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On tsunami inundation modeling for hazard estimation at three coastal areas in Indonesia

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Numerical modeling deals with physical phenomena, from which a model can only consider a selection. A specific event as well as the description of the terrain has to be represented adequately by model input data. Furthermore, model results are averaged quantities, which are supposed to be representative for an area. They have to be interpreted with respect to the used data and model simplifications and compared to physical data, leading to a validation of the model, before they can be used for their purpose. In tsunami modeling, the application of these steps is very difficult because of the availability of required data. Furthermore, some phenomena, e.g. a tsunamigenic earthquake and inundation, are still not adequately understood. These points lead to an uncertainty, which comes along with every inundation result. Especially when modeling results are supposed to be applied in hazard assessment a critical discussion on the uncertainties is required. In this study, a non-linear shallow water model with finite volume discretization has been used to calculate wave propagation from the source region to the shoreline and inundation. Terrain roughness has been implemented using the quadratic friction law. Considering experiences from onsite surveys in the areas of Cilacap, Kuta and Padang (Indonesia), sensitivity tests have been done varying bathymetry data and Manning values. One hypothetical tsunamigenic earthquake has been applied to all areas, using similar source parameters and distances between the epicenter and the particular area. The Manning values have been generated on the basis of land use data, considering energy losses due to drag and inertia. The results have been analyzed with respect to flow depths and flow velocities onshore. In all three areas, inundation depths show a small sensitivity against Manning values, onshore flow velocities show high sensitivity. The fluxes have been determined from flow depths and velocities and classified using stability criteria for humans and different structure types. The sizes of the so distinguished areas can be used to describe a hypothetical tsunami hazard in relation to land use and terrain characteristics at any area prone to tsunamis.