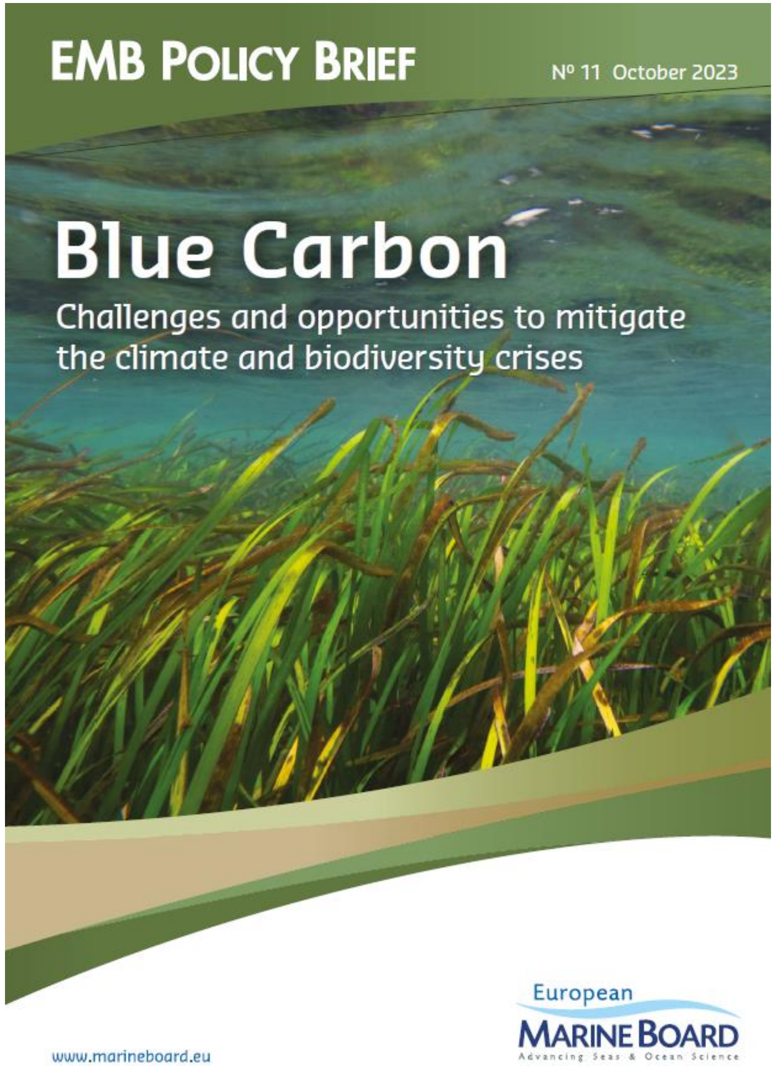
EMB Policy Brief N°11: Blue Carbon



Blue Carbon

Challenges and opportunities to mitigate the climate and biodiversity crises

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What does the document cover?

1. What is Blue Carbon?
2. The benefits of Blue Carbon ecosystems
3. The role of the Ocean in the carbon cycle
4. Examples and benefits of Blue Carbon ecosystems in Europe
5. Uncertainties and questions on Blue Carbon ecosystem conservation and restoration as a climate change solution
6. Summary and Recommendations

The document provides a high-level overview of Blue Carbon and is written to be understandable by a wide audience

What is Blue Carbon?

- **Traditional definition**: Mangroves, tidal marshes and seagrasses (coastal vegetated ecosystems with rooted vegetation)
- **Expanded definition:** also coastal, shelf and offshore marine sediments, where carbon is buried and stored
- **Other components of the biological carbon cycle:**
  - The deep Ocean, whales, fish stocks
  - Kelp and macroalgae (absorb CO_2 but do not bury it)
  - Calcifying organisms (e.g. maerl and shellfish) – can trap and store carbon in sediments, but emit CO_2 as they calcify

In this policy brief:

Coastal vegetated ecosystems with rooted vegetation & marine coastal, continental shelf and offshore sediments

The most important issue is the long-term storage of carbon

Mangrove forest in Guadeloupe, France

The benefits of Blue Carbon ecosystems

Protection and restoration of Blue Carbon ecosystems as a Nature-based Solution

- Climate change mitigation (in the long-term)
- Co-benefits include marine biodiversity (habitat / food provision)
- Stabilises livelihoods, protect coasts (e.g. storms and floods) and support other societal needs such as food security from the Ocean

Saltmarshes in an estuary in UK

Limitations

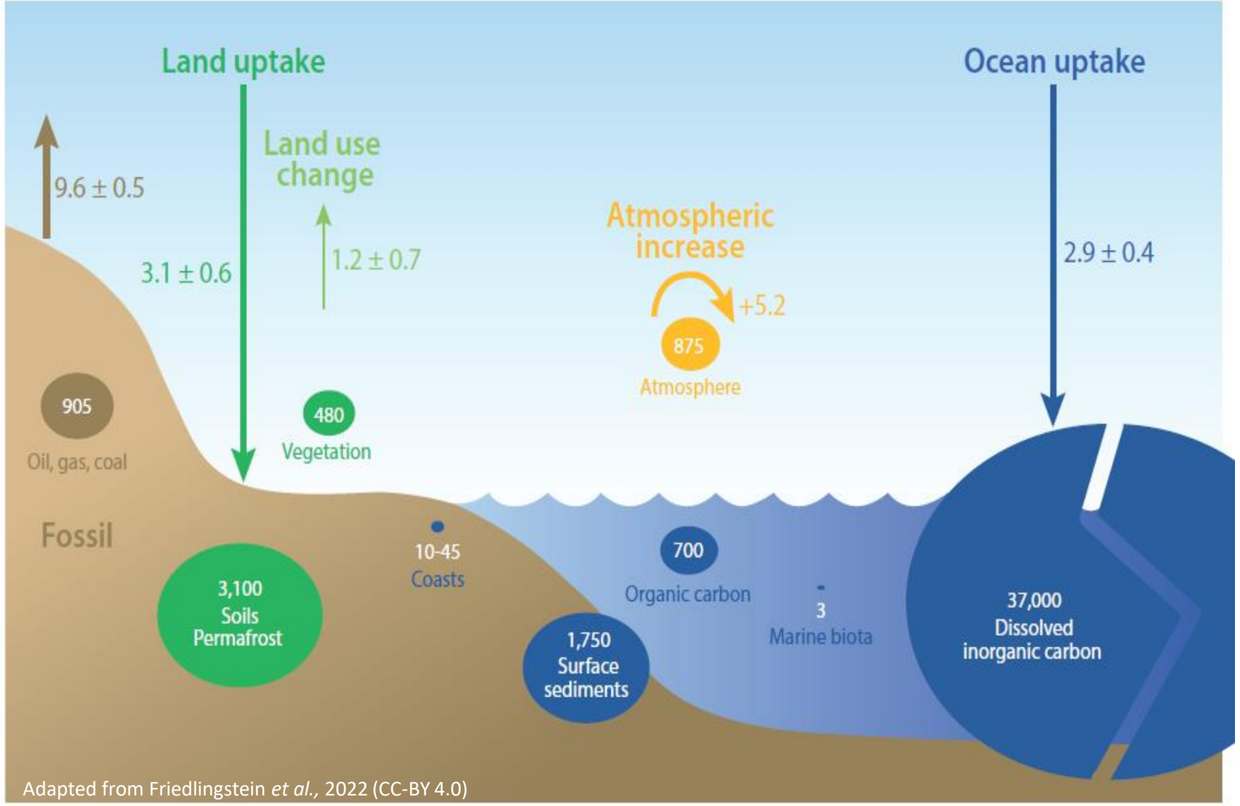
- Effectiveness limited by available space
- Maximum mitigation ~ 2% of our current global emissions
- Climate change can reduce effectiveness (e.g. loss of space, negative impacts of warming, drought)

➢ Essential to also drastically reduce greenhouse gas emissions
➢ Keep global warming close to 1.5°C above pre-industrial

Oystercatcher in coastal sediments in Ireland

The role of the Ocean in the carbon cycle

The global carbon cycle



The global carbon cycle in billion tonnes of carbon (from 2012 to 2021)

The Ocean currently takes up ~25% of all CO_2 emissions each year

- Uptake depends on:
  - Ocean's ability to absorb CO_2 from atmosphere (gas exchange)
  - Transport and storage of carbon in deep Ocean through currents and Biological Carbon pump
- This uptake will diminish in the future with more greenhouse gas emissions
- CO_2 in seawater can be released back into the atmosphere through Ocean currents and mixing
  - Carbon removal timescale correlates with depth

→ The uptake of CO_2 by the Ocean is critically important for climate change mitigation

The role of the Ocean in the carbon cycle

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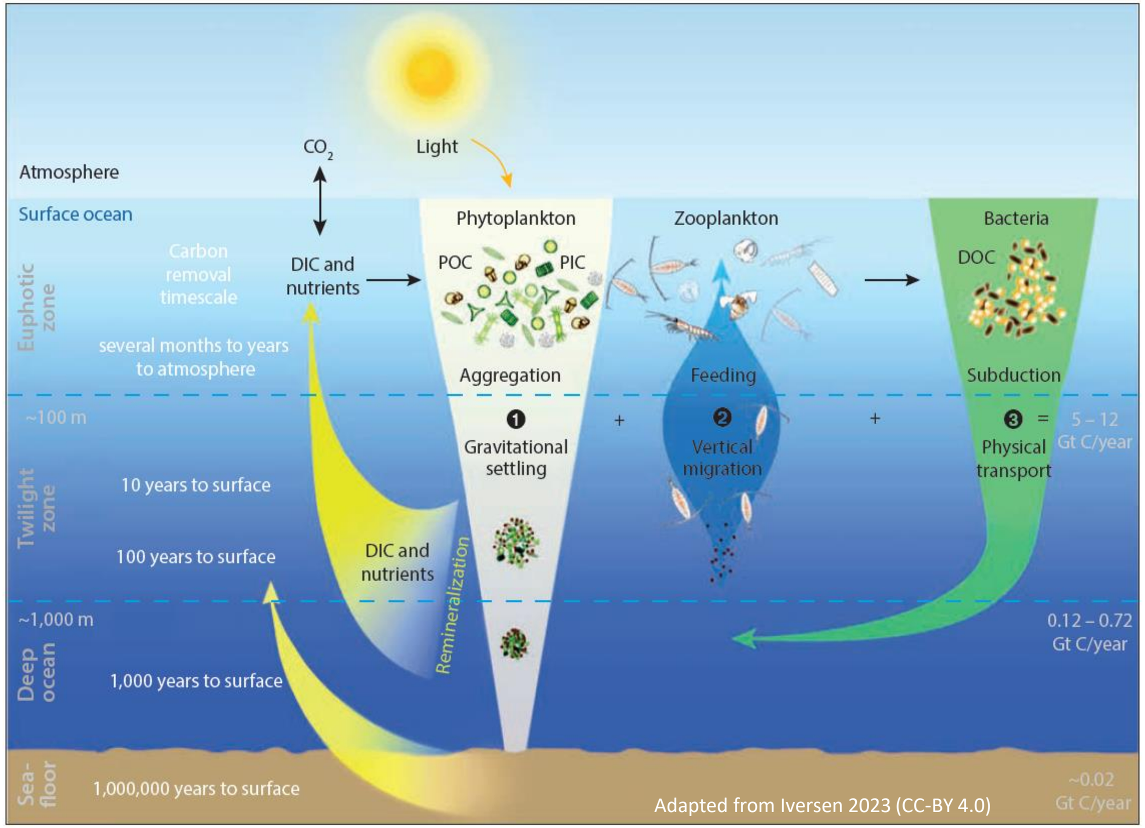
The Biological Carbon Pump (BCP)

Transport of organic carbon from surface to deep Ocean

- Mainly driven by phytoplankton: convert CO_2 into organic carbon through photosynthesis
  - ➢ Carbon transferred to other animals through food-webs
- Part of this carbon reaches twilight zone (~100-1,000m depth) though sinking particles, vertical animal migration or physical mixing
  - ➢ Most of the carbon converted back into CO_2 and nutrients through remineralisation
- Only a small proportion reaches deeper waters where it can be stored for 100-1,000 years
- An even smaller proportion is stored in sediments for up to millions of years

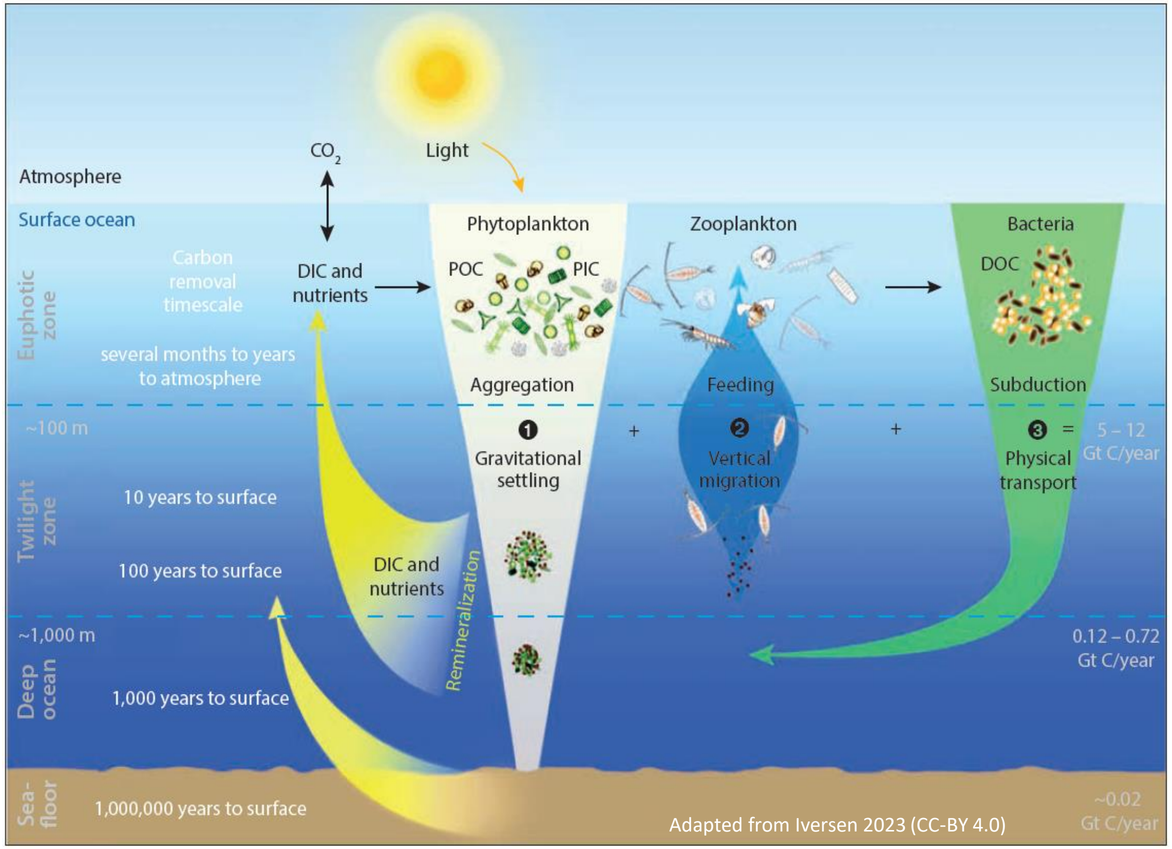


The BCP Includes all living organisms that move carbon around the Ocean

→The BCP helps in building Blue Carbon ecosystems, but yearly contribution is very small

The role of the Ocean in the carbon cycle

Carbon removal timescales in the open Ocean depend on depth



Surface Ocean (0-100m):

Removal timescale: **months to years**

Twilight Zone (100-1000m):

Removal timescale: **10-100 years**
~5-12 billion tonnes C/year

Deep Ocean (>1,000m):

Removal timescale: **1,000 years**
~0.12-0.72 billion tonnes C/years

Seafloor

Removal timescale: **up to 1 million years**
~0.02 billion tonnes C/year

Decreasing amount of carbon removal with depth

Bottom trawling & dredging might release some of the carbon stored in sediments back into the water column, but uncertainty is too large to make robust estimates

The role of the Ocean in the carbon cycle

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Many uncertainties in Ocean carbon cycle

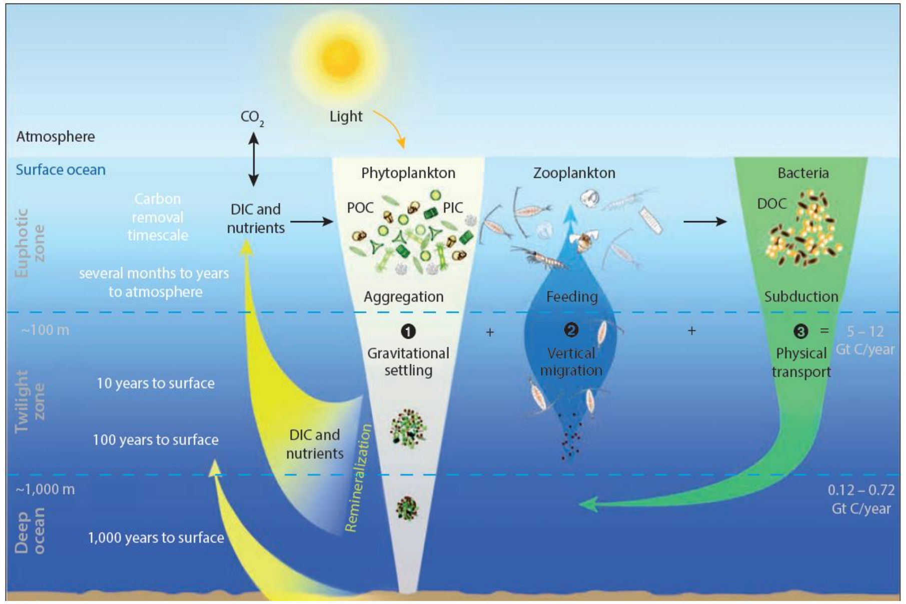
Biological carbon Pump & Carbon budget

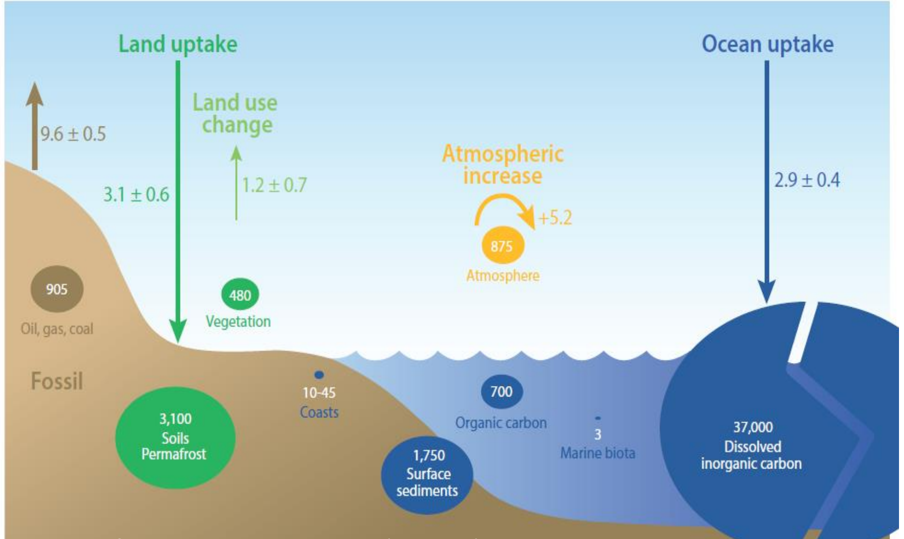
Marine carbon cycle is complex!

- Uncertainty on the amount of carbon exported annually from the surface very large
- Uncertainty about influence of Carbon Counter Pump (CCP), which counters effect of BCP and increases CO_2 in surface waters
- Uncertainty in how climate change will affect BCP and CCP
- Uncertainty in role of species, such as whales in strengthening natural carbon cycle (through fertilization by whale excrements)
- Large uncertainties in coastal carbon budget

Carbon buried in deep-water sediments less sensitive to climate change than carbon in the water column or in coastal/shelf sediments

→ **Ideal storage place for excess anthropogenically emitted carbon for multiple centuries**





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Examples and benefits of Blue Carbon ecosystems in Europe

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Mangroves

- Earliest and best understood example of Blue Carbon
- No mangroves in mainland Europe, but prevalent in tropical and subtropical territories of EU
- Mangroves also very important for biodiversity, food provision and coastal protection

Seagrass meadows

- Mediterranean Sea: *Posidonia oceanica* (large species and subtidal)
- Atlantic Sea, Baltic Sea and North Sea: *Zostera* species (smaller species, intertidal and subtidal)
- Important for carbon storage, biodiversity, including nursery grounds and food provision


Mangrove forest in Guadeloupe, France


Seagrass meadow (*Zostera marina*) in England, UK.


Saltmarsh in an estuary in UK

Examples and benefits of Blue Carbon ecosystems in Europe

Salt marshes

- Always intertidal
- Often fringe natural or grazing grassland
- Many salt marshes historically drained to reclaim land for farming or living
- Co-benefits include biodiversity, coastal defence and flood protection

Marine sediments

- Coastal, shelf and offshore sediments (muds and sands)
- Includes intertidal mudflats
- Accumulation rates less well understood, but contain extensive stores of carbon (sourced from other habitats)
- Carbon dynamics least understood


Mangrove forest in Guadeloupe, France


Seagrass meadow (*Zostera marina*) in England, UK.


Saltmarsh in an estuary in UK

Examples and benefits of Blue Carbon ecosystems in Europe

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Blue carbon ecosystems (BCE's) are connected

- Coastal BCE's are often found adjacent to each other (e.g. saltmarsh, mudflat, seagrass meadow) -> seascape connectivity
- Carbon moves between them (flows and fluxes)
- Implications for restoration and management

Effective management of these marine habitats will help to protect the integrity and storage of carbon stocks & the co-benefits they provide


Mangrove forest in Guadeloupe, France


Seagrass meadow (*Zostera marina*) in England, UK.


Saltmarsh in an estuary in UK

Uncertainties and questions on Blue Carbon ecosystem conservation and restoration as a climate change solution

Blue Carbon supports carbon storage and long-term climate stabilization, but many uncertainties on magnitude of climate benefits

Uncertainties due to:

(1) Limited area available in coastal environments for Blue Carbon due to:

- Suitability of substrate
- Human use of coastal environment

(2) High uncertainty around carbon accounting

- Needed for reliable monitoring, reporting and verification &
- To demonstrate benefits for climate policy actions

Seagrass meadow with exposed root system and sediment, where carbon is buried and stored

Uncertainties and questions on Blue Carbon ecosystem conservation and restoration as a climate change solution

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Uncertainties impacting carbon accounting

- Large variations in burial rate values → more measurements needed
- Errors in site-specific measurements
  - Burrowing animals disturb sediments, affecting sediment-dating
  - Up to 90% of carbon buried in coastal sediment might be land-derived
- Coastal Blue Carbon ecosystems can produce methane and nitrous oxide (potent greenhouse gases)
  - Measurements before and after restoration needed to quantify this across timescales and habitats
- Long-term integrity of restored and natural Blue Carbon habitats can be impacted by:
  - Future climate change impacts (heatwaves, storms, sea level rise)
  - Human pressures (encroachment, agriculture, industries, tourism etc.)
- If Blue Carbon habitats degraded or lost: likely to release carbon back to atmosphere

Saltmarsh in an estuary in UK

Summary

Uncertainties impacting carbon accounting

→ Risky to rely on Blue Carbon ecosystems to offset current and continued emissions

But no reason not to protect them:

- Provide many co-benefits (e.g. biodiversity, food provision and coastal protection)
- Long-term contribution to climate change can be significant once emissions are strongly reduced

Oystercatcher in coastal sediments in Ireland

Protection and conservation of Blue Carbon ecosystems:

- Will **contribute in solving both the biodiversity and climate change crises**
- But: no excuse to continue emitting greenhouse gas emission

→ **Keeping global warming close to 1.5°C is essential** to ensure long-term functionality of Blue Carbon

Recommendations

Recommendations for funders and research

- **Reduce uncertainties about the amount of carbon removed and stored** by Blue Carbon ecosystems
  - Essential for reliable, science-based crediting and offsetting systems
- **Quantify the possible production of methane and nitrous oxide that might arise from coastal restoration** efforts over the long term, and impact on greenhouse gas emissions
- **Understand the dynamics of offshore carbon stocks and sequestration, and the possible impact of human activities**, such as trawling and deep-sea mining
- Tailored monitoring and observations of carbon (stocks, fluxes, process rates temporal and spatial scales) to **improve our understanding of the global Ocean carbon budget, the biological carbon pumps (BCP, CCP) and sedimentary carbon storage**
- Support sustained observations to **better parameterize processes (e.g. remineralisation, fragmentation, sinking) in carbon cycle models**
- **Promote collaboration between environmental scientists, social scientists and engineers** to ensure the integration of Blue Carbon solutions (**multi-disciplinary approach**)