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Editorial

Hydrological Modeling in Water Cycle Processes

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The water cycle shows the continuous and complex movement of water within the earth and atmosphere in which water moves from the land and ocean surface to the atmosphere and back in form of precipitation. The water cycle maintains the balance of the natural ecosystem and promotes the development of human society. In turn, the water cycle has been affected by human activities and a changing environment. Therefore, it is significant to understand the water-cycle processes and their responses to human interferences and environmental changes [1].

Developing hydrological models to describe the processes is a critical strategy of studying the water cycle. There are many forms of hydrological models, as they were originally designed to solve different problems, of which the two primary objectives are the followings: (1) to gain a better understanding of the hydrological processes operating in a catchment and of how changes in the catchment may affect these processes and their relationships; and (2) to generate synthetic sequences of hydrological data (in both gauged and ungauged catchments) for facility design, water resources management, and/or flow forecasting. In past decades, they were also used to study the potential impacts of changes in land use or climate, reservoir operation, real-time hydrodynamic streamflow routing, real-time flood inundation evaluation, etc.

Although great progress has been achieved in the application of hydrological models, challenges still exist in the area. Water-cycle processes become more complex and are increasingly affected by climate change and human interferences under global warming and increasing the number of water conservancy facilities. Current researches lack a further mechanism exploration about the impact of this changing environment on the water-cycle process and corresponding effective modeling methodology. Due to the complex character of the water cycle and the human activities and the change of natural ecosystems, uncertainty issues related to data, model parameters, and structure should be taken seriously [2]. Discussing these challenges, finding solutions, and presenting the latest achievements are the key purposes of this Special Issue.

Sixteen articles are selected and published in this Special Issue: fifteen research articles and one review covering quantification of elements of the water cycle, optimization of hydrological models, the impact and response of climate change and human activities, and hydrological model uncertainty as well as hydrological forecast.

Among the research articles, Wang et al. [3] evaluated the key water-cycle elements e.g., soil moisture, evapotranspiration, and generated surface runoff, by the stand-alone WRF model and the fully coupled WRF/WRF-Hydro modeling system. Szilagyi et al. [4] estimated the annual watershed precipitation by the calibration-free generalized complementary relationship of evaporation. The two articles show the quantification of water-cycle elements.

Optimization of hydrological models is significant to accurately quantify water-cycle elements. Zhu et al. [5] and Zhao et al. [6] explored the evaluation of satellite precipitation

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products to VIC hydrological models over the upper Yangtze River Basin and the Yellow river Basin, respectively. Their results show that using satellite products to calibrate the model parameters could greatly improve the accuracy of hydrological model simulation.

Most of the papers evaluated the impact of climate change and human activities on watershed hydrological variables [7–13], which indicated that the influence of a changing environment on the water cycle has been of concerned to more researchers. Among these articles, the hydrological variability under climate change and human influence in the Wuding River Basin was investigated [7]; the result shows that climate change and human influence drive both evapotranspiration and runoff changes. Wang et al. [8] evaluated changes of flow and sediment transport in the Lower Min River under the impacts of the above two drivers. The research demonstrated that the reduction of precipitation is the leading cause of runoff reduction, followed by human activities. The paper of Liu et al. [9] came to the same conclusion in the Lancang River Basin. Meanwhile, Wen et al. [10] quantified the contribution of climate change and human activities (charactered by land changes) on the ecological instream flow. The result shows that the changes of ecological instream flow are in good line with precipitation and are mainly influenced by land changes. Next, three papers respectively evaluated the impact of climate change and human activities. Regarding the impact of climate change, Zhang et al. [11] analyzed the responses of rainfall runoff and snowmelt water to recent climate change in the Lhasa River Basin and the upstream of Niyang River Basin in the Tibetan Plateau. For both basins, increasing rainfall runoff was identified as the dominant driver for the upward trend in total runoff. In addition to addressing the impact of climate change on runoff, its impact on evapotranspiration was discussed by Cui et al. [12]. Regarding the impact of human activities, Wang et al. [13] found that artificial vegetation recovery may have a positive feedback effect on regional precipitation by comparing the spatial and temporal characteristics of precipitation in the Loess Plateau before and after the implementation of the grain for green project.

Three papers [14–16] predicted the hydrological cycle elements under the changing condition, including precipitation and runoff, and developed a new flood early-warning system through the forecast processes.

Finally, the research paper by Tang et al. [17] and the review by Moges et al. [18] addressed the issues of hydrological model uncertainty. The uncertainty stems from input and calibration data, model structure, and parameters. The different sources of uncertainty need different analysis methods. Each method has its skills and limitations, and none is universally superior.

To conclude, this Special Issue contains sixteen research papers and one review dealing with the problems of quantification and forecast of water-cycle elements, optimization of hydrological models combined with satellite products, and impacts and response of climate change and human activities as well as hydrological model uncertainty. The research findings are novel and provide further insight into aspects of hydrological science, which is of significance to explore the water cycle under a changing environment.

We believe that the collation of these papers contributes to piquing further interest in hydrological element measurements and modeling in water-cycle processes.

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