Position paper

October 2022

Carbon sinks

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

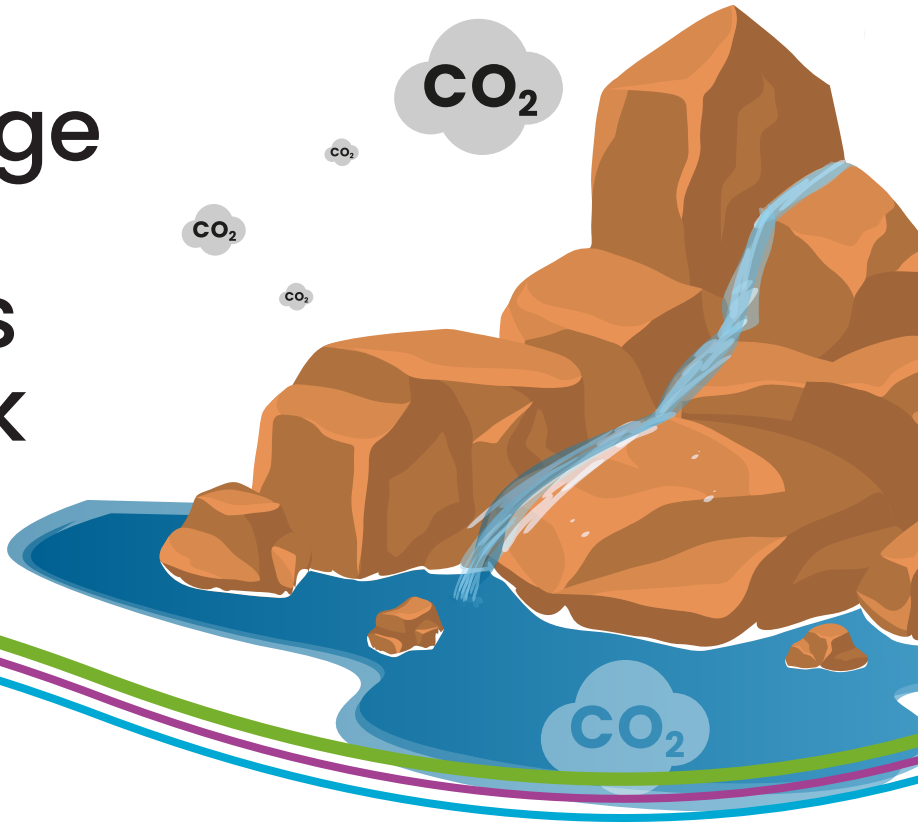
In order to remove CO_2 from the atmosphere, carbon sinks are a solution that is currently being considered as a unavoidable. Increasing but also preserving carbon sinks and, in some cases, restoring them, are priority issues. Based on a study by a group of experts from the ANCRE alliance, six major 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.

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 aquatic environments and from rock weathering



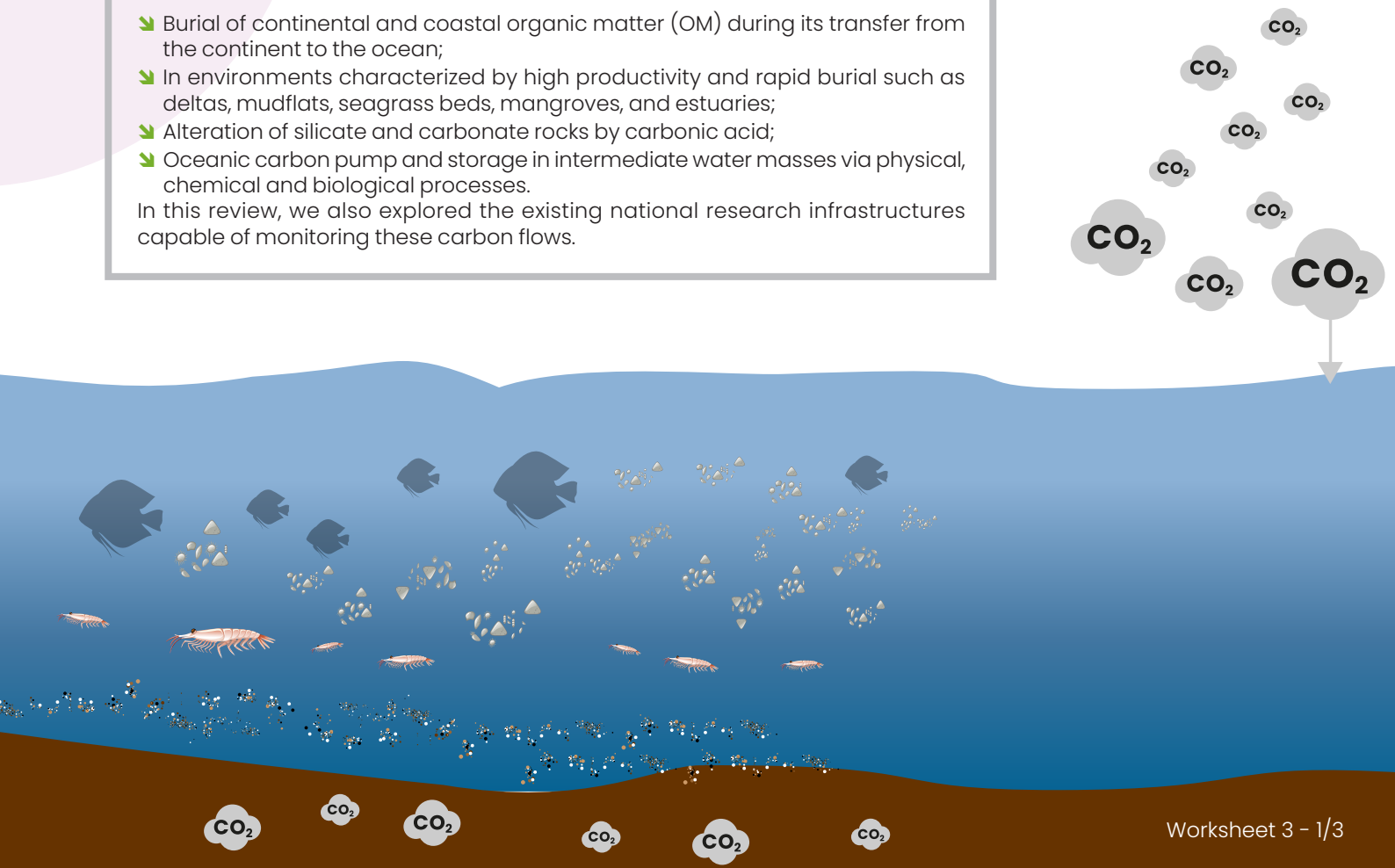
State of play

The carbon cycle, that integrates carbon dioxide (CO_2), refers to carbon fluxes within the different Earth's surficial reservoirs, and the biogeochemical processes, and physical exchanges that control them. It defines the stocks and exchanges over time scales ranging from decades to millions of years.

For metropolitan France and the French overseas territories, we made a inventory of the mechanisms linked to the net transfer of CO_2 from the atmosphere to aquatic environments, consisting of carbon sinks on time scales of more than a hundred years. We also examined the biogeochemical processes responsible for these transfers:

- Burial of continental and coastal organic matter (OM) during its transfer from the continent to the ocean;
- In environments characterized by high productivity and rapid burial such as deltas, mudflats, seagrass beds, mangroves, and estuaries;
- Alteration of silicate and carbonate rocks by carbonic acid;
- Oceanic carbon pump and storage in intermediate water masses via physical, chemical and biological processes.

In this review, we also explored the existing national research infrastructures capable of monitoring these carbon flows.



Challenges

The challenges we have identified are essential to establish the potential for CO_2 sequestration for the entire territory of France:

- Quantify the fluxes of atmospheric CO_2 trapped via the various biogeochemical processes occurring in continental (rocks, rivers and lakes), coastal (marshes, mangroves, deltas, seagrass beds) and oceanic environments;
- Quantify methane emissions from organic carbon storage in continental and coastal environments;
- Determine the sensitivity of sink/source environments to climatic and anthropogenic pressures;
- Deliberate on the definition of ocean storage in the French Exclusive Economic Zone (EEZ) in the context of international policy on CO_2
- Pursue mapping of the different sources and sink areas at the national level with the aim to achieve a sustainable management of the national carbon balance.

Barriers

The fluxes of CO_2 are often poorly constrained and in many cases even unknown. The factors affecting the intensity of these fluxes are even less well known, likewise their dependence on variations in climate and environmental parameters. Consequently, the total balance and future evolution of the CO_2 sequestration potential on the French territory remains elusive. To improve the carbon budget estimate, it is essential to pursue the study of the complexity of natural systems, i.e. the large variety of biogeochemical processes, their interdependence and temporal variability.

Continental and coastal areas:

POORLY CONSTRAINED AND UNDERSTOOD DYNAMICS OF THE ORGANIC MATERIAL:

mechanisms leading to burial and recycling (respiration and methanogenesis);

RESTRICTED KNOWLEDGE OF THE SPATIAL EXTENT OF SOURCE/SINK OF INTEREST

Necessity to map the total national area of rock weathering zones, lakes and retaining dams, coastal blue carbon areas with high storage potential and variability. This would improve the assessment of fluxes and stocks of carbon potentially modified by anthropogenic activities (coastal developments, port activity, dredging/trawling, dewatering for agriculture, aquaculture, etc.) or climate changes.

UNDERSTANDING THE EVOLUTION OF PROCESS DYNAMICS

carbon storage/release in relation to climate and environmental changes (temperature, extreme events, nutrient and carbon transfers, etc.).

The open ocean:

PHYSICO-CHEMICAL MECHANISMS

Well known but poorly quantified for carbon transfer to intermediate waters, with uncertainty on the biological pump and its evolution in response to climate change;

REDUCE UNCERTAINTIES

of the residence times of stored carbon before its release to the atmosphere.

Actions

We have identified the actions we believe important to remove the identified barriers and achieve the aforementioned challenges:

- Strengthen carbon observation systems in continental aquatic environments and coastal domains to take into account the complexity of the investigated systems at different spatial and temporal scales, and thus increase the volume of data available to facilitate the development of forecasting models, and even digital twins. This implies increasing the number of analytical techniques, and standardising and optimising measurement and sampling procedures. A national policy to support and maintain the existing observatories and to create new ones is essential. This also implies a scientific policy for data management: archiving, sharing, dissemination use and valorisation.

- Further investigate the biogeochemical processes related to sinks and sources of CO_2 by reservoirs and determine their time constants. Calculate net carbon balances by considering both CO_2 and CH4. This enhance the existing modeling and simulation tools use to infer the response of carbon sources and sinks undergoing to future anthropogenic and climate changes.

- Pursue research assessing the potential for CO_2 sequestration through actions that aims at protecting, preserving and restoring key carbon sink ecosystems.

- Launch discussions on how to consider ocean storage within the French EEZ in the international political context of greenhouse gas emissions, keeping in mind that storage is not permanent and moves from one EEZ to another.