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Modelling landslide-generated tsunami: from landslide propagation to downstream flood in dam context

Martin Franz, Yury Podladchikov, Florian Humair, Battista Matasci, and Michel Jaboyedoff
University of Lausanne, Institute of Earth Sciences, Faculty of Geosciences and Environment, Lausanne, Switzerland (martin.franz@unil.ch)

Alpine regions have a high density of dammed lakes, either natural or anthropogenic. Those are frequently surrounded by steep slopes and thus, are potentially affected by mass wasting processes. The penetration of landsliding material in the water body may lead to impulse waves that could overtop the dam and, in the worst case scenario, breach or break the latter. The possible resulting outburst flood is a serious threat for populated places, commonly concentrated downstream in the valleys. In order to assess the risk resulting from the succession of all phenomenon, a numerical model able to handle all of them is required. Although specific models of flooding simulation or wave propagation are efficient, there is currently no fully achieved model capable to integrate all the above-mentioned processes at the same time.
In order to address this, we propose a new model capable to handle these difficult combinations and which is suitable for risk assessment in dam contexts.
Our model is based on both the shallow water equations and viscous flow equations. The first ones are stabilised by the Lax-Friedrichs scheme and compute the wave propagation and the downstream flow, i.e. the wet state. The viscous flow equations are used for the dry state and to propagate the landslide body. The transition from one state to the other is ruled by a threshold based on the Reynolds number.
First, in order to test the capacity of our model to endure critical situations, we conducted numerical sandbox tests such as Riemann problems, dam break, and landslide tsunami-related ones in 2 dimensions. In a second time, the model is applied on a real case study: the Oeschinen Lake (Switzerland). This naturally dammed lake is specifically selected since it is potentially affected by all above-mentioned phenomenon, including landsliding, wave generation, wave propagation in the water body and on the shore as well as the downstream flooding. Results show that the municipality of Kandersteg, located 3 km downstream the dam, is subject to catastrophic consequences in case of slope failure of large rock compartments from the slopes above the lake.