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Detecting hazardous rivers: the physically-based extreme value distribution (PHEV!)

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Flood frequency curves are the basis to design ordinary engineering structures and devise strategies aimed at mitigating an increasing flood risk. Moreover, they are a crucial tool of risk assessment for insurance and reinsurance purposes. This work is concerned with the presence of abrupt increases of the flood frequency curve (i.e., sudden increments of streamflow magnitudes for a certain return period, named step changes), and investigate their occurrence by means of the physically-based extreme value distribution (PHEV!) of streamflow. This is an analytic probability distribution of extremes, which emerges from a lumped mechanistic-stochastic description of runoff generation and rainfall, soil moisture and discharge dynamics.

In the study, long synthetic time series of streamflow for river catchments exhibiting step changes have been generated and randomly resampled to construct sub-series of decreasing length. These shorter series are then used to test the performance of the PHEV!, of standard purely statistical distributions of the extremes, and of empirical observation-based estimates of the flood frequency curve in detecting the existence of a step change in the long time series from scarce data. Findings show that the PHEV! robustly detects the occurrence of step changes also when only short time series (e.g., 10 years) are used for parameter estimation. Conversely, the alternative methods tested mostly fails in this objective. These results indicate that the PHEV! might be a reliable tool for detecting the propensity of rivers to generate extreme floods in regions lacking long series of discharge observations.