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Hydrogeomorphological and stability modeling of pyroclastic soils covering peri-vesuvian hillslopes (Campania – Southern Italy)

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In the area surrounding the Campanian volcanic districts the greater natural risk, after the volcanic one, is represented by the debris flows that occur along the steep slopes of carbonate and volcanic mountains. These phenomena involve loose ash-fall pyroclastic mantle and impact with human lives and infrastructures at the foot-slope. A cause-effect relationship between landslide triggering and high intensity and/or prolonged rainfalls is commonly recognised as well as the seasonal effect due to the soil moisture variability. The huge research activities carried out after the 1998 disastrous events that hit Sarno and the neighbouring towns allowed to recognise the complex evolution of the landslides that start as debris slides and then evolve as widening and extremely rapid unchannelled debris avalanche and/or channelled debris flow. Notwithstanding the general characterisation of the phenomena, many uncertainties about the temporal and spatial formation of the perched groundwater flow, responsible of the initial instability, remain. In fact, even if the casuistry of natural and artificial morphological conditions indicates that hollows, narrow zones at the top and at the foot of rocky cliffs and unprotected road-cuts are the most susceptible areas, a specific hydrogeomorphological model of the pyroclastic mantle has not been clearly focused. The latter seems to be a key achievement that could justify the punctual location of the initial slides and thus could improve the application of distributed stability models, besides allowing the planning of specific stabilization works on the slopes.

With the aim to focus such a research objective we have carried out engineering geological surveys on pyroclastic mantle in a sample area of the Lattari Mountains, representative of the morphological conditions in which debris slides initiate. Specifically, the surveys consisted in stratigraphic characterisation of the overburdens in different morphological condition, from the morphological divide to the hollow axis. Moreover, a set of soil samples has been classified and characterised in terms of hydraulic and mechanical properties.

Among the principal results, the vertical heterogeneity of pyroclastic horizons characterised by very contrasting hydraulic conductivity values, especially between the high-permeability pumiceous lapilli C-horizon and the low-permeability basal B-buried horizon, can be pointed out, therefore according to the observation of many other researchers. Moreover, we have verified the existence of an inverse relationship between pyroclastic soil thickness and slope angle, confirming what previously discovered in other sample areas of Lattari and Sarno Mountains. This kind of distribution of pyroclastic mantle along the slope indicates the progressive decrease of soil thickness, above $35^{\circ} \div 40^{\circ}$, till to negligible values above 50°, which results in a pich-out of the C-horizon and thus in an abrupt decrease of hydraulic transmissivity of pyroclastic mantle. The aforesaid condition leads to hypothesise the existence, during high intensity rainfalls, of a local increase in pore pressure where hydraulic transmissivity decreases. We have verified such hypothesis by means of unsaturated/saturated flow numerical model. The results achieved, also supported by field observations in the triggering areas, appear to suggest that a finite slope stability model can better represent the high lateral variability of thickness and hydraulic conductivity of the pyroclastic mantle.