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Editorial: Coastal biogeomorphology

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Editorial on the Research Topic
Coastal biogeomorphology

Biogeomorphic feedbacks are the two-way interactions between ecological and geomorphological processes, such as the effects of organisms on earth surface processes and landforms, and vice versa (Naylor et al., 2002). Approximately 84% of the continents' surface is covered by vegetation that is sufficiently dense to affect geomorphologic processes (Corenblit et al., 2011). In extreme environments with low vegetation coverage (e.g., drylands and Antarctica), the effect of biological crusts and bioturbation can still significantly affect geomorphic processes (Cannone et al., 2008; Viles, 2020). Knox (1972) presents one of the first studies on biogeomorphic feedbacks. As a precursor to subsequent works on the interplay between landform and biota changes, Knox reveals the non-linearities in the interactions between climate, vegetation and fluvial morphology processes. Since 2000, the field of biogeomorphological research has been thriving with a rapid increase in the number of related references and citations (Viles, 2020).

In coastal environments, various ecosystems such as intertidal mudflats, salt marshes, mangroves, sea grass beds and coral reefs are typical biogeomorphic systems, where landscape development is closely linked to the interaction between biota and abiotic conditions at multiple spatiotemporal scales (Mudd, 2011; Gong et al., 2021). It is increasingly recognized that biogeomorphic processes in these coastal ecosystems determine their key services and resilience (Kirwan and Mudd, 2012; Zhou et al., 2016). For instance, saltmarsh and mangrove wetlands can provide important services as coastal protection by attenuating wave energy and preventing sediment erosion (Spencer and Möller, 2013; Möller et al., 2014; Yao et al., 2018; Hu et al., 2022). These processes are clear examples of biostabilisation, which enhances accretion and makes coasts more resilient to storm impacts and Sea Level Rise (SLR). Biostabilization thus promotes the persistence of these coastal ecosystems. In turn, bioturbation of the sediment by macrozoobenthic organisms' activities is an example of a biogeomorphic process that releases sediment into the coastal system, which has an important impact at both local and landscape scales (Cozzoli et al., 2020, Cozzoli et al., 2021).

Although the general concept of two-way bio-physical interactions is known to the research community, our understanding of the key biogeomorphic mechanisms and the related thresholds for ecosystem survival is still lacking. Thus, more research effort is needed to improve our capacity for a better, scientifically-informed, management of the coast. This is especially important in the context of coastlines' natural dynamism and their response to human interference and global climate change. These factors are driving changes to sea level, wave climates and sedimentary regimes that are unprecedented over Holocene timescales (De Dominicis et al., 2020; Hu et al., 2021). Appropriate coastal management must rely on advancements in theory and methodology, as well as, crucially the application of biogeomorphological research in coastal contexts (Viles, 2020). The 19 papers in this Research Topic address important coastal biogeomorphic processes, and can be grouped as: 1) coastal wetlands under SLR, 2) coastal protection services, 3) key traits and dynamics of coastal ecosystems, and 4) innovative research methodologies and their application.

The first group of articles in this Research Topic investigates the resilience of coastal wetlands under SLR. From a modelling perspective, Kumbier et al., shows that SLR may influence tidal range by changing wetland extents and intertidal wetland geomorphology through sedimentation. Thus, in channelized estuaries, interconnections between hydrodynamics and intertidal wetlands needs to be accounted for when estimating wetland response to SLR. Rogers et al. focus on relationships between SLR, sedimentation and coastal wetland dynamics, using short-term (< 10s years) data of surface elevation observation and long-term (> 10s years) data of ^{210}Pb chronology of shoreline change. It provides a rare comprehensive dataset of coastal wetland sedimentation and elevation adjustment in the southern hemisphere, and an interesting record of diverse marsh and mangrove response to SLR. As a complimentary study, Rogers and Saintilan assess the processes influencing surface morphodynamics including variation in substrate characteristics, autocompaction and vertical accretion. Walters et al. report a 5-year long field experiment to reveal the ability of marsh to retreat to adjacent uplands. Himmelstein et al. investigate the characteristics and mechanism of pond growth in coastal marshes under SLR. Importantly, they provide an empirical power-law equation to predict the pond growth and the critical time window for interventions to prevent the irreversible pond expansion or merging.

The second group of articles investigates the coastal protection service provided by wetlands. Zhou et al. document variations in wave attenuation by mangroves of different ages, providing a rare *in-situ* dataset and useful information on wetlands' wave attenuation capacity needed for nature-based coastal protection scheme. Besides wave attenuation, the promotion of sedimentation is another important ecosystem service of mangroves. Sayers and Reef report that while large scale (1 km^2) patterns of sedimentation are temporally consistent, small scale patterns (< 100 m^2) consist of large temporal variations, where local mangrove density and wave height seem to have no direct impact. Based on an XBeach model, Chen et al. illustrate that the combination of sand nourishment and seagrass meadow restoration (i.e., so-called 'green nourishment'), can be an effective nature-based coastal protection measure for sandy coasts.

The third group of contributions aims to reveal the key traits and dynamics of coastal ecosystems, which are closely related to their resilience and function. Hitzegrad et al. report topographical roughness parameters of *Magallana gigas* oyster reef surfaces in the central Wadden Sea. The obtained information can assist the quantification of the interaction between hydrodynamics and reef structures. Based on a mesocosm experiment, He et al. reveal that root morphological features of mangrove seedlings are significantly affected by substrate (sediment characteristics) but not by nitrogen input, providing implications for restoration. Contrastingly, Wang et al. report that nitrogen input together with herbivory may both influence the health of seagrass ecosystems, but their relative importance is mediated by turbidity. Zhu et al. investigate the impact of wave and related sediment dynamics on saltmarsh seed banks and imply that climate change may threaten saltmarsh persistence by wearing away its seed banks. Smit et al. find that when considering the reduction in critical bed shear stress (τ_{cr}) for sediment resuspension by a group of macrobenthic species, the specie that has the largest individual effect in reducing τ_{cr} plays a dominated role in determining τ_{cr} variation, rather than that with the highest metabolic rate. Continuing with the subject of bioturbation, Wiesebron et al. reveal that benthic macrofauna change their behavior under different sediment bulk densities (a measure of sediment compaction and water content): lower bulk density conditions lead to more active macrofaunal movement and sediment reworking. This subtle but important variation may have long-term impacts on tidal flat biogeomorphology.

The last group of articles develops either predictive modelling or new data processing techniques that can be used to quantify or predict ecogeomorphic evolution of coastal wetlands. Finotello et al. build a new marsh vegetation dynamics model based on the fundamental niche of each halophytic species, enabling the quantification of dispersal and interspecific competitions. Kleinhans et al. present a novel automated image classification method that allows objective mapping of saltmarsh and tidal flat area dynamcis at an unprecedented resolution. This method offers a practical tool for estuary-scale ecosystem management and comparison between estuaries. Willemsen et al. applied recently-developed Optical (Hu et al., 2015) and Acoustic Surface Elevation Dynamics sensors (O-SED and A-SED) to continuously monitor bed level dynamics around the edge of natural and semi-natural salt marshes. The obtained data highlights possibilities of developing favorable conditions for marsh restorations. Liu et al. and Pang et al. address the technical challenges of using ADV (Acoustic Doppler Velocimeter) to separate wave and tidal current forcing and detect bed level change in coastal biogeomorphic systems.

Overall, the 19 articles in this Research Topic represent important datasets, interesting dynamics as well as novel methodology in coastal biogeomorphology. This Research Topic as a whole advances our current understanding and research capacity towards better management of the dynamic coastal biogeomorphic systems, and we hope that it inspires further discussion and exploration.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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