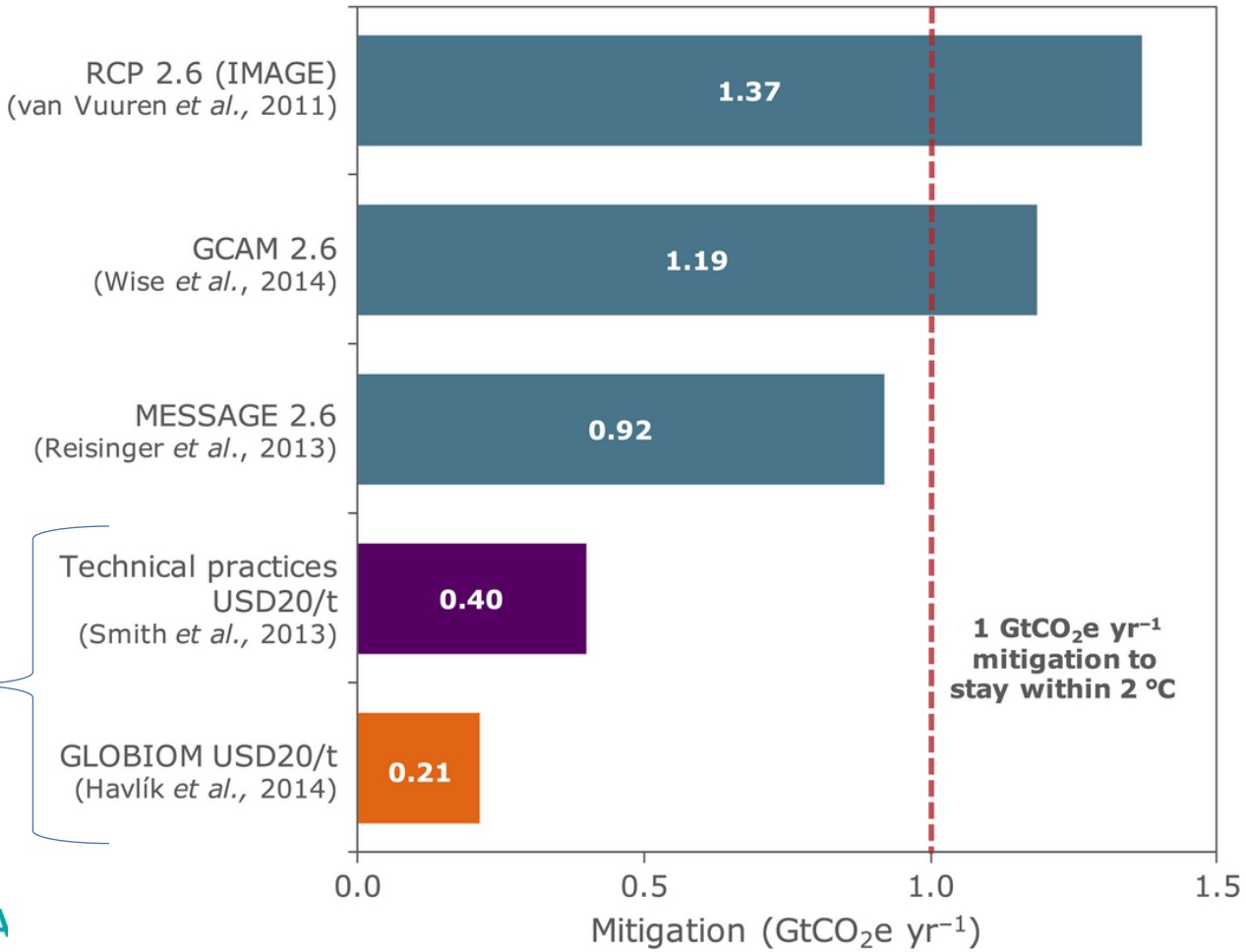
The potential for carbon sequestration in the soil and by re-afforestation of land

Jean-François Soussana, INRAE, France

Without soil carbon sequestration, staying within 2°C cannot be achieved by the agriculture sector by 2030



N_2O and CH_4 mitigation

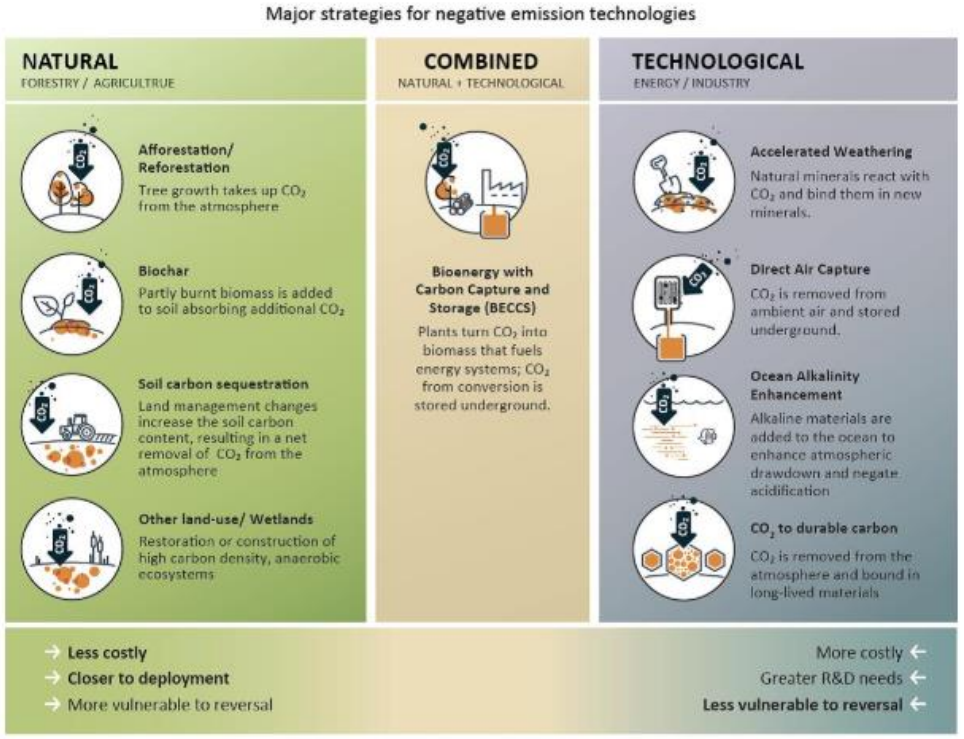
Only 21 to 40 % of the target

[Wollenberg et al., 2016, GCB]

Soil carbon sequestration: a major option for climate mitigation

- **2-3** times more carbon in soil organic matter than in atmospheric CO_2 *[IPCC, 2013]*

- **1.4** Gt C could be stored annually in agricultural soils, equivalent to an annual storage rate of 0.4 % (rationale for the 4 per 1000 initiative) in top soil *[after IPCC, 2007, 2014]*



[Emission gap report UNEP, 2017]

- **90 %** of this potential could be reached for US$100/t$CO_2$, a price compatible with the 2°C global warming target *[Smith et al., 2007,2014, Frank et al., 2017]*

- **Cost effective** *[UNEP, 2017]*

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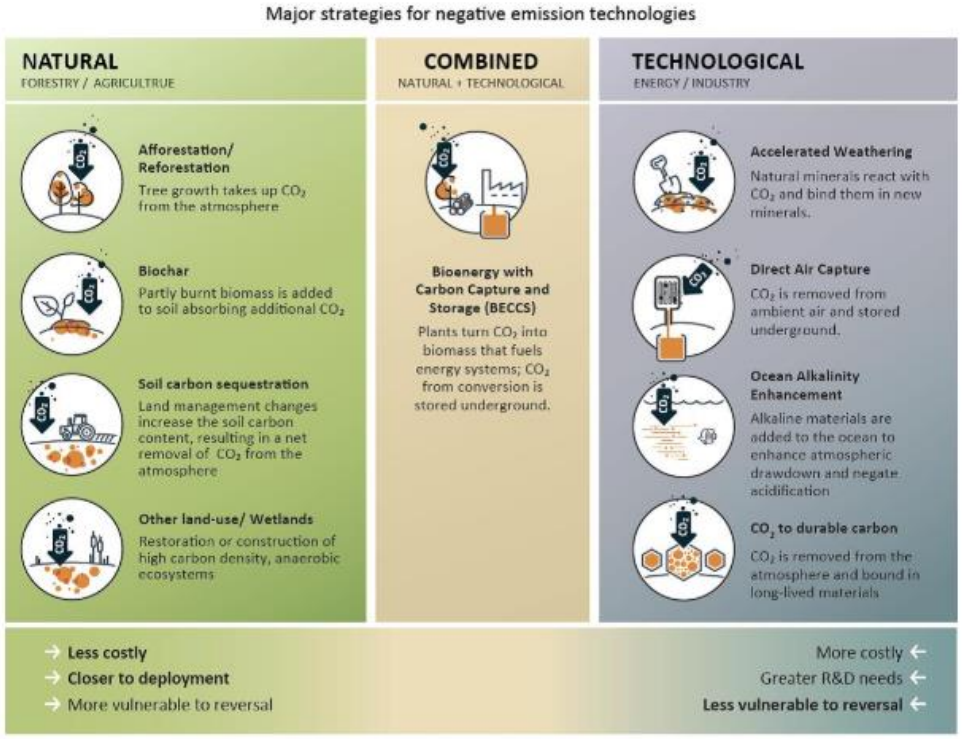

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The « 4 per 1000 » initiative

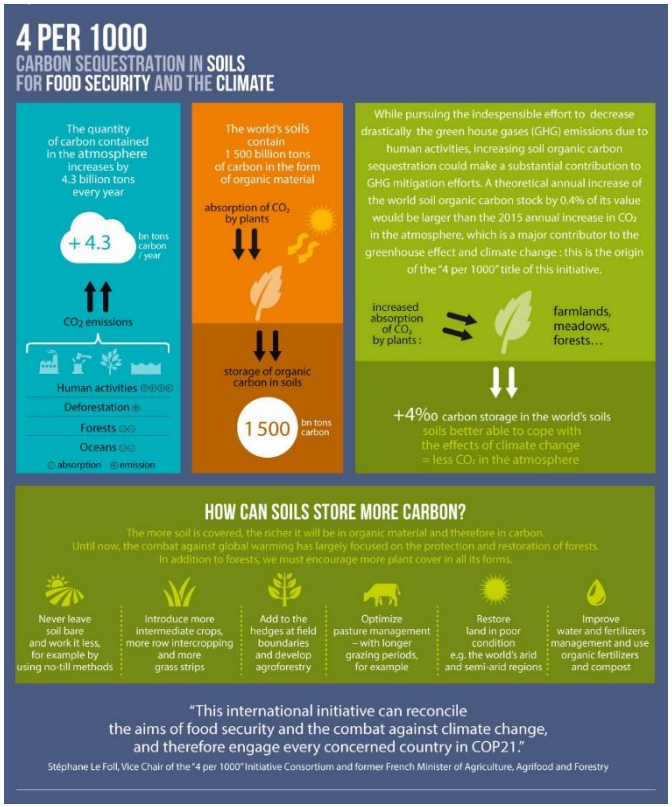
- Improving soil carbon is now high on the political agenda.
- In 2015 at the Paris climate summit, France launched the 4p1000 initiative— to promote research and actions globally to increase soil carbon stocks by 4 parts per 1,000 per year.

Increase SOC sequestration in soils,

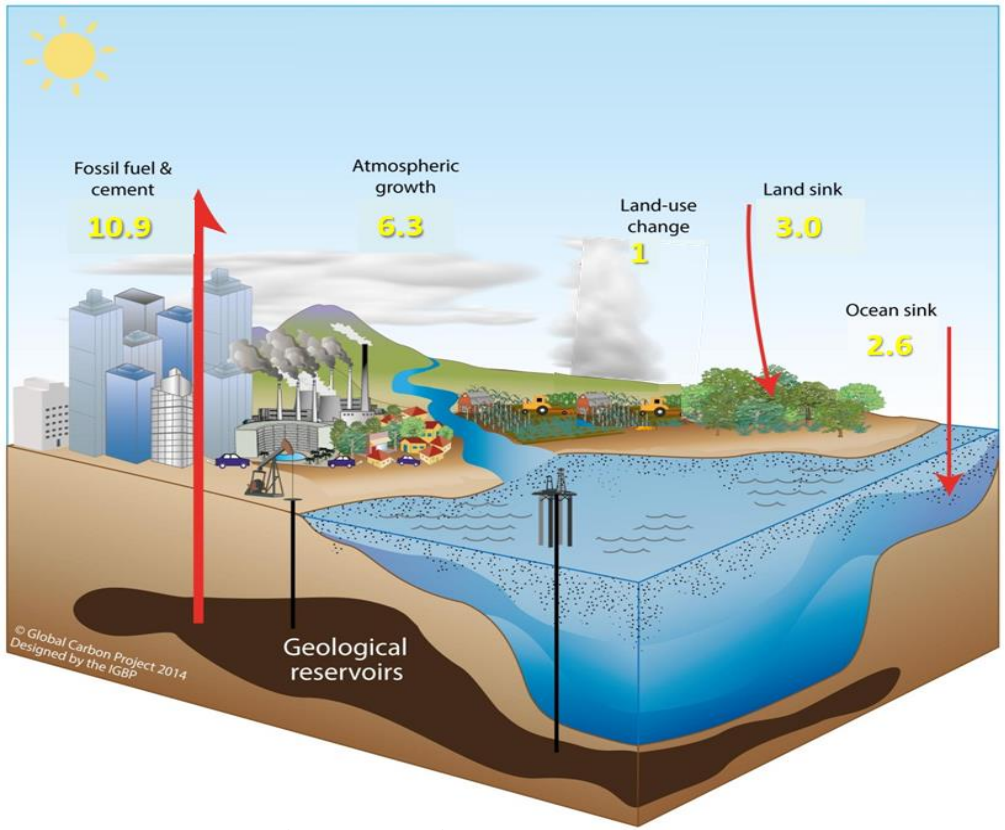
with a view to:

- improving food security
- adapting agriculture to climate change
- mitigating climate change (1.5° C/ 2° C target)

Contributing to the Paris Agreement (UNFCCC), the Agenda 2030 (Sustainable Development Goals) and the land degradation neutrality principle (UNCCD)



How could « 4 per 1000 » strengthen the Paris agreement?



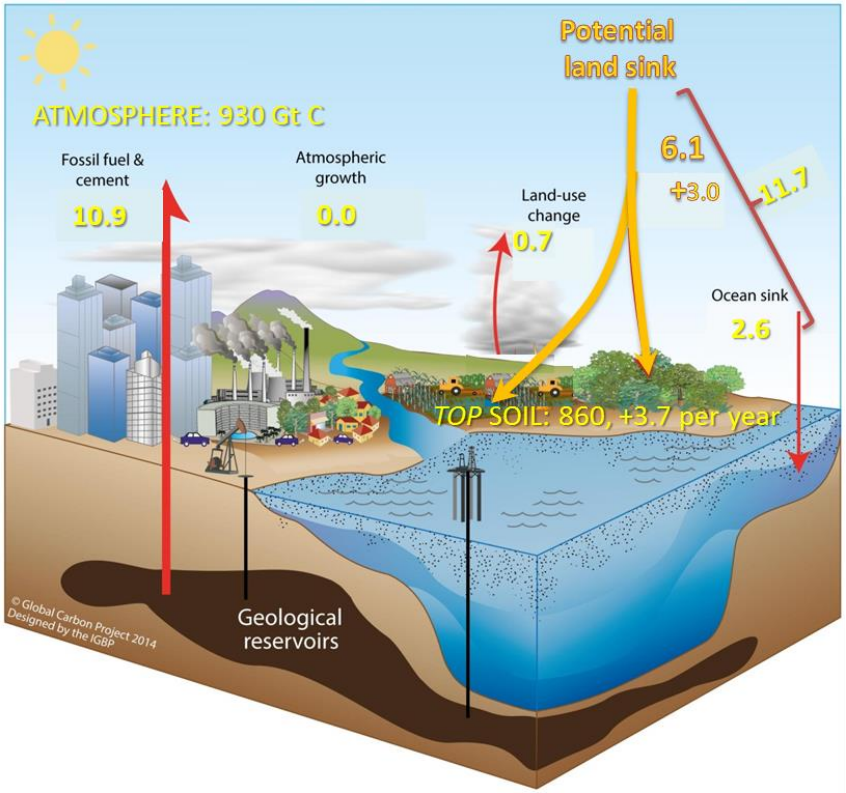
Gt C (billion metric tons of carbon)

[Soussana et al., 2017, STILL]

The global carbon cycle in the 2030 based on Paris Agreement (COP21) pledges

(***assuming no changes in carbon sinks***)

Strengthening the Paris agreement by setting an aspirational target of full implementation of soil organic carbon sequestration potential



Gt C (billion metric tons of carbon)

[Soussana et al., 2019, STILL]

In 2030-2050, stabilizing atmospheric CO_2 by a **large** soil organic carbon sequestration rate calculated over **top** soil (0-40 cm) and accounting for the role of **forest management on total land C sink (soil + above-ground)**

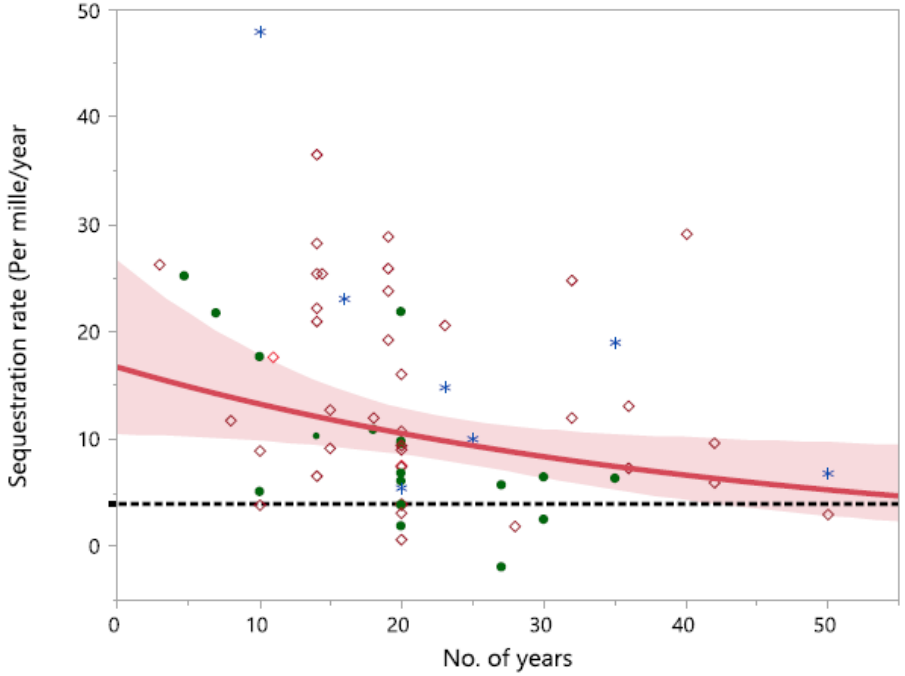
The 4 per 1000 target of 3.7 GtC/ yr is the sum of:

- Agricultural soils (1.8 Gt C/yr)
- Desertified/salinized soils (0.9 GtC/yr)
- Forest soils & agroforestry (1.1 GtC/yr)

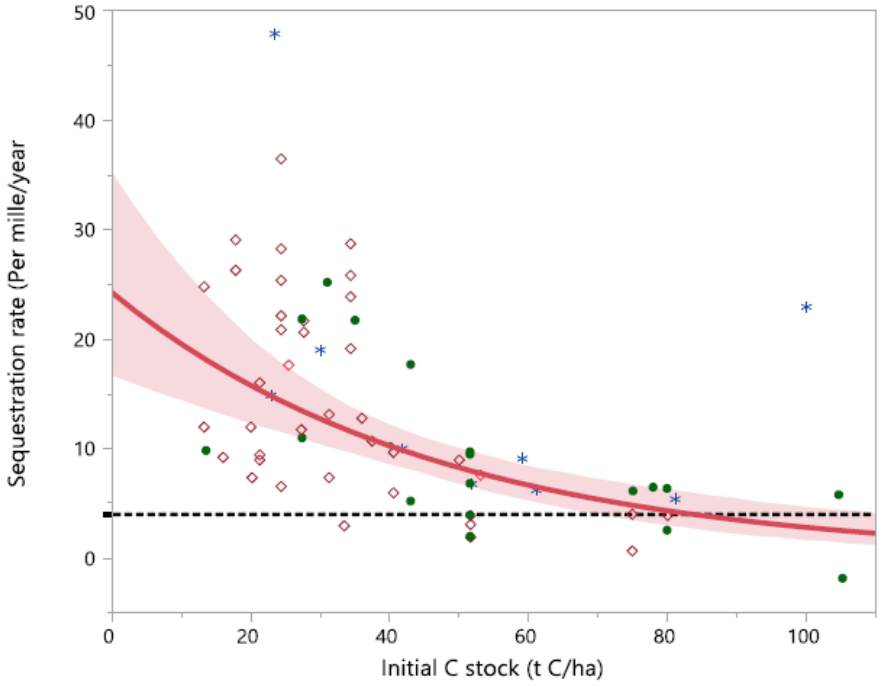
Forest management combines regrowth of secondary forests, plantations and agroforestry (extending Bonn declaration) and brings an above-ground sink of 2.4 GtC/yr

A 4 per 1000 SOC sequestration rate has often been exceeded in long-term arable field trials

(over up to 50 yrs)



..but the rate declines with initial SOC stock



[Minasny et al., 2016, Geoderma]

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Simulating the annual soil organic carbon storage potential in France

30 million tons of CO_2 equivalent per year for agricultural land over 0-30 cm: 0.33% per year, close to the 4 per 1000 target,

Most potential over arable crops (0.5% per year) with 3 practices: cover crops, grass leys, increased organic fertilization

Potential is higher where initial soil organic carbon stocks are low. Overall, it is little affected by climate change over 2020-2060.

No net effect on N_2O emissions

A cost mostly compatible with the shadow price of carbon (less than € 55 per ton of CO_2 in 2020)

(Pellerin, Bamière et al., 2019, 2020. INRAE)

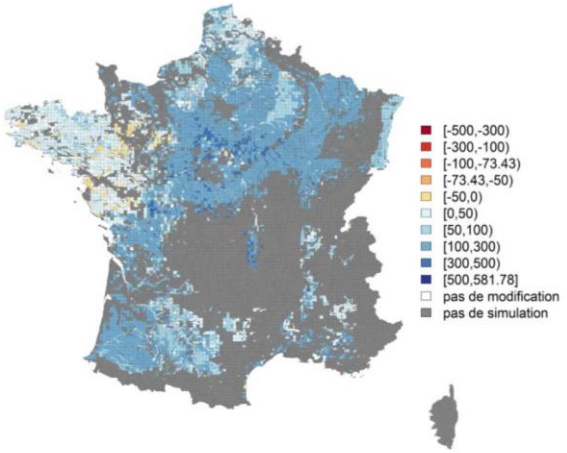

Figure 7. Stockage additionnel absolu (kgC/ha/an) sur 0-30 cm avec le scénario "Insertion et allongement des cultures intermédiaires"

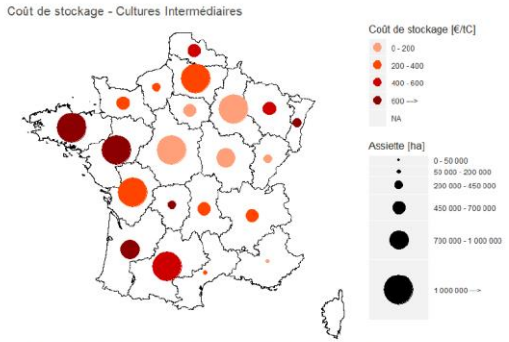

Figure 8. Coût de la tonne de C stockée (€/tC) et Assiette maximale technique (ha) de la pratique, par région

Soil carbon sequestration: Limits

- Adoption of SOC sequestration measures will take time
- SOC will increase only **over a finite period (30-50 yrs locally),** up to the point when a new SOC equilibrium is approached
- The **additional SOC stock will need to be monitored** and preserved by adapting land management practices to climate change
- Soil phosphorus (P) and nitrogen (N) should be available (root symbioses could help) as well as organic carbon recycling, while **avoiding increased N_2O emissions**
- Soil and **water management** need to be combined, especially in dry regions
- Improved agricultural practices need to be **maintained over decades**

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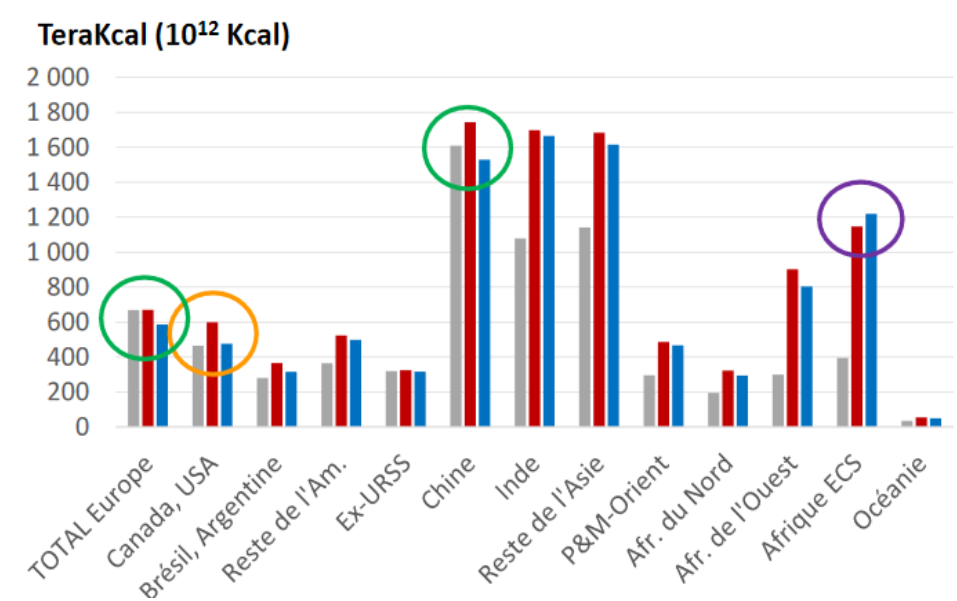
World food demand (calories) by 2050

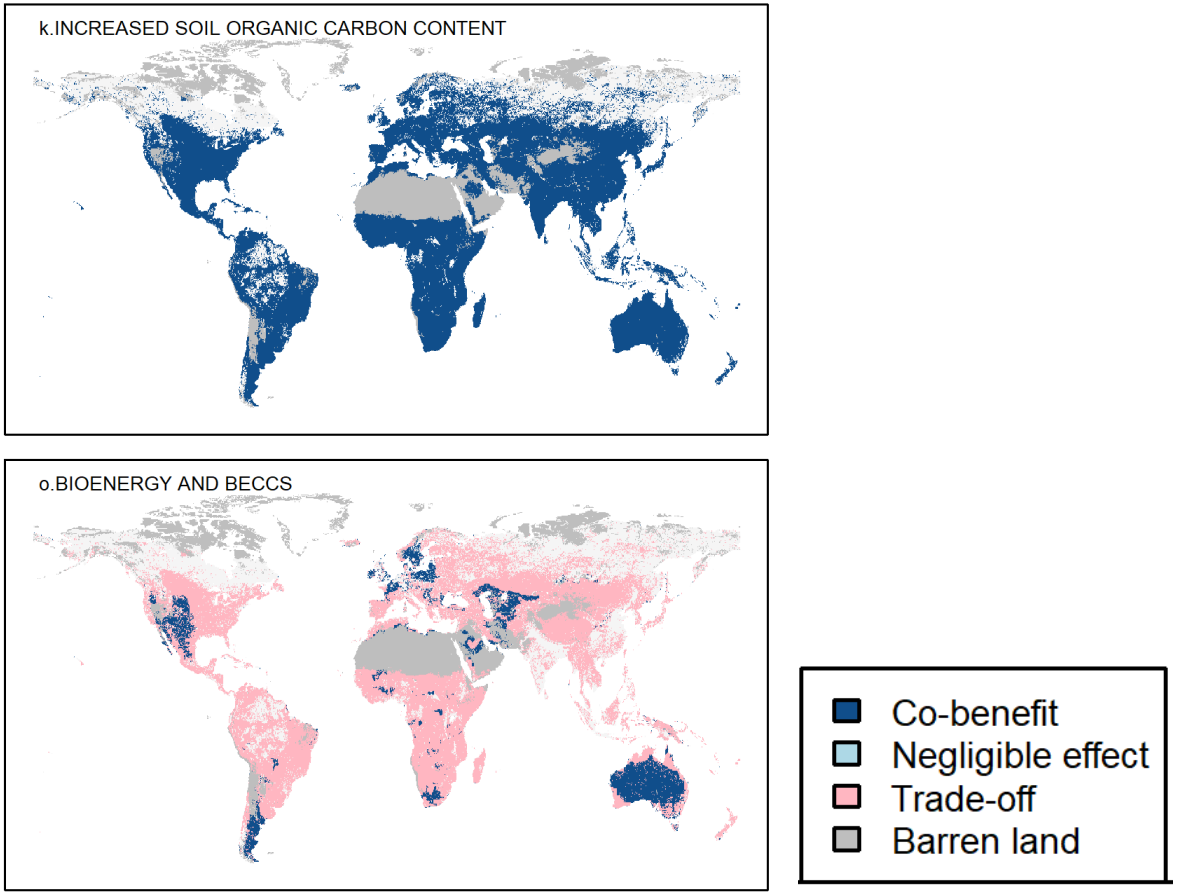
Compared to 1990, according to global simulations (INRAE, 2020):

- +47% with current trends in diets (westernization)
- +38% if healthy diets are adopted

Further reduced to +30% by limiting wastes and losses



Contrasted options for sustainable land management: co-benefits and trade-offs across challenges



Large-scale deployment of mitigation options such as bioenergy and afforestation would have negative impacts on food security, biodiversity and land degradation: - From 0.1 to 1 million km^2 in scenarios with a large population and reduced environmental policies (SSP3) - From 1 to 4 million km^2 in scenarios of low population and strong environmental policies (SSP1)

IPCC Special Report Climate Change and Land, 2019

This project has received funding from **the European Union's Horizon 2020** research and innovation programme under grant agreement No **774378**

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Coordination of International Research Cooperation on soil CArbon Sequestration in Agriculture

Towards an International Research Consortium on Soil Carbon

www.circasa-project.eu

Open Collaborative Platform: https://www.ocp.circasa-project.eul

@CIRCASAproject

SRA supporting the alignment of research into an International Research Consortium

Research Priorities

Pillar 1 – Frontiers research: unlocking the potential of soil carbon

=> International research calls

Pillar 2 – Soil carbon stock change MRV: international standard

=> International innovation projects

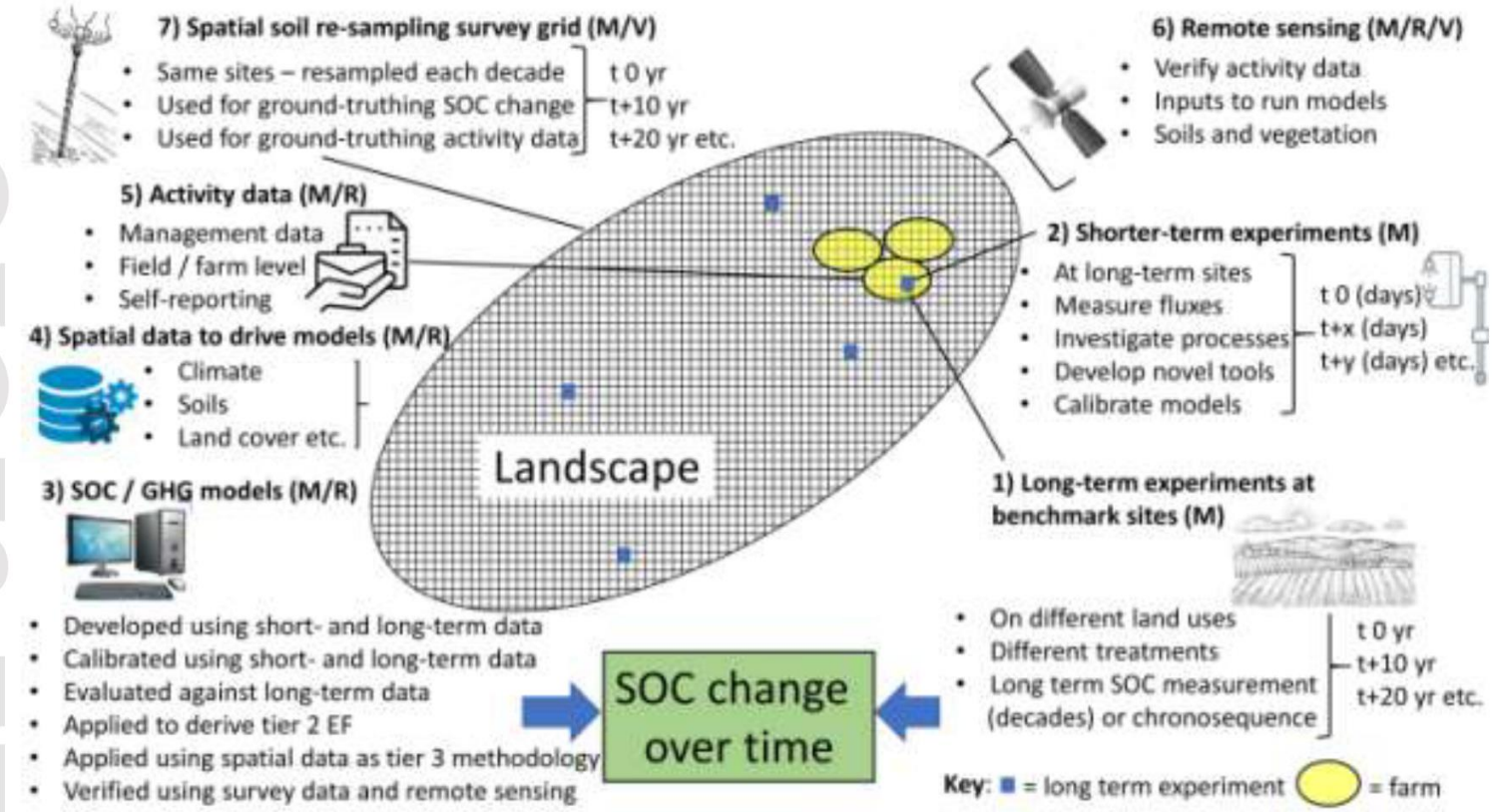
Pillar 3 – Agro-ecological and technological innovations

=> Private-Public innovation projects

Pillar 4 – Enabling environment and knowledge co-creation

=> Open online collaborative platforms

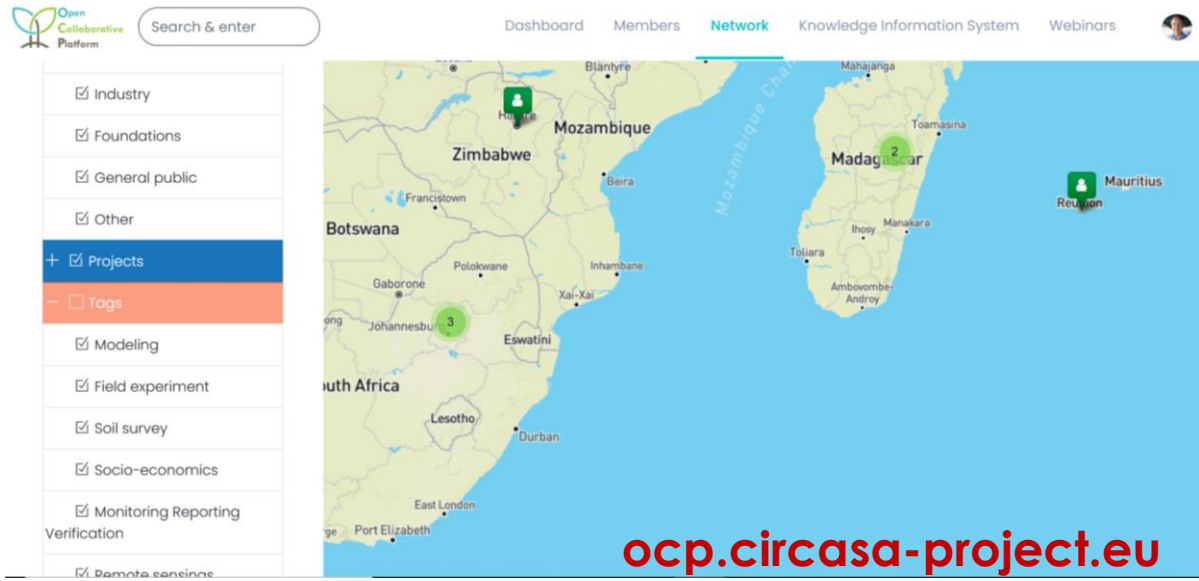
Combining data for international scale monitoring of soil carbon

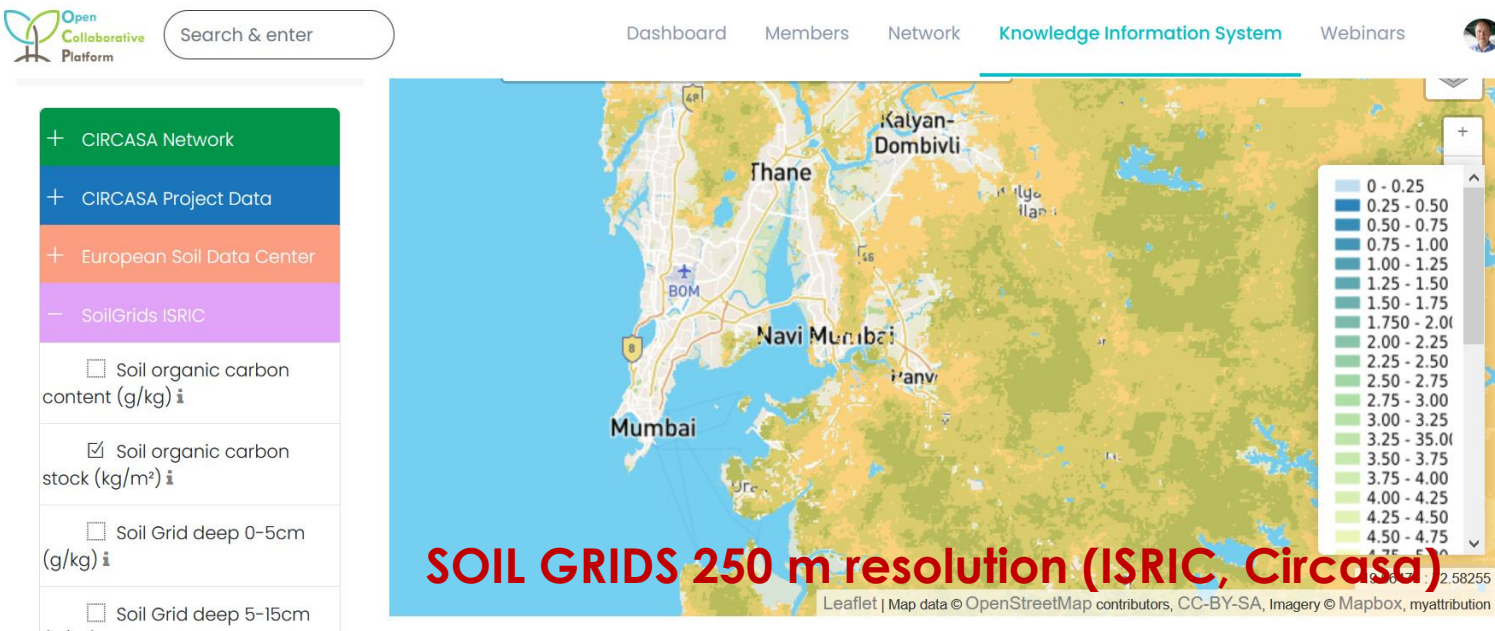


(Smith, Soussana et al., Global Change Biology, 2019)

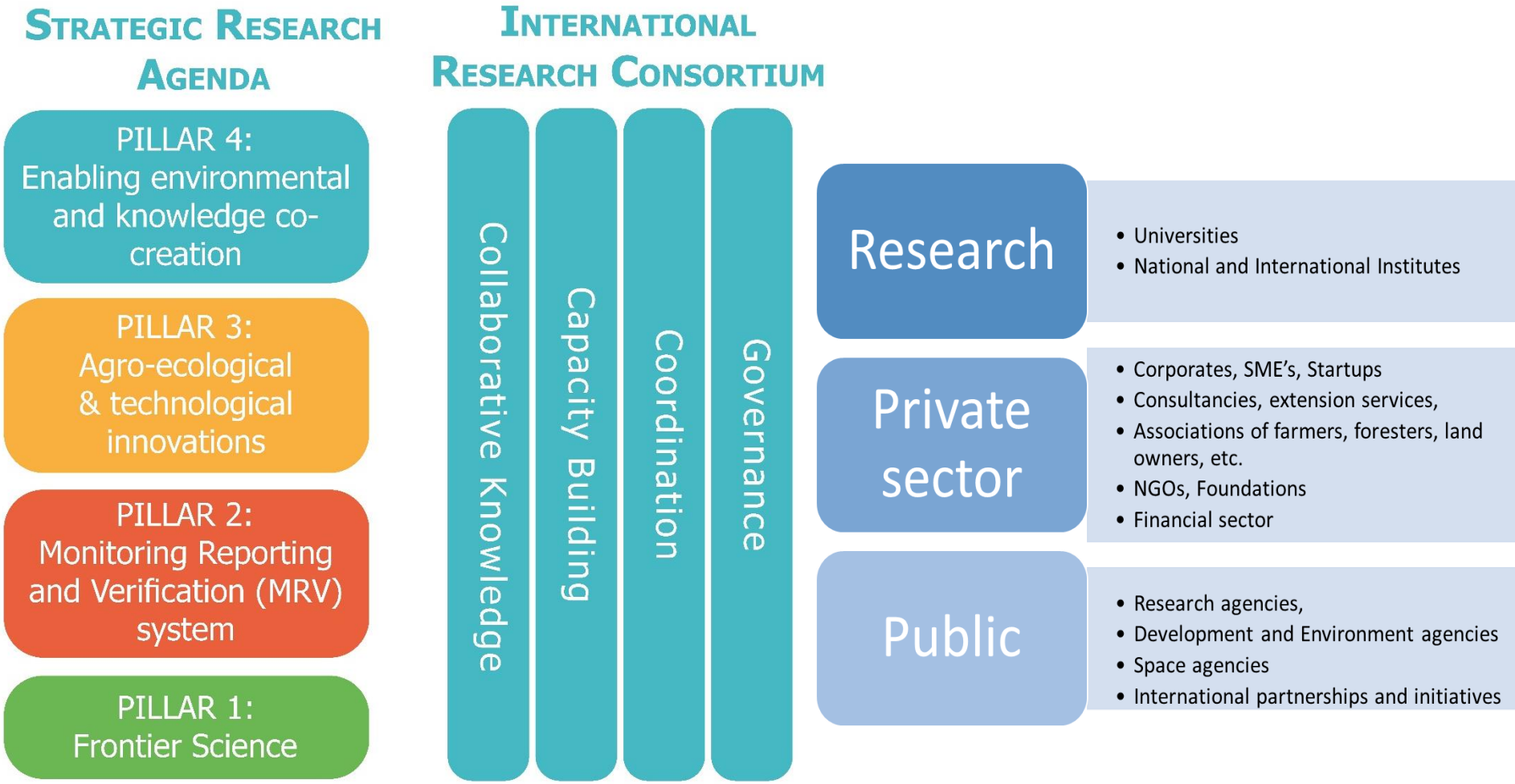
CIRCASA Open Collaborative Platform services: matchmaking, knowledge sharing, information system (data and maps)

An open data repository (Data Verse) with geospatial and modelling data

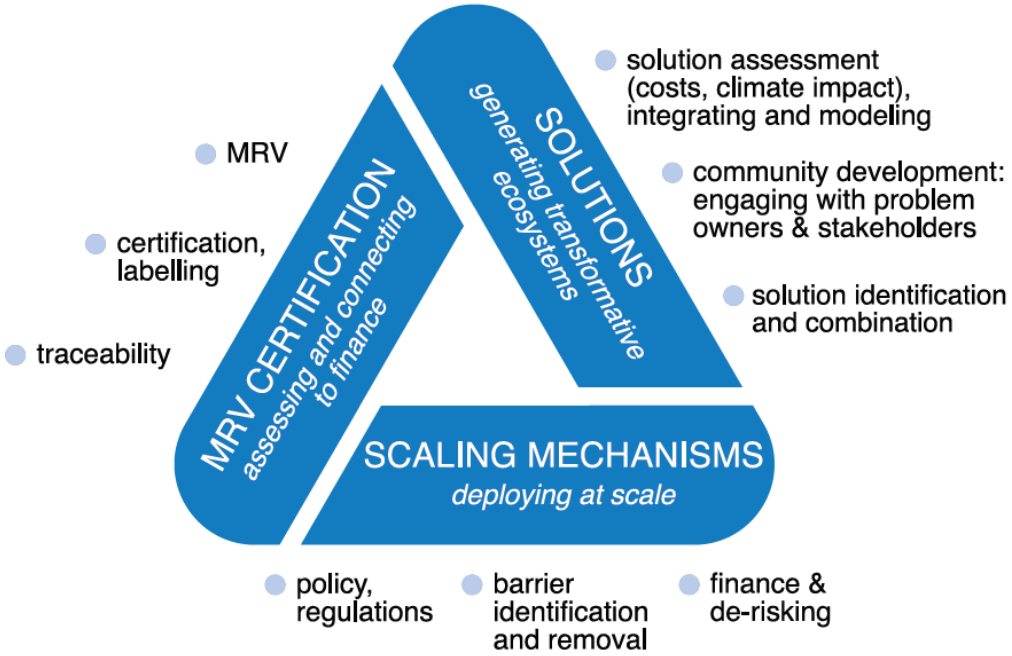




VISION OF THE INTERNATIONAL RESEARCH CONSORTIUM



The soil Carbon Farming project



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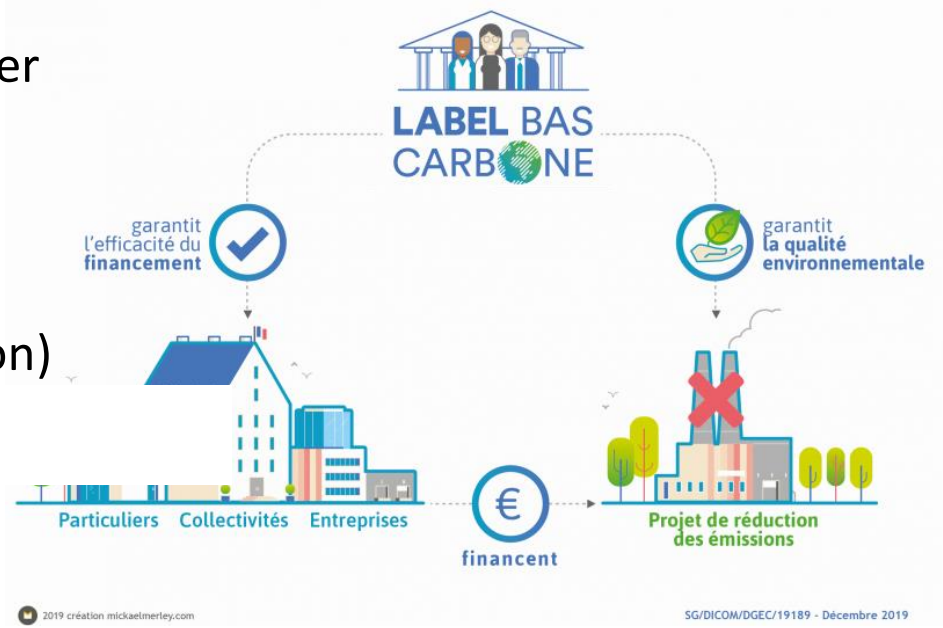
Partners :

The French low carbon label : an opportunity for carbon credits

- Created and entered in force in November 2018
- Local GHG emission reduction projects (avoided emissions+ carbon sequestration)
- Certified credits by the Ministry of Ecological Transition



Thank you for your attention

jean-francois.soussana@inrae.fr