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Derived flood frequency analysis using different precipitation input data - a comparison

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For planning of hydraulic structures design floods with different recurrence intervals are required. For monitored river cross sections these values are usually obtained using flood frequency analysis based on long time series of observed discharge. If such observations are missing or if effects of new flood protection measures or changes in natural conditions are to be evaluated derived flood frequency analysis based on continuous rainfall-runoff modelling is a recommended alternative.

The objective of this contribution is the comparison of rainfall-runoff modelling for the estimation of floods using three different rainfall inputs on an hourly time step. First design storms are used with event based hydrological modelling. Then two different types of synthetic precipitation loads are applied with continuous hydrological modelling. These are disaggregated daily precipitation data based on a multiplicative random cascade model and stochastic precipitation generated using a space-time alternating renewal model.

The specific focus of this study is to investigate strategies for optimal parameter estimation and application of a rainfall-runoff model for derived flood frequency analysis considering different precipitation data. For hydrologic modelling the conceptual semi distributed model HEC-HMS is used. The study areas are some mesoscale catchments within the Bode river basin in northern Germany.

For parameter estimation and application of the hydrological model the following three strategies are investigated: a) calibration of the model on observed single events b) calibration of the model on observed discharge time series, each using observed precipitation data as model input. In the third strategy c) calibration of the model on fitted probability distributions of observed annual maximum discharge series is carried out using synthetic precipitation data. For application of the model to estimate the design floods precipitation data and parameter sets are combined as follows. For single events design storms and parameter sets a) and b) are used, and for continuous simulation synthetic precipitation data and parameter sets b) and c) are applied. Then the peak flows of the simulated runoff time series are statistically analysed. Finally, the estimated flood quantiles resulting from the different precipitation loads and calibration strategies are compared with observed flood statistics paying special attention to the uncertainty. The results show that the spread of the uncertainty bands can be reduced considerably if synthetic rainfall is used directly for calibration of the hydrological model based on probability distributions of observed annual maximum flows.