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Introducing empirical and probabilistic regional envelope curves into flood frequency curves

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Due to the limited length of observed discharge time series at a site of interest estimates of discharges for large recurrence intervals are highly uncertain. To reduce this uncertainty, additional information can obtained from an analysis of the regional occurrences of extreme floods. To date, the integration of this regional information into the at-site estimation has faced many difficulties. We propose a novel approach in which we combine large flood quantiles and upper bounds derived from probabilistic regional and empirical envelope curves, respectively, with the at-site flood frequency analysis.

The method of probabilistic regional envelope curves (PRECs) estimates a recurrence interval for a regional envelope curve, which bounds the maximum observed floods of all sites of a pooling group. A PREC provides a large flood quantile, i.e. a pair of discharge and associated recurrence interval, for each site of the pooling group.

For the first time, PREC flood quantiles are introduced into an at-site flood frequency analysis, by assuming that they are representative for a certain range of recurrence intervals. For higher recurrence intervals, a Generalised Extreme Value distribution function with a positive shape parameter is applied which asymptotically approaches an upper bound derived from an empirical envelope curve. In this way, the mixed distribution function considers large flood quantiles as well as an upper bound discharge. A sensitivity analysis examines the effect of the empirical envelope curve, the selection of the PREC flood quantiles and the recurrence interval thresholds on the flood quantile estimates.

The approach is applied for a large number of gauges in Saxony/Germany. We can show that the presented mixed distribution function adequately considers PREC flood quantiles, as well as upper bound discharges. The introduction of both into the mixed distribution function improves the quantile estimates for large recurrence intervals.