Effect of trends on the estimation of extreme precipitation quantiles

A. Cancelliere[1], B. Bonaccorso[2] and G. Rossi[3]
Department of Civil and Environmental Engineering, University of Catania, Catania, Italy

Abstract. Estimation of quantiles of hydrological variables, i.e. values corresponding to fixed non-exceedence probabilities or return periods, is traditionally carried out by assuming that the variables are identically distributed and by fitting a probability distribution function to an observed sample. Generally, 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 meteorological 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. Despite several methods have been developed and applied to model non stationary series, very few studies have addressed the problem of how non stationarity affects the error of estimation of quantiles.
Regardless of the way non stationarities are modelled, dropping the stationarity hypothesis appears to have direct impacts on at least two aspects: first of all, in a non stationary setting, the paradigm "the longer the sample, the better the estimation" does not hold anymore. One may expect on the other hand 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. The second aspect is related to the same concept of return period, which loses in this case its traditional meaning of expected interarrival time and therefore would require a new formulation.
Furthermore, when one suspects the presence of a trend in a series, the question arises as to whether de-trending the series, i.e. assuming a parametric form for the trend and removing it prior to the estimation of the distribution parameters, leads to an improved estimation of quantiles. Indeed, due to the uncertainties related to the choice of the correct parametric form of the unknown trend, as well as to the sampling variability related to the estimation of its parameters, the estimated quantiles may not necessarily be affected by a smaller error with respect to the case when the trend is neglected. Thus the analyst is left with the dilemma whether to detrend a potential trend, or to neglect it.
In the paper, preliminary analyses oriented to assess how the presence of trend in precipitation series affects the sampling properties of the estimated quantiles are illustrated. In particular, sampling properties of precipitation quantiles, namely bias and Mean Square Error (MSE) are investigated with respect to the size of the estimation sample, assuming a trend in the parameters 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.

[1] acance@dica.unict.it
[2] bbonacco@dica.unict.it
[3] grossi@dica.unict.it