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Incorporation of information on extreme floods in regional flood frequency analyses: some methodological reflections.

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Flood frequency analyses are often based on continuous series at gauging station. However, the length of the available data sets is usually too short to provide reliable estimates of extreme design floods. Hence, hydrologists have tried to make use of alternative sources of information to enrich the datasets used for their statistical inferences. Three main approaches were therefore proposed. The first one consists of a "temporal extension" of information based on the valuation of historical and paleoflood data. The second, "spatial extension”, consists in merging statistically homogeneous data to build a large regional data samples. Recently, a combination of the two techniques aiming at including regional estimated extreme discharge values at ungauged sites in regional flood frequency analyses has been proposed (Gaume et al., 2010).

This new approach necessitates the calibration of a function relating the characteristics of the watersheds and an index flood value. Each available discharge has to be divided by its corresponding index flood to obtain values of the same magnitudes that can be merged into a regional sample. The index flood relation of the form μ=S ˆβ appeared satisfactory (μ being the index flood value, S the area of the watershed and β the parameter to be calibrated). A Bayesian Monte Carlo Markov Chain (MCMC) framework is then used to adjust the regional growth curve with its uncertainties. The application of the approach to some case studies illustrated the possible important added value of ungauged extremes in flood frequency analyses. In the initially proposed approach (Gaume et al., 2010), the index flood relation was adjusted a priori and the uncertainties associated with this calibrated relation were not considered.

An improvement of this method will be presented where both (i) the index flood relation and (ii) the regional growth curve are calibrated in the same time using a Bayesian MCMC framework and enabling an accurate estimation of the uncertainties associated to the estimated peak discharge distributions. Two regional samples from France (167 records at 5 gauges and 35 ungauged extremes) and central Vietnam (210 records at 7 gauges and 3 ungauged extremes) are used to test and validate the method. Three types of results will be presented.

The proposed method is first applied to regional samples of gauged discharges and compared to a standard regional flood frequency analysis method consisting in taking the average value of each sample as the index flood value. This first comparison delivers very satisfactory results. Despite the additional parameter β, the estimated credibility intervals computed for the various flood quantiles are very similar with the two methods. The added parameter does not increase the uncertainty of the estimated flood quantiles.

In a second step, ungauged extremes are taken into account in the statistical inference which is only possible with the proposed approach. This illustrates their possible usefulness: the 90% credibility ranges for the Ardeche case study for the 100-year and 1000-year quantiles are divided by a factor of two.

Finally, the standard and proposed regional flood frequency analysis methods are applied to evaluate 100-year flood quantiles of a large number of synthetic series generated through a Monte Carlo run. The conducted accuracy tests revealed that the proposed method provides unbiased estimates of flood quantiles and of their credibility bounds when applied to regional gauged series including or not including ungauged extremes. A little bias appears when the considered watershed area for the adjusted regional growth curve is significantly larger or smaller than the largest or smallest areas of the gauged watersheds in the region.