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Extrapolation limits of extreme-value methods for return-levels estimation

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The EDF (Electricity of France) R&D department makes use of the extreme-value theory to perform many statistical studies of extreme events from meteorological series (temperature, river flow, wind speed, ...). These studies are used to size structures against meteorological events such as flood, storm or drought. They consist, given an extreme-value distribution fitted on data, in estimating return-levels, or equivalently extreme quantiles, of one hundred or more return period. In this communication, we investigate the credibility of these extrapolations. In particular, we introduce new mathematical rules based on the convergence analysis towards extreme-value distributions. To this end, we focus on data from a distribution in the Gumbel maximum domain of attraction. First, we provide necessary and sufficient conditions for the relative consistency of the estimator of an extreme quantile in the Gumbel maximum domain of attraction. Our second result establishes a first order equivalent of the asymptotic extrapolation error associated with the previous estimator. Third, new estimators of the extrapolation error are introduced, using the previous equivalent together with some extreme order statistics. Finally, given a maximum admissible error, we are able to estimate how far one should extrapolate. Our results indicate that extrapolation range can be limited depending on the data distribution. An application to the flows of the Rhône river (France) is provided. We show that extrapolation is indeed greatly limited in this case.