Geophysical Research Abstracts
Vol. 16, EGU2014-15961, 2014
EGU General Assembly 2014

Physically-based failure analysis of shallow layered soil deposits over large areas

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In the last decades, the analysis of slope stability conditions over large areas has become popular among scientists and practitioners (Cascini et al., 2011; Cuomo and Della Sala, 2013). This is due to the availability of new computational tools (Baum et al., 2002; Godt et al., 2008; Baum and Godt, 2012; Salciarini et al., 2012) - implemented in GIS (Geographic Information System) platforms - which allow taking into account the major hydraulic and mechanical issues related to slope failure, even for unsaturated soils, as well as the spatial variability of both topography and soil properties. However, the effectiveness (Sorbino et al., 2010) of the above methods it is still controversial for landslides forecasting especially depending on the accuracy of DTM (Digital Terrain Model) and for the chance that distinct triggering mechanisms may occur over large area. Among the major uncertainties, layering of soil deposits is of primary importance due to soil layer conductivity contrast and differences in shear strength.

This work deals with the hazard analysis of shallow landslides over large areas, considering two distinct schematizations of soil stratigraphy, i.e. homogeneous or layered. To this purpose, the physically-based model TRIGRS (Baum et al., 2002) is firstly used, then extended to the case of layered deposit: specifically, a unique set of hydraulic properties is assumed while distinct soil unit weight and shear strength are considered for each soil layer. Both models are applied to a significant study area of Southern Italy, about 4 km2 large, where shallow deposits of air-fall volcanic (pyroclastic) soils have been affected by several landslides, causing victims, damages and economic losses.

The achieved results highlight that soil volume globally mobilized over the study area highly depends on local stratigraphy of shallow deposits. This relates to the depth of critical slip surface which rarely corresponds to the bedrock contact where cohesionless coarse materials lie on deeper soil layers with small effective cohesion. It is also shown that, due to a more realistic assessment of soil stratigraphy, the success of the model may increase when performing a back-analysis of a recent real event.

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