European Commission

Science for Environment Policy

River flooding: area simultaneously affected in EU has grown by 50% in past 50 years

River flooding costs billions of euros annually in the EU. When one river floods, others nearby often do so at the same time — extending the overall impact beyond the border of an individual drainage basin. With this in mind, this study analysed the spatial extent of flood events across Europe from 1960 to 2010, using data from the European Flood Database (EFD). The research presents key findings for flood forecasting, risk financing and flood-mitigation policy.

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Landscape and weather conditions in Europe lead to flood events involving multiple drainage basins — and sometimes multiple countries — simultaneously. Such large-scale flooding can significantly affect the societies that inhabit these areas, and bring huge financial costs. However, such events have not been systematically analysed at the continent scale in Europe.

This study used data from the European Flood Database (EFD) to analyse the spatial extent of flood events across Europe from 1960 to 2010, spanning over 4 000 river basins. The researchers looked for trends over time and across Europe, to establish if there is any correlation with landscape features and recurrent climatic oscillations such as El Niño.

The study applied a measure known as the 'flood synchrony scale' to the data — the maximum radius around an individual river gauge, within which a minimum of 50% of the other river gauges recorded flooding within a seven-day period. The researchers calculated 'mean flood synchrony scales' for individual stations by averaging annual flood synchrony scales over time. The same calculation was used for rainfall data, for which the study calculated 'precipitation synchrony scales'.

The EFD data comprised annual maximum streamflows (a measure of the flow of water within a waterway expressed as volume per unit time) for 4 037 river catchments from 1960 to 2010, with basins ranging in size from approximately 5 to 100 000 square kilometres ($km^{2)}$ and daily gridded precipitation data for the same time period (with a spatial resolution of 0.25 degrees).

The researchers analysed the dataset to identify trends over time on a) station and b) continental scales. The analysis showed that flood synchrony scales averaged 148 kilometres in size across Europe (an area of almost 70 000 km^2), but varied regionally. However, in mountainous regions — the Pyrenees in northern Spain, into central Europe and across the Carpathian mountains (central and Eastern Europe) — flood synchrony scales were generally less than 100 km, indicating that flooding in these regions is more localised. Flood synchrony scale is affected by topography, and is inversely correlated with station elevation and ruggedness — therefore flatter landscapes at lower elevations are more prone to larger synchrony scales.

The rest of Western Europe usually experiences floods over greater distances and the flood synchrony scale often exceeds 250 kilometres across swathes of north-eastern Europe. Overall, this scale has risen by 50% over the 50-year study period — flooding has become more spatially synchronised, affecting larger areas concurrently. This scale grew more in certain regions, including the British-Irish Isles, parts of Germany, Belgium, The Netherlands, Austria, Italy, Sweden and the Balkans; and shrunk in others: eastern Poland, Romania and parts of Russia.

Continued on next page.

Source: Berghuijs, W., Allen, S., Harrigan, S. and Kirchner, J. (2019). Growing Spatial Scales of Synchronous River Flooding in Europe. *Geophysical Research Letters*, 46(3), pp.1423-1428.

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Flooding events spanning large areas tended to cluster in time — this suggested a possible link to drivers that vary over multiannual time scales, such as long-term climatic oscillations including the El Niño-Southern Oscillation and the North Atlantic Oscillation, but neither showed a measurable correlation. This may be due to regional differences in how these oscillations affect flood risk in Europe. The study did not find a correlation between precipitation levels and flood synchrony scales. The researchers suggest that climate change may play an important role here, but, this is at present purely speculative, and they add that other causes have potentially led to this increase in synchronous flooding.

The flood synchrony scale far exceeds the size of an individual drainage basin and varies regionally. Synchronous flooding events beyond the scale of a single basin have been largely neglected in analyses of flood behaviour, with efforts usually concentrated on individual basins. However, the researchers argue that flood forecasting, trend interpretation, risk financing and policy to govern, or mitigate, flood risk could benefit from considering how flood risks extend beyond individual basins.

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