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Editorial: Consequences of global change in coastal ecosystems from a multidisciplinary perspective

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Editorial on the Research Topic
Consequences of global change in coastal ecosystems from a multidisciplinary perspective

On the need to investigate ecosystems from a multidisciplinary perspective

Ecosystems will play a key role in the future of our planet, as they are capable of great adaptabilty and are resilient to climate (e.g. Bulleri et al., 2018). However, they are also vulnerable to multifactorial disturbances (e.g. anthropic/Gómez et al., 2022). An ecosystem's long-term response to global change (climate change, biodiversity loss, changes in water cycling, etc.) is also affected by the natural, epistemic, and aleatory uncertainty of the environment.

The methods used to evaluate an ecosystem mean that the services it provides are difficult to quantify and predict. While ecosystem conservation strategies should come from a combination of different perspectives, they are commonly tackled *via* independent disciplines, such as coastal management, coastal engineering, ecology, water quality, etc. and therefore, insights into the long-term conservation of our ecosystems is still a key challenge. The starting point to address ecosystem conservation on a changing planet must be a multidisciplinary characterization of the physical and environmental context.

Summary of contributions

Through nine papers, this special issue emphasises the need to address multi-scale problems with multidisciplinary perspectives in which key physical and environmental issues are highlighted:

Biomass loss

Coastal protection

Future scenarios

Biomass loss

Extreme heatwaves at sea may cause ecosystem loss. For example, Magel et al. analyzed the effect of the increase in water temperature on eelgrass and macroalgae in the marine heatwave of 2013-2016 in the northeast Pacific Ocean in four estuaries (Willapa Bay, Washington, and Netarts Bay, Yaquina Bay, and Coos Bay, Oregon). They found that the eelgrass biomass declined for shallower estuaries, with normally higher temperatures. In contrast, there was a neutral or temporarily positive change in aboveground eelgrass biomass in the deeper and colder estuaries.

Similar conclusions were found in another study in the Coos Estuary by Marin Jarrin et al., which also analyzed the impacts of the unusually warm oceanic and atmospheric conditions that occurred from 2014-2016. They found that an increase of at least 1.5°C for over 100 days induced stress and caused eelgrass loss at some stations in this shallow estuary.

At the other end of the temperature spectrum, Ren et al. examined abundance and composition in the bacterial community in Aoshan Bay, in the southern Yellow Sea, during a cold surge in January 2021. They identified differences in the abundance of bacteria in the sea ice and in seawater, presumably from the physical impact of ice formation.

Also associated with biophysical changes, Fang et al., used an integrative model to show that the 304 ton decrease in ragworm biomass in the Western Scheldt estuary (Netherlands) between 1955 and 2010 was driven by alterations in peak current velocities and inundation times in the intertidal habitat, resulting from deepening, dredging and disposal activities.

Coastal protection

Changes in hydrodynamic patterns and ecosystem health may alter valuable ecosystem services, such as coastal protection. On a local scale, Maximiliano-Cordova et al. studied how plants contribute to mitigating dune erosion during a single storm, by monitoring dune evolution on three beaches in the state of Veracruz, Mexico. They found that plants provide dune resistance but that this resistance is site- and species-specific, strongly depending on the pre-storm dune and conditions for species.

Salt-marsh ecosystems also provide valuable coastal protection services, although anthropization and extreme events damage the marsh vegetation and alter this capacity. Reents et al. investigated the response of salt-marsh vegetation to extreme hydrodynamic conditions in a true-to-scale flume experiment. They found salt-marsh vegetation generally had high robustness, although this varied between species: pioneer species showed higher resistance than the high-marsh species.

Future scenarios

As climate change and local and regional anthropization are often responsible for ecosystem loss, McMahon et al. developed a spatially explicit risk model to determine the impacts of various factors on seagrass along the 35,000 km of the Australian coast. They identified two risk hotspots based on climate change (i.e., increase temperature, increased rainfall, and sea level rise), and many other areas at high risk due to multiple threats (e.g., resuspension, industrial pollution, shipping accidents).

Regarding marine species, Diaz-Carballido et al. generated models in Maxent for four climate change scenarios (RCP2.6, RCP4.5, RCP6.0, and RCP8.5) to predict the geographic distribution of 25 carcharhinid sharks that inhabit Mexican waters. They determined that by 2050, climate change will reduce the areas suitable for most of these species.

Loss of ecosystem services can be quantified in terms of economic losses. For example, Fernández-Díaz et al. estimated a loss of 6 billion USD for flooding related to the loss of ecosystem services in Mexico under a scenario of sea level rise of +0.84 m from SSP5-8.5 (2081-2100).

Outlook

While the papers in this special issue do not give a definitive answer as to how coastal ecosystems and their services are affected by climate change processes, they do illustrate how physical and environmental perspectives should be integrated to get a system understanding. We hope this special issue will inspire scientists to document case studies, and to measure key parameters in order to gain a full understanding of how coastal ecosystems function and, over time, feed into predictive models to help better manage them.

Author contributions

RS and VC wrote the first draft of the manuscript. NM, TB and IO revised and edited the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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