Editorial: Flood Catastrophes in a Changing Environment

Floods are among the most severe natural disasters all around the world (Yin *et al.* 2015; Kundzewicz *et al.* 2018; Bergsma 2019; Echendu 2020; Loudyi & Kantoush 2020; Mohanty *et al.* 2020). It was reported that 3,945 flood disasters occurred during 1989–2018, among which, about 1,200 events occurred in China, India, the United States and Indonesia (NRSCC 2019). Floods cause significant economic losses, for example, the global direct economic loss for 2018 was estimated to be US$4.5 billion (NRSCC 2019). Therefore, flood hydrology and risk management have been attracting significant attention in the academic community and water management authorities.

On November 15–18, 2018, the Conference on Flood Catastrophes in a Changing Environment 2018 (CFCCE'18) was held in Nanjing, China. The Conference was organized by Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences (NIGLAS), and was co-organised by Centre for Environmental Sustainability and Water Security (IPASA), Universiti Teknologi Malaysia (UTM), Asian Network on Climate Science and Technology (ANCST), and Southeast Asia Disaster Prevention Research Initiative (SEADPRI) of Universiti Kebangsaan Malaysia (UKM) and Key Laboratory of Watershed Geographic Sciences, Chinese Academy of Sciences (WSGS). Prof. Chongyu Xu of University of Oslo chaired the Science Advisory Committee of this Conference. A total of 29 oral talks from 15 different research organisations were presented, of which nine were invited. The presentations covered a wide range of topics including extreme rainfall and flood development, impacts of climate change and urbanisation, flood regulation of large hydraulic engineering, flooding modelling, flood forecasting and projection, flood risk assessment and management.

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After the Conference, a call was made internationally for submission of original contributions for publication in a special issue of *Hydrology Research*. After a normal peer-review process, nine papers were accepted for publication in this special issue, covering topics of climate impacts, modelling and model uncertainty, flooding pollution and flood risk management.

Three papers studied how climate may impact on the high flows and further the development of high flooding stage. The impacts of climate change on flood frequencies were assessed using a hydrological model coupled with a stochastic weather generator to simulate the summer flood regimes in two mountainous catchments in China and Switzerland. Results indicated that across all assessed return periods (10–100 years), the potential flood magnitudes may increase by more than 30% in both catchments for 2021–2050 (Ragettli *et al.* 2021). The timing of extreme precipitation and its correlation with the peak runoff flows was studied in Li *et al.* (2021a) in Poyang Lake catchment in China. Results showed that the change of the timing of extreme precipitation delayed the peak flows from the lake catchment for 1960–2012. Projections of future climate change indicated a further delay in the timing of future peak rainfall, for 2020–2099, which may cause higher flood risk in the Poyang Lake region in the future (Li *et al.* 2021a). Li *et al.* (2021b) showed similar results for the Poyang Lake region, i.e., in the future, the lake water level may be elevated by around 2 m in the flood season due to climate change. Both studies indicated an increasing flood risk in Poyang Lake region in the future due to change in seasonal distribution of precipitation and the timing of the extreme precipitation values.

Modelling has been very useful in determining the flooding inundation extents and in evaluating the effectiveness of various flood risk management options. A comprehensive hydrodynamic flood modelling framework was proposed in the MIKE FLOOD platform considering river, stormwater, overland flow and tidal influence to generate flood inundation and subsequently hazard maps for various inland hydraulic scenarios. The modelling framework was applied in the Mithi River watershed in Mumbai, India, and was suggested as an effective tool in data-scarce, densely populated urban areas (Ghosh *et al.* 2021). Models were also used in projecting future flood development under various climate scenarios, i.e., the combination of watershed hydrological model WATLAC, lake hydrodynamic models and neural network model was very successful in determining flood changes under future climate conditions (Li *et al.* 2016, 2021a, 2021b). However, models contain uncertainties, from sources of the driving stresses, the errors in observation data and the model structure itself. Fan *et al.* (2021) evaluated the impact of land cover resolution, in comparison with the digital elevation model (DEM) resolution in a semi-arid region in northeastern China, on hydrological modelling outputs, and concluded that land-use land cover resolution was more important than DEM resolution in hydrological modelling.

Environmental and socio-economic damage is unavoidable following large floods. A recent study showed that the flood impacts seem to be aggravated when associated with rapid land-use modification and climate changes (Lee & Choi 2018). The impacts also vary with flood size and the physical characteristics of the basin. Annammala *et al.* (2021) examined the source of sediment and heavy metal deposition following a large flood in Kelantan River Basin, Malaysia. The basin has been undergoing rapid land-use changes particularly forest harvesting and plantation establishment and operation. Erosion rates were measured on several hillslopes that represent different land uses. A multi-proxy sediment fingerprinting was found useful to identify disaster prone areas. The consequence of large floods on ecotoxicological risk of heavy metals deposition along the bank of Pahang River in Malaysia was addressed by Lim *et al.* (2021). Several geochemical pollution indices, namely enrichment factors, geo-accumulation index, contamination factor, modified degree of contamination and pollution load index, were used to assess the risk of heavy metal accumulation in sediment. It is found that an integrated geochemical and ecotoxicological risk index is more expressive and representative for the health risk assessment of heavy metal contamination in the aquatic river sediment.

Reliable assessment of socio-economic damage caused by floods is still lacking especially in developing countries where data is scarce and not readily accessible. In this regard, Tananaev *et al.* (2021), in central Yakutia, Russia, examined the physical processes that caused major floods in Amga River Basin. The flood impacts on wellbeing and social aspects were determined using the standard assessment method employed in the Russian Federation. Ice jam has been identified as the major cause of flooding, which was worsened by cold spells in spring and the presence of mid-channel sand bars that impeded the ice movement. Community responds to flood risk such as population and livestock relocation work well for minimizing flood damages. The tangible direct damage estimates found in this study were much higher compared to the compensation given to the community. In Malaysia, Romali & Yusop (2021) developed flood damage rating curves for commercial and residential areas. The study aimed at promoting a risk-based approach in flood management by combining hazard, exposure and vulnerability. Flood maps of 10- to 1000-year return periods were simulated and used to estimate the expected annual damages. For the residential category, the highest damage was found for medium priced houses, followed by high priced houses, and the least for low priced houses.

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REFERENCES

Annammala, K. V., Mohamad, N. A., Sugumaran, D., Masilamani, L. S., Liang, Y. Q., Jamal, M. H., Yusop, Z., Yusoff, A. R. M. & Nainar, A. 2021 Sediment clues in flood mitigation: the key to determining the origin, transport, and degree of heavy metal contamination. *Hydrology Research* **52** (1), 91–106.

Bergsma, E. 2019 The development of flood risk management in the United States. *Environmental Science and Policy* **101**, 32–37.

Echendu, A. J. 2020 The impact of flooding on Nigeria's sustainable development goals (SDGs). *Ecosystem Health and Sustainability* **6** (1), 1791735.

Fan, J., Galoie, M., Motamedi, A. & Huang, J. 2021 Assessment of land cover resolution impact on flood modeling uncertainty. *Hydrology Research* **52** (1), 78–90.

Ghosh, M., Mohanty, M. P., Kishore, P. & Karmakar, S. 2021 Performance evaluation of potential inland flood management options through a three-way linked hydrodynamic modelling framework for a coastal urban watershed. *Hydrology Research* **52** (1), 61–77.

Kundzewicz, Z. W., Pińskwar, I. & Brakenridge, G. R. 2018 Changes in river flood hazard in Europe: a review. *Hydrology Research* **49** (2), 294–302.

Lee, J. S. & Choi, H. I. 2018 Comparison of flood vulnerability assessments to climate change by construction frameworks for a composite indicator. *Sustainability* **10** (3), 768. 1–13.

Li, X., Hu, Q., Wang, R., Zhang, D. & Zhang, Q. 2021a Influences of the timing of extreme precipitation on floods in the Poyang Lake, China. *Hydrology Research* **52** (1), 26–42.

Li, Y., Zhang, Q., Tao, H. & Yao, J. 2021b Integrated model projections of climate change impacts on water-level dynamics in the large Poyang Lake (China). *Hydrology Research* **52** (1), 43–60.

Li, Y., Tao, H., Yao, J. & Zhang, Q. 2016 Application of a distributed catchment model to investigate hydrological impacts of climate change within Poyang Lake catchment (China). *Hydrology Research* **47** (S1), 120–135.

Lim, K. Y., Zakaria, N. A. & Foo, K. Y. 2021 Geochemistry pollution status and ecotoxicological risk assessment of heavy metals in the Pahang River sediment after the high magnitude of flood event. *Hydrology Research* **52** (1), 107–124.

Loudyi, D. & Kantoush, S. A. 2020 Flood risk management in the Middle East and North Africa (MENA) region. *Urban Water Journal* **17** (5), 379–380.

Mohanty, M. P., Mudgil, S. & Karmakar, S. 2020 Flood management in India: a focussed review on the current status and future challenges. *International Journal of Disaster Risk Reduction* **49**, 101660.

National Remote Sensing Center of China (NRSCC) 2019 *The Typical Severe Natural Disasters and Their Impacts* Global Ecosystem and Environment Observation Analysis Research Cooperation (GEOARC), Ministry of Science and Technology of the People's Republic of China.

Ragettli, S., Tong, X., Zhang, G., Wang, H., Zhang, P. & Stähli, M. 2021 Climate change impacts on summer flood frequencies in two mountainous catchments in China and Switzerland. *Hydrology Research* **52** (1), 4–25.

Romali, N. S. & Yusop, Z. 2021 Flood damage and risk assessment for urban area in Malaysia. *Hydrology Research* **52** (1), 142–159.

Tananaev, N. I., Efremova, V. A., Gavrilyeva, T. N. & Parfenova, O. T. 2021 Assessment of the community vulnerability to extreme spring floods: the case of the Amga River, central Yakutia, Siberia. *Hydrology Research* **52** (1), 125–141.

Yin, J., Ye, M., Yin, Z. & Xu, S. 2015 A review of advances in urban flood risk analysis over China. *Stochastic Environmental Research and Risk Assessment* **29**, 1063–1070.