atmosphere

Editorial

Extreme Hydro-Climate Events: Past, Present, and Future

Haiyun Shi [1,2,*], Bellie Sivakumar [3], Suning Liu [1,2,4], Xuezhi Tan [5] and Nasser Najibi [6]

1 State Environmental Protection Key Laboratory of Integrated Surface Water-Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, China; u3002906@connect.hku.hk
2 Guangdong Provincial Key Laboratory of Soil and Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, China
3 Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai 400076, India; b.sivakumar@iitb.ac.in
4 Center for Climate Physics, Institute for Basic Science, Busan 46241, Korea
5 School of Civil Engineering, Sun Yat-sen University, Guangzhou 510275, China; tanxuezhi@mail.sysu.edu.cn
6 Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY 14850, USA; nn289@cornell.edu
* Correspondence: shihy@sustech.edu.cn; Tel.: +86-755-88018870

In recent years, extreme hydro-climate events (such as floods and droughts) have occurred more frequently, leading to significant threats to lives and damage of property [1–6]. For example, the Food and Agriculture Organization (FAO) of the United Nations (UN) reported that the annual loss caused by drought was between 250 and 300 billion USD [7]. It is, therefore, important and necessary (1) to better understand their mechanisms of occurrence and evolution, (2) to propose more effective methods for early warning, and (3) to develop novel techniques for risk analysis and vulnerability analysis. For instance, it is vital to study extreme hydro-climate events at different spatial–temporal scales for a better understanding of their occurrence and propagation [8,9]; to utilize multisource data (e.g., ground data and remote sensing data) for more accurate and reliable prediction [10]; and to develop accurate disaster control methods (e.g., soil moisture prediction, rainfall data crowdsourcing, and streamflow forecasting) for better planning and management [11]. Advances in these fields can be helpful for coping with extreme hydro-climate events.

This Special Issue (SI) was proposed with the aim to collect the latest methodological developments and applications in studying both historic and future extreme hydro-climate events. Potential topics included but were not limited to the following: dynamics, mechanisms, and evolutions of extreme hydro-climate events; development of methods for the identification and early warning of extreme hydro-climate events, especially in ungauged basins; improvements to information integration using multisource data; new techniques for risk analysis and vulnerability analysis of extreme hydro-climate events; mitigation practices for real-world extreme hydro-climate events; etc. The collection of papers covers several of these aspects, and the contributions of each specific paper are summarized in the following.

The first paper was written by Yin et al. [12], who explored the spatiotemporal patterns of meteorological drought changes and the mechanisms of meteorological drought occurrence in Yulin City of northern Shaanxi from 1961 to 2015. The authors used the Standardized Precipitation Index (SPI), the Empirical Orthogonal Function (EOF) analysis, and a composite analysis for their analyses, and the findings obtained could provide a reference for the early warning and prediction of regional meteorological drought.

The second paper was written by Luhaim et al. [13], who used two indices (i.e., SPI and the Standardized Streamflow Index (SSI)) to analyze the spatiotemporal changes in historical droughts, taking the Muda River basin in Malaysia as the study area. The authors not only evaluated the trends and magnitude changes in the droughts but also explored the relationships among the droughts with large-scale atmospheric circulations. They reported

Citation: Shi, H.; Sivakumar, B.; Liu, S.; Tan, X.; Najibi, N. Extreme Hydro-Climate Events: Past, Present, and Future. *Atmosphere* **2022**, *13*, 843. https://doi.org/10.3390/atmos13050843

Received: 9 May 2022
Accepted: 17 May 2022
Published: 20 May 2022

that the El Niño Southern Oscillation (ENSO) could have the largest impact on the drought formations over the study area, especially during the dry period. They also pointed out the potential directions for future studies, for example, including other parameters (e.g., temperature and relative humidity) to investigate the atmospheric circulation impact on regional drought.

The third paper was written by Vega-Durán et al. [14], who evaluated the areal monthly average precipitation estimates in the Sinu River basin, Colombia, based on two reanalysis datasets (i.e., MERRA2 and ERA5). The authors found that both datasets would overestimate the monthly average precipitation in the study area, and ERA5 generally outperformed MERRA2. It is suggested that other techniques (e.g., bias correction techniques, additional mathematical and statistical techniques, etc.) should be included in future studies to improve the performance of these reanalysis datasets.

In conclusion, the present SI provides new avenues for recognizing past, present, and future extreme hydro-climate events. The findings reported are helpful for understanding the evolution of extreme hydro-climate events, especially in the context of climate change.

Author Contributions: H.S. conceptualized the theme of this SI and prepared the original draft of this editorial. B.S., S.L., X.T. and N.N. reviewed and edited this SI. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

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

References

1. Agilan, V.; Umamahesh, N.V.; Mujumdar, P.P. Influence of threshold selection in modeling peaks over threshold based nonstationary extreme rainfall series. *J. Hydrol.* **2021**, *593*, 125625. [CrossRef]
2. Rao, G.V.; Reddy, K.V.; Srinivasan, R.; Sridhar, V.; Umamahesh, N.V.; Pratap, D. Spatio-temporal analysis of rainfall extremes in the flood-prone Nagavali and Vamsadhara Basins in eastern India. *Weather Clim. Extreme* **2020**, *29*, 100265.
3. Liu, S.N.; Shi, H.Y.; Sivakumar, B. Socioeconomic drought under growing population and changing climate: A new index considering the resilience of a regional water resources system. *J. Geophys. Res.-Atmos.* **2020**, *125*, e2020JD033005. [CrossRef]
4. Zhou, Z.Q.; Shi, H.Y.; Fu, Q.; Li, T.X.; Gan, T.Y.; Liu, S.N. Assessing spatiotemporal characteristics of drought and its effects on climate-induced yield of maize in Northeast China. *J. Hydrol.* **2020**, *588*, 125097. [CrossRef]
5. Ding, Y.B.; Xu, J.T.; Wang, X.W.; Cai, H.J.; Zhou, Z.Q.; Sun, Y.N.; Shi, H.Y. Propagation of meteorological to hydrological drought for different climate regions in China. *J. Environ. Manag.* **2021**, *283*, 111980. [CrossRef] [PubMed]
6. Najibi, N.; Devineni, N. Recent trends in the frequency and duration of global floods. *Earth Syst. Dyn.* **2018**, *9*, 757–783. [CrossRef]
7. FAO. *The Impact of Disasters and Crises on Agriculture and FOOD SECURITY 2017*; FAO: Rome, Italy, 2018.
8. Collins, M.J.; Hodgkins, G.A.; Archfield, S.A.; Hirsch, R.M. The occurrence of large floods in the united states in the modern hydroclimate regime: Seasonality, trends, and large-scale climate associations. *Water Resour. Res.* **2022**, *58*, e2021WR030480. [CrossRef]
9. Zhou, Z.Q.; Shi, H.Y.; Fu, Q.; Ding, Y.B.; Li, T.X.; Liu, S.N. Investigating the propagation from meteorological to hydrological drought by introducing the nonlinear dependence with directed information transfer index. *Water Resour. Res.* **2021**, *57*, e2021WR030028. [CrossRef]
10. Refice, A.; Capolongo, D.; Chini, M.; D'Addabbo, A. Improving flood detection and monitoring through remote sensing. *Water* **2022**, *14*, 364. [CrossRef]
11. Helmrich, A.M.; Ruddell, B.L.; Bessem, K.; Chester, M.V.; Chohan, N.; Doerry, E.; Eppinger, J.; Garcia, M.; Goodall, J.L.; Lowry, C.; et al. Opportunities for crowdsourcing in urban flood monitoring. *Environ. Model. Softw.* **2021**, *143*, 105124. [CrossRef]
12. Yin, Y.; Zhang, L.; Wang, X.; Xu, W.; Yu, W.; Zhu, Y. Meteorological drought changes and related circulation characteristics in Yulin City of the Northern Shaanxi from 1961 to 2015. *Atmosphere* **2020**, *11*, 1196. [CrossRef]
13. Luhaim, Z.b.; Tan, M.L.; Tangang, F.; Zulkafli, Z.; Chun, K.P.; Yusop, Z.; Yaseen, Z.M. Drought variability and characteristics in the Muda River Basin of Malaysia from 1985 to 2019. *Atmosphere* **2021**, *12*, 1210. [CrossRef]
14. Vega-Durán, J.; Escalante-Castro, B.; Canales, F.A.; Acuña, G.J.; Kaźmierczak, B. Evaluation of areal monthly average precipitation estimates from MERRA2 and ERA5 reanalysis in a Colombian Caribbean Basin. *Atmosphere* **2021**, *12*, 1430. [CrossRef]