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Estimation of extreme flooding based on stochastic weather generators supported by a regional precipitation study and non-systematic flood data

Carles Beneyto[1], José Ángel Aranda[1], Gerardo Benito[2] and Félix Francés[1]

[1] *Research Institute of Water and Environmental Engineering (IIAMA), Universitat Politècnica de València, Camino de Vera s/n, E-46022 Valencia, Spain*
[2] *Geology Department, National Museum of Natural Sciences – CSIC, c/ José Gutiérrez Abascal, 2, E-28006, Madrid, Spain*

Accurate estimates of extreme and rare floods has been a fundamental problem in flood hydrology, and it is still present among the scientific and engineering communities 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.

In the recent years, an alternative method extensively adopted is to combine statistical and deterministic methods in a continuous simulation (CS). The procedure involves the generation of synthetic discharge data series combining a stochastic weather generator (WG) and a hydrological model(HM). Nevertheless, WG 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.

The fact that longer records provide less biased estimates calls for the use of existing regional studies of extreme precipitations(RSEP) and the inclusion of historical and other non-standard flood data. The latter includes historical observations and palaeoflood records, providing physical evidence of flooding over secular time scales. By having an extreme precipitation study and/or flood information beyond the systematic records, it is generally possible to extend the observations beyond the 100-year return period and therefore reduce the quantile uncertainty.

This study presents a case study for the estimation of extreme floods in a Mediterranean ephemeral river combining synthetic data series within a CS approach, with additional inclusion of non-systematic information.

The case study is a Spanish Mediterranean ephemeral catchment, Rambla de la Viuda. It comprises an approximate area of 1,500km^2 and presents a mean rainfall of 615mm, most of them falling within the autumn months due to heavy Mesoscale Convective Systems. The WG used was GWEX, and the HM implemented was TETIS.

The results, in terms of precipitation, showed an important improvement on the accuracy of the generated precipitation quantiles due to an appropriate selection of the WG and the integration of RSEP for the WG implementation. This, in turn, improved the accuracy of the generated flood quantiles. The incorporation of non-systematic information gave extra information of the higher tail of the distribution function, allowing validating the generated discharges up to larger return periods and, therefore, reducing the uncertainty of the extreme discharge estimations