

Combining non-precise historical information with instrumental measurements for flood frequency estimation: a fuzzy Bayesian approach

Jose Luis Salinas, Andrea Kiss, Alberto Viglione, and Günter Blöschl

Vienna University of Technology, Institute of Hydraulic Engineering and Water Resources Management, Centre for Water Resource Systems, Vienna, Austria (salinas@hydro.tuwien.ac.at)

Efforts of the historical environmental extremes community during the last decades have resulted in the obtention of long time series of historical floods, which in some cases range longer than 500 years in the past. In hydrological engineering, historical floods are useful because they give additional information which improves the estimates of discharges with low annual exceedance probabilities, i.e. with high return periods, and additionally might reduce the uncertainty in those estimates. In order to use the historical floods in formal flood frequency analysis, the precise value of the peak discharges would ideally be known, but in most of the cases, the information related to historical floods is given, quantitatively, in a non-precise manner.

This work presents an approach on how to deal with the non-precise historical floods, by linking the descriptions in historical records to fuzzy numbers representing discharges. These fuzzy historical discharges are then introduced in a formal Bayesian inference framework, taking into account the arithmetics of non-precise numbers modelled by fuzzy logic theory, to obtain a fuzzy version of the flood frequency curve combining the fuzzy historical flood events and the instrumental data for a given location. Two case studies are selected from the historical literature, representing different facets of the fuzziness present in the historical sources. The results from the cases studies are given in the form of the fuzzy estimates of the flood frequency curves together with the fuzzy 5% and 95% Bayesian credibility bounds for these curves.

The presented fuzzy Bayesian inference framework provides a flexible methodology to propagate in an explicit way the imprecision from the historical records into the flood frequency estimate, which allows to assess the effect that the incorporation of non-precise historical information can have in the flood frequency regime.