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Uncertainty assessment of synthetic design hydrographs

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Reliable flood estimates for different return periods are needed for the appropriate design of water engineering structures and spatial planning. While these flood estimates usually refer to peak discharge values, different flood management decisions, such as drawing hazard maps and the design of retention structures, also require information about flood volumes or event hydrograph shapes. In this respect, synthetic design hydrographs constructed from observed discharges provide a useful tool for a joint estimation of the dependent design variable quantiles, peak discharge and flood volume. In addition to the quantiles, the entire hydrograph shape is modelled by a probability density function. However, the construction of such design hydrographs involves several steps which all may introduce some uncertainty. For a reliable estimation of synthetic design hydrographs, this uncertainty needs to be addressed and communicated to the engineers and practitioners.
We therefore studied different uncertainty sources inherent in the construction of synthetic design hydrographs and assessed their impact on the design hydrograph magnitude and shape by means of a two-steps sensitivity analysis. In a first step, we assessed the relative contribution of each of the uncertainty sources on the design hydrograph. The most important sources of uncertainty were the following: the sample size and the choice of the flood event sampling strategy, the choice of the marginal distribution to model the peak discharges, and the choice of the probability density function to represent the hydrograph form. Of lesser importance was the choice of the dependence structure between peak discharges and flood volumes. In a second step, we jointly propagated all different uncertainty sources and assessed the resulting total uncertainty. The total uncertainty, quantified for different hydrograph characteristics, varied between 20 and 40% for the different catchments and characteristics. Additional uncertainty must be considered when design hydrographs need to be regionalized to catchments without runoff observations. The quantification of the uncertainty coming from the choice of the regionalization method was quantified by computing regionalized design hydrographs using different methods. The uncertainty introduced by regionalization was considerable, especially for the magnitude of the event.