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Coupling 1D hydrodynamic, dike breach and inundation models for flood risk assessment along the Elbe River

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Recent flood events in Europe, especially in August 2002, stress the necessity for comprehensive inundation risk assessment in flood-prone areas. Large-scale flood risk maps are one of the products of such assessments and aim at communicating inundation extent and expected damage, thus raising public awareness and setting the priorities for developing management strategies. For risk assessment an accurate estimation of the inundation depth and the extent is required. Furthermore, the uncertainty associated with the obtained results has to be analysed. During floods inundation of widespread areas can be prevented by river dikes. It is also the case along the Elbe that large flood extents have occurred due to the dike failures. A coupled model approach is proposed for the estimation of inundation areas and depth for diked reaches along the Elbe River. An explicit consideration of dike breaches due to overtopping based on critical overflow criteria is included in the modelling approach. To account for other breach mechanisms, which are difficult to describe deterministically for large-scale simulations, a stochastic approach based on the fragility curves is proposed. A full 1D hydrodynamic model of the river channel is coupled with the dike breach model. In case of a dike failure the outflow discharge through the breach serves as a boundary condition for the storage cell inundation model based on continuity and diffusion wave equations discretized over the grid. The back coupling between the dike breach and the 1D channel model is realized to correctly represent the flood wave reduction in the river due to the outflow at the breach. The modelling codes are coupled using the Typed Data Transfer (TDT) library providing an interface for data exchange between models at runtime. The challenge in coupling models of different spatial and temporal discretization is efficiently overcome by implementing the TDT library. Test runs of the modelling system for the Elbe flood 2002 in the 91 km reach between Tor-

gau (Elbe-km 154.6) and Vockerode (Elbe-km 245.6) indicate a high sensitivity of the modelled locations and times of dike breaches to river bed geometry and dike characteristics such as course, chainage and crest height. The effect of the back coupling between inundation and river channel models on the inundation depth and extent is demonstrated and becomes clearly pronounced in case of the filled hinterland areas. The proposed modelling approach represents a compromise between the number of processes considered, the degree of model complexity and the computation time requirements relevant for the catchment scale flood hazard assessment, which is believed to be applicable for inundation assessment and uncertainty analysis within a Monte-Carlo framework using e.g. Latin-Hypercube Sampling.