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Interaction among Hydrological, Environmental, and Ecological Processes in Aquatic Ecosystems

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In the context of climate change and human disturbance, the hydrological and environmental processes in aquatic ecosystems have undergone significant changes, which could affect the material cycle and energy conversion processes required by aquatic organisms to maintain life. The interaction among hydrological, environmental, and ecological processes is essential to understanding the mechanisms of ecological degradation and design effective measures for ecological protection and restoration in aquatic ecosystems. This Special Issue mainly focuses on such an interaction mechanism and comprises seven papers, which can be classified into three sub-themes, (1) the interaction between hydrological and environmental processes, (2) the interaction between hydrological and ecological processes, and (3) the interaction between environmental and ecological processes.



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1. Interaction between Hydrological and Environmental Processes

Flow Regimes are closely related to the condition of water bodies. Many studies have been performed to establish the relationship between flow regime alteration and ecosystem degradation. However, these papers mainly consider the interaction between hydrological processes and ecological processes. The flow regime also could be an effective indicator for the alteration of environmental processes. Onwuka et al. [1] adopted three different types of rivers (i.e., natural channel with floodplain connectivity, sinuosity, and uninhibited flow, natural and shallow channel with sheet flow, and modified channel due to dredging, straightening, and regulated flow) to analyze the effects of the flow regime on water quality. They proposed that the concentration–discharge (C–Q) relationship should be considered in discharge operations to reduce the transport of nutrient and pollutant loads downstream to ecologically delicate ecosystems.

Wetlands are essential in regional carbon cycles and the carbon balance. Extensive research has been performed on CO₂ sources and sinks of wetlands. However, few research articles have investigated CO₂ flux in plateau wetlands. Accordingly, Wu et al. [2] adopted a wetland in the Qinghai–Tibet Plateau and performed a long-term experiment to reveal the temporal and spatial characteristics of CO₂ flux. This research indicated the wetland ecosystems in plateau served as a strong carbon sink in warm seasons.

2. Interaction between Hydrological and Ecological Processes

Algae are an important primary producer in aquatic ecosystems. Their growth processes are related to many hydrological factors. It is necessary to describe the growth processes by mathematical models. Traditionally, the non-uniform sampling method is used to optimize the sampling temporal schedule. However, this method depends on prior knowledge of the nominal values of the model parameters and largely ignores the uncertainty associated with the nominal values. Li and Zhang [3] designed a new method

that coupled the traditional uniform and non-uniform sampling schedules by adopting the D-optimal design and Monte Carlo simulations. The new method could be effective for sampling schedule design in algae research.

Fishways are important facilities to mitigate the influence of dams on fish migration, but fishways will change the hydraulic condition, leading to the difficulty of fish swimming. It is necessary to reveal the influence of hydraulic conditions on fish's swimming ability. Anaerobic metabolism is a useful indicator to reflect fish swimming ability. He et al. [4] performed an interesting experiment to reveal the influence of flow velocity on anaerobic metabolism. In this research, they determined the flow velocity at which adult crucian carp started anaerobic metabolism and established a function between oxygen consumption and swimming speed.

The connectivity of wetland (rivers, canals, ditches, lakes, and ponds) system network plays an important role in the ecological function maintenance of wetlands. Connectivity evaluation is an important procedure to design wetland restoration measures. Due to the difference in structures, morphologies, and attributes for different wetland types, it is necessary to consider this difference during wetland connectivity evaluation. Accordingly, Tian et al. [5] proposed to define this difference as grade characteristics and established a new method for connectivity evaluation by incorporating grade characteristics. This method offers a promising measure for the function maintenance of wetlands.

3. Interaction between Environmental and Ecological Processes

The hydrochemical characteristics of rivers could influence the growth of zooplankton. To investigate this influence, Yermolaeva et al. [6] performed a long-term experiment for the composition of zooplankton in the Ob River, Russia, in the years 1994, 1996, 1999, 2001, 2002, and 2009. This experiment found that species richness and abundance were closely related to the temperature in the month before sampling; PH had a negative correlation, while phosphate and nitrate concentrations had a positive correlation with zooplankton abundance. These findings offer valuable scientific support for zooplankton management.

The heavy metals in wetland ecosystems could impose ecological risks on waterbirds. Previous studies have effectively revealed the distribution characteristics of heavy metals in water and sediments. However, the heavy metals in the snow cover of wetlands have seldom been considered. Zhang et al. [7] found the areas with high residues of heavy metals were all located near the buffer zone of the wetland (except for Zn). They further pointed out that the exposure risks to winter resident birds from snow ingestion was minimal, but the risk was higher in birds with lower body weights.

Collectively, the papers in this Special Issue could be helpful to advance the research on interactions among hydrological, environmental, and ecological processes in aquatic ecosystems and could provide some ideas about aquatic ecosystem restoration measures by regulating hydrological and environmental processes.

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