Blue Carbon – impact of destruction/degradation





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United Nations Educational, Scientific and Cultural Organization A 'stressed' ocean: Mitigation and Adaptation Possibilities Applying Ecosystem-Based Management Aricò, S.¹, Isensee, K.¹, Boyd, P.², Suntharalingam, P.³, Iglesias Campos, A.¹ and J. Barbière¹

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The world ocean is, at multiple spatial and temporal scales but surely in most of its locations, affected by multiple stressors.

Several of such stressors are of an anthropogenic nature. These include ocean acidification and ocean warming; coastal pollution and subsequent alteration of ecological structures and processes; de-oxygenation due to eutrophication and the alteration in ocean stratification patters and, potentially, current regimes; habitat fragmentation and loss and reduced health of coastal 'blue carbon ecosystems' (saltmarshes, seagrasses and mangroves). Moreover, certain stressors may interact with each other under certain conditions, resulting into cumulative effects. These stressors effect the role of the world ocean as a major carbon sink, in terms of both plankton productivity as well as storage of carbon in blue carbon ecosystems. Other stressors, such as macro and microplastics in the ocean add further pressure to an already stressed world ocean. It is necessary to understand and properly manage such multiple stressors if the world ocean is to continue playing its critical functions in relation to the climate system and to mitigation of and adaptation to climate change.

How do stressors impact the role of the ocean in the climate system?



Mitigation and adaptation possibilities related to multiple ocean stressors

- Reducing pressures on ocean ecosystems due to human induced stressors will enhance ecosystem functioning including in terms of carbon absorption and storage.
- Solutions related to mitigation include healthy blue carbon ecosystems; and clean coastal waters.
- Promotion of literacy about the causes and effects of multiple ocean stressors will encourage all stakeholders to adopt a more responsible and informed behavior towards the ocean and its resources
- One of the Strategic Objectives of the UN Decade of Ocean Science for Sustainable Development (2021–2030) is "Understanding the effects of cumulative stressors on ocean systems including the socio-economic dimension". The Decade provides an opportunity to communicate widely about the science of multiple stressors and related cumulative impacts.

Research and observation questions on ocean carbon from a multiple stressors lens

- There is a need to better understand the links between ocean physical and biogeochemical variability and the **impacts of multiple stressors** (e.g., warming, ocean deoxygenation and acidification) **on GHG sources and sinks**.
- There is a need to combine GHG measurements in regions especially critical for GHG fluxes (the polar oceans, coastal and marginal seas, and coastal upwelling zones) with relevant biogeochemical measurements (e.g., oxygen, nutrients) to support GHG data analyses and model simulations.
- There is a need for future experimental research efforts to exploit 'natural laboratories' (e.g., in regions of distinct biogeochemical gradients such as ocean eddies, or following climate and ecosystem perturbations induced by volcanic eruptions) to investigate the response of marine GHG flux changes to multiple environmental stressors.
- There is a need to elucidate further the processes of the microbial and biological pumps in both coastal areas and the open ocean and to assess how these may be affected by anthropogenic stressors such as pollution in coastal areas and by ocean warming.





Knowledge on multiple stressors is crucial for ecosystem-based management

Ecosystem-based management (EBM) is therefore needed to improve ocean health and support ocean sustainability and societal well-being. EBM successfully combines ocean science with Marine Spatial Planning (MSP) – a public process to decide what uses of and benefits from the marine area will be pursued by concerned stakeholders.

Through adaptive MSP (due to changing environmental conditions and the effects of sea-level rise, ocean acidification, de-oxygenation, warming, etc.), based on scientific evidence on the effects of multiple stressors, adequate ocean policies can be devised. Scientific knowledge, an informed general public and enforced stakeholder engagement will result in management actions reflecting the functioning of the ocean ecosystem and allowing it to continue delivering the service of carbon storage and to maintain the degree of health and resilience needed to adapt to climate change.

