

Wetland Conservation and Ecological Restoration

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Wetlands, also known as the “kidney of the earth,” are one of Earth’s three major ecosystems, along with oceans and forests. They are widespread worldwide and provide valuable ecosystem services for humans [1]; however, they have also suffered large-scale deterioration and loss, and such events highlight their value and importance [2,3]. In the 21st century, wetland-related issues have alarmed the global community, manifesting through phenomena such as water quality deterioration, eutrophication, water body depletion, and loss of biodiversity [2,4].

To reverse the trend of wetland loss and degradation and mitigate negative impacts, a growing number of wetland restoration efforts have been undertaken in recent years. Ecologists, biologists, and environmentalists have been working to find more effective solutions to restore degraded wetland ecosystems on a global scale [5–9]. However, the efficiency and effectiveness of these methods vary according to different measures, locations, wetland types, and the state of the wetland ecosystem [10]. Moreover, ecological restoration projects may have negative impacts [11–13]. Understanding the basic ecological process mechanisms and recognizing the interactions of different components in wetland ecosystems is crucial for effective and efficient wasteland conservation.

The concepts of “nature-based solutions,” “adaptive management,” and “ecological networks” seem to offer promising prospects and are currently being used to reframe wetland restoration in areas such as critical uncertainties reduction, climate change adaptation, and mitigation strategies [6,9]. As we enter the United Nations’ Decade of Ecosystem Restoration (2021–2030), countries and organizations worldwide will pay closer attention to the innovations underpinning ecological restoration to ensure that restoration efforts reach their full potential in delivering social and ecological coordination and, ultimately, sustainable development.

We aim to advance discussions on the various aspects of wetland conservation and ecological restoration, such as the key ecological processes of wetlands and their implications for restoration; nature-based solutions in wetlands; wetland ecological risks and management; wetland biodiversity conservation; wetland pollution and control; and wetland ecological function improvement. The seven articles and two review papers presented discuss biological aspects, biogenic element, carbon sink function and resilience in wetland, wetland ecological water replenishment, wetland conservation survey, ecological restoration suitability evaluation, and water purification in treated wetland.



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Two of the presented articles discuss the biological aspects of natural wetlands. Chen et al. focus on wetland hydrology's influence on plants. They use hydrological monitoring data to study different flooding conditions and investigate the responses of a typical species in the lakeside wetland in Momoge National Natural Reserve at multiple levels, finding that maintaining seasonal flooding is essential for the natural restoration of *Bolboschoenus planiculmis* wetlands. These findings have important implications for the near-natural restoration of *Grus leucogeranus* habitats. Liu and Zhang consider the responses of microbial communities in urban wetland ecosystems to the atmospheric pollution, especially at three major interfaces of atmosphere, foliage and water. They describe how the structure and function of microbial communities (i.e., α - and β -diversity) change in response to different pollution levels, aiming to provide guidelines for monitoring urban wetland ecosystems and species diversity conservation.

Li et al. studied Dongting Lake, the second largest freshwater lake in China, which is connected to the Yangtze River and provides a valuable habitat for migratory birds. In their paper, they analyze the spatial distribution of nutrients (TOC, TN, and TP) in the soil along a hydrographic gradient and discuss the impact factors of the nutrient patterns. The results enhance our understanding of the relationship between soil nutrient variations and hydrological dynamics in the floodplain and have implications for the conservation of migratory bird habitats.

The two review papers pertain to wetland carbon sink function and resilience to drought. Guo et al. review the impact of ecological restoration on carbon sink function in coastal wetlands. They explain the concept of coastal wetland carbon sink function and its influencing factors; summarize various restoration projects, along with their objectives and measures at the national scale; and discuss the different impacts of restoration measures on the carbon sink function. Finally, they recommend integrating carbon sink function enhancement into the design and implementation of ecological restoration projects. This study provides a comprehensive understanding of the relationship between ecological restoration and carbon sink function, which has significant reference value and management implications for ecological restoration. Meanwhile, Lu et al. discuss plant drought resilience, which is an important indicator of wetland ecosystems' resilience to climate change. They review plant drought resilience at multiple scales, from molecular mechanisms to ecosystem sustainability, and predict future emphasis on multi-scale and multi-dimensional integrated analysis. Their work aims to provide a theoretical basis for ecosystem sustainability and agricultural production under climate change.

Meng et al. propose a novel framework for estimating wetland ecological water requirements. They conduct a case study in the Momoge Wetland, where the current water replenishment projects are inadequate to meet the ecological water demand. To promote the development of dynamic water replenishment strategies, especially during periods of drought, the authors highlight the urgent need to implement multi-source water replenishment techniques. Specifically, their study provides insights relevant to annual and seasonal water replenishment planning and multi-source water management of wetlands that are facing similar issues to the Momoge Wetland, which will help wetland ecosystems adapt to climate change in the future.

Mo and Yan's social science study provides suggestions for wetland conservation. They conducted a questionnaire-based survey in Beijing to systematically analyze the residents' awareness, attitudes, and behaviors regarding wetland conservation and provide constructive suggestions for urban wetland management practices. They point out that the geographical location and functional configuration of wetlands are the main factors influencing residents' behaviors, with higher visit rates recorded at wetlands closer to urban

areas. Moreover, public awareness of wetlands' ecological functions is lacking, particularly with regard to biodiversity conservation and water quality improvement.

Miao et al. evaluate ecological restoration in an Agro-Pastoral Transition Zone and assess the importance of ecological functions, such as soil and water conservation, biodiversity maintenance, windbreak and sand fixation; and ecological sensitivity and protection. They also provide a scientific case study for local ecosystem restoration and conservation which will guide future ecological restoration efforts in such areas. In the future, multi-source data fusion, the establishment of a multi-scale evaluation system, and trade-off analysis between conservation and development will be explored in greater detail.

Moustafa et al. test the effects of physical parameters, such as flow, transport, and water depth, on phosphorus retention in treated wetlands, which could benefit the design of artificial wetlands by enhancing their purification efficiency. They suggest that optimizing flow and depth controls in wetland design and management is important for enhancing phosphorus removal efficiency in large constructed wetland systems.

Wetland conservation and ecological restoration are extensive topics with many unresolved questions. We anticipate that this compilation of papers will offer clear and valuable insights into wetland conservation and ecological restoration, presenting restoration, conservation, and management implications and specific strategies to address areas of uncertainty.

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