Position paper

October 2022

Carbon sinks

What role should research play in accelerating their development in France?

In order to remove CO_2 from the atmosphere, carbon sinks are a solution that is currently being considered as a unavoidable. Increasing but also preserving carbon sinks and, in some cases, restoring them, are priority issues. Based on a study by a group of experts from the ANCRE alliance, six major categories of carbon sinks have been identified for the French context: three categories of natural CO_2 capture solutions in more or less anthropised environments, and three categories of solutions integrating technological developments. The state of play, challenges, barriers and research recommendations for each of the solutions were highlighted in 7 worksheets.

- **Worksheet 1.**
  Carbon storage in biomass and agricultural and forest soils
- **Worksheet 2.**
  Carbon storage in biomass and soils in urban and anthropised environments
- **Worksheet 3.**
  Carbon storage in aquatic environments and from rock weathering
- **Worksheet 4.**
  Technological solutions for capturing atmospheric CO_2 for geological storage
- **Worksheet 5.**
  Storage of CO_2 in materials via mineralisation
- **Worksheet 5bis.**
  Biogenic CO_2 capture and storage in bio-based materials
- **Worksheet 6.**
  Technological solutions for recycled carbon capture, utilisation, and long-term storage

The full report and each of worksheets are available on:
https://www.allianceenergie.fr/etudes-et-rapports/

ANCRE
Alliance Nationale de Coordination de la Recherche pour l'Énergie

Carbon storage in biomass and agricultural and forest soils

State of play

The natural mechanism of photosynthesis allows the sequestration of atmospheric CO_2 in the form of organic matter, in almost equal parts, between agricultural and forest biomass and soils. French terrestrial ecosystems already constitute a very significant carbon sink that EFESE estimates in Metropolitan France at nearly 20% of 2015 French emissions, i.e. approximately 90 Mt CO_2 eq/year [EFESE, 2019]. The vast majority of these sinks are in forest environments (more than 60 Mt in 2018 in mainland France according to ADEME, 2021). In the French Overseas Territories and in Guyana in particular, it is considered that these forests have reached their maximum carbon storage capacity and therefore their sink seems to have stopped (according to ADEME Guyane, 2016).

With regard to metropolitan soils in particular, the study conducted by INRAE in 2019 indicates that forest soils account for 38% of the total carbon stock, permanent grasslands 22% and field crops 26.5%. It is the latter which have the highest additional storage potential in the litter because of their current low carbon content and the size of their surfaces. On the already hand, for forest soils and permanent grasslands, which have a high carbon content, the challenge is to maintain their stock and preserve their surface area. The report highlights concrete actions to maintain and develop carbon storage in soils and the type of practices to achieve this, assuming no change in land use. The practices are potentially diverse (agroforestry, intermediate crops, hedges, extension of temporary grasslands, return of co-products to the soil, etc.) and they are accompanied by co-benefits in terms of water quality and biodiversity. However, all these practices must be considered in a given geographical and temporal context (soil conditions, stocks of origin, costs in line with existing crop rotation and existing opportunities). Through this study, a maximum additional storage potential of 30 Mt of CO_2 eq/year has been estimated for agriculture. However, there are many major risks to these carbon sinks due to, among other things, the reduction in forest area as a result of fires, pest attacks, drought and reductions in area through changes in land use. More work is therefore needed to improve understanding of the long-term effects of these practices and the effects of climate change on storage and sequestration.

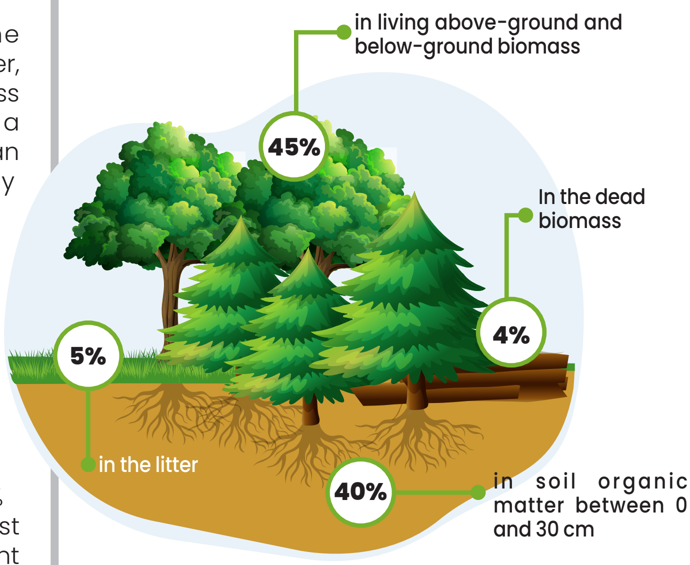


Figure 1 - Carbon storage in the forest
(ADEME, 2021)

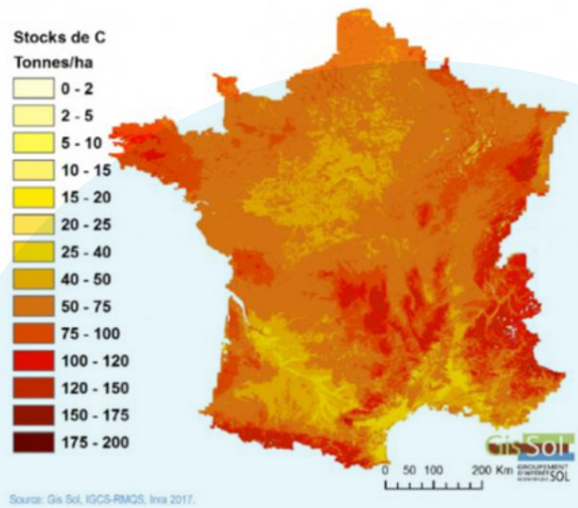
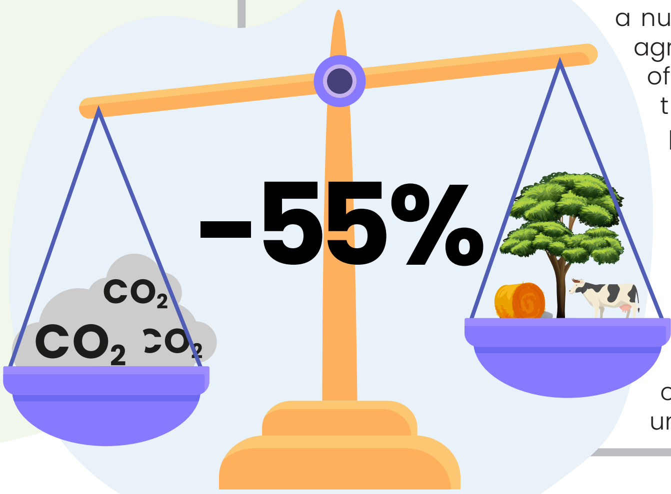


Figure 2 - Mapping carbon stocks in metropolitan soils (INRAE, 2019)

Challenges

At EU level, among the measures to accompany the latest proposed target of at least a 55% reduction in GHG emissions by 2030 are actions to preserve and expand the capacity of natural carbon sinks in each Member State, with binding targets from 2026. By 2035, the Union should strive to achieve climate neutrality in land use, forestry and agriculture [...] (Green Pact for Europe of 14 July 2021).

In addition, in its National Low Carbon Strategy (SNBC, 2020), France attributes an important role to natural carbon sinks for achieving carbon neutrality in 2050, which should be doubled to reach approximately 65 Mt CO eq2 /year in 2050, of which a growing share is in long-lived wood products (20 Mt, see sheet 5bis) as well as in agricultural areas (11 Mt). This scenario is accompanied by a number of measures such as increasing carbon storage in agricultural soils through changes in practices; the development of active and sustainable forest management, allowing both the adaptation of the forest to climate change and the preservation of carbone stocks in the forest ecosystem; the development of afforestation adapted to climate change and the reduction of land clearing.



France must therefore now acquire the means to consolidate existing data and knowledge in order to specify the real potential of these carbon sinks and to improve the monitoring of land use and the understanding of carbon dynamics within ecosystems. It also appears necessary to construct quantified scenarios of the evolution of these sinks under the impact of climate change. Locks

Barriers

LACK OF DATA
on the current evolution of carbon stocks and fluxes in ecosystems and the interactions between carbon, nitrogen and water,

LACK OF PROJECTION
on the dynamics of these developments under the impact of climate change,

LITTLE BACKGROUND
on the effects of changes in agricultural practices on long-term carbon storage,

LACK OF SCENARIOS
on projections under the impact of climate change,

NEED FOR TRACEABILITY
competition between agricultural and forestry land uses and artificial development (land reclamation vs.urbanisation),

LACK OF STUDIES AND INDICATORS
on assessing the environmental impacts of biomass harvesting,

LACK OF KNOWLEDGE
and regulations on the agronomic use of bioenergy co-products (digestates, biochar, etc.),

COMPARTMENTALISATION OF SECTORS
agri-food and energy, lack of systemic vision,

LACK OF PUBLIC POLICY
in the long term and lack of coherence between agricultural, food and energy policies,

Actions

Research recommendations

Behaviour of media and products:

- **Propose technological solutions** for in-situ biogeochemical analyse (biosensors, miniaturised geochemical and geophysical sensors, smart samplers).
- **Maintain databases** and samples of French soils, including the diversity of the macrofauna and microflora of the soil.
- **Build databases** on material transfer processes and establish behaviour laws to assess the consequences of these transfers (quantify the closing of C, N, P cycles).
- **Analyse the sensitivity** of ecosystems to the export of small wood and the return of ash to the soil (Sensitivity indicators for major mineral elements and overall combination - Field diagnostics).
- **Develop multi-criteria approaches** to the duality of biomass removal addressed on all elements: physical, chemical and biological, develop multiscale predictive models of the evolution of sustainability indicators.
- **Understanding the relation between the structure** of biochars and digestates from methanisation and their properties when returned to the soil.
- **Develop scenarios** for sustainable biomass harvesting at the levels of territories under climate change impact.

Identification of practices

- **In terms of silvicultural** practices, develop biophysical and economic approaches to identify practices for sustainable forest management (conversion of coppice to high forest, reasoning out soil preparation, avoiding clear-cutting with soil degradation, not harvesting the whole tree), and transfer these stocking practices to professionals.
- **Develop strategies for optimising climate** change mitigation in the choice of stand rotation length at the scale of territories, propose new stands with species resistant to biotic and abiotic stresses (rather than considering only one economic criterion).
- **Conducting trials on forest** (and agroforestry) plots to intensify biomass growth and soil carbon storage, carrying out complete balances of the biogeochemical cycle of the plots over a long period of time and then integrating the entire (multiproduct) wood value chain.
- **In terms of agricultural practices:** broaden the species of intermediate crops and refine the practices of insertion in rotations; deepen the trials of spreading digestates and biochars, characterise the carbon that can be stored and feed the soil/ microorganism/plant models.
- **Couple pyrolysis** and methanisation for the agronomic quality of the digestate and favour its return to the soil.

Implementing recommendations

- Need to centralise, record and appraise FAIR data from experiments with new practices and environmental behaviour,
- Deploy or maintain the national infrastructure for long-term monitoring of C, N, P cycles.
- Deploy projects that can benefit from a low-carbon label with generation of carbon sinks in agricultural and forestry environments.
- Identify the full range of ecosystem services from new practices.
- Strengthen public agricultural and forestry policies at national and territorial levels that promote sustainable agricultural and forestry practices to increase carbon storage.
- Identify and reforest degraded land.
- Enable the resilience and adaptation of forest stands to the effects of climate change so as to ensure the preservation of their different ecological functions in order to carry out mitigation action.