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Recent floods in Central Europe in July 2021: A new challenge for extreme value analyses!

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Abstract

In July 2021, several European countries were affected by severe floods. Some were catastrophic, causing about 220 deaths and widespread damage. The floods affected several river basins across Europe. Between 12th and 15th July 2021, heavy rain fell across the United Kingdom, Western Germany, Netherlands, Belgium, and Luxembourg. A storm complex moved from France to Germany and stalled over the region for two days. Precipitation was intense with more than 270 mm in 48 hours and more than 200 mm fell within a 9-hour period. Some of the affected regions may not have seen rainfall of this magnitude in the last 1,000 years.

With at least 184 deaths, this flood is the deadliest natural disaster in Germany since the North Sea storm surge. 1,300 people had been initially reported as missing on July 16th. About 15,000 police, soldiers and emergency service workers have been deployed in Germany to help with the search and rescue. Some of the worst damage from the flood was in the Ahr valley in Rhineland-Palatinate, where the river Ahr rose, destroying many buildings and causing at least 110 deaths. The flooding here was the worst since 1910 when up to 200 people have lost their life. The topography of Ahr valley in western Germany, with some sections resembling gorges, may have exacerbated the effects of the heavy rainfall. These catastrophic flooding in the Ahr valley in July 2021 leads to questions: “How safe is safe enough?” and “Deluge or poorly calculated design values?”

An important finding of the 2021 flood is that the previous water level-discharge relationship was no longer correct due to morphological changes/sediment transport and displacement of bridges by debris. The design water levels for the Ahr valley were determined from a homogeneous discharge time series from 1947 onwards. E.g., the currently valid design discharge at the gauge Altenahr is 241 m^3/s, but a maximum discharge of 410 to 630 m^3/s was reconstructed for the 1910 flood and about twice the discharge for the 1804 flood (Roggenkamp and Herget 2014 and 2015). The gauge Altenahr was washed away in the 2021 flood at a water level of 5.05 m (equivalent to a discharge of 332 m^3/s).The maximum discharge during the catastrophic flood in July 2021 was estimated at about 400 to 700 m^3/s (CEDIM, KIT 2021). The reconstructed water level for this discharge is 7 to 8 m! The previous record of gauge observations since 1947 was a discharge of 236 m^3/s and a water level of 3.71 m. Comparing the values above reveals a major dilemma: The discrepancy between the current design values and the catastrophic flood in July 2021 and also the reconstructed historical data. A mayor challenge for extreme value analyses!