Geophysical Research Abstracts
Vol. 12, EGU2010-4994, 2010
EGU General Assembly 2010


# Analysis of infiltration into pyroclastic layered slopes: physical and mathematical modelling

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Mountainous areas of Northern Campania, Southern Italy, are characterised by steep slopes covered with pyroclastic deposits, in form of alternating layers of volcanic ashes and pumices, laying above a pervious fractured calcareous bedrock, in some cases covered by a layer of impervious weathered ashes. Slope inclination is often larger than internal friction angle of such ashes (around 38°), thus equilibrium is assured by the contribution of apparent cohesion due to soil suction in unsaturated conditions. That is why, during intense and persistent rainfall events, when soil approaches saturation and consequently suction decreases, shallow landslides are frequently triggered. The physical characteristics of involved soils are such that landslides often evolve in form of debris flows, which can cause huge damages to buildings and infrastructures and, in some cases, even casualties.

Understanding the role played by the different layers and by the bottom boundary condition at the soil-bedrock interface is essential to develop reliable models of layered slope response to rainfall infiltration, allowing to define triggering conditions of landslides.

To this aim, infiltration tests in small scale model slopes have been carried out in an instrumented flume. In the flume, a model slope is reconstituted by a moist-tamping technique and subjected to an artificial uniform rainfall. The state of stress and strain of the slope is monitored with various kinds of sensors during the entire test. In particular, soil suction is measured at different locations and depths with mini-tensiometers, and soil moisture is measured with TDR sensors, used with an innovative technique allowing to reconstruct the water content profile of soil along the entire thickness of the investigated deposit.

Infiltration and evaporation experiments in artificial slopes, with alternating layers of volcanic ashes and pumices, have been carried out with various inclinations and bottom boundary conditions.

The coupled values of soil suction and water content, observed during the experiments, have allowed to define the most reliable water retention curves for volcanic ashes and pumices. The curve obtained for the ashes presents pronounced hysteresis and looks quite different form the curves obtained with standard laboratory techniques over undisturbed and reconstituted soil specimens.

The performed infiltration experiments have been simulated with a mathematical model based on the integration of Richards equation with the finite volumes technique. The use of the retention curves obtained from the experiments, rather than the curves estimated in laboratory, resulted in a substantial improvement of the agreement between simulation results and experimental data, confirming the reliability of the obtained curves and the importance of physical modelling for building up reliable mathematical models of infiltration in complex geometry.