Geophysical Research Abstracts
Vol. 18, EGU2016-8923, 2016
EGU General Assembly 2016

A multidisciplinary methodological approach for slope stability assessment of an area prone to shallow landslides

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Rainfall-induced shallow landslides are widespread slope instabilities phenomena in several hilly and mountainous contexts all over the world. Due to their high density of diffusion also in small areas, they can provoke important damages to terrains, infrastructures, buildings, and, sometimes, loss of human lives.
Shallow landslides affect superficial soils of limited thickness (generally lower than 2 m), located above weathered or not bedrock levels. Their triggering mechanism is strictly linked to the hydrological response of the soils to rainfall events. Thus, it becomes fundamental a comprehensive analysis of the soil properties which can influence the susceptibility of a slope to shallow landslides.
In this study, a multidisciplinary approach was followed for the characterization of the soils and the individuation of the triggering conditions in an area particularly prone to shallow failures, for slope stability assessment. This area corresponded to the hilly sector of North-Eastern Oltrepò Pavese (Lombardy Region, Northern Italy), where the density of shallow landslides is really high, reaching more than 36 landslides per km2.
The soils of the study area were analyzed through a multidisciplinary characterization, which took into account for the main geotechnical, mechanical and mineralogical parameters and also for the main pedological features of the materials. This approach allowed for identifying the main features and the horizons which could influence the soil behavior in relation to the conditions that are preparatory to shallow landslides development.
In a test-site slope, representative of the main geomorphological, geological and landslides distribution characteristics typical of the study area, a continuous in time monitoring of meteorological (rainfall amount, air temperature, air humidity, atmospheric pressure, net solar radiation, wind speed and direction) and hydrological (soil water content, pore water pressure) parameters was implemented. In this way, the triggering mechanism of shallow failures in the study area was identified and the effects of the different hydrological parameters on slope stability assessment through a simplified physically-based model (Lu and Godt's model) was quantified.
In several slopes, representative of the main land uses (cultivated vineyards, abandoned vineyards, shrub lands, woodlands) of the study area, soil root reinforcement of the vegetation of the slopes was measured since root density and root tensile strength. This parameter was, then, integrated in the same simplified physically-based model (Lu and Godt's model), in order to improve the assessment of slope instabilities. Moreover, this analysis allowed for a better identification of the land use classes more susceptible to shallow landslides, furnishing an important tool for land planning.