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Effects of uncertainty in boundary-conditions on flood hazard assessment

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Comprehensive flood-risk assessment studies should quantify the global uncertainty in flood hazard estimation, for instance by mapping inundation extents together with their confidence intervals. This appears of utmost importance, especially in the case of flood hazard assessments along dike-protected reaches, where dike failures have to be considered. This paper focuses on a 50km reach of River Po (Italy) and three major sources of uncertainty in inundation mapping: uncertainties in the (i) upstream and (ii) downstream boundary conditions, and (iii) uncertainties in the dike-failure location and breach morphology. We derive confidence bounds for flood hazard maps by means of the Inundation Hazard Assessment Model (IHAM) – a hybrid probabilistic-deterministic model. IHAM couples in a dynamic way a 1D hydrodynamic model and a 2D raster-based hydraulic model through a probabilistic dike-breaching analysis that considers three different failure mechanisms: overtopping, piping and micro-instability due to seepage. To address the randomness resulting from the variability in boundary conditions and dike-failures the system is run in a Monte Carlo framework. Uncertainties in the definition of upstream boundary conditions (i.e. design-hydrographs) are assessed by applying different bivariate copula families to model the frequency of flood peaks and volumes. Uncertainties in the definition of downstream boundary conditions are characterized by associating the rating-curve used as boundary condition with confidence intervals which reflect discharge measurements errors and interpolation errors. The results of the study are presented in terms of the Monte Carlo-based flood hazard mapping for different flood-intensity indicators (e.g., inundation depth, flow velocity, inundation duration, etc.) together with the corresponding uncertainty bounds. We conclude on the influence of uncertainty in boundary conditions and provide decision makers with an important piece of information for devising and implementing flood-risk mitigation strategies.