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Lahar simulation with SPH and field calibration at the Colima Volcano (Mexico)

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As a result of the frequent effusive activity of Volcán de Colima (10º 30′44′′N, 103º 37′02′′ W), the most active volcano in Mexico, plenty of rain triggered lahars are produced, especially during the rainy season. Along the recent period of activity, particularly from 2010, many of these lahars channelled through the main ravines of the volcano and reach large distances, representing high risk for more than 10,000 people at the surroundings.
Modeling of lahars has become an important tool in the assessment of the related hazards, in order to undertake appropriate mitigation actions and reduce the associated risks. Recent lahars at the Colima Volcano are well documented, so they can be used to prove the accuracy of modelling.
In this work, we used the SPH (Smoothed Particle Hydrodynamics) method, a depth integrated coupled model created by Pastor in 2005, to replicate the propagation stage of 3 recent Colima lahars occurred on Montegrande ravine in 1992, 2011 and 2012. The studied events include hyperconcentrated, debris and a mixture of the previous flow natures.
The inputs used for the SPH simulations were the initial point, volume of each lahar and an adapted morphology of its mass. Field data used to verify the SPH results include the stopping point of the lahar, its path, velocity and height values, as the floodplain area. All this information was a result of fieldwork recognition (cross section profiles of the inner part of the ravine) and free satellite imagery analysis.
The best results were obtained using Bingham rheology. The proposed parameters to simulate Colima lahars were 20 Pa of yield strength and 30 Pa.s of viscosity for the 1992 lahar (hyperconcentrated flow), 200 Pa and 50 Pa.s in case of the 2011 debris flow, and finally 20 Pa and 24 Pa.s for the 2012 event, whose nature evolved from debris to an hyperconcentrated flow. In all cases a 1900 kg/m3 density was used.
Highly accurate results showed the relevant role played by rheological parameters and the necessity of a systematic collection of field data to calibrate the model.

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