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How changes in future precipitation impact flood frequencies: a quantile-quantile mapping approach

Luigi Cafiero[1], Miriam Bertola[2], Paola Mazzoglio[1], Francesco Laio[1], Günter Blöschl[2], and Alberto Viglione[1]

[1]Politecnico di Torino, Department of Environment, Land and Infrastructure, Italy (luigi.cafiero@polito.it)
[2]Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology

Flood risk management institutions and practitioners need accurate and easy-to-use approaches that incorporate the changing climate conditions into flood predictions in ungauged basins. The present work aims at developing an operative procedure to include the expected variation in precipitation extremes in flood frequency analysis. We relate Flood Frequency Curves and Intensity-Duration-Frequency curves through quantile-quantile relationships. Assuming that the percentage variations of precipitation and flood quantiles are linked by the quantile-quantile relationship, we obtain modified Flood Frequency Curves accounting for the projected changes in precipitation extremes. The methodology is validated in a virtual world based on the Rational Formula approach where flood events are the result of the combination of two jointly distributed random variables: extreme precipitation and peak runoff coefficient. The proposed methodology is found to be reliable in basins where flood changes are dominated by precipitation changes rather than variations in the runoff generation process. To illustrate its practical usefulness, the procedure is applied to 227 catchments within the Po River basin in Italy using projected percentage changes of precipitation extremes from CMIP5 CORDEX simulations for the end of the century (2071-2100). With projected changes in 100-year precipitation ranging from 5 to 50\%, the corresponding variations in 100-year flood magnitudes are expected to span a broader range (10 to 90\%), reflecting substantial heterogeneity in catchment responses to rainfall changes.