Plinius Conference Abstracts
Vol. 13, Plinius13-113, 2011
13th Plinius Conference on Mediterranean Storms

Spatiotemporal modeling of some case histories of shallow landslides in the area of Oltrepo Pavese, Northern Italy

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On the 27th and 28th of April 2009, the north-eastern sector of the area of Oltrepo Pavese has been affected by a heavy storm, which has caused the triggering of thousands of shallow landslides. On the 28th of April, Cigognola rain-gauge station recorded 150 mm of rain in 48 h (20% of the annual average amount) with a maximum rainfall intensity of 22 mm•h-1 at 9 p.m. on April 27th. Most of the landslides were concentrated on slopes with vineyards or woodlands of newly formed. The triggering of soil slips provoked one fatality and the damaging or the blocking of many roads. Arial photointerpretation, coupled with field surveys, revealed that the rainfall event of April 2009 triggered about 1,600 landslides in the north-eastern sector of Oltrepo Pavese. At least 115 landslides occurred in the municipal territory of Broni. Landslides appear on SW-NE oriented slopes and were observed in the slope range from 16° to 37°. The highest landslide frequency corresponds to slope angles between 25°-30°. Most of the landslides tended to be concentrated in areas where the slope angle changed from a gentle slope to a steep slope or vice versa. The soils involved in the shallow landslides are represented by the colluvial deposits derived by the weathering of the bedrock (S.Agata Fossili Marls, M. Arzolo Sandstones, Rocca Ticozzi Conglomerates, and fluvial and alluvial deposits). Once acquired the input data about the topography, the geotechnical properties of soil, and the land use of the study area, it has been carried out a slope-stability analysis on regional scale, at first on an area of 2.4 km2, and then, on other two zones, respectively, of 17.5 km2, partially coinciding with the first area, and of 15.8 km2. The slope stability analysis has been carried out using distributed model, named SLIP (Shallow Landslides Instability Prediction), which has been recently implemented in a platform, which allows to process the required territory information on regional scale. In particular, the territory is divided into a 10x10 m grid, where each cell is independently modeled considering its own soil features. The slope angle corresponding to each cell is derived from a Digital Terrain Model (DTM) with a resolution of 10 m, whereas geotechnical data have been assigned to each cell starting from the lithological and soil coverage maps previously produced for the area. The slope-stability analysis has been carried out for the municipal territory of Broni for the period between the 1st of May 2008 and the 30th of April 2010. Finally, the model predictions are compared, from a spatial point of view, with observed landslide localizations, through the ROC analysis (Receiver Operating Characteristic), and from a temporal point view, regard as the expecting date, evaluating for a two years the quantity of instable areas against the precipitations.