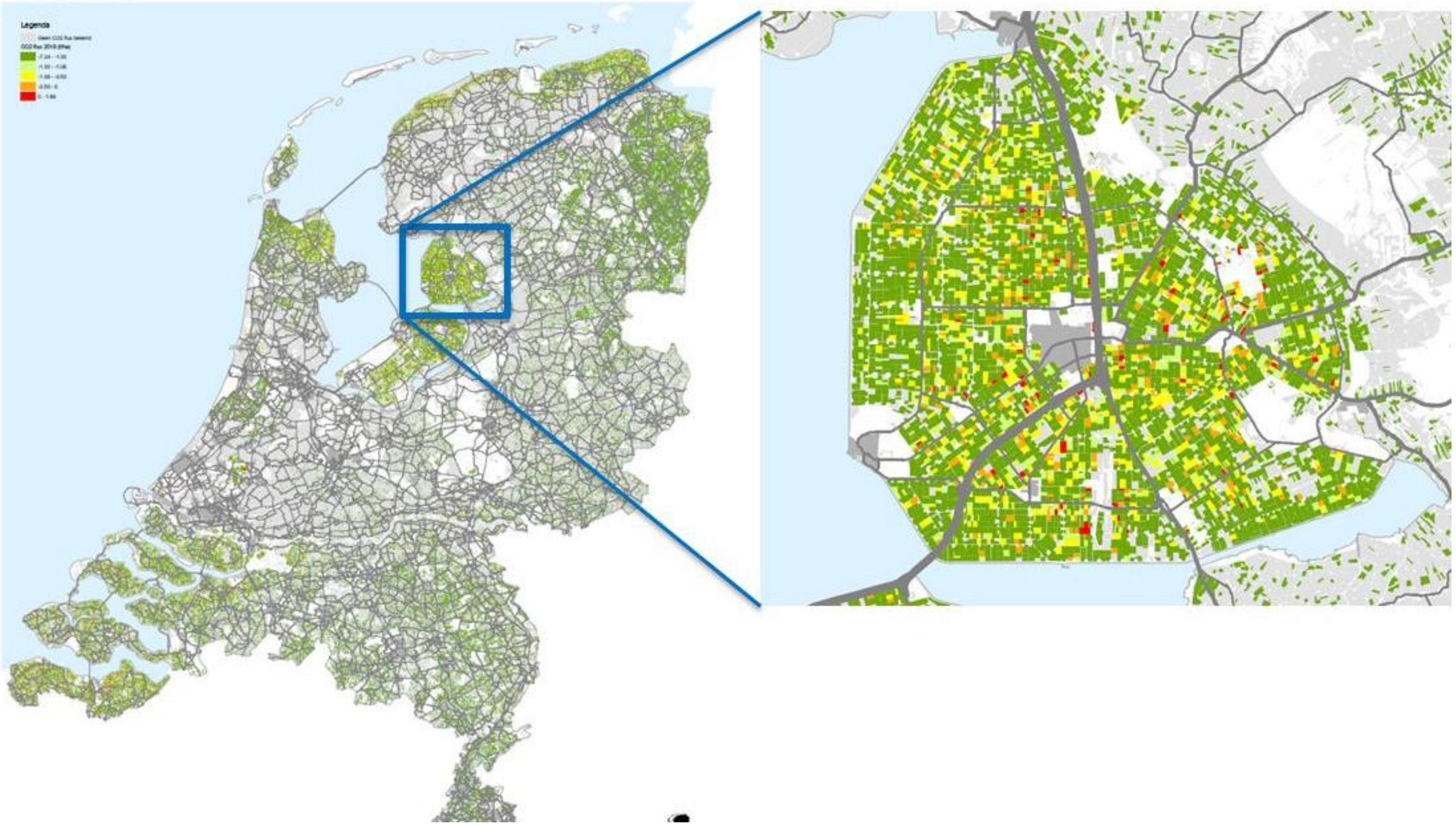
Exemple of MRV prototype

The AgriCarbon-EO processing chain (H2020 NIVA project) ➔ 10m resolution annual biomass, CO_2 flux & C budget estimates at regional/national scale for cropland with the support of CNES (French Space Agency).



Mapping cropland plots CO_2 fluxes (Tier 1)

Map of the net annual CO_2 fluxes for cropland in 2018 over the Netherlands based on an estimate of the duration of the soil coverage by vegetation with remote sensing data (Sentinel 2).

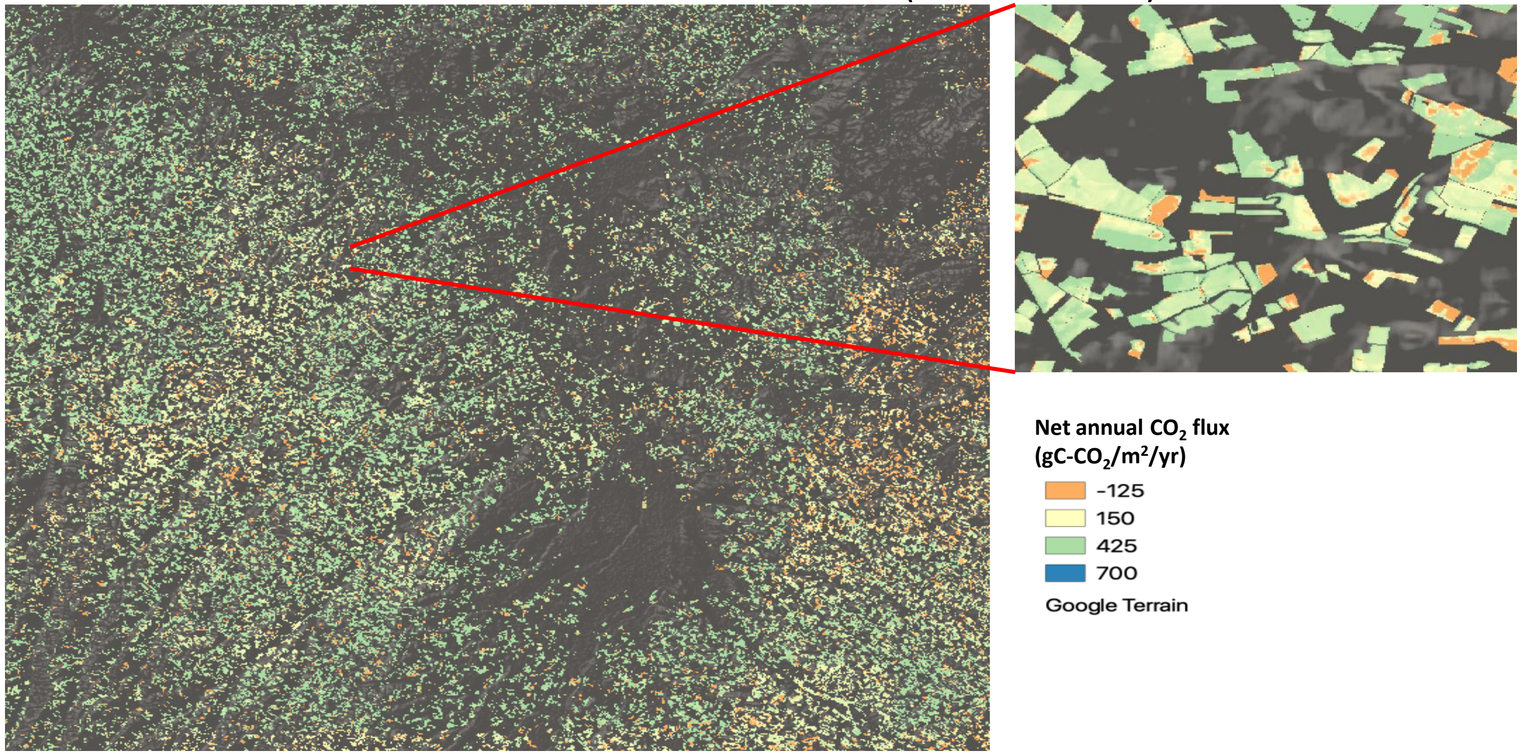


Net annual CO_2 fixation 🙂
Net annual CO_2 losses 🙁

In collab with Ministerie van Economische Zaken en Klimaat
IGN and ASP for the NIVA project

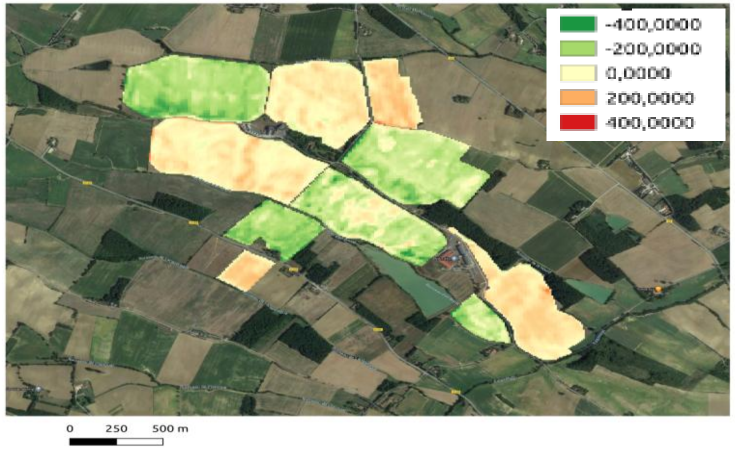
Mapping cropland components of the C budget (Tier 3)

10 m resolution map of the net annual CO_2 fluxes for straw cereals in 2017 in South West France over an entire Sentinel 2 Tile (100 x 100 km)



Cover crop biomass ➔ C storage

High resolution C budget map for cover crop/maize/wheat crop rotations at the Bézéril farm (gC/m^2/yr)



- ➢ Method compliant with Verra's Certified Carbon Standard VCM0042,
- ➢ Only parametrised for a few crops species so far, not fully operational yet.

Many challenges to overcome

- The MRV approach/tool should be flexible (possibility to adapt to the context of application) and modular (possibility to change the bricks) ➔ increases the acceptability & accuracy,

- Access to farmer's activity at large scale (needed to calculate SOC stock changes) is a challenge in many contexts ➔ need 1) for coordinated actions relative to farmer's data access, standardisation, consent management…(e.g. AgDatahub) and 2) still produce indicators related to the C budget (TIER 1) that can be implemented easily, at low cost, everywhere (current actions in H2020 NIVA and with Planet A),

- Huge volume of data to handle (e.g. remote sensing) & need for intensive computing ➔ dedicate infrastructure, need for sophisticated algorithms for EO data assimilation in the models…,

- Guaranty the security, traceability & transparency of the approach,

- Need to involve a large panel of potential users & stackeholders to define ➔ ensure the largest possible accession.

Conclusion

- Large consensus about the need for a coordinated action about MRV for soil carbon ➔ the IRC Soil Carbon should start in 2023,
- A shared vision of which bricks should constitute the MRV methodological framework and several already exist/are operational,
- Need to assemble them and to propose a modular/flexible approach/set of tools adapted to different context of applications, meeting the demand of various potential users/stakeholders (e.g. NGOs, companies involved in the C market)
- But many technological challenges yet to overcome ➔ need for a major technological breakthrough supported by an international action involving research agencies, space agencies, private foundations and companies as well as a large panel of scientists.

Thanks for your attention

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