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Flood risk estimation using joint probability methods

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Flood risk estimation has traditionally been based on univariate statistical methods considering only one characteristic of a flood event (typically the flood peak). However, extreme loading of flood defense structures are often dependent on joint characteristics of floods in terms of peak, volume and duration. In addition, an extreme flood is often caused by a combination of several sources, e.g. extreme rainfall in different upstream catchments and downstream tides and storm surges. To adequately address the combined nature of flood characteristics and flood generating sources joint probability methods should be applied.

Multi-variate statistical estimation techniques using copula dependence functions are applied to estimate joint probabilities. The approach is divided in two steps. First, the dependence between the different flood generating sources is considered using a multi-variate analysis of single characteristics (e.g. peak values). Secondly, for each individual source joint probabilities of all event characteristics (e.g. peak, volume and duration) are estimated.

The joint probability method is applied for flood risk analysis in a low-lying river system discharging to the sea through a tidal sluice. Flooding is caused by a combination of heavy rainfall in two upstream catchments and tides and storm surges regulating the tidal sluice. The results of the multi-variate statistical analysis are used to force a river flow simulation model in order to obtain the probability of flooding at arbitrary locations in the river system.