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Are gauge-specific flood probabilities suitable for flood hazard mapping and risk assessment?

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Flood frequency analyses of discharge series at gauge locations are typically used to define flood return periods. These are than applied in combination with inundation modelling approaches for flood hazard mapping and risk assessment. The gauge-specific flood probabilities are used as proxies for inundation and damage probabilities to support hazard and risk statements. We present a probabilistic flood hazard and risk assessment for the City of Cologne on the Rhine River. It is based on the fully coupled 1D-dike breach-2D flood model for channel flow and floodplain inundation. The flood model is combined with a suite of damage models for loss assessment to residential buildings. We demonstrate that gauge-specific flood probability estimations become inadequate for hazard mapping and risk assessment in downstream areas due to dike breaches and floodplain storage effects. The deviation from the expected probability of inundation and of loss increases with flood magnitude.