Geophysical Research Abstracts
Vol. 13, EGU2011-7770-1, 2011
EGU General Assembly 2011
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Hydrological response of steep slopes in unsaturated pyroclastic soils: long-term monitoring results

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Large mountainous areas of Campania (southern Italy) are subjected to recurrent catastrophic flowslides triggered by heavy rainfalls. The slopes are covered by shallow deposits of loose pyroclastic soils, usually in unsaturated conditions, laying above calcareous bedrock. Slope inclination is often larger than the internal friction angle of the soils (around 38°), thus equilibrium is assured by the contribution of apparent cohesion due to soil suction in unsaturated conditions. Therefore, a key tool for the stability analysis of such slopes is the knowledge of hydrological response of shallow covers during intense and persistent rainfall events and its dependence on initial and boundary conditions, which continuously change during the seasonal cycles. To this aim, field hydrological monitoring is essential to develop reliable models to reproduce the effects of rainfall through modelling and possibly predict the onset of slope failure triggered by critical precipitations.
The results of a several years long monitoring of a steep hillslope located 30 km East of Naples, just beside an area where a catastrophic flowslide occurred, are presented. Hydrological monitoring from 2002 to 2006, mainly concerning precipitation height and matric suction measurement at different locations and depths, was carried out with low temporal resolution, by collecting data every week.
Since summer 2009, an automatic monitoring station has been installed at the site, consisting in several jet fill tensiometers for measurements of matric suction, and several time domain reflectometry probes of various lengths, connected through a multiplexer to a reflectometer, for the measurement of water content profile. The new devices are installed at different depths up to 1.60m below the ground surface and the data are collected with hourly temporal resolution.
Experimental data with low time resolution, acquired over several years, allowed to highlight some important aspects of the slope behaviour during the entire seasonal cycle, while the more recent higher temporal resolution data, collected through the automatic station, confirm the usefulness of simultaneous monitoring of rainfall height, soil suction and soil water content for a better understanding of slope infiltration processes.