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Analysis of the properties of tsunamis generated by landslides on a rectilinear coastline through numerical modelling

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Landslides can be responsible for direct threat, but they must also be regarded as dangerous phenomena in virtue of the events they can trigger, as demonstrated by the sequence of landslides and tsunamis occurred on the 30^{th} December 2002 at Stromboli island, southern Italy. In that particular case, the most destructive effects in the populated areas and the highest threat for people were produced by the tsunamis generated by landslides rather than by the landslides themselves. So the Stromboli events have given new impulse to the study of tsunamis generated by unstable bodies. In this context we have examined the tsunamigenic potential of submarine landslides by using analytical and numerical methods. Here we represent the landslide body as a unique rigid block, the dynamics of which is modelled through analytical formulas and depend only on gravity force, buoyancy, and basal friction. The propagation of the tsunami waves is computed on an ideal basin through a finite element numerical method. The study is divided into two parts. In the first one we consider a 1D case, in which the height of the landslide is transversally uniform; in the second, a 2D model is used in order to take into account the finiteness of the landslide width. One of the most important parameters that characterises the tsunamigenic potential of a landslide is represented by the ratio between the landslide and the water wave velocities, known as Froude number. The dependence of the tsunami on the landslide velocity is studied by varying some parameters that influence the dynamics of the landslide itself: in particular, we vary both the material properties (density, buoyancy) and some geometrical features (landslide length, initial position, and volume). The tsunamis generated in each different case are analysed by comparing the profiles of maximum water elevation in the direction of the slide motion and the tide gauges computed on a number of significant nodes, both offshore and onshore.

The 2D model has been utilized to study not only the correlation between tsunami properties and the slump width, but also to detail the importance of the Froude number and of the transfer function. The results show that the tsunamigenic potential of landslides is the highest when their motion approaches the critical Froude regime. The analysis of the simulation outcomes has been carried out also by evaluating the maximum and minimum tsunami elevations along the coast.