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Estimation of extreme flooding based on stochastic weather generators supported by the use of non-systematic flood data

Carles Beneyto[1], José Ángel Aranda[1], Gerardo Benito[2], and Félix Francés[1]
[1]Universitat Politècnica de València, Research Institute of Water and Environmental Engineering, Valencia, Spain (carbeib@alumni.upv.es)
[2]Department of Geology, National Museum of Natural Sciences, Madrid, Spain

An adequate characterization of extreme floods is key for the correct design of the infrastructures and for the flood risk estimation. Traditionally, these studies have been carried out based on the design storm. However, we now know that this approach is uncertain since peak discharges and hydrographs are strongly dependant on the initial conditions of the basin and on the spatio-temporal distribution of the precipitation.
One of the possible solutions that has recently been better welcomed between the scientific community is the continuous simulation. This combination of statistical and deterministic methods consist of the generation of extended synthetic data series of discharges by combining the use of a stochastic weather generator and a hydrological model. Nevertheless, weather generators still need robust data series of observed precipitation in order to perform adequately, especially when trying to capture extremes. To date, however, the length of both available precipitation and discharge records are still not sufficient to guarantee an adequate estimation of extreme discharges, presenting these high uncertainty.
In the present study, the same approach is taken (i.e. continuous simulation). However, in order to deal with the short length of the data records and to improve the estimations of extreme discharges, non-systematic information (i.e. historical and Palaeoflood) is integrated in the methodology, extending the length of the flow records and giving extra information of the higher tail of the distribution function, thus reducing the uncertainty of these estimations.
This methodology was implemented in a Spanish Mediterranean ephemeral catchment, Rambla de la Viuda (Castello, Valencia). The study area comprises an approximate area of 1,500 km2 and presents a mean rainfall of 615 mm, most of them falling within the autumn months (SON) as a consequence of medicanes. The weather generator used was GWEX, which was designed to focus on extremes, and the hydrological model implemented was TETIS, which is a conceptual model and spatially distributed. Both of them were implemented at a daily scale. Non-systematic information was obtained from previous studies, having information at two locations and, therefore, being able to validate the results in more than one point.
The results, in terms of precipitation, showed that weather generators using heavy-tailed marginal distribution functions outperform those using light-tailed distributions (e.g. Exponential or Gamma), especially when extra information is incorporated, as in this study, where regional maxima precipitation studies were integrated for the parametrisation of the weather generator.
With regards to discharges, the incorporation of non-systematic information clearly gave extra

information of the higher tail of the distribution function (up to approx. T=600 years in this study), allowing to validate the generated discharges up to larger return periods and, therefore, reducing the uncertainty of the extreme discharge estimations