water

Editorial

Integrated Ecohydrological Models in Aquatic Ecosystems

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Citation: Wu, N.; Wang, Y.; Wang, Y.; Cai, Q.; Ouyang, W. Integrated Ecohydrological Models in Aquatic Ecosystems. *Water* **2022**, *14*, 204. https://doi.org/10.3390/w14020204

Received: 20 November 2021
Accepted: 17 December 2021
Published: 11 January 2022

As a critical component of the global environment, aquatic ecosystems support a wide range of organisms, including bacteria, fungi, algae, invertebrates, plants, and fish [1]. With the rapid population increase and economic development, aquatic ecosystems have been increasingly affected by human induced stressors, such as nutrient enrichment, organic and inorganic pollution, land use change, geomorphological alteration, water abstraction, invasive species, and climate change [2–5]. These stressors interact and result in complex effects on organisms, and ultimately on biodiversity, ecosystem functions, and services that are vital for human well-being [3,6–12]. Restoration and sustainable management of aquatic ecosystems affected by multiple stressors is thus a key contemporary challenge for environmental scientists and policymakers [13–15]. Integrated ecohydrological models enable us to run "virtual experiments" and are helpful to disentangle the complex interaction of stressors and organisms, and compare the impacts of different management scenarios on aquatic ecosystems [16–18]. To explore the impacts of environmental changes on aquatic organisms, several biological models have been constructed. One example was an empirical macroinvertebrate community model Habitat Evaluation Tool (HET), which was developed to assess the impact of substrate changes on macroinvertebrate assemblages and ecological status [19]. Recently, another freshwater ecosystem health index (FEHI) model has been built based on a modified zooplankton-based index of biotic integrity (ZIBI) to compare and estimate the health of aquatic ecosystems from different watersheds in eastern China [20]. So far, studies about integrated models are still rare, although there are a few successful implementations [16–18,21]. In addition, most of these previous successful models were focused on specific species rather than key taxonomic identities, but see [22,23].

Prompted by the importance of integrated models on aquatic ecosystems and research scarcity in this field, three authors (Profs Naicheng Wu, Qinghua Cai and Wei Ouyang) of this paper have jointly proposed a Special Issue "Integrated Ecohydrological Models and Aquatic Ecosystem Management", which aimed to attract high quality manuscripts in the field of integrated ecohydrological models and/or aquatic ecosystem management. We wanted to bring scientists and policymakers addressing aquatic ecosystems around the world together to explore the state-of-the-art methods, study the key research questions for aquatic biodiversity and associated management strategies, and identify the on-going and potential future perspectives in order to progress the use of integrated models in aquatic ecosystems. This Special Issue collected finally only very few articles (4 research and 1 review articles), which was unexpected but partially reflected the big research gap in this field. Studies covered a variety of geographic locations from a single tropical lake of south China [24], Pearl River Delta [25] to the Upper Yangtze River Basin [26] and South-to-North Water Diversion Project [27]. These articles also considered distinct environmental variables, such as water temperature [24], river discharge [26], and various taxonomic groups including zooplankton [25] and macroinvertebrates [27]. The review article by

Chen et al. (2020) [28] addressed the updating history, pros, and cons of the Regional Hydro-Ecological Simulation System, a tool to simulate the interactions between ecological and hydrological processes, to improve the system and promote ecohydrological studies.

Intensifying climate change and human activities highlight the urgency and importance of evaluating the ecological status of aquatic ecosystems. Aquatic organisms, e.g., algae, zooplankton, macroinvertebrates, have been widely used to measure environmental impacts, and as bioindicators in biomonitoring and bioassessment [29]. Gao et al. (2021) examined the population characteristics of *Brachionus calyciflorus* and found that the spatial and temporal distribution of *B. calyciflorus* could reflect pollution in water bodies and could be used to evaluate water quality. Jiang et al. (2020) employed macroinvertebrates as a bioindicator to evaluate the potential impacts of a big water transfer project (i.e., South-to-North Water Diversion Project) on an important storage lake. Their study provided useful background information on macroinvertebrate communities and environmental conditions before the water transfer and proposed several management strategies.

Rising air temperature can be absorbed by water bodies, leading to increasing water temperatures in aquatic ecosystems, such as lakes and reservoirs, which affect aquatic organisms, biodiversity, and even ecosystem functions. The understanding of reservoir water temperature has thus been widely studied. Gu et al. (2021) has developed and verified a water temperature model (i.e., a vertical one-dimensional numerical model) for a tropical reservoir in Hainan Province, China. Their results showed that the modeled water temperature agreed with the observations very well, and the model was feasible for water temperature simulations in large reservoirs in tropical zones.

Among the impacts of climate change, extreme hydrological events often cause enormous economic and catastrophic environmental damage throughout the world. Therefore, there is an urgent need to explore the impacts of climate change on water resources by coupling the climate model with hydrological models. Wu et al. (2021) integrated four hydrological models with four global climate models and assessed the impacts of temperature and precipitation changes on the discharge in the upper Yangtze Basin from pre-industrial to the end of the 21st century. Their results indicated that decreases in precipitation often resulted in the decline of mean discharge, while increases in precipitation did not always lead to increases in discharge because of the temperature rise. These extreme events were expected to be more intense and frequent in the future, which could have potential devastating impacts on the society and ecosystem in this region.

In sum, although there were only a limited number of articles in this Special Issue, it incorporated diverse topics on the impacts of anthropogenic activities on freshwater ecosystems and explored ecohydrological models and management in aquatic ecosystems. However, the relevant topic warrants further deep and wide investigations.

Author Contributions: Conceptualization, N.W.; methodology, Y.W. (Yixia Wang) and Y.W. (Yaochun Wang); formal analysis, Y.W. (Yixia Wang) and Y.W. (Yaochun Wang); writing—original draft preparation, Y.W. (Yixia Wang), Y.W. (Yaochun Wang) and N.W.; writing—review and editing, N.W., Q.C. and W.O.; supervision, N.W.; project administration, N.W. and Q.C.; funding acquisition, N.W. and Q.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Key R&D Program of China, grant number 2017YFC0506406; the Strategic Priority Research Program of Chinese Academy of Science, grant number XDA23040500, the Foundation of Key Laboratory of Southwest China Wildlife Resources Conservation (Ministry of Education), China West Normal University, China, grant number XNYB18-06; the Starting Grants of Ningbo University, grant numbers 421999292 and 422110123.

Acknowledgments: We are grateful to all colleagues who submitted, reviewed and edited manuscripts for this Special Issue.

Conflicts of Interest: The authors declare no conflict of interest.

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