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Editorial: Advances in Water Science Research

The 18th China Water Forum (CWF) was held in Nanjing, China, from December 6 to 8, 2020. The CWF is the largest conference in Chinese water science. It is sponsored by the China Society of Natural Resources and promotes research, discussion, and resolution of issues related to hydrology, water resources, and the water eco-environment.

The 2020 CWF, entitled 'Water Science and Future Earth', brought together 1,200 participants from more than 160 universities, institutions, and enterprises in China to address current and future risks to the water resources under the Future Earth research initiative, which serves to develop a global community with a shared future for mankind. In this forum, presentations and discussions centered around (1) the challenges to current theory and practice in hydrology arising from the increasing complexity and uncertainty of climate change and human intervention, and (2) how technological innovation and conceptual advances may be combined to meet increasing societal and environmental demands to improve water management in Future Earth. The participants focused on 17 issues, namely: theoretical methods for water science; watershed hydrological change and attribution; hydroclimatic processes; extreme weather and flooding; hydrological hydrodynamic processes; reservoir regulation and response to climate change; water resources utilization management; city and social hydrology; biodiversity and ecological processes; comprehensive management of the water environment; advanced technology on water information; ecological and environmental protection and restoration in the Yangtze River basin; high-quality development in the Yangtze River Economic Belt; ecological protection and high-quality development in the Yellow River Basin; problems and countermeasures for sustainable use of water resources in China; the global water crisis; and the youth academic forum.

This special issue of Advances in Water Science Research includes a collection of 12 papers presented at the 18th CWF. The papers are grouped into three sections that encompass the main topics of the CWF, although some papers are relevant to several groups.

The first group of papers focuses on **hydrological processes in changing environment**s, involving climate change and human intervention. They provide clear responses to the challenges triggered by increasing complexity and uncertainty in a changing environment. Zhou *et al.* (2021) describe the spatial migration characteristics of Meiyu events occurring in Anhui Province of China under environmental change and propose a new Meiyu intensity index relevant to flood or drought events that transcend the national standards. This work provides a better tool to identify the statistical characteristics of precipitation and data support for regional drought disaster risk analysis and reservoir operation. Changes in precipitation are certain to trigger variations in hydrological processes such as floods. To understand these relationships, Pan *et al.* (2021) investigate the temporal dependency of parameter sensitivity for three flood types (flash floods, short rainfall floods, and long rainfall floods). The runoff simulations show flash floods and short rainfall floods are more sensitive to parameter perturbations than long rainfall floods; parameter sensitivity is highly dependent on temporal resolution. It is well known that parameter transferability plays a significant role in sub-daily hydrological simulations in many regions without sub-daily data. This study will serve as a valuable reference for transferring parameter values in similar catchments and for reducing parameter estimation uncertainty according to temporal dependency.

Attribution analysis has always been an important part of investigations into hydrological processes in changing environments. A new extended-Budyko-based decomposition framework is proposed by Xie *et al.* (2021) to quantify the contributions of different climatic variables. Their validation shows that the extended Budyko model has a better performance in representing the regional water and energy balance and improves the accuracy of variance in runoff estimated by the new decomposition framework. This paper also emphasizes that changes in terrestrial water storage are useful to understand the interactions between regional atmospheric and hydrological processes; it offers a valuable understanding of the response of hydrological cycles to climatic variability.

It is critical to explore solutions for hydrological analysis in a changing environment. For this, Zhang *et al.* (2021) explore the characteristics of hydroclimatic variables and the spatial distribution of dominant runoff processes under the influence of land-use changes in the Tuwei River basin. They find that runoff decreased significantly because of regional climate change

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(33.2%) and human activities (66.8%) from 1956 to 2016. Additionally, large-scale soil and water conservation measurements have significant impacts on changes to the dominant runoff processes between 1980 and 2015, tending to generate subsurface flow processes. This reminds us that changing environments trigger a more complex process of runoff generation.

The topics of **remote sensing, modeling, and new technology** in hydrology are prominent in this issue. Four papers develop the application of the technologies in hydrology and water resources (Dang *et al.* 2021; Guan *et al.* 2021; Tian *et al.* 2021; Vorobevskii *et al.* 2021). Tian *et al.* (2021) assess the accuracy of GPM products by comparing GPM-based satellite data and observed rain data for the Xiangjiang river catchment. They verify that GPM products have wider spatial coverage and higher temporal and spatial resolution than TRMM products. In addition, the authors discuss the causes of spatiotemporal differences in GPM data. They consider that the differences mainly result from changes in the detection capability of satellite products with the seasons and different precipitation intensity levels. A new method to determine reservoir characteristic curves is developed by Guan *et al.* (2021) through remote sensing processing and analysis technology. This method constructs the relationship between the measured water level and water area by analyzing satellite imagery in various periods. It aims to describe the relationship among reservoir water levels, water surface area and reservoir capacity and further draw reservoir characteristic curves. The verification results indicate that this method has an accuracy advantage and can be used as a convenient tool to determine reservoir characteristic curves.

Vorobevskii *et al.* (2021) evaluate the performance of the Global BROOK90 automatic framework for hydrological modeling using discharge observations from 190 small catchments located across the globe. They find that the framework performs well in more than 75% of the cases and significantly better on a monthly rather than on a daily scale. It is worth mentioning that this framework is applicable for a wide range of relief, land cover, and soil types within all climate zones.

A simple hybrid approach for natural streamflow reconstruction based on identifying streamflow variation, namely NSRSVI, is proposed as a new technology for hydrology by Dang *et al.* (2021). The advantage of this approach is that it can provide stable streamflow processes under different human interventions, which only depend on the variation in streamflow. Furthermore, the proposed approach can be used to attribute streamflow variation by adding a cumulative streamflow curve. This undoubtedly provides a useful means of guiding the design and management of water resource engineering in changing environments.

Finally, four papers investigate issues in **eco-hydrology and eco-environmental protection**, involving soil salinization (He *et al.* 2021), heavy metal in shrubs (Gong *et al.* 2021), phosphorus loads (Jian *et al.* 2021), and lake hydrodynamics (Wu *et al.* 2021). Cangzhou city is a typical coastal area located on the North China Plain, and the land has always been impacted by seawater intrusion and inappropriate agricultural irrigation. He *et al.* (2021) investigate the relationship between soil salinization and groundwater hydro-chemical processes in this region and find that regional soil salinization shows clear patterns of zonation from inland to coastal areas, mainly restricted by shallow groundwater salinization in the coastal area. The authors also show that strong evaporation of relict seawater played a dominant role in the creation of high soil salinity, providing valuable evidence for the appropriate use of water in coastal regions in North China.

The paper by Gong *et al.* (2021) focuses on the question of whether rainfall runoff containing pollutants will damage shrubs in road bioretention. The authors explore the relationship between the heavy metal (Cd and Pb) contents of four shrubs and three physiological indexes. They discover that Cd and Pb inhibit the physiological functions of most shrubs, and increase some physiological indexes in individual shrubs. Additionally, they consider that the heavy metal absorption by shrubs may be associated with the heavy metal content in stormwater runoff, offering a potential method to clarify the issue.

The SWAT model is employed by Jian *et al.* (2021) to investigate the influences of hydrological conditions and the spatial effect of the quantity of livestock and poultry on the phosphorus load at the basin scale. They identify a critical link between variations in the phosphorus load and the hydrological conditions. Seasonal and interannual variations in hydrological conditions may assist with pollution control. Additionally, the authors find that finer resolution town-level data on the quantity of livestock and poultry improve the model performance when estimating phosphorus loads.

Wu *et al.* (2021) propose a collaborated framework based on the variable infiltration capacity (VIC) model, the soil and water assessment tool (SWAT), and the integrated valuation of ecosystem services and tradeoffs (InVEST) model, and certify the applicability of hydrologic ecosystem services (HESs) management in the Yixunhe River basin (YRB). In this study, the authors discover that the VIC and SWAT models have advantages in improving precise water resource control and management at various time scales, and the low data requirement of the InVEST model can strengthen its performance in general water quantity control and management. In addition, it is also found from the validation results that the collaborated framework for improving HESs management is efficient in improving HESs estimation and management, especially at the data-sparse scenario.

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All the papers collectively reflect many urgent issues in water science in China today, such as the changing environment, new technology, and eco-environmental protection. These issues are also faced by other countries. The valuable research presented at the 18th CWF not only promoted knowledge exchange among water science researchers but also triggered discussions on practice among practitioners and water resource managers. The CWF can provide additional Chinese solutions to global water problems and promote academic exchanges in water science with hydrologists and water resource managers globally.

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