FLOW-S*: a physically-based CA-model for flow-type landslides

G. G.R. Iovine, P. Mangraviti, and L. Merenda

CNR, IRPI, Rende (Cosenza), Italy (g.iovine@irpi.cnr.it, +39 0984 835.319)

Predicting the spatial development of debris flows is usually a severe task. Nevertheless, such prediction is fundamental for hazard assessment purposes. Modelling and simulation techniques are a valuable tool for risk assessment and mitigation. In the past decades, different conceptual approaches, ranging from laboratory experiments to numerical schemes, have been proposed, and interesting attempts of modelling have been carried out. Among these methods, some are specifically aimed at evaluating the susceptibility, or spatial hazard.

A family of Cellular Automata (CA) models for simulating flow-type landslides has recently been developed within the frame of a scientific cooperation between the CNR-IRPI and the University of Calabria. Such models fall within the class of CA for Macroscopic Fluids. In the most recent releases, they proved to be quite robust, and do not generally show instability problems. Finally, they can fully incorporate even very-dense DEMs.

FLOW-S* is the latest version of the family: with respect to its ancestors, it is by far more physically-constrained. It has been developed by properly transposing the well-known "equivalent-fluid" and "geotechnical" modelling approaches into the discrete space-time framework of CA modelling. In FLOW-S*, the landslide material moving from a given cell to another one of the neighbourhood is driven by the gravitational acceleration along the local slope. Dissipative and pressure terms variously affect the conservation of the energy of the moving mass. Momentum conservation is guaranteed, as well as a proper management of collisions; mass conservation depends on processes of entrainment, which may occur along the flow path. As concerns model parameters, they reflect either the discrete type of CA approach, or are related to the characteristics of the material involved, and to the type of phenomenon.

Model performances are briefly discussed by referring to a set of real events recently occurred in Southern Italy. Results of flume experiments carried out at the CNR-IRPI geotechnical laboratory, by employing different types of water-debris mixtures, are also being considered for a deeper comprehension of model behaviour.