One step closer to simulating stochastic flood events globally: use of hydrological models to characterise spatial dependency in global stochastic flood modelling

Gaia Olcese[1,2], Paul Bates[1,2], Jeffrey Neal1[2], Christopher Sampson[2], Oliver Wing[2] and Niall Quinn[2]

(1) School of Geographical Sciences, University of Bristol, Bristol, United Kingdom
(2) Fathom, Bristol, United Kingdom

Flood models typically produce flood maps with constant return periods in space, without considering the spatial structure of flood events. At a large scale, this can lead to a misestimation of flood risk and losses caused by extreme events. A stochastic approach to global flood modelling allows the simulation of sets of flood events with realistic spatial structure that can overcome this problem, but until recently this has been limited by the availability of gauge data. Previous research shows that simulated discharge data from global hydrological models can be used to develop a stochastic flood model of the United States (Wing et al., 2020) and suggests that the same approach can potentially be used to build large scale stochastic flood models elsewhere but this has not so far been tested.

This research therefore focuses on using discharge hindcasts from global hydrological models to drive stochastic flood models in different areas of the world. By comparing the outputs of these simulations to a gauge-based approach, we analyse how a model-based approach can simulate spatial dependency in large scale flood modelling outside of well-gauged territories such as the US. Based on data availability we selected different areas in Australia, Southern Africa, Southeast Asia, South America and Europe for the analysis.

The results of this research show that the performance of a model-based approach in the different continents is promising and in most areas the errors are comparable to the results obtained in the United States by Wing et al. (2020). In the United States, with this magnitude of errors, the loss distribution obtained using the model-based approach is near identical to the one produced by the gauge-based method. This suggests that this method could be used in other regions to characterize losses. Using a network of synthetic gauges with data from global hydrological models would allow the development of a stochastic flood model with detailed spatial dependency, generating realistic event sets in data-scarce regions and loss exceedance curves where exposure and vulnerability data are available.

References

Wing, O. E. J., Quinn, N., Bates, P. D., Neal, J. C., Smith, A. M., Sampson, C. C., Coxon, G., Yamazaki, D., Sutanudjaja, E. H., & Alfieri, L. (2020). Toward Global Stochastic River Flood Modeling. Water Resources Research, 56(8). https://doi.org/10.1029/2020wr027692