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Recent spatio-temporal dynamics of floods of record across Europe

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Economic losses and social consequences caused by floods have been steadily increasing over the last decades over Europe. In such a situation, the detection of changes in flood behaviour is crucial and the scientific community itself calls for a common effort to better understand recent flood dynamics and their evolution in space and time.

In this context, our study considers an extensive dataset of annual maximum series of peak flow discharges for more than 3400 catchments across Europe for the period 1820-2016 (average record length of 53 years). Based on this extensive dataset, our study analyses the behaviour of the specific flood of record (i.e. the largest flood observed in the time interval of interest divided by the drainage area of the corresponding catchment, hereafter also referred to as SFOR) in space and time across the European continent. In particular, we consider the spatial variability of SFOR computed for the entire observation period and for two 30-years sub-samples, namely 1987-2016 and 1957-1986. We focus on three macro-regions over northwestern, southern and eastern Europe, which have been identified by previous studies as homogeneous in terms of flood regime changes and processes driving flood changes. For the selected different timespans and macro-regions, we analyse the spatial variability of the year in which SFOR was observed, and the number of times in which a new record was observed at each and every gauge, also evaluating their relationship with catchment area. By referring to the theory of record-breaking processes, we also evaluate the non-stationarity in flood sequences by accounting for the presence of spatial correlation among flood sequences.

Finally, we provide a continuous spatial representation of SFOR values across Europe by referring to the dataset of elementary catchments identified by the Joint Research Centre (JRC) of the European Commission. For each elementary catchment of the JRC dataset, we interpolate empirical SFOR values by means of the geostatistical procedure termed top-kriging, which accounts for nesting between catchments.

The outcomes of our study provide useful information on the spatio-temporal evolution of flooding potential across Europe, enabling a visualization of the current flooding potential across Europe and of significant changes and shifts of the flood of record occurred during the last five decades.