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A model for predicting the spatial-temporal development of flow-type landslides

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S4d is the latest release of the Cellular-Automata model SCIDDICA for the simulation of flow-type landslides. With respect to previous releases, the physical description of the phenomenon has been refined, albeit still within a semi-empirical and macroscopic approach: computation of flow velocity and energy dissipation has been improved, by considering the basal slope between the cells and the duration of the model step; the effects of internal pressure in the flowing body have been made explicit; finally, debris distribution among the cells is computed by properly altering the elevation of all the cells of the neighbourhood. Accordingly, the peculiar characteristics of even very/extremely rapid flows can be better taken into account.

Despite being characterized by a discrete space-time framework, the model strictly reflects the classical modelling approaches of dynamic models. Movement of debris masses is, in fact, driven by gravitational acceleration; the resulting force can be influenced by the internal pressure, and by the basal resisting force. In S4d, the moving material is approximated by means of an "equivalent fluid", whose bulk properties are macroscopically similar to the real case. Model parameters can not be directly measured in laboratory tests, but must be determined through calibration. With respect to lumped mass models, the model allows for predicting the propagation of the flow front, besides other details about the phenomenon and the overall affected area. Yet, differently from most continuum mechanics models, it allows for the selection of a variety of material rheologies, by also permitting to simulate the propagation of the flow either onto complex topography or open slopes. The model is able to simulate the erosion of the regolith along the flow-path, according to the energy of the flow-

ing mass, as well as events of branching and re-joining of the masses. Dissipative effects are modelled in terms of not-exclusive velocity-dependent mechanisms, which allow to reproduce even complex rheological behaviours. Effects of mass collisions are correctly managed by guaranteeing mass conservation; in case of no dissipation, conservation of energy and momentum are also assured.

Preliminarily calibration has been carried out through sequential Genetic Algorithms, by considering the Curti mudflow occurred on the southern slope of the Pizzo d'Alvano massif (Campania) in May 1998. Thorough calibration and validation phases are presently being carried out by means of parallel Genetic Algorithms, by considering other study cases, similar to the Curti one, occurred in the same region: at Pizzo d'Alvano, on May 1998, and at San Martino Valle Caudina-Cervinara, on December 1999. Finally, an extensive sensitivity analysis has also been started, aimed at both refining the optimisation of the parameters against the considered study cases, and also at clarifying model robustness/weakness points with respect to the considered factors. Preliminary results have confirmed the reliability of the model in reproducing the considered types of phenomena.