



Ocean-based Negative Emission Technologies



| Deliverable Title | Synthesis report on public perceptions from WP 3 |
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| Lead Related Work Package Related Task Author(s) Prieto Dissemination Level Due Submission Date Actual Submission Project Number Start Date of Project Duration | NORCE WP 3 Task 3.1–3.3. Gisle Andersen, Christine Merk and Endre Tvinnereim Public 31.12.2023 29.12.2023 869357 01. July 2020 60 months |
| <p>Abstract: This deliverable synthesizes the results from WP 3 on public perceptions of marine Carbon Dioxide Removal (CDR). The main purpose is to inform the overall synthesis report of OceanNets. It also helps inform the other work packages and stakeholders about our results in a timely and brief manner about the ways members of the public view marine CDR specifically.</p> | |



Document History

| Date | Version | Description | Name/Affiliation |
|------------|---------|-------------------------|----------------------------------|
| 29.12.2023 | 1.0 | First submitted version | Andersen, Merk and Tvinnereim |

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List of abbreviations, acronyms and definitions

BECCS – Bioenergy with Carbon Capture and Storage

CCS – Carbon Capture and Storage

CDR – Carbon Dioxide Removal

mBECCS – Marine bioenergy with Carbon Capture and Storage

NETs – Negative Emission Technologies

NGO – Non-governmental organization

OAE – Ocean Alkalinity Enhancement

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Acknowledgements

This synthesis report is based on collaboration with OceanNETs work package 3 project members and their contribution to previous deliverables: Siri Veland, Åsta Dyrnes Nordø, Marie Louise Ljones, Jon Kåre Skiple, Sveinung Arnesen and Mikael Johannessen.

1. Introduction

1.1 Context

OceanNETs is a European Union project funded by the Commission's Horizon 2020 program under the topic of Negative emissions and land-use based mitigation assessment (LC-CLA-02-2019), coordinated by GEOMAR Helmholtz Centre for Ocean Research Kiel (GEOMAR), Germany.

OceanNETs responds to the societal need to rapidly provide a scientifically rigorous and comprehensive assessment of negative emission technologies (NETs). The project focuses on analyzing and quantifying the environmental, social, and political feasibility and impacts of ocean-based NETs. OceanNETs will close fundamental knowledge gaps on specific ocean-based NETs and provide more in-depth investigations of NETs that have already been suggested to have a high CDR potential, levels of sustainability, or potential co-benefits. It will identify to what extent, and how, ocean-based NETs can play a role in keeping climate change within the limits set by the Paris Agreement.

1.2 Purpose and scope of the deliverable

The main purpose of D.3.6 is to inform the work on other synthesis reports from the OceanNets project. We have therefore chosen to focus on high-level messages from the work package that are relevant to policymakers and future research within the field. This deliverable also helps inform the other work packages and stakeholders about the most important of our results in a timely and brief manner.

1.3 Relation to other deliverables

D 3.6 synthesizes results from work package 3 on public perceptions of marine CDR. The report is based on previous tasks and deliverables:

- Task 3.1 – Focus groups in Germany and Norway, results presented in deliverable 3.3 (Veland & Merk, 2021).
- Task 3.2 – A deliberative poll conducted in Norway, results presented in deliverable 3.4 (Andersen et al., 2022).
- Task 3.3 – A cross-country survey on public perceptions of marine CDR methods. The survey was run in Canada, China, France, Germany, Norway, and Taiwan. Results are presented in deliverable 3.5 (Merk et al., 2023).

2. High-level summary of main findings in public perceptions of marine CDR

Especially of approaches that are perceived as more technical compared to ecosystem-based approaches, public perceptions are seen as a constraint on political feasibility of Carbon Dioxide Removal deployment, (Bertram & Merk, 2020; GESAMP, 2019; IPCC, 2022; Rickels et al., 2019). Public outcries against early marine CDR research projects such as LOHAFEX on ocean iron fertilization in the Southern Ocean (Schiermeier, 2009a, 2009b), proposals for CO₂-injection off the coast of Hawaii and Norway (Figueiredo et al., 2003; Gewin, 2002; Giles, 2002; Scott, 2005) or the ocean fertilization project by the Haida Salmon Restoration Corporation in international waters off the Canadian west coast (Gannon & Hulme, 2018; Tollefson, 2017) (Tollefson, 2017; Gannon and Hulme, 2018) support these assessments though marine CDR is not well known in the public domain and there has been little prior research on public perception of these methods (Bertram & Merk 2020).

The OceanNETs work package 3 broadens and deepens the insights on public perceptions of marine CDR methods covering a broad range of approaches, extending the geographical scope and combining insights from qualitative and quantitative research. It has explored laypersons' perceptions of and attitudes toward ocean-based NET research and deployment to provide insights into public knowledge, engagement, and opposition to or support of such methods. The research contributes a deeper understanding of the variations in perceptions of marine CDR also in comparison to land-based approaches based on individual attitudes, framings, and demographics. Geographically, it covers Canada, China, France, Germany, Norway, and Taiwan.

Overall, we have found low or medium-low support for ocean-based NET deployment among laypersons (see summary in Table 1). Data from a cross-country survey indicate a difference between Western and Asian countries and higher levels of support in the two Asian countries surveyed: China and Taiwan. Results from the deliberative poll conducted in Norway indicate greater concern about marine than about terrestrial CDR approaches (Andersen et al., 2022). This seems to be because laypersons are mostly unfamiliar with natural processes in the ocean that would be enhanced by these CDR techniques and because ocean-based removal is often perceived as uncontrollable. Of the eight NETs studied, the only approach that found relatively high levels of support is blue carbon management. This approach was researched in the focus groups conducted in Germany and Norway (Veland & Merk, 2021).

The quantitative cross-country survey has focused on the following three ocean-based removal approaches: Ocean Alkalinity enhancement (OAE), macroalgae farming with biomass sinking and macroalgae farming with CCS (mBECCS). Results indicate that support for OAE is lowest and that this method is perceived as “risky” and “costly”. The public support and familiarity with seaweed sinking is also low and comparable to OAE. As for OAE, sinking biomass is often associated as “risky”; the association for “uncontrollable” is highest for this approach. Of these three approaches, mBECCS receives the highest level of public support. The level can be considered low/medium in Western countries surveyed and medium in Asian countries.

We have not found systematic differences in the perceptions of marine CDR between genders or levels of education. In Western countries, older study participants tend to perceive especially OAE and sinking biomass more negatively. In China, this relationship is reversed – older participants evaluate these approaches more positively. We find no such relationships in Taiwan. These differences between Western and Asian countries might also be due to the difference between the country groups in the average age of the population and thus the study participants.

Overall, the results mirror that there is no public debate about CDR yet. This is relevant for understanding how laypersons respond to CDR approaches. Overall, self-reported familiarity with CDR approaches is low. In Western countries, a majority (55-84%) report never having heard of these approaches; in Asian countries, a majority (56-75%) report having heard of the methods before. In the cross-country survey, this is also reflected in a high share of respondents answering "don't know" or "no opinion" (NODK) when asked about specific CDR methods (Merk et al., 2023). When informed and provided the opportunity to deliberate approaches, we observe a significant reduction in the share of NODK answers and an increase in participants' self-assessed certainty about their assessment of the methods, but only slight changes in the direction of the assessment (Andersen et al., 2022).

In the qualitative data collected, we observe that laypersons often associate the CDR approaches with issues and debates they are already familiar with. Participants in the focus groups and the deliberative poll were given ample information about the technologies, about CDR as a complement to drastic emissions reductions, and their role in net zero strategies. Still, the qualitative data illustrate that participants found it hard to engage with the idea of removing carbon dioxide and the methods. Instead, they tend to discuss the importance of reducing emissions and changing consumption patterns and not the need to remove CO₂ from the atmosphere to reach climate goals. Although we find clear support for continued research and innovation on marine CDR, we overall observe a skepticism towards specific approaches. Most participants also perceived the information available for methods as too limited and asked for more information to form an opinion (Andersen et al., 2022; Veland & Merk, 2021).

We found that laypersons are concerned about the actual feasibility of deployment at a relevant removal scale, e.g. on a large area, and for longer time periods as well as the potential unforeseen effects on ecosystems. Connected to this are concerns about the controllability of the deployment and the methods' environmental impact. They also tend to question the build-up of additional infrastructure or additional interventions into nature on top of already existing human interference.

WP3 findings therefore illustrate the need for further research to answer these key questions and clarify the impacts of marine CDR on climate, ecosystems, local communities, and the economy. Additionally, results indicate a concern that the (unsubstantiated) promise of CDR options might be taken as a license to continue polluting behavior. Table 1 summarizes the associations with, concerns about and levels of public support for the eight NETs studied in WP 3.

| CDR approach | Data | Associations | Concerns | Public support |
|---|-------------|--|--|--|
| Artificial upwelling | FG | Offshore wind energy | Feasibility | Low |
| Blue carbon ecosystem management | FG | Natural process | Invasive species Human interventions going wrong | High |
| Ocean fertilization | DS | Marine pollution | Feasibility, controllability | Low |
| Ocean alkalinity enhancement | FG, DS & CS | Marine pollution, freshwater liming. In CS: risky, costly, not environmentally friendly nor feasible. | Additionality, mining, energy footprint, controllability | Low, low/medium in China. |
| Enhanced weathering | DS | Fertilization | Mining, energy footprint | Low/medium |
| Macroalgae farming | DS & CS | Aquaculture | Monoculture, pollution | |
| <i>With sinking</i> | | Waste dumping at sea. In CS: Risky, uncontrollable | Controllability, impermanence of storage | Low in Western countries, low/medium in Asian countries |
| <i>With CCS</i> | | CCS as a climate solution. In CS: Innovative | Additionality related to CCS | Low/Medium in Western countries. Medium in Asian countries. |
| Terrestrial BECCS | DS | Agriculture, CCS as climate solution | Land-use, food production | Low/Medium |

Table 1: Summary of public perceptions of eight NETs studied in WP3, combined results from focus groups (FG), deliberative survey (DS), and cross-country survey (CS). Data source, associations, concerns and indication of public support.

3. References

- Andersen, G., Merk, C., Ljones, M. L., & Johannessen, M. P. (2022). Interim Report on Public Perceptions of Marine CDR. *OceanNets*. https://doi.org/10.3289/oceannets_d3.4.
- Bertram, C., & Merk, C. (2020). Public Perceptions of Ocean-Based Carbon Dioxide Removal: The Nature-Engineering Divide? [Perspective]. *Frontiers in Climate*, 2. <https://doi.org/10.3389/fclim.2020.594194>
- Figueiredo, M. A. d., Reiner, D. M., & Herzog, H. J. (2003). - Ocean Carbon Sequestration: A Case Study in Public and Institutional Perceptions. In J. Gale & Y. Kaya (Eds.), *Greenhouse Gas Control Technologies - 6th International Conference* (pp. 799-804). Pergamon. <https://doi.org/10.1016/B978-008044276-1/50126-4>
- Gannon, K. E., & Hulme, M. (2018). Geoengineering at the “Edge of the World”: Exploring perceptions of ocean fertilisation through the Haida Salmon Restoration Corporation. *Geo: Geography and Environment*, 5(1), e00054. <https://doi.org/https://doi.org/10.1002/geo2.54>
- GESAMP. (2019). *Guidelines on the monitoring and assessment of plastic litter and microplastics in the ocean* <http://www.gesamp.org/publications/guidelines-for-the-monitoring-and-assessment-of-plastic-litter-in-the-ocean>
- Gewin, V. (2002). Ocean carbon study to quit Hawaii. *Nature*, 417(6892), 888-888. <https://doi.org/10.1038/417888b>
- Giles, J. (2002). Norway sinks ocean carbon study. *Nature*, 419(6902), 6-6. <https://doi.org/10.1038/419006b>
- IPCC. (2022). Cross-sectoral Perspectives. In C. Intergovernmental Panel on Climate (Ed.), *Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1245-1354). Cambridge University Press. <https://doi.org/10.1017/9781009157926.014>
- Merk, C., Andersen, G., & Tvinnereim, E. (2023). Report on public perceptions in cross-country survey. Deliverable 3.5. *OceanNets*.
- Rickels, W., Merk, C., Reith, F., Keller, D. P., & Andreas, O. (2019). (Mis)conceptions about modeling of negative emissions technologies. *Environmental Research Letters*, 14(10). <https://doi.org/10.1088/1748-9326/ab3ab4>
- Schiermeier, Q. (2009a). Ocean fertilization experiment draws fire. *Nature*. <https://doi.org/10.1038/news.2009.13>
- Schiermeier, Q. (2009b). Ocean fertilization experiment suspended. *Nature*. <https://doi.org/10.1038/news.2009.26>
- Scott, K. N. (2005). The Day After Tomorrow: Ocean CO₂ Sequestration and the Future of Climate Change. *Georgetown International Environmental Law Review*, 18(1), 57-108.
- Tollefson, J. (2017). Iron-dumping ocean experiment sparks controversy. *Nature*, 545(7655), 393-394. <https://doi.org/10.1038/545393a>
- Veland, S., & Merk, C. (2021). Lay Person Perceptions of Marine Carbon Dioxide Removal (CDR). *OceanNets*. https://doi.org/10.3289/oceannets_d3.3