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Towards a better knowledge of flash flood forecasting at the Three Gorges Region: Progress over the past decade and challenges ahead

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The study area, the Three Gorges Region (TGR), plays a critical role in predicting the floods drained into the Three Gorges Reservoir, as reported local floods often exceed 10000m3/s during rainstorm events and trigger fast as well as significant impacts on the Three Gorges Reservoir's regulation. Meanwhile, it is one of typical mountainous areas in China, which is located in the transition zone between two monsoon systems: the East Asian monsoon and the South Asian (Indian) monsoon. This climatic feature, combined with local irregular terrains, has shaped complicated rainfall-runoff regimes in this focal region. However, due to the lack of high-resolution hydrometeorological data and physically-based hydrologic modeling framework, there was little knowledge about rainfall variability and flood pattern in this historically ungauged region, which posed great uncertainties to flash flood forecasting in the past.

The present study summarize latest progresses of regional flash floods monitoring and prediction, including installation of a ground-based Hydrometeorological Observation Network (TGR-HMON), application of a regional geomorphology-based hydrological model (TGR-GBHM), development of an integrated forecasting and modeling system (TGR-INFORMS), and evaluation of quantitative precipitation estimations (QPE) and quantitative precipitation forecasting (QPF) products in TGR flash flood forecasting. With these continuing efforts to improve the forecasting performance of flash floods in TGR, we have addressed several critical issues: (1) Current observation network is still insufficient to capture localized rainstorms, and weather radar provides valuable information to forecast flash floods induced by localized rainstorms, although current radar QPE products can be improved substantially in future; (2) Long-term evaluation shows that the geomorphology-based distributed hydrologic model (GBHM) is able to simulate flash flooding processes reasonably, while model performance will decline at hourly scale with larger uncertainties. However, model comparison suggests that this physically-based distributed model (GBHM), compared with a traditional lumped model (Xin'anjiang model), shows more robust performance and larger transferability for prediction in those ungauged basins in TGR; (3) Operational test of our integrated forecasting system (TRG-INFORMS) shows that it works reasonably to simulate the flood routing in Three Gorges reservoir, indicating the accuracy of simulation of total floods generated at region scale; (4) Current operational QPF is too coarse to provide valuable information even for flood forecasting of whole TGR, thus, downscaling and high-resolution QPF are necessary to unravel the potentials of weather forecasting.

Finally, according to these results, we also discuss about some possible solutions with high priority for future advanced forecasting scheme of local flash floods in TGR.