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Sea grass is no patent solution for climate change

Regenerating sea grass beds in coastal waters aims at removing carbon dioxide from the atmosphere to fight climate change. However, tropical sea grass beds can release more carbon dioxide than they absorb. This was shown in a study by an international research team led by biogeochemist Bryce Van Dam from the Helmholtz Centre Hereon, in which also scientists from the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) participated. Whether the recultivation of sea grass actually is helpful in the climate context depends on their location.

To ward off the worst climate change effects, the amount of the greenhouse gas carbon dioxide (CO_2) in the atmosphere must be reduced substantially. Potential measures flanking the reduction of CO_2 emission are efforts to restore natural CO_2 storages along the coasts, which have been destroyed in many places in the past. These include mangrove swamps, salt marshes and sea grass beds. Sea grasses are aquatic plants that grow in shallow water on soft sediment. They are essential for the survival of many species, for example as nursery grounds for young fish or, in the tropics, as grazing grounds for manatees. The plants in these ecosystems absorb CO_2 to build up their tissue. Dead plant parts accumulate in the sediment. Thus, part of the CO_2 that the plants absorbed from the air is stored there for considerable time. The reforestation of mangroves swamps and the regeneration of salt marshes and sea grass beds are nowadays classified as blue carbon methods and are regarded as extremely promising measures to combat climate change with the help of natural CO_2 sinks.

Tropical sea grass beds in focus

The team led by Dr Bryce Van Dam of the Helmholtz Centre Hereon has now proven, that combating climate change through sea grass recovery is not always as efficient as previously thought. For some sea grass beds release more CO_2 into the atmosphere than they store. This surprising finding, which has now been published in the renowned journal *Science Advances*, is important for correctly calculating the actual climate protection potential of sea grass in the future.

Sea grass occurs worldwide, but is most widespread in the tropics. “Through our measurements off the coast of Florida, we were able to show that these particular tropical sea grass beds often absorb significantly less carbon dioxide in total than long thought,” says Van Dam. “On the contrary, at some coastlines they even release an increased amount of CO_2.” That this is not yet generally known is due to the fact that many chemical processes take place at the plants and in the sediment that have so far been neglected when balancing CO_2 uptake, the researcher continues.

Dissolved carbonates play a major role

The oceans can absorb a lot of carbon dioxide from the atmosphere – about a quarter of anthropogenic CO_2. Dissolved carbonates, which enter the sea through rock weathering, play the main role. In simple terms, they bind CO_2 from the atmosphere to substances in the seawater. The more carbonate the water contains, the more CO_2 it can absorb. In warm tropical waters, however, the metabolic processes of the sea grass plants result in the conversion of dissolved carbonate to lime, which precipitates down to the seabed. Carbonate that could otherwise bind CO_2 is thus lost. “The interactions between solid,

dissolved and gaseous components of the carbon cycle in tropical sea grass ecosystems are particularly complex. Their analysis is therefore a methodological challenge that is not known from other sea grass sites, for example in the North and Baltic Seas," explains Prof. Michael Böttcher, head of the IOW Geochemistry and Isotope Biogeochemistry Working Group and co-author of the current study.

Two methods combined for the first time

To get a complete carbon budget that accounts for all the CO_2 produced and consumed in the ecosystem, the researchers for the first time combined two methods. With the so-called "eddy covariance", an approach that has long been used in terrestrial ecosystems but was adapted for coastal waters with the Hereon's participation, the direct CO_2 exchange between water and atmosphere was measured. The second method was the focus of the IOW researchers involved in the study. By analysing stable isotopes that can be used as marker substances, they examined the reactions of bicarbonate and other substances in the sediment in close detail. They particularly concentrated on the sedimental pore water. "This is where many of the complex processes take place that ultimately determine whether carbonate crystallises into lime and is thus lost as a potential CO_2 sink and whether the system as a whole releases CO_2," explains IOW researcher Böttcher. "The novelty of our study was to combine these approaches in the same place at the same time. Only by linking the measurements in the sediment, in the water and in the air we were able to track and factor in all the ecosystem processes responsible for storing and releasing CO_2," adds study leader Van Dam.

Understanding fundamentals to assess climate effects

As countries look for ways to meet their carbon reduction targets under the Paris Agreement, blue carbon measures hold promise. "In many locations, sea grass beds can make a very good contribution and are also habitats with valuable ecosystem properties and are well worth protecting anywhere in the world. However, our current studies in the tropics show that one has to look very closely and first understand all the fundamental aspects to be able to assess how high the actual contribution to climate protection can be in a specific case. That is why the rigorous limitation of CO_2 emissions must remain at the top of the list of climate change mitigation measures," Michael Böttcher concludes.

Original Publication: Bryce R. Van Dam, Mary A. Zeller, Christian Lopes, Ashley R. Smyth, Michael E. Böttcher, Christopher L.Osburn, Tristan Zimmerman, Daniel Pröfrock, James W. Fourqurean, Helmuth Thomas (2021): *Calcification-driven CO_2 emissions exceed "Blue Carbon" sequestration in a carbonate seagrass meadow.* Sci. Adv. 7, **doi: 10.1126/sciadv.abj1372**

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In addition to the Hereon and the IOW, researchers from Florida International University, the University of Florida and North Carolina State University were also involved in the study.

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