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A proposal for a methodology for the generation of large sets of flood scenarios at country scale

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The global economic loss caused by fluvial floods in 2015 was 27 billions $, resulting to be the most expensive among different natural hazards (earthquakes, tropical cyclones, severe weather, wildfires, etc). It is thus critical a correct and accurate estimate of the fluvial flood hazard in order to characterize the risk in a given region prone to this problem. The number and complexity of the phenomena involved, and the need of a multi-expertise computation chain (meteorological input – distributed hydrological simulation – 2D hydraulic simulation) makes the task of producing an exhaustive set of possible scenarios particularly difficult, if not impossible. A direct ensemble simulation, if not for particularly small regions, is extremely computational demanding and, sometimes, technically almost impossible, for example because of the need of producing a large ensemble number of different meteorological input coherent with the climatology of the area of interest and that maintain the spatial and temporal correlation structures.
In this work, a novel approach is proposed, that require as input a set of limited-length streamflows time series and a set of hazard maps of water level previously computed for a given set of return periods on the region of interest. Starting from this data (e.g. 50 years-length), the annual maxima time-series of streamflows are synthetically prolonged by keeping the information of the spatial correlation structures and, at the same time, perturbing the original data, in order to obtain a synthetic multivariate time series millennia-long. Through a CDF-matching procedure, this time series is then converted in a equal-length set of yearly maximum water level scenarios that allows to characterize the flood hazard without extremely long hydrological and hydraulic simulations.
The algorithm is applied on a case study and results are discussed, including the hypothesis and limits of the approach.