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Editorial

Coastal Wetlands

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Coastal wetlands are valuable and sensitive environments that are among the most productive yet highly threatened systems in the world. They are typically located in areas where freshwater and saltwater mix, such as estuaries, lagoons, deltas, and have many forms, including mangrove forests, salt marshes, seagrass beds and tidal flats [1]. These ecosystems are characterized by a unique combination of hydrology, soil conditions, and vegetation that allows them to thrive in the harsh coastal environment. The complexity of coastal wetland systems can be better understood within the context of the biogeomorphology that includes the coastal landscapes of which they are a part. They provide numerous ecosystem services, including habitats for wildlife, water filtration, carbon sequestration, and storm protection [1]. One of the most important roles of wetlands is the regulation of global climate change through sequestering and releasing a major proportion of fixed carbon in the biosphere. Global climate change is expected to exacerbate the loss and degradation of many coastal wetlands and the loss or decline of their species and to harm the human populations dependent on their services; however, projections about the extent of such loss and degradation or decline are not yet well-established.

The Special Issue "Coastal Wetlands" includes eight contributions published during 2020–2022. The contributions can be subdivided into the following subjects: cartography, carbon sequestration, halophytic vegetation and impacts of global climate change.

Historical mapping provides very valuable information for the understanding of the geomorphological evolution of the coastal wetlands, and, in most cases, it represents the first step in the analysis of coastal processes [2]. Piccardi et al. (2020) [3] have carried out an interesting study on the historical evolution (16th–20th Century) of Cispatá Bay and Mestizos (Colombian Caribbean coast) from ancient documents and maps. They have had to review about 500 manuscripts or printed maps produced from the 16th century to 1937, time when the Tinajones delta was formed in the mouth of Sinu River. Some cartographies were georeferenced, and others were visually analyzed. The analysis of all the documents clarifies the evolution of this coastal stretch and allows establishing a new reconstruction of the formation stages of Cispatá bay.

Carbon sequestration is one of the most important ecosystem services provided by coastal wetlands. Coastal wetlands can capture carbon dioxide (CO_2) from the atmosphere and store it in plants and in the soil, helping to mitigate the effects of climate change. Coastal wetlands are among the most effective natural carbon sinks on the planet, removing up to 10 times more carbon per unit area than tropical rainforests [4].

Mao et al. (2021) [5] measured total organic carbon (TOC), total nitrogen (TN), and stable carbon isotopes ($\delta^{13}C$), in surface sediments from vegetated intertidal saltmarsh areas and bare tidal flat sediments near (BF1) and far (BF2) from the vegetated areas, along the Rudong Coast (eastern coast of China). These observations were used to explore the spatial distribution of organic carbon in different depositional environments. The distribution and sources of organic carbon were examined under different depositional environments based on C/N ratios and a two-terminal mixing model. The results showed that the organic carbon content of the vegetated saltmarsh sediment is higher than that of the bare tidal flat areas, with the tidal flat sediments nearer to the vegetated area (BF1) having a relatively higher organic carbon content than sediments further away (BF2). The C/N ratios reflect an increasing marine contribution with distance from the vegetated zone. Combined with the two-terminal mixing model, the organic carbon in the vegetated saltmarsh sediments was dominated by terrestrial sources, while the bare tidal flat sediments (BF2) were more influenced by marine sources (including phytoplankton) and the bare tidal flat sediments nearer to the vegetated zone (BF1) were influenced by a combination of vegetation, marine sources, and other terrestrial factors. The results of this study help to clarify the influence of coastal zone vegetation on the source(s) of organic carbon, which may contribute to the development of "blue carbon" programs in the future.

Aitali et al. (2022) [6] analyzed the effects of land use/land cover changes on carbon stocks, over 20 years, in six North African coastal wetlands (three lagoons: Moulay Bouselham, Marchica and Ghar El Melh and three estuaries: Tahaddart, Moulouya and Reghaia), and estimated the economic value of the carbon sequestered during the considered period. The methodology used combined remote sensing and modeling (InVEST-CSS model). The results showed that among the six studied sites, only two (Moulouya and Moulay Bouselham) showed an increase in stored carbon and therefore are potential carbon sinks. In turn, the other four showed a significant loss of carbon, which will likely be released into the atmosphere. The underlying processes that drive changes in carbon dynamics are mainly urban expansion and land use conversion, which often occur at the expense of the natural habitats surrounding the wetlands. This study showed that less anthropized sites, such as the Moulouya wetland, store more carbon and therefore deserve to be protected from coastal development, which is detrimental to their sustainability. Understanding these processes can provide valuable decision-making information for land use planning, wetlands conservation and carbon reduction policies.

Greenhouse gas (GHG) emissions are also an important aspect of coastal wetland ecosystems. Wetlands are known to be sources and sinks of a range of greenhouse gases, including CO_2 and methane (CH_4). CH_4 emissions from wetlands are of particular concern, as CH_4 is a potent greenhouse gas with a global warming potential 25 times greater than CO_2 over a 100-year period [7]. Coastal wetlands are known to be significant sources of CH_4, due to the high levels of organic matter in their soils and the presence of anaerobic conditions, which are conducive to methanogenesis.

Following this line, Dang et al. (2021) [8] have developed the GHG Emissions Model for tidal flat areas based on the carbon mass balance to simulate the carbon dynamics. The model assumes that the tide flat layer is composed of two layers: young layer (YL), defined as the layer where organic carbons are decomposed biologically to generate CO_2 only under aerobic conditions, and old layer (OL), defined as the layer where those emit CO_2 and CH_4 under anaerobic conditions. The model has been verified using annual carbon accumulation in sediment from 2017 to 2020 and daily CO_2 and CH_4 emissions in 2019 from four different locations in Ganghwa, Korea. In general, the simulation results of the model show a significant increase in CH_4 emissions in the future, while CO_2 emissions will remain relatively stable. The main reason is due to the increased sequestration of carbon in the sediments. Dang et al. [8] point out the interference of the other factors such as tides, changes in salinity, the content of microbial enzymes, etc., as well as factors affecting the change in carbon content in sediments, which could contribute to the uncertainty of the model. Finally, they point out that understanding the characteristics of the coastal wetland emissions is critical for devising future climate change mitigation strategies.

Coastal wetlands are also home to a wide variety of plant and animal species, many of which are adapted to the unique conditions found in these ecosystems. Halophytes are adapted to the high salinity of coastal soils and can tolerate a wide range of environmental conditions, including flooding, drought, and nutrient-poor soils. Halophytes are also important contributors to the carbon storage capacity of coastal wetlands, with the high rates of plant production and decomposition contributing to the accumulation of organic matter in the soil.

Park et al. (2021) [9] aimed to obtain information on the diversity and distribution of the endophytic fungi within emersed halophytes in Korean Ramsar wetlands (Suncheon Bay, southern coast of the Korean Peninsula). The salt marshes of Suncheon Bay are formed by two types of ecotones (tidal flats and deltas) that are supported by the emersed halophytes *Phragmites australis* and *Suaeda japonica*. Overall, 324 endophytes were isolated and partially identified. Higher variance in diversity indices and unevenness was observed in the delta marsh compared with the tidal flat marsh. Further, morphological diversity in the delta salt marsh was 1.8 times higher than that of the tidal flat. Several dominant fungal genera (*Aspergillus, Cladosporium, Penicillium, Epicoccum, Paraconiothyrium, Septoriella,* and *Talaromyces*) were widely distributed regardless of the aquatic conditions or halophyte species. This study highlights the distinct distribution and diversity of marine endophytes in various ecotones that can physically protect the coastal areas. This data are valuable to secure a national culture collection for future restoration of the coastal wetlands and their ecosystems.

Despite their importance, coastal wetlands are vulnerable to the impacts of global climate change, which include sea level rise, changes in temperature and precipitation patterns, and extreme weather events. In addition, such areas have been actively modified by human activities, especially for agriculture, which leads to a loss of ecosystem services impacts the human welfare as well as the regulation of climate change by coastal wetlands [10].

Rodríguez-Santalla and Navarro (2021) [11] carry out a review of the coastal wetlands state, paying special attention to the Ebro Delta (Spain), identifying the main threats it faces, as well as possible adaptation and mitigation strategies to these changes driven by climate change. The study shows that the effects on the Ebro Delta are similar to other Mediterranean coastal lagoon systems, and it is remarkable how most of them suffer the consequences of environmental changes linked to coastal erosion, subsidence, and meteorological events extremes recently amplified by global change. This article also makes an interesting comparison of the strategies for adaptation and mitigation of Global Change in the Ebro Delta with other Mediterranean deltas, showing the need to accelerate scientific research and expand monitoring and forecasting programs, impact studies and public consultations to prevent their disappearance.

The development and maintenance of the coastal lagoon systems are associated with the persistence of the barrier that protects them. Thus, Rodríguez-Santalla et al. (2021) [12] apply a vulnerability index in the dune field located in the Riumar, which represents the natural barrier of the El Garxal coastal lagoon system (Ebro Delta, Spain). The index used integrates the dimensions of exposure, susceptibility, and resilience from the analysis of 19 variables. The results obtained show moderate susceptibility and high resilience. The study concludes that the study area shows a low vulnerability and is able to withstand the most severe conditions as long as it has enough time for recovery. However, the El Garxal coastal barrier-lagoon system is located in a highly fragile environment and coastal flooding and erosion events are expected due to the influence of climate change that would increase the vulnerability of this coastal stretch, endangering the persistence of all the whole system.

Navarro et al. (2021) [13] reviewed the current environmental status of the arid coastal wetlands of northern Chile (Lluta, Camarones, Loa, La Chimba, Copiapó, Totoral, Carrizal Bajo) in terms of regulations, management, and future aims. These coastal wetlands go unnoticed despite being located in areas of high water deficit (desert areas) and their role in bird migratory routes along the north–south coastal cordon of South America. The main natural and anthropogenic threats to these coastal wetlands were identified, as well as the main management tools applied for their protection. They are severely threatened by a wide variety of both natural (winter storms, tsunamis, sea-level rise, and droughts) and anthropogenic processes (urban sewage, industrial waste, the advancement of agricultural and urban borders, the effect of introduced species and irrigation ditches, clandestine landfills) and the lack of legal and practical mechanisms ensuring the future viability of the few currently protected wetlands. In all of them, uncontrolled tourism occurs with consequent wildlife perturbation and the occurrence of illegal dumping sites and/or wildfires. Furthermore, the exploitation of surface and groundwater resources next to and upstream of the wetlands is the most hazardous threat, as these ecosystems occur because of the input of freshwater, either surface water or groundwater, that governs the suitability of local conditions for specific wetland species. The study showed that there is a lack of management tools and there is mismanagement of the coastal wetlands in northern Chile. The convergence of many institutions with different competences leaves some aspects uncovered and some functions uncoordinated, such as regulatory inspections. Hence, the scarcity of categories that protect these coastal wetlands, and the failure of these categories to consider the particularities of arid wetlands, makes them especially vulnerable. These dryland coastal wetlands should be preserved not only because of their uniqueness, but also for the ecosystem services they provide.

The articles published in this Special Issue have contributed to a better understanding of the processes affecting such important ecosystems as coastal wetlands, as well as to assessing their contribution to climate change mitigation and vulnerability.

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