CM14A-1128 EVALUATING OCEAN ALKALINITY ENHANCEMENT FROM CHEMICAL-BIOLOGICAL TO THE ECONOMIC ASSESSMENT OF RISKS AND BENEFITS

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ABSTRACT: Ocean Alkalinity Enhancement (OAE) is an approach aimed at mitigating climate change by increasing the alkalinity of the ocean. The concept interacts with various dimensions, including environmental impact, economic feasibility, and governance and regulation, in complex and interrelated ways. Presently, the biological and biogeochemical effects of OAE remain poorly studied, despite possible negative effects on aquaculture and fisheries. This requires the development of suitable biological risk assessment frameworks that need to be considered for the development of policy and governance. Here, we present the results of the biological risks assessment, which was based on the synthesis of 82 biological studies that predicted potential impact of OAE on variety of marine pelagic calcifiers. Our results predict 45% of the investigated species to respond positively, 39% of species respond negatively, and 16% are predicted to have neutral response upon OAE treatment. This shows that OAE implementations will have winners and losers, emphasizing the importance of the precautionary approach for implementing OAE. We identified the range of 10-50 µmol NaOH as a threshold for the most sensitive calcifiers, with a call for the future studies to identify the thresholds at which negative ecological effects could happen. Such risk assessments are used in economic valuations of the ecosystem services, linking it to financing mechanisms, market incentives and economic barriers. Third, we recognize and explore three governance framework that cover the ecosystem services and link them with the economic and policy frameworks, e.g., Kunming-Montral biodiversity framework; Paris Agreement and Sustainable Development Goals.

BIOLOGICAL ASSESSMENT

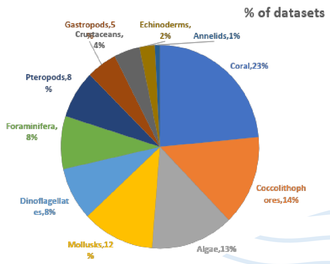


Figure 1*:* Distribution of the functional groups (N=11) used for the biological risk assessment across 82 different studies.

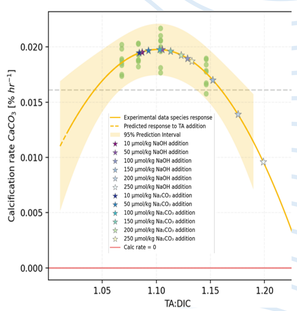
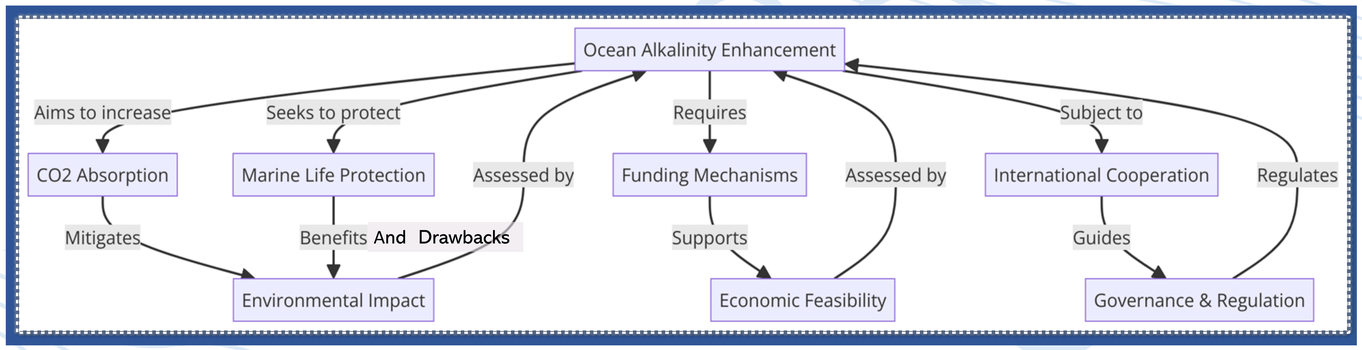


Figure 2*:* Predicted biological response using the regression models upon addition of NaOH and Na_2CO_3, showing specific parabolic response with identified the threhsold.



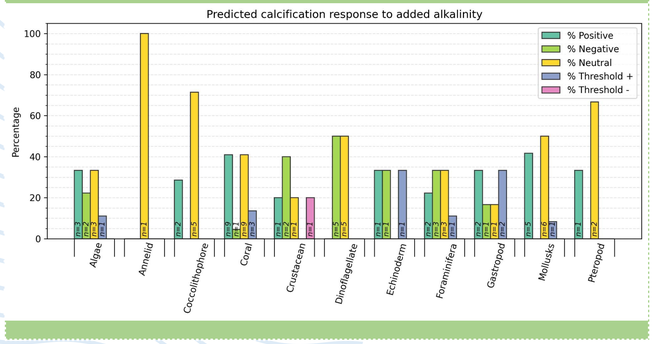


Figure 3: The summary of biological responses to OAE addition across various functional groups. The results are species- and functional group-specific, showing positive and negative responses. Some of the ecologicall and economically important groups are predicted to be negatively impacted, potentially compomising ecosystem services.

For more OAE-sensitive species (echinoderms, dinoflagelates), the threshold concentrations range from 10-50 µmol NaOH and 50-100 µmol Na_2CO_3. For less sensitive (decapods), the thresholds are positioned between 50-100 µmol NaOH and 150-250 µmol Na_2CO_3.

ECONOMICS CONSIDERATIONS AND BARRIERS

Following the biological risk assessment and threshold on the ecosystem services (fisheries), the economic aspects of OAE involves analysis of the costs, financing mechanisms, and market incentives:

1) ***Cost-Effectiveness****:* Assessing the economic viability of OAE compared to the other mCDR strategies, also including risk assessment of ecosystem services and mitigating ocean acidification effect.
2) ***Funding and Investment****:* Identifying sources of funding, including public, private and philanthropic investments.
3) ***Carbon Credits and Markets:*** Developing mechanisms for quantifying, certifying, and trading carbon sequestration achieved through OAE can provide financial incentives for investment and operation.

Barriers:

- Information gaps
- Limited blue financing with low returns
- Siloed approaches with poor multi-sectorial, cross-boundary connection

GOVERNANCE

- ***Kunming-Montreal (KM) Global Biodiversity Framework***
- ***Sustainable Development Goals***
- ***Paris Agreement***

The connection between OAE and the KM lies in their shared objectives of mitigating climate change impacts, preserving and enhancing biodiversity, ensuring the sustainable use of natural resources. Effective and responsible deployment of OAE technologies requires global collaboration, knowledge sharing, and capacity building, especially among countries.

The connection between OAE and the SDGs is multifaceted:

- ***SDG 13:*** Climate Action
- ***SDG 14:*** Life Below Water, supporting SDG 14's goal to conserve and sustainably use the oceans and marine resources.
- ***SDG 7:*** Development of OAE involves research and innovation
- ***SDG 12:*** Ensuring Responsible Consumption and Production towards promoting sustainable practices across industries.
- ***SDG 17:*** Enhancing international cooperation and partnerships between governments, the private sector, and academia.

OAE and the Paris Agreement share a connection through their mutual focus on climate change mitigation. The integration of OAE into global climate action presents both challenges and opportunities. It necessitates rigorous scientific validation, robust governance structures to manage risks and uncertainties, and clear methodologies for quantifying CO_2 removal.
OAE could play a role in diversifying the portfolio of mitigation strategies towards countrys‘ NDCs, provided its governance is aligned with the principles of transparency, accountability, and environmental protection.

CHALLENGES AND CONSIDERATIONS: The implementation of OAE involves complex interactions between environmental, economic, and governance factors. The environmental considerations encompass the potential impacts on marine ecosystems, the effectiveness in reducing atmospheric CO_2, and the scalability of such interventions. Economically, the feasibility, cost, and funding mechanisms of deploying OAE at a scale need to be assessed. Governance issues require the regulation, monitoring and potential international cooperation to implement such a geoengineering strategy responsibly and effectively, especially recognizing potential negative effects on the ecosystems and related threhsolds. The technology must be governed by rigorous environmental impact assessments, ethical considerations, and international regulations to ensure that its deployment does not harm marine ecosystems or biodiversity, achieved by adhering to international guidelines and best practices for environmental protection, sustainability and international cooperation. Moreover, OAE should complement, not replace, emission reduction efforts across other sectors of the economy.

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