Research Mission of the German Marine Research Alliance (DAM)
**»Marine carbon sinks in decarboniation pathways«**

KNOWLEDGE SUMMARY

Biological methods

# Increased carbon storage through the expansion of marine meadows and forests

Coastal vegetated ecosystems, such as salt marshes, seagrass beds, mangrove, and kelp forests, grow on less than one percent of the ocean and coastal area, but contribute a significant portion of the natural carbon sequestration in the seabed, as well as many other ecosystem services. Plans to expand these valuable coastal habitats to enhance their natural carbon dioxide uptake sound promising. But how realistic are they really and in what ways can coastal ecosystems be expanded in a targeted way? The research mission CDRmare provides answers and ideas for solutions.

**The big climate goal: a net zero of carbon dioxide emissions**

> There is a consensus in climate research: even with ambitious climate policies, Germany is still expected to release **10 to 20 per cent** of current greenhouse gas emissions by the middle of the 21st century and will continue to drive global warming.

> In order to compensate for these residual emissions, humankind will either have to capture the carbon dioxide directly at its source or remove it from the atmosphere to the same extent.

**Using nature-based solutions: Coastal vegetated ecosystems as carbon reservoirs**

> Such **increased carbon dioxide removal** could be achieved with the help of the ocean, for example through the **(re-)establishment and large-scale expansion of coastal vegetated ecosystems** in tidal and shallow water areas (up to 40 metres water depth). These include salt marshes, mangrove forests, seagrass meadows, and kelp forests.

> Their combined areas account for less than one percent of the world's ocean area, including the intertidal zone. Together, however, the **meadows and forests of the ocean** sequester a significant portion of the carbon stored in the seabed and are thus **key players in the Earth's carbon cycle**.

## Coastal ecosystems as carbon reservoirs

Costs: **approx. US$1 to US$1000 dollars per tonne of $CO_2$**

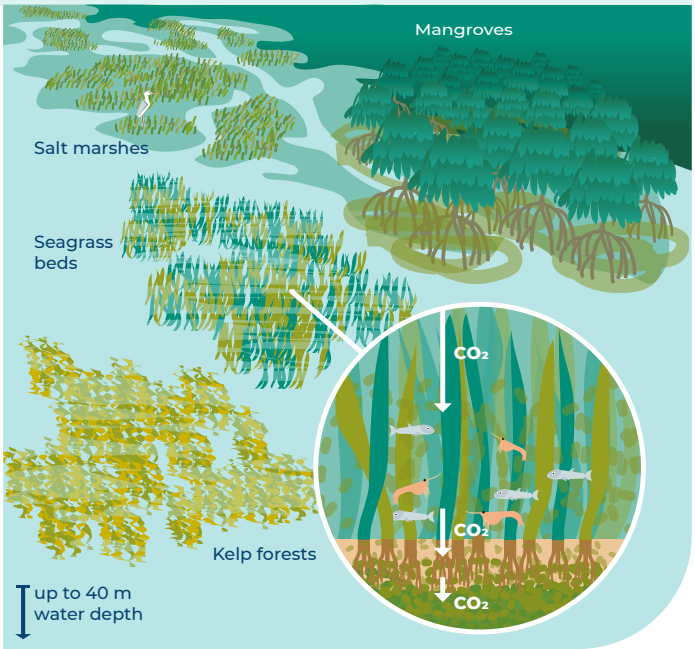
Scalability: An **extensive expansion of coastal vegetated ecosystems is theoretically possible.**

Duration of storage: **From several decades to thousands of years**

Technical state of development: Coastal ecosystems are being restored around the globe, but often only in their original areas.

A **massive expansion** of their extent is theoretically possible but has not yet been attempted practically anywhere.

*The restoration and large-scale expansion of coastal vegetated ecosystems in tidal and shallow waters could enhance the carbon dioxide uptake of the ocean. These include salt marshes, seagrass beds, and mangrove and kelp forests.*




Graphic: Rita Erven, CDRmare/GEOMAR

> Salt marshes, mangrove forests and seagrass beds absorb carbon dioxide from the air and seawater, bind the carbon they contain and store it underground. Over time, this creates **large carbon deposits below the plant cover**, which are preserved as long as the vegetation protecting them thrives – for up to several millennia.

> But coastal vegetated ecosystems do much more: they produce oxygen, clean the water, protect the coasts from erosion, foster biodiversity, and provide food and income for millions and millions of people around the world.

## The degradation of coastal ecosystems

> The harsh reality is that **the area of coastal vegetated ecosystems is shrinking worldwide** due to climate change, coastal development, marine pollution, overfishing, and other intensive uses. In the past 100 years, up to 50 percent of all salt marshes, about a third of all seagrass beds, and about 35 to 50 percent of mangrove forests have been lost. Of the world's kelp forests, 40 to 60 percent are experiencing clear area losses.

> Where plant communities die, their belowground carbon stores also decay.

> The good news: **coastal ecosystems can be restored**. Successful restoration projects exist in many parts of the world.

## Strategies to increase carbon dioxide removal by marine meadows and forests

> To effectively compensate for residual emissions, highly productive coastal habitats would not only need to be protected and restored but **expanded beyond their recently lost areas**.

> Prerequisite: Humans would have to replant mangrove forests, seagrass meadows, kelp forests, and salt marshes also in areas where they have not occurred naturally so far and implement communities of species to be planted in such a way that they achieve maximal carbon uptake and storage as an ecosystem and strengthen biodiversity at the same time.

> Experts refer to this approach as ecosystem co-design. It is believed to: (1) increase the carbon uptake and storage of coastal ecosystems; (2) promote coastal biodiversity; and (3) facilitate the adaptation of people and nature to climate change – the latter mainly because of the **many ecosystem services** provided by marine coastal ecosystems (food, coastal protection, subsistence, etc.).

## Many questions, especially about the effects of climate change

> **Climate change** poses an **acute threat** to coastal vegetated ecosystems. Among other things, the question arises, in which regions of the world they will be able to contribute to climate change mitigation through their carbon dioxide uptake, and where investments in their protection and large-scale expansion would be promising for the future.

> In addition, much **detailed knowledge** is still lacking on the **ecology** of marine meadows and forests, their **carbon fluxes**, basic **storage and degradation processes** in coastal sediments, and how their carbon dioxide removal and storage could be quantified and monitored in the long term.

> It is also questionable whether the coastal population would support the massive expansion of ecosystems. Potential points of contention would be the abandonment of intensively used land and sea areas in order to be able to renature them, as well as the expansion of coastal vegetated ecosystems at the expense of sandy beaches, tidal flats, and other local ecosystems.

## CDRmare provides answers and recommendations for action

> In the research mission CDRmare, scientists investigate the **basic mechanisms of carbon storage** in coastal vegetated ecosystems, their vulnerability to the impacts of climate change, and the willingness of coastal societies to support a massive expansion of marine meadows and forests.

> Based on this basic research, the experts will then develop **innovative procedures and political recommendations for action** to expand the area of coastal vegetated ecosystems, with which the carbon dioxide uptake of marine meadows and forests could be increased in an **environmentally compatible and socially acceptable way** – on German coasts as well as worldwide.

All associated research is carried out in the CDRmare research network »sea4soCiety – Innovative approaches to improving the carbon storage potential of vegetated coastal ecosystems«.





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