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EDITED AND REVIEWED BY  
Jay E. Diffendorfer,  
United States Department of the Interior,  
United States

\*CORRESPONDENCE  
Alice Newton  
✉ anewton@ualg.pt

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# Editorial: Ecosystem services, biodiversity, and water quality in transitional ecosystems

Alice Newton<sup>1\*</sup>, Michele Mistri<sup>2</sup>, Angel Pérez-Ruzafa<sup>3</sup> and Sofia Reizopoulou<sup>4</sup>

<sup>1</sup>CIMA, Centre of Marine and Environmental Research\ARNET - Infrastructure Network in Aquatic Research, University of Algarve, Campus de Gambelas, Faro, Portugal, <sup>2</sup>Department of Chemical, Pharmaceutical and Agricultural Sciences, University of Ferrara, Ferrara, Italy, <sup>3</sup>Department of Ecology and Hydrology, International Excellence "Mare Nostrum", Universidad de Murcia, Murcia, Spain, <sup>4</sup>Hellenic Centre for Marine Research (HCMR), Institute of Oceanography, Anavyssos, Greece

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## Editorial on the Research Topic

Ecosystem services, biodiversity, and water quality in transitional ecosystems

Transitional ecosystems, including estuaries, lagoons, and coastal lakes, are complex human-environmental systems that offer a wide range of societal benefits, including both commercial and non-commercial values. This book sets the stage for significant advances in several aspects of transitional ecosystem research and management.

Climate change shifts in temperature, precipitation, storminess, and sea levels affect the evolution of transitional ecosystems, including the functioning of ecosystem processes, and alterations to species biodiversity. Long-term coastal observations and historical reconstructions can thus provide valuable insights into the consequences of global change on transitional ecosystems (Newton et al.).

The complexity of transitional ecosystems is further increased by the activities of economic sectors that take place in them, acting as drivers of change with different degrees of (un)sustainability. The most important sectors are tourism, fishing, aquaculture, salt mining, industrial activities, maritime shipping and ports, development of urban areas, and related activities, and agriculture. These complex, coastal zones are therefore subject to various social and environmental pressures, including changes in land use, hydrology, and sedimentology, as well as the extraction of mineral resources such as salt and sand. These pressures can lead to changes in the physical environment, including variations in geomorphology or salinity and dissolved oxygen levels, and can also result in the loss of biodiversity and the decline of important ecosystem services, such as coastal protection and seafood. The combination of past interventions, physical forcing functions and present activities is responsible for the numerous pressures and issues that threaten transitional ecosystems (Newton et al.). Understanding the causes and consequences of these anthropogenic pressures helps to identify effective management strategies that minimize negative consequences and promote the sustainable use of valuable resources. By understanding the drivers of change and the impacts of human activities, managers can work toward the sustainable use and conservation of these important systems. This may involve a range of measures, such as the regulation of freshwater inflows and connectivity, the implementation of best management practices and the designation of protected areas.

Environmental, economic and social issues call for new integrated management perspectives. The need for systematic conservation planning has further motivated the analysis of patterns and processes at regional scales. Social-environmental analysis is a useful tool to inform management of coastal lagoons. El Mahrad et al., shows this for 11 lagoons in North Africa by applying an adaptive management framework (Drivers-Activities-Pressures-State Change-Impact-Responses), to provide a structured approach for the social-ecological analysis of coastal lagoons systems to identify potential management measures as responses to address negative impacts.

Human activities and pressures, such as land use change and pollution, can also have significant consequences on the biodiversity and water quality of transitional ecosystems. The implementation of environmental policies, such as Natura 2000 and the Water Framework Directive (WFD), provide a legal framework for improving water quality, ecological status and biodiversity. Picone et al., using the polychaete worm *Hediste diversicolor*, show the biota itself can be used to monitor contaminant levels in the environment. In this example, *Hediste diversicolor* bioaccumulates polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs).

Biodiversity and water quality are important aspects of the functioning and value of transitional ecosystems, to both human and animal populations, such as birds. The distribution and abundance of water birds can also be used as indicators of ecosystem health and water quality, as many species are sensitive to changes in their habitat and can be affected by pollution and other forms of human disturbance (Maneas et al.).

Coastal lagoons and other transitional ecosystems thus provide a range of valuable goods and services that support human wellbeing and economic development. Ecosystem services, including both commercial and non-commercial values, can be important considerations in the management and conservation of transitional ecosystems. Coastal management approaches that consider the full range of ecosystem services can help to ensure sustainable use of these systems. These ecosystem services offer a wide range of societal benefits. Key ecosystem processes, such as nutrient cycling and primary production, can support the biological resources that underpin these industries. In addition, these ecosystems play a critical role in the regulation of environmental processes, such as the purification of water, the sequestration of carbon, and the protection against storms and erosion. Some are commercial and can be readily valued in monetary terms, for example shellfish and finfish harvested for human consumption, as well as timber and medicinal plants (Afonso et al.).

The ecosystem services approach values the ecosystem by a variety of means, including monetary, non-monetary and ecological. There is also a need for more research on the spatio-temporal evolution of the ecological services provided by mangroves and salt marshes in transitional ecosystems. Practical methodologies can be used to quantify the variability of limiting factors that impact the provision of these services, as shown by the literature review of Carrasco. Such studies can help to identify the key drivers of change and inform the development of effective conservation and management strategies to maintain

the resilience of these ecosystems and the benefits they provide to humans. Furthermore, the use of modeling, to better understand the consequences of human activities combined with climate change, provide the knowledge-base necessary to identify potential methods to improve the functioning of coastal lagoons and restoration options.

Effective conservation and management of transitional ecosystems is essential to maintain and enhance the goods and services they provide. Coastal management strategies and decisions should also consider the social, cultural, and historical values of these ecosystems, as well as the interconnections between lagoons and other marine protected areas (De Wit et al.). Transitional ecosystems may also be connected to marine protected areas (MPAs), and the interplay between these systems can be important in terms of conservation and sustainable use. This may involve a range of approaches, such as the identification and protection of key habitats, the restoration of degraded areas, and the implementation of best management practices, such as nature-based solution, for example using reed-beds (Karstens et al.).

Transitional ecosystems also offer potential opportunities for sustainable use, such as the exploitation of macroalgal biomass as a tool for the recovery of these systems (Sfriso et al.). The use of green and blue infrastructures, such as mangroves and salt marshes and reed beds, can provide multiple benefits, including the enhancement of biodiversity, the protection of coastal communities from storms and erosion, and the provision of recreational and cultural services (Afonso et al.; Karstens et al.). In addition to the traditional goods and services provided by transitional ecosystems, there is also potential to produce energy and the development of blue growth and blue infrastructure. The storage of blue carbon in aquatic, riverine, and underwater ecosystems, such as seagrasses, can also have significant economic value.

Overall, transitional ecosystems provide a range of valuable goods and services, and the management and conservation of these systems should consider the full range of these values. For example, unsustainable fisheries and aquaculture activities can also affect transitional ecosystems, requiring strategies and methodologies for adopting sustainable practices in these economic sectors. Transitional ecosystems can also have impacts on human health and wellbeing, both directly and indirectly. For example, the provision of clean water, food, and recreation can all contribute to human health and wellbeing. Nevertheless, transitional ecosystems can also be affected by human activities, such as pollution and contamination, which can have negative impacts on human health. The full range of impacts on human health and wellbeing should be considered when managing and conserving transitional ecosystems. Effective governance and decision-making processes are critical for the sustainable management and conservation of transitional ecosystems. This may involve the participation of a range of stakeholders, including local communities, government agencies, and industries. Inclusive and transparent decision-making processes can help to ensure that the needs and values of all stakeholders are considered.

There are still many questions and challenges to be addressed in the study and management of transitional ecosystems. Future research may focus on improving our understanding of the impacts

of human activities and climate change on these systems, as well as developing and testing new management and conservation approaches (Newton et al.). It will also be important to continue to engage with stakeholders and decision-makers to ensure that the needs and values of all interested parties are considered in the management of transitional ecosystems. The economic value of ecosystem services provided by transitional ecosystems, such as coastal lagoons, is often undervalued and not fully recognized. This can lead to the under investment in their conservation and management. More research is needed to better understand the economic impact of these ecosystems and to develop mechanisms for the valuation and payment of ecosystem services. This could include the use of economic instruments, such as the creation of markets for carbon credits or the development of compensation schemes for the provision of ecosystem services. The potential economic impact of blue carbon stocks, such as those found in mangroves, saltmarshes and seagrasses, is an area of growing interest and could provide a valuable source of funding for the conservation and management of these valuable ecosystems.

## Author contributions

MM provided the outline. AN drafted and edited the text and submitted the editorial. AP-R, SR, and MM provided edits and suggestions. After feedback from the journal Editor, AN re-submitted a revised and improved text. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

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