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Using rainfall patterns and IDF in flood hazard assessment

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Spatio-temporal patterns of rainfall are commonly used as model input in e.g. urban drainage design or flood hazard studies. The hydraulic model that is used is oftentimes too computationally demanding to alllow for a simulation of a long historical time series. Instead, a limited set of high-intensity events is selected that is considered representative for the extreme rainfall over a given period at the location of interest. The set of events can be compiled from historical records, from stochastic rainfall generators or NWP model simulations. In general, there are numerous sources of realistic and plausible rainfall patterns and it is possible to compile a set of representative rainfall events for an application of interest. However, in order to apply the set of events to a flood study, a probability must be assigned to each event. This poses a challenge. Ideally, the event probabilities are derived from Intensity-Duration-Frequency (IDF) curves. For a given event and for a given duration, the exceedance frequency of the rainfall depth directly follows from the IDF curves. However, for a different duration, the exceedance frequency of the rainfall depth for the same event will typically be different. The exceedance frequency thus depends on the duration. Unfortunately, for many applications, the critical duration is not known beforehand. In the proposed approach this problem is overcome by selecting a set of events that covers extreme rainfall over a range of durations. A probability is assigned to each event such that the collective set of events reproduces the IDF curves. This way, the set of events not only represents the spatio-temporal rainfall patterns that may occur in the area, but also the IDF curves. The proposed method thus offers a way to use realistic rainfall patterns in combination with IDF curves in probabilistic flood studies. We will explain how the event probabilities are derived and demonstrate that a relatively small set of 50 to 100 events can reproduce the IDF curves over a relevant range of durations that are potentially critical for the application at hand. A simple rainfall runoff study will show how the method compares to alternative approaches, including a single design event method and a long historical time series approach.