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Comparison of 2D numerical models for river flood hazard assessment: simulation of the Secchia River flood in January, 2014

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Hydrodynamic modeling of inundation events still brings a large array of uncertainties. This effect is especially evident in the models run for geographically large areas. Recent studies suggest using fully two-dimensional (2D) models with high resolution in order to avoid uncertainties and limitations coming from the incorrect interpretation of flood dynamics and an unrealistic reproduction of the terrain topography. This, however, affects the computational efficiency increasing the running time and hardware demands. Concerning this point, our study evaluates and compares numerical models of different complexity by testing them on a flood event that occurred in the basin of the Secchia River, Northern Italy, on 19^{th} January, 2014. The event was characterized by a levee breach and consequent flooding of over 75 km^2 of the plain behind the dike within 48 hours causing population displacement, one death and economic losses in excess of 400 million Euro. We test the well-established TELEMAC 2D, and LISFLOOD-FP codes, together with the recently launched HEC-RAS 5.0.3 (2D model), all models are implemented using different grid size (2-200 m) based on the 1 m digital elevation model resolution. TELEMAC is a fully 2D hydrodynamic model which is based on the finite-element or finite-volume approach. Whereas HEC-RAS 5.0.3 and LISFLOOD-FP are both coupled 1D-2D models. All models are calibrated against observed inundation extent and maximum water depths, which are retrieved from remotely sensed data and field survey reports. Our study quantitatively compares the three modeling strategies highlighting differences in terms of the ease of implementation, accuracy of representation of hydraulic processes within floodplains and computational efficiency. Additionally, we look into the different grid resolutions in terms of the results accuracy and computation time. Our study is a preliminary assessment that focuses on smaller areas in order to identify potential modeling schemes that would be efficient for simulating flooding scenarios for large and very large floodplains. This research aims at contributing to the reduction of uncertainties and limitations in hazard and risk assessment.