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Estimation of extreme hydrological quantiles in non stationary series

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Estimation of quantiles of hydrological variables, i.e. values corresponding to fixed non-exceedence probabilities or return periods, is generally carried out by fitting a probability distribution function to an observed sample. Traditionally, the assumption of identically distributed variables is made and consistent estimators are applied, leading to the paradigm that the longer the available sample the better the estimation of quantiles.
Recent concerns about potential changes in present and future climate, however have led to challenge the hypothesis of stationary series. In particular, more and more evidence is produced in literature about the presence of non stationarities in many climatic and hydrological records around the world in the form of trends and/or jumps in the statistics of the series. Regardless of the causes, the presence of non stationarities in the available sample requires to dramatically modify the procedures for estimating probabilistic properties of hydrological time series. Although several methods have been developed and applied to model non stationary, nonetheless, very few studies have addressed the problem of how non stationarity affects the error of estimation of quantiles.
In a non stationary setting, the paradigm "the longer the sample, the better the estimation" does not hold anymore. On the other hand, one may expect that too short a sample also should lead to larger errors of estimation. Therefore, the existence of an optimal sample size, where optimal refers to the sampling properties of the estimators, can be postulated.
Furthermore, when one suspects the presence of trend in a series, the question arises as to whether detrending the series, i.e. assuming a parametric form for the trend and removing it from the series for estimating the distribution parameters, leads to an improved estimation of quantiles.
In the paper, preliminary analyses regarding how the presence of trend in hydrological series affects the sampling properties of the estimated quantiles are illustrated. In particular, sampling properties of hydrological quantiles, namely bias and Mean Square Error (MSE) are investigated with respect to the size of the estimation sample, both for simple simple (one-parameter) and complex (two-parameters) distribution, assuming a trend in the first and second moments of the underlying distribution.
Also the effect of preliminary trend removal is investigated and compared to the case when trend is neglected. Analytical results are derived for the cases of simple distributions, while more complex cases are investigated numerically by simulation.