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Maximisation of flood events by superposition at confluences

Philipp Bühler, Svenja Fischer, and Andreas Schumann
Ruhr University Bochum, Hydrological Engineering and Water Management, Engineering, Germany

The superposition of two or more flood events at confluences is an important factor in the genesis of extreme floods. With extreme floods in 2002 and 2013 in Germany, analyses of the genesis of those floods becomes a more vital part in the understanding of their mechanisms. While the superposition is not the main driver of extremity, it still influences the peak significantly, depending on the arrival of the peaks from upstream floods as well as the shape and steepness of the floods. Hereby, the degree of superposition depends much on the flood type: for steep and short waves, the probability of overlapping peaks is low but has a high chance to result in an extraordinary flood or the overlapping of long flood waves has a high probability with a smaller chance to produce a flood event with an extreme peak after the point of confluence. In order to quantify the effects of superposition for extreme events, confluences of tributaries in the Mulde river basin in the east of Germany were analysed based on hourly discharge data. For these events, the range of best- and worst case scenarios was analysed based on sensible shifts of the routing. The travel times and therefore the arrivals of flood events at the downstream gauge were evaluated from the data as well as with a theoretical approach calculated by the mean slope of the stream as a static and the peak discharge of a flood event as the dynamic component. It is shown how the different combinations of arrival times in the downstream gauge may result in long events with damped peaks or a maximization of the flood peaks by overlaying. With the developed methodology, the observed peak can be compared with an ensemble of possible flood events and their peaks, caused by different superposition scenarios. This leads to an extended range of high empirical quantiles for flood statistics, with impact on the selection of most appropriated distribution functions.