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Mathematical modelling of Santa Lucia (Chile) landslide and mudflow

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A severe rainstorm between 15th and the 16th of December 2018 led to a major landslide on the upper River Burritos watershed, Chaiten Region, Chile, and a destructive flood that killed around 15 people and caused widespread damage. The precipitation reached around 120 mm in the vicinity of Villa Santa Lucia, a town of 300 people approx. The combination of intense precipitations and saturated soils originated around a 200,000 m3 landslide, judging from the differences between the pre-event DEM and the post-event DEM, built by SERNAGEOMIN and INH from drone-based aerial photogrammetry.
The aim of this work is to perform the simulation of the hydro- and morphodynamic aspects of the landslide and flood in Burritos River, highlighting the physical processes at play and showing, in the process, the capabilities of STAV2D mathematical model for assessing landslide and mudflow hazards. STAV2D is a high-performance shallow-water model suited for territorial applications developed at CERIS. It is fully suited to high-performance computing on distributed systems and different parallel processor architectures (Central and Graphics Processing Units).
The simulation of this extreme flood event represents a highly demanding computational test that entails the description a) of the initially displaced mass based on sediment properties and geotechnical criteria, b) of the pronounced morphologic impacts in River Burritos, with erosion depths of more than 10 m, and deposition layers of about 3 m, and considerable stream widening, c) the interaction of the flood and the buildings of Santa Lucia.
A sensitivity analysis was carried out to assess the influence of the choice of flow rheology and the influence of the grain-size in the river bed (for which there were no accurate information at the time of the simulation). It was found that a better description of the field measurements was attained for a 1-phase turbulent flow with variable density. The simulations depict a high-momentum flow in the upper part of the river, due to its high bed slope, hence highly erosional, with little sensitivity to the characteristic grain-size of the river bed. The flow becomes depositional in the vicinity of the village. The momentum imparted on some of the built structures was calculated under the premise that they remain perfectly impervious. The hydrodynamic actions are show to be able to drag some buildings out of their locations if their foundations are shallow.

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