Expanding blue carbon assessments: the overlooked role of alkalinity in seagrass meadows

Wen-Chen Chou[1], Mariche B. Natividad[1,2], Jian-Jhih Chen[3], Wei-Jen Huang[4]

[1]Institute of Marine Environment and Ecology, National Taiwan Ocean University, Keelung, Taiwan
[2]Ecosystems Research and Development Bureau, Laguna, Philippines
[3]Department of Marine Environmental Engineering, National Kaohsiung University of Science and Technology, Kaohsiung, Taiwan
[4]Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan
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*** Correspondence:**
Wen-Chen Chou
wcchou@mail.ntou.edu.tw

Abstract

Coastal blue carbon ecosystems (CBCEs), including seagrass meadows, play a crucial role in carbon sequestration. While traditional assessments have largely focused on particulate organic carbon (POC) burial, emerging research highlights the significant yet often overlooked contributions of total alkalinity (TA) to long-term carbon storage. This study synthesizes insights from two recent investigations: one emphasizing the role of TA and dissolved organic carbon (DOC) as **"invisible"** blue carbon sinks, and another demonstrating how sediment composition influences TA production in seagrass meadows. The findings reveal that seagrass meadows situated in organic carbon (OC)-rich reef sediments exhibit benthic TA fluxes up to two orders of magnitude higher than those in OC-poor terrestrial sediments. This enhanced TA production fosters CO_2 uptake through alkalinity-driven processes, reducing the partial pressure of CO_2 in seawater and strengthening the ocean's buffering capacity against acidification. Key biogeochemical mechanisms facilitating these processes include metabolic carbonate dissolution and sulfate reduction, which together contribute to enhanced TA production. Given that TA outwelling from CBCEs may surpass in situ organic carbon burial, we propose expanding blue carbon assessments to incorporate these overlooked pathways. Integrating TA dynamics into global carbon accounting will provide a more comprehensive understanding of coastal ecosystems' contributions to climate mitigation. Additionally, prioritizing seagrass restoration in high-OC reef sediment regions could maximize long-term sequestration benefits, improving coastal resilience and supporting marine biodiversity. To optimize the effectiveness of these conservation efforts, further research is needed to refine our understanding of TA production mechanisms, their variability across different environments, and their long-term stability. Incorporating these insights into climate policy and blue carbon credit frameworks will enhance the role of CBCEs in global carbon budgets, ensuring that their full sequestration potential is realized in climate mitigation strategies.