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Climate change impacts not yet detectable in river flow data

A new study suggests that annual maximum peak discharge data in central Europe over the last century contain no detectable signs of climate change. Human activity, such as hydro-electric schemes, land use changes or river course alterations, which may form part of climate change adaptation in many policy areas, have until now had greater impact on peak discharge than climate change itself.

Climate change appears to accelerate the hydrological cycle and is expected to increase the frequency and impact of extreme events, such as droughts and floods. Central Europe has experienced several large floods in recent years. Many reviews of historical flows occasionally give contradictory results – flows increase at some sites but decrease at others, season-specific differences may be identified, while some studies find no evidence for any change at all.

The latest study looked at daily discharge (flow) records from 55 monitoring stations – 32 in Germany, 13 in Switzerland, 6 in the Czech Republic and 4 in Slovakia, with between 75 and 192 years of continuous monitoring data. Clear seasonality was identified, with greater peaks in the winter months in the west of the study region (Germany) and more spring-summer peaks in Switzerland, linked to snow melt. Most river courses have undergone management or development during this time and no attempt was made to study 'pristine' catchments.

Statistical analyses of annual maximum peak discharges were used to identify two types of possible changes in river flow - either abrupt 'change points', or gradual long-term trends. If change points were identified at any site, the data were divided into 'before' and 'after' and each portion analysed separately for trends. For all other sites, the entire dataset was tested for trends. The presence of change points can result in 'false' trends being identified and can also have a large effect on the estimation of flood return periods.

Out of 55 stream gage stations, 18 sites were found to have significant change points in their annual flood peaks. These abrupt changes could generally be associated directly with human societal causes, e.g. changes to the course of the upper Rhine in the 1970s which accelerated run-off and increased flood peaks, the construction of dikes and reservoirs on the Elbe, and hydro-electric schemes in Switzerland between 1950 and the 1970s. Peaks decreased after the change point in over half the cases.

By contrast, no sites without change points were found to have significant long-term trends (two increasing trends were noted before change points, and one after a change point). No trends were found in the seasonal timing of flood peaks at any site, and no trends in the spring, summer, autumn or winter data. This lack of a climate change signal may be due to its relative weakness in comparison to 'noise' and anthropogenic effects.

The overall distribution of annual peak discharges helps to estimate the return period frequency of particular flood events - more frequent higher peaks (a 'heavy tail') implies that extreme events are more likely. Of the 37 sites without change points or trends, there was a tendency towards lighter tails.

Analyses of the 55 stations in Central Europe indicate that engineered change is evident and may increase in response to future climate impacts. This suggests that responsive hydrological management interventions are required, which can adapt to potential changes in flow patterns.

Source: Villarini, G; Smith, J.A., Serinaldi, F. & Ntelekos, A. A. (2011). Analyses of seasonal and annual maximum daily discharge records for Central Europe. *Journal of Hydrology.* 399:299-312.

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