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Stochastic Generation of Spatiotemporal Precipitation Events for Flood Risk Assessment

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Current flood risk analyses that only consider local peaks of hydro-meteorological forcing variables have limitations regarding their representation of reality. Simplistic assumptions regarding antecedent conditions are required, often different classes of precipitation are lumped in distributions, and the complex temporal and spatial evolution of the events is not considered. For sustainable flood risk management, it is desirable for flood risk analyses to reflect reality more appropriately. Analysis of risk mitigation measures and comparison of their relative performance is therefore likely to be more robust and lead to improved solutions.

We propose a new framework for the provision of boundary conditions to flood risk analyses that more appropriately reflects reality. The simulated boundary conditions generated under this method capture the temporal dependencies of complex storms whilst preserving associated spatial dependencies, imposing the distributions of extreme values and other hydrological signatures. We apply this framework and generate a synthetic precipitation events set from global reanalysis precipitation data (CFSR) on a large scale. We define spatiotemporal clusters of high intensity precipitation as events, extract hydrological features of each spatiotemporal event, generate synthetic feature sets with a multivariate distribution with a focus on the joint tail probability [Heffernan and Tawn, 2004], create synthetic events from the generated synthetic features and finally join the synthetic events with non-extreme observation data to form continuous-time boundary conditions.

We contrast this approach to a simplistic approach where local (i.e. spatially fixed) features are used. We examine the difference in return period and return level estimation for features of extreme rainfall events, which we think adds value to the discussion of ‘extraordinary’ events [e.g. Viglione et al., 2013], further completing the concepts introduced in [Merz & Blöschl, 2008] with ‘spatiotemporal’ expansion of information.