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CDRmare

DAM
GERMAN MARINE RESEARCH ALLIANCE

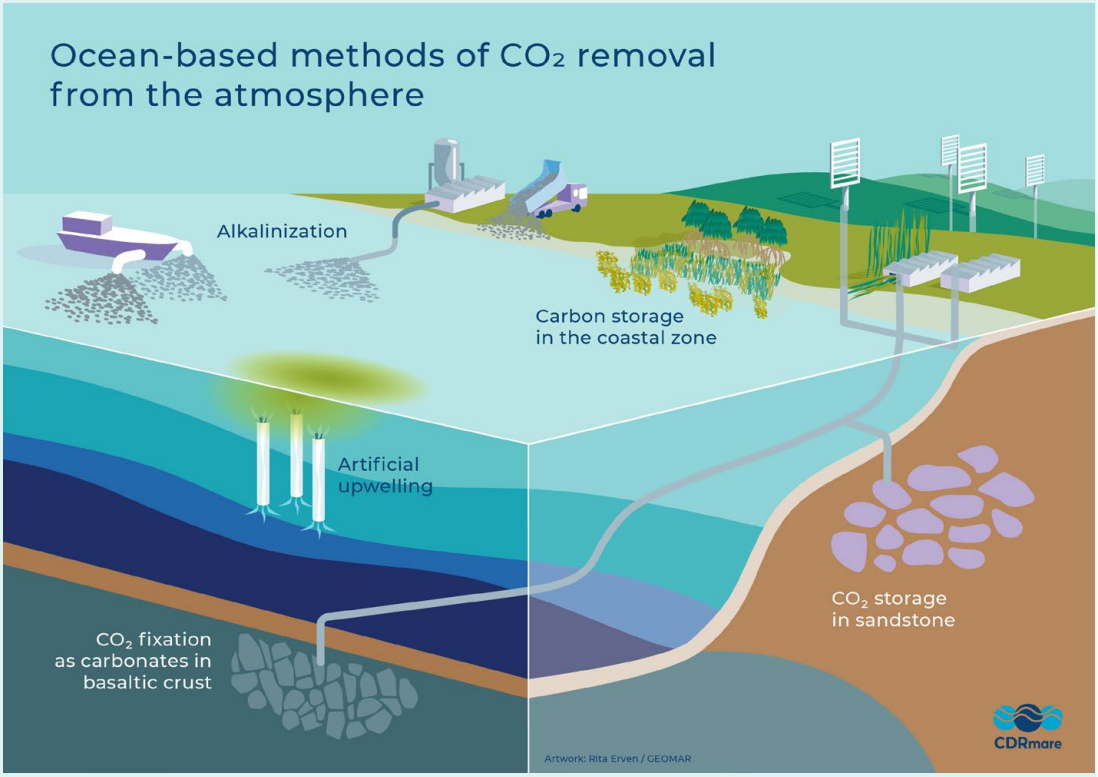
German Marine Research Alliance (DAM)

»Marine carbon sinks in decarbonisation pathways«

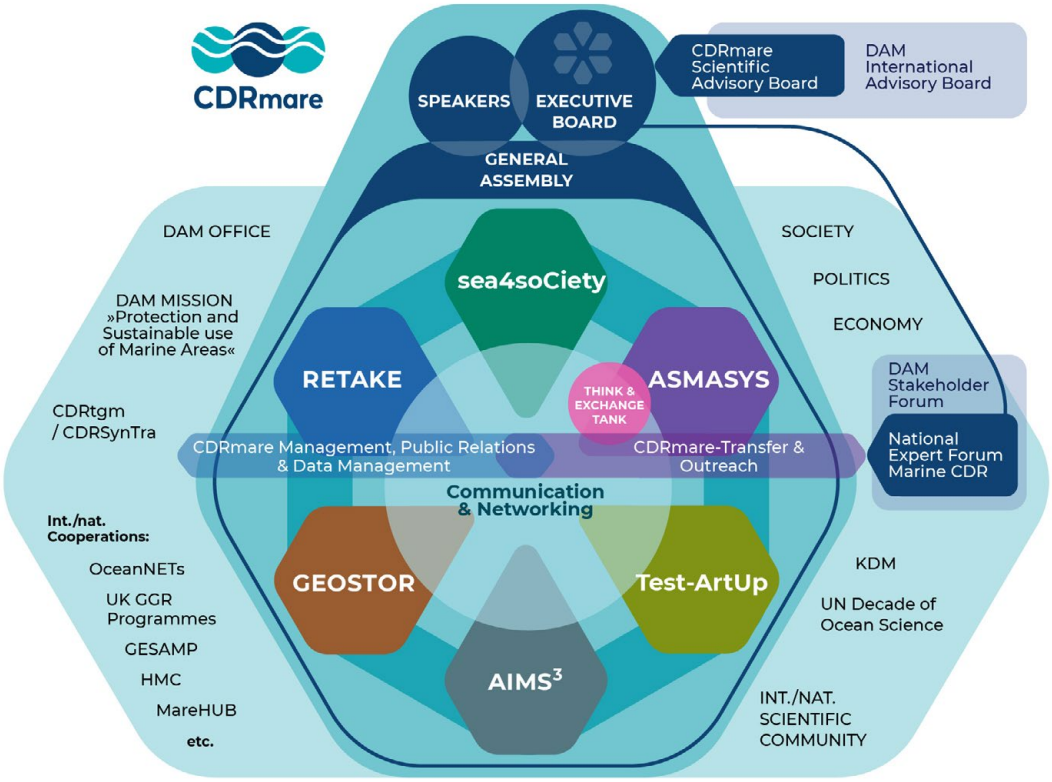
Funded by Federal Ministry of Education and Research (BMBF)
Funding Amount: 26 Mio. Euro
Funding Period: Aug 2021 – July 2024

OBJECTIVE

In order to support pathways to mitigate the increasingly drastic consequences of human-made climate change and to achieve the Paris Agreement goals, the removal of CO_2 from the atmosphere will be an important measure alongside massive CO_2 emission reductions. The research mission CDRmare (CDR: Carbondioxide Removal – CO_2 removal) will investigate whether and to what extent the ocean can play a significant role in the removal and storage of CO_2 from the atmosphere. It will also consider the linkages with and impacts on the marine environment, Earth system, and society, as well as appropriate approaches for monitoring, attributing, and accounting for marine carbon storage in a changing environment. The research mission will establish relevant assessment criteria and, in the long term, a Marine Carbon Roadmap for the sustainable use of marine carbon storage at regional to global scales, in close dialogue with stakeholders.



STRUCTURE



The DAM research mission CDRmare »Marine Carbon Sinks in Decarbonization Pathways« is composed of 6 consortia investigating different methods of marine CO_2 removal and storage (alkalinization, blue carbon, artificial upwelling, CCS) in terms of their potential, risks and trade-offs and bringing them together in a transdisciplinary assessment framework. The speakers of CDRmare are Prof. Andreas Oschlies (GEOMAR) and Prof. Gregor Rehder (IOW).

ASMASYS

ASMASYS

Coordinator: Prof. Gregor Rehder

Within ASMASYS, a transdisciplinary evaluation framework for marine CDR options will be developed as the base for a uniform evaluation of the different marine CDR options, and as a nucleus for further homogenization with the evaluation of CDR options on land. Strong emphasis will be put on non-natural science aspects, including criteria addressing legal, social, and ethical aspects, as well as political framing and policy-inherent internal mechanisms. Current gaps in the evaluation chain will be analysed. ASMASYS will also address the current hurdles with respect to the permission of demonstration projects involving field studies, which are an indispensable prerequisite for full scale technical application. In particular, sustainability will be a strong component of the assessment framework, using the UN Sustainable Development Goals (SDGs) as criteria. The current knowledge on some marine CDR-options not covered by the joint projects of the DAM mission will be compiled, including recent progress and development in other international initiatives. Knowledge of methods addressed within the research mission will be requested from the funded projects of the FM and compiled with regard to the assessment framework. The marine CDR options under consideration in the mission will be assessed in detail using the developed assessment framework. Based on this, an interim synthesis will be provided, and potential new directions for the 2nd funding phase of the Research Mission will be identified. During the entire course of ASMASYS, strong interaction and exchange is foreseen with all projects of the mission, currently active international research activities, stakeholders, and the synthesis project of the CDR-funding-line. The transfer component within ASMASYS will assure involvement of specialists and stakeholders during the development of the evaluation framework, and provide tailored dissemination products for the scientific community, decision makers, and the public. Special attention will be paid to ensure that the work results and products of ASMASYS are of relevance for the national climate strategy of Germany.

RETAKE

Coordinator: Prof. Andreas Oschlies

The project will assess the potential, feasibility and side effects of various forms of alkalinity enhancement (AE) as a means to reliably and sustainably remove CO_2 from the atmosphere. Increased ocean alkalinity reduces the activity of CO_2 in seawater, and prompts an enhanced flux of CO_2 from the atmosphere into the ocean, thereby reducing the atmospheric CO_2 concentrations. A range of mineral alkalinity sources will be examined with respect to dissolution kinetics, CO_2 sequestration potential and side effects on chemistry and biology. Laboratory studies and mesocosm experiments of AE in benthic and pelagic systems will simulate realistic environments with focus on the Baltic and the North Sea. A hierarchy of numerical models will be used to simulate deployment in German coastal waters and elsewhere, and to extrapolate experimental results from local to regional and global scales. Permanence and accounting of carbon storage as well as monitoring, detection and attribution issues will be examined against the background natural variability. An investigation of economic aspects, the legal situation and the relation to the U.N. sustainability goals will complete the comprehensive assessment in order to inform policymakers about the feasibility, overall sequestration potential and environmental risks of ocean alkalinity enhancement.

sea4soCiety

Coordinator: Prof. Martin Zimmer

The Consortium sea4soCiety aims to develop innovative approaches to enhance the potential for carbon sequestration in coastal ecosystems in Germany and worldwide that are ecologically feasible, environmentally sound, legally and ethically unobjectionable, and based on societal requirements for additional benefits, including economic viability, as well as broad acceptance. The consortium sea4soCiety will quantify the storage capacity of »blue carbon« in four coastal ecosystem types and compare it with the deposits of organic material in unvegetated marine sediments. The origin and stability of organic matter deposits, as well as their dynamics, will be analysed comparatively on the German North Sea coast, the German Baltic Sea coast, the Caribbean Sea, and the Indonesian Sea. Remote sensing is used for quantifying the aboveground biomass of vegetation in the study areas. Based on the characterization of the respective habitat, those currently unvegetated coastal regions that would be suitable for assisted expansion of coastal ecosystems (Ecosystem Design) will be identified. In this way, evidence- and scenario-based recommendations for policy- and decision-makers will be developed and subsequently scaled up to levels of national, international and global relevance, based on local field research. In an innovative and participatory approach, new governance systems will be designed to address local needs for ecosystem services in addition to mitigating climate change through »blue carbon« sequestration. Identifying potential synergies and trade-offs in GHG storage and sequestration initiatives from a regional development perspective (in line with the United Nations SDGs, the German Sustainable Development Strategy, and the German Climate Change Program) contributes to the goal of creating a roadmap for the sustainable use of marine carbon storage and will build national capabilities in atmospheric CO_2 extraction (carbon dioxide removal, CDR). More explicitly, sea4soCiety will improve competence for the assessment of potential and feasibility, risks and societal acceptance – as well as interactions with other ecosystem services and sustainability goals – for coastal ecosystems in Germany and worldwide. The knowledge gained will be translated into solution-oriented action knowledge for politics, business and civil society in order to support political and societal decision-making processes in a scientifically sound manner in the regional, national and international context, and thus also strengthen the international effectiveness and visibility of German marine research.

GEOSTOR

Coordinator: Prof. Klaus Wallmann

Carbon dioxide (CO_2) emissions from large stationary point sources such as industrial plants can be strongly reduced by CO_2 capture and storage in deep geological formations. A large share of the storage capacity for CO_2 in Europe is located in sandstone formations below the North Sea. Even though potential storage formations in the German Exclusive Economic Zone (EEZ) are only partly explored, the available estimations suggest that CO_2 emissions of German industries can be substantially reduced by capturing and storing CO_2 below the seabed within the German North Sea sector. Against this background, GEOSTOR aims to find prospective areas for CO_2 storage and design a roadmap for the implementation of CO_2 storage within the German North Sea. To achieve these aims, GEOSTOR will reassess static CO_2 storage capacities for the entire German North Sea, quantify dynamic storage capacities for two selected sites, study potential leakage pathways and mechanisms, assess potential environmental impacts during various project development stages, e.g. of seismic noise on marine mammals, and develop a new passive seismic system for the environmentally sound monitoring of storage formations. Further, GEOSTOR will assess potential interactions of CO_2 storage operations with other uses and functions of the North Sea area with respect to environmental, technical, legal and economic aspects and derive approaches for resolving potential conflicts.

Test-ArtUp

Coordinator: Prof. Ulf Riebesell

Global warming is predicted to increase ocean stratification, decrease the supply of nutrient-rich deep waters to the sunlit surface layer and thereby cause a decline in ocean productivity, particularly in low to mid latitudes (IPCC 2019). Active transport of nutrient-rich deep water to the sunlit surface layer, termed artificial upwelling, can partly compensate for this trend. While the benefit of this approach for the marine food web is undisputed, it's potential in sequestering CO_2 is considered to be negligible. Recent studies on artificial upwelling, however, revealed a much higher potential for CO_2 removal than previously expected. Test-ArtUp aims to examine, in a unique transdisciplinary approach, the use of artificial upwelling for the purpose of CO_2 removal with respect to its technical application and optimization, its capacity for additional CO_2 uptake and long-term storage, the associated environmental risks and ecological side effects, the related economic benefits and trade-offs and the legal constraints and governance requirements. Dissemination of the project results will be achieved in a two-way stakeholder dialogue, facilitated through a stakeholder reference group, and through target-ed communication and dissemination channels with selected audiences, offering group-specific dissemination products. The results of Test-ArtUp will be synthesized to provide knowledge-based advice on the possible implementation of artificial upwelling for CO_2 removal and will contribute to developing a Marine Carbon Roadmap in accordance with the UN Sustainable Development Goals, particularly SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 14 (Life below Water).

AIMS³

Coordinator: Prof. Achim Kopf

The AIMS³ project will deliver new insights, monitoring tools and best practice guidelines for CO_2 storage at oceanic Carbon Capture and Storage (CCS) sites, specifically in crustal rocks (basaltic ocean crust) on the slow-spreading flanks of mid-ocean ridges (MORF) with sedimentary drape where CO_2 can be fixated effectively without the risk of a later escape. The study forms a distinct progression of CO_2 injection experiments such as GRE Sleipner [2012] or STEMM-CCS [2017-19], with a focus of oceanic MORF environments. In contrast to conventional CO_2-injection in former coastal subseafloor reservoirs or aquifers, AIMS³ utilises reactive rock formations, namely the upper, heavily altered oceanic crust, with precipitation of carbonate minerals in pore waters upon introduction of liquid CO_2 or bicarbonate. Carbon mineralization in basaltic rocks offers a global storage potential that exceeds anthropogenic emissions. AIMS3 will identify (using existing commercial sensors and newly developed sensors such as ISFET-pH, DIC and optical CO_2), and monitor (arrays of stationary and autonomous platforms) potential CO_2 leakages at CCS sites. We will develop with industrial partners a suite of cost-effective tools to identify, detect and quantify CO_2 leakage with high precision and accuracy, which will provide the basis for an enhanced public confidence in CCS and a sustainable management of CCS procedures under various geological scenarios, well beyond the examples studied in AIMS³. Based on the wealth of data and direct comparison between the two most immanent geological scenarios (in AIMS³ and the GEOSTOR project), we will also deliver best practices for selection and operation of offshore CCS reservoirs, including an assessment of the utility of chemical tracers in the marine environment (mostly the carbonate system).

CDRmare

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

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