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Stochastic Simulation of Fluvial Inundation at Continental Scales

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Recent advances in the acquisition of spatiotemporal environmental data and improvements in computational capabilities have transformed the field of hydraulic modelling. We are now capable of conducting flood risk analysis at large, even global, scales. Traditional flood risk assessment uses frequency curves to define the magnitude of extreme flows at gauging stations, which are then used as inputs to hydraulic models to produce flood hazard maps, assuming a constant annual exceedance probability (AEP) flow. Such an approach works well for a specific location or very local model, however, over large continental scales the assumption of a stationary event AEP break downs. In reality, an event 'footprint' will consist of a range of AEP flows across a set of river gauges. To accurately define event risk over large regions, it is essential to characterise this spatial dependence in extreme flows between sites.

Therefore, this research utilises a recently developed model-based approach to describe the multisite joint distribution of extreme river flows across the gauged sites within the USGS catalogue. Given an extreme event at a site, the model characterises the likelihood that neighbouring sites are also impacted. This information is used to simulate an ensemble of plausible synthetic extreme event footprints from which flood depths are extracted from an existing global flood hazard catalogue. Expected economic losses are then estimated by overlaying flood depths with national datasets defining asset locations, characteristics and depth damage functions. The ability of this approach to quantify probabilistic economic risk and rare, threshold exceeding events is expected to be of value to those interested in the flood mitigation and insurance sectors.

This work describes the methodological steps taken to create the flood loss catalogue over a national scale; highlights the uncertainty in the expected annual economic vulnerability within the USA from extreme river flows; and presents future developments to the modelling approach.