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Time and intensity prediction in landslide hazard assessment with Cellular Automata models SCIDDICA

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Cellular Automata (CA) represent a formal frame for dynamical systems, which evolve on the base of local interactions. Some types of landslide, such as debris/mud flows, match well this requirement. For CA simulation purposes, landslides can be viewed as a dynamical system, subdivided into elementary parts, whose state evolves exclusively as a consequence of local interactions within a spatial and temporal discretum. Space is the world of the CA, here constituted by hexagonal cells. The attributes of each cell ("substates") describe physical characteristics. For computational reasons, the natural phenomenon is "decomposed" into a number of elementary processes, whose proper composition makes up the "transition function" of the CA. By simultaneously applying this function to all the cells, the evolution of the phenomenon can be simulated in terms of modifications of the substates. Our research group developed the family of semi-empircal deterministic CA models SCIDDICA (Simulation through Computational Innovative methods for the Detection of Debris flow path using Interactive Cellular Automata). First releases of SCIDDICA were simple and their application field restricted to slow mud flows. The latest releases of the model were specifically developed for simulating very/extremely rapid debris flows. They need to simulate the erosion of the regolith along the flow-path, besides branching and rejoining events of the flow masses. Dissipative effects are modelled in terms of notexclusive velocity-dependent mechanisms, which allow to simulate even complex rheological behaviours. Moreover, it is important to manage the peculiar characteristics of rapid flows, and the effects of mass collisions, by guaranteeing mass conservation. In case of no dissipation, conservation of energy and momentum are also assured. Substates are the following: altitude of the cell (in meters a.s.l.), thickness of landslide (in

meters), depth of erodable regolith (in meters), outflows of landslide (in meters) from a cell toward the adjacent cells, mechanical energy (in joules) of the landslide, components of the momentum of the landslide along the directions x and y. The processes, captured by the transition function of the cells are: regolith erosion, computation of the cell debris outflows, conservation of mass, energy and momentum, energy loss. The CA computes each substate at each time step. The models were validated against the Sarno (Italy) landslides of 1998 with the use of Genetic Algorithms. The features of the model permit to obtain time and intensity consideration from the simulations in the limits of the space-time discretisation. Significant examples can be exhibeted.