Synthesis of regional flood frequency models: case study in Northern Italy

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Regional flood frequency analysis methods make use of hydrological information from multiple sites to reliably estimate flood quantiles in ungauged or poorly gauged catchments. Different regional models have been developed and tested in the past by different research groups and are now operational in different areas of the Po river basin. The Polytechnic of Milan group uses the so-called index flood method, with growth curves estimated by pooling data from hydro-meteorological homogeneous regions determined through a multi-level approach (see e.g., De Michele and Rosso, 2002). The Bologna University group uses an extension of the index flood method, in which the growth curves are identified through focused pooling by building ad-hoc regions for each site of interest (i.e., Region of Influence approach, see e.g., Castellarin et al., 2001) and selecting statistical models and parameters based on the method of L-moments. The Polytechnic of Turin uses the Spatially Smooth Regional Estimation method, which is based on multiregressive estimation of L-moments without requiring the definition of homogeneous regions (Laio et al., 2011). All methods provide estimates of the uncertainty associated with the estimated flood quantiles.

In this work, we apply the three regional flood frequency analysis methods to a consistent dataset of maximum annual peak discharges and several climatic and physiographic catchment characteristics for 191 sites in the Po River basin. The results of the three methods are compared and their differences are analysed. Most importantly, the results of the three methods are merged, accounting for their respective estimated uncertainties, to provide updated design flood estimates within the Po district. Through cross-validation experiments, we show that, when the uncertainty of each regionalization approach is correctly accounted for, the adoption of a plurality of regional approaches results in more reliable predictions than resorting to a single regional model. This study demonstrates, also in the context of practical engineering hydrology, the importance of model uncertainty estimation, without whom a reliable merging of different models would not be possible.

References

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