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Integrating flood modelling in a hydrological catchment model: flow approximations and spatial resolution.

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Within hydrological models, flow approximations are commonly used to reduce computation time. The validity of these approximations is strongly determined by flow height, flow velocity, the spatial resolution of the model, and by the manner in which flow routing is implemented. The assumptions of these approximations can furthermore limit emergent behavior, and influence flow behavior under space-time scaling. In this presentation, the validity and performance of the kinematic, diffusive and dynamic flow approximations are investigated for use in a catchment-based flood model. Particularly, the validity during flood events and for varying spatial resolutions is investigated. The OpenLISEM hydrological model is extended to implement these flow approximations and channel flooding based on dynamic flow. The kinematic routing uses a predefined converging flow network, the diffusive and dynamic routing uses a 2D flow solution over a DEM. The channel flow in all cases is a 1D kinematic wave approximation. The flow approximations are used to recreate measured discharge in three catchments of different size in China, Spain and Italy, among which is the hydrograph of the 2003 flood event in the Fella river basin (Italy). Furthermore, spatial resolutions are varied for the flood simulation in order to investigate the influence of spatial resolution on these flow approximations. Results show that the kinematic, diffusive and dynamic flow approximation provide least to highest accuracy, respectively, in recreating measured temporal variation of the discharge. Kinematic flow, which is commonly used in hydrological modelling, substantially over-estimates hydrological connectivity in the simulations with a spatial resolution of below 30 meters. Since spatial resolutions of models have strongly increased over the past decades, usage of routed kinematic flow should be reconsidered. In the case of flood events, spatial modelling of kinematic flow substantially over-estimates hydrological connectivity and flow concentration, leading to significant errors. The combination of diffusive or dynamic overland flow and dynamic channel flooding provides high accuracy in recreating the 2003 Fella river flood event. Finally, flow approximations substantially influenced the predictive potential of the (flash) flood model.