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Numerical modelling of hydrological slope response: GIS application to rainfall induced landslides forecasting

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A significant part of Italian mountainous areas are covered by pyroclastic deposits resting at slope angles higher than 40-50°. The stability of these steep slopes in loose or poorly cemented pyroclastic materials is essentially guaranteed by the positive effects of matrix suction on shear strength until an increase in saturation (and hence a decrease in suction) is induced by seepage initiated by different processes. The Cervinara flowslide (Campania, Italy) is a typical case where rainfall infiltration increased saturation and hence led to failure of shallow layered pyroclastic deposits. This case study is examined by means of a numerical model calibrated through back-analysis of flume tests, which link instability to rainwater infiltration.

The complexity of infiltration process on unsaturated layered slope requires the set up of a numerical model. The model includes a 3D volume finite algorithm (I-MOD3D) developed in VBA application for ARCOBJECTTM/ARCGIS 9.2TM to automate the mesh-generation starting from a Digital Terrain Model allowing the analysis of slope response at catchment scale.

Model calibration was carried out using either data from laboratory tests on natural soil samples or from infiltration tests on layered slope model. Model validation was carried out through back-analysis of in situ suction measurements using initial and boundary conditions derived from field monitoring.

Comparison between the results of slope model infiltration tests, numerical simulations and in situ measurements showed that the developed numerical model represents reliable tool for predicting slope response to rainfall infiltration for shallow layered pyroclastic deposits.