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Coupling hydrologic and hydraulic models to take into consideration retention effects on extreme peak discharges in Switzerland

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Estimating peak discharges with very low probabilities is still accompanied by large uncertainties. Common estimation methods are usually based on extreme value statistics applied to observed time series or to hydrological model outputs. However, such methods assume the system to be stationary and do not specifically consider non-stationary effects. Observed time series may exclude events where peak discharge is damped by retention effects, as this process does not occur until specific thresholds, possibly beyond those of the highest measured event, are exceeded. Hydrological models can be complemented and parameterized with non-linear functions. However, in such cases calibration depends on observed data and non-stationary behaviour is not deterministically calculated.

Our study discusses the option of considering retention effects on extreme peak discharges by coupling hydrological and hydraulic models. This possibility is tested by forcing the semi-distributed deterministic hydrological model PREVAH with randomly generated, physically plausible extreme precipitation patterns. The resulting hydrographs are then used to force the hydraulic model BASEMENT-ETH (riverbed in 1D, potential inundation areas in 2D). The procedure ensures that the estimated extreme peak discharge does not exceed the physical limit given by the riverbed capacity and that the dampening effect of inundation processes on peak discharge is considered.