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Surprising megafloods in Europe – learning from the big picture

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Megafloods that far exceed previously observed records at a given location can take citizens and flood managers by surprise. Existing methods based on local and regional information rarely go beyond national borders and cannot predict these floods well because of limited data on megafloods, and because flood generation processes of such extremes differ from those of smaller, more frequently observed events. Here we analyse the most comprehensive dataset of annual maximum discharges in Europe available to date, to assess whether recent locally surprising megafloods could have been anticipated using observations in hydrologically similar catchments across the continent.

We base our analysis on annual maximum river discharge observations from 8023 gauging stations for the period 1810–2021. We identify about 500 “target” catchments where recent (i.e., after 1999) megafloods have occurred that are surprising based on local data. We perform a hindcast experiment of predicting their peak discharge with regional envelope curves, using flood observations from similar “donor” catchments up to the year before their occurrence. From this group of donor catchments we construct an envelope curve which we compare with the megaflood that occurred later in the target catchments. We repeat this analysis for all the detected megafloods in the target catchments.

Our analysis shows that, in 95.5% of the target catchments, the discharge of the envelope is larger than that of the observed megaflood, suggesting that, from a European perspective, almost none of the events can be considered a regional surprise. Similar results are obtained by repeating the analysis on two consecutive sub-periods, indicating that megafloods have not changed much in time relative to their spatial variability. In conclusion, our findings show that recent megafloods could have been anticipated from observations in other parts of Europe, which would not be possible using only national data.

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