Impact of river confluences on return periods of large floods

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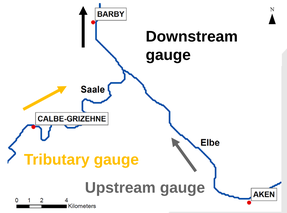
Motivation

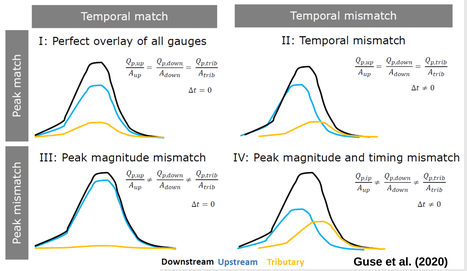
- Flood peaks are influenced among others by flood wave superposition at confluences
- It remains unclear how flood return periods at downstream gauges are impacted

Triple point analysis

- A triple point consists of tributary gauge and two gauges on main river, upstream and downstream of confluence

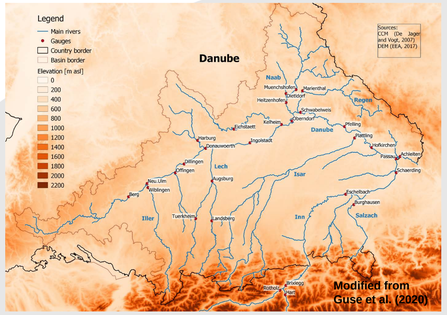


- Flood wave superposition is analyzed with regard to (1) time lag between peaks and (2) peak magnitudes
- Four types of flood wave superposition can be distinguished in theory (Guse et al., 2020)



Triple points

- Triple points are analyzed in Germany and Austria
- Results are shown here for the Danube basin



Research questions

- How do the return periods of flood peaks change in the main river at confluences?
- How does wave superposition control return periods of flood peaks?

Methods

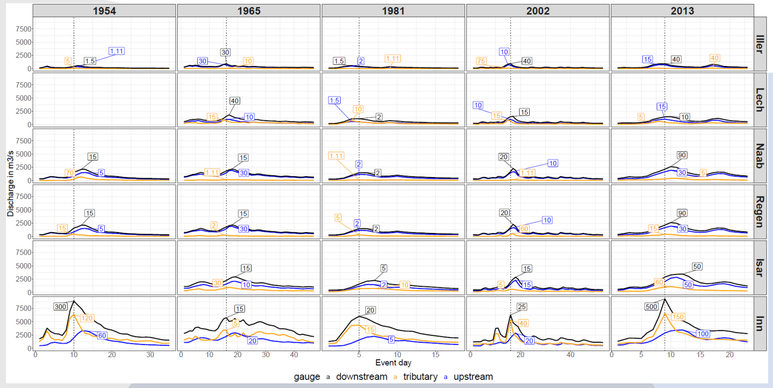
- Selection of five largest flood peaks at most downstream confluence (since 1951)
- Comparison of all flood events along the major tributaries
- Calculation of return periods with GEV (L-moments) specifically at each triple point

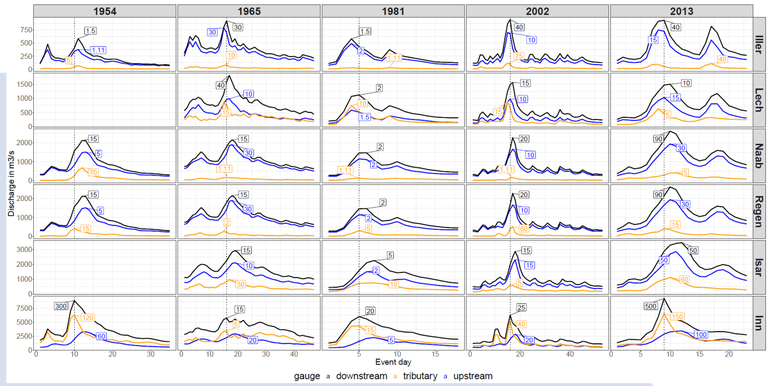
Hypothesis

- The return period of the downstream peak is between the return periods of upstream and tributary peak

Change of return periods of flood peaks along the Danube river

Five major floods at six Danube confluences with fixed y-axis for at all confluences (left) and individual y-axis for each confluence (right)

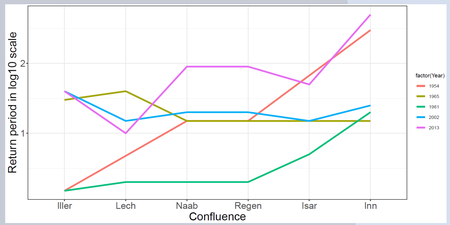




- In most of the cases no temporal match of flood peaks at the three gauges of a triple point.
- In particular for the largest floods, return period at downstream gauge is not between the return periods of upstream and tributary gauges
- Confluences of Naab and Regen are between two Danube gauges.

Comparison of return periods at confluences

- Largest return period at the confluence of the Inn
- A large flood peak at the Inn confluence can occur in the case of a small flood upstream



Take-home messages

- Return periods of flood peaks change along the main river
- The return period at downstream gauge river is not always between the return periods at upstream and tributary gauges.
- At the Danube river, the maximum return period is calculated at the most downstream gauge (confluence of the Inn).

References:
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Guse, B., Merz, B., Wietzke, L., Ullrich, S., Viglione, A., Vorogushyn, S. (2020): The role of flood wave superposition for the severity of large floods, Hydrol. Earth Syst. Sci., 24, 1633-1648.

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