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Influence of dike breaches on flood frequency estimation

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Many former river floodplains and their assets are protected by dikes. In case of extreme flood events, dikes may breach and flood water may spill over into the dike hinterland. Depending on the specific situation, e.g. time and location of breach, capacity of the hinterland to contain the flood water, dike breaches may lead to significant reductions of flood peaks downstream of breach locations. The influence of dike breaches on flood frequency distributions along rivers has not been systematically analysed. To quantify this influence a dynamic-probabilistic model is developed. This model combines simplified flood process modules in a Monte Carlo framework. The simplifications allow us to simulate a large number of different scenarios, taking into account the main physical processes. By using a Monte Carlo approach, frequency distributions can be derived from the simulations. In this way, process understanding and the characteristics of the river-dike-floodplain system are included in the derivation of flood frequency statements. The dynamic-probabilistic model is applied to the Lower Rhine in Germany and compared to the usually used flood frequency analysis. For extreme floods the model simulates significant retention effects due to dike breaches, which lead to significant modifications of the flood frequency curve downstream of breach locations. The resulting probabilistic statements are much more realistic than those of the flood frequency approach, since the dynamic-probabilistic model incorporates an important flood process, i.e. dike breaching, that only occurs when a certain threshold is reached. Beyond this point the behaviour of the flood frequency curve is dominated by this process.