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Calibration of a SPH model for the numerical analysis of mud-flow run-out: the case of the Rotolon torrent in Italy

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Among the numerical models developed in the last twenty years to predict the propagation of flow-like landslide in the framework of the continuum and discrete element mechanics, the SPH model proposed by Pastor et al. (2009) is particularly suitable for this kind of analysis. The model is based on the theory of the shallow-water waves, assuming that for the flow-like landslides the average depths are small in comparison with their length or width, and also simplifying the 3D propagation model by integrating the equations along the vertical axis. In this way, the Biot – Zienkiewicz equations for non-linear materials and large deformation problems are coupled to various constitutive models (Bingham, Voëllmy, Morh-Coulomb, etc.) obtaining a 2D depth-integrated model, which presents an excellent combination of accuracy and simplicity and provides information about propagation, such as average velocity or depth of the flow along the path.
This study presents the calibration of Pastor's model carried out on the base of observations obtained in the Rotolon torrent valley. In this site, located in the Northeastern part of Vicenza province (Italy) a debris-flow triggering area is active since a century and periodically it creates risk conditions for the down-stream valley. The last dangerous events occurred in November 2009 and 2010 and seriously engaged the valley worrying the inhabitants and the local administrators. Fortunately no dead and injured people have been registered.
In this case, the rheological tests carried out in a coaxial rheometer on the finest part of the material collected along the stream did not furnished reliable data for the calibration of the model: this because the material is composed by heterogeneous material including large parts of coarse particles, which cannot be introduced in the rheometer. Thus, the model calibration was performed using the in-situ observation carried out immediately after the 2009 event.
The calibrated model proved to be a very useful tool to assess the critical flow conditions in some cross-sections along the stream and also to suggest some interventions for the risk reduction in the valley.