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A process-based model for the definition of hydrological alert systems in landslide risk assessment

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During October 31-November 2, 2010 an exceptional rainfall event hit the Veneto Region, located in North Eastern Italy. The heavy rainfall, up to 500 mm cumulated in 3 days, produced large flood conditions and triggered hundreds of landslides. After the rainfall event, the Soil Protection Division of the Vicenza Province received more than 200 warnings of landslide phenomena. Most of the phenomena consist of small and medium shallow landslides generally affecting eluvial and colluvial covers and past landslide deposits. In 10 cases, large and deep landslides and reactivations have been recorded.

This work reports preliminary results on a process-based model for the definition of an hydrological alert system for the Val di Maso Landslide. It is a complex landslide with a volume of about 200,000 m3. In the middle and lower part it consists of a debris flow involving eluvial/colluvial deposits and past landslide debris. In the upper part, clear morphological evidences indicate that the phenomenon is rapidly retrogressing by multiple rotational slides involving volcanic deposits that can be referred to a paleo-landslide. After the mass movements had been occurred, buildings located near the foot of the landslide had been evacuated to avoid human losses.

The first step of this work is the definition of the geological model of the slope affected by the landslide on the basis of field surveys, including geognostic and geophysical investigations, and monitoring data (piezometric, inclinometric and extensometric data) collected after the event. Then, the hydrological conditions that led to the collapse are determined reproducing the rainfall infiltration and seepage related to the triggering of the instability. These conditions are introduced in some stability analyses to evaluate, through parametric study and a back-analysis approach, the geotechnical properties of the material involved in the landslide.

Once reproduced the landslide event, results from the parametric study are used to simulate rainfall and seepage conditions inducing instability in the crown area. Rainfall events with different return periods are considered and linked to groundwater conditions. The use of these conditions in stability analyses allows us to identify rainfall thresholds that can potentially trigger instability phenomena, i.e. rotational slides evolving in channelized debris flows. Finally, the propagation of the displaced material from the crown area is determined to evaluate risk conditions.

The hydrological alert systems for Val di Maso landslide will be implemented by the process-based model briefly described above that combines results from hydrological-statistical and deterministic analyses. The system will consist of a rain gauge station, a software code that compare rainfall data to rainfall events with different return periods and degree of alert, and a transmission system of the warning levels to Authorities.