Frequency of Italian record-breaking floods over the last century (1911-2020)

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Economic losses and social consequences caused by floods have been steadily increasing over the last five decades worldwide. Detecting changes in flood behavior is a topical research issue, and the scientific community calls for a common effort to better understand recent flood dynamics and their spatiotemporal evolution. Our study aims at contributing to this research question by an in-depth analysis of the frequency regime of record-breaking floods in Italy. In particular, we focus on an extensive data-set of flood sequences (i.e. annual maximum series, AMS) observed at 522 stream gauges in Italy between 1911 and 2020 and we consider the entire observation period, as well as two consecutive time intervals: 1911-1970 and 1971-2020. We look at two different kinds of record-breaking events in a time series, that is the events with the maximum (+*record*) or minimum (-*record*) intensity up to that year, and we focus on the average number of record-breaking events in a region (i.e., in a pooling-group of AMSs), and in the three time-intervals of interest. By performing a series of resampling experiments that preserve the spatial correlation among the AMSs of the pooling group (see e.g., Vogel et al., 2001, 2019), we test the hypothesis that the observed regional average number of record-breaking events results from a group of stationary sequences. We identify the pooling group of sites by referring to (a) hydrological and (b) spatial proximities: (a) we group catchments that are similar in terms of size, mean annual precipitation, mean annual snow depth, elevation, or latitude; (b) we use a moving square pooling window of $90 \cdot 90$ km^2. Our results show strong and spatially coherent patterns of increasing intensity of floods (i.e., more frequent +*record* events and less frequent -*record* events) in central and in north-eastern Italy during the last 50 years, while anomalies and non-stationarity signals become much weaker if one considers the time intervals 1911-2020 or 1911-1970. During the last 50 years, significant deviations of the regional number of record-breaking events from what would be expected for stationary flood sequences seem to be more common in drier climates or higher altitudes, while the catchment size does not seem to be a meaningful descriptor.

References

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