Geophysical Research Abstracts
Vol. 21, EGU2019-4854, 2019
EGU General Assembly 2019

Potential use of satellite information on soil moisture to improve landslide forecasting: a numerical investigation

Pasquale Marino (1), Thom Bogaard (2), Roberto Greco (1), and David Peres (3)

(1) Dipartimento di Ingegneria, Università della Campania, Aversa (CE), Italy (pasquale.marino1@unicampania.it, roberto.greco@unicampania.it), (2) Water Resources Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands (t.a.bogaard@tudelft.nl), (3) Department of Civil Engineering and Architecture, University of Catania, Catania, Italy (peresdj@gmail.com)

The most important non-structural landside risk mitigation measure is early warning, by which lives can be saved, thanks to prompt evacuation of affected areas. Currently, landslide early warning systems (LEWS) are still mainly based on empirical relations obtained through the combined analysis of rainfall records and landslide inventories. Empirical-statistical precipitation thresholds are derived by plotting two characteristics of precipitation, usually intensity and duration, and drawing a line separating precipitation events that have or have not resulted in landslides in a given area. Such an empirical approach, completely disregarding any description of the hydrological processes leading to landslide triggering, always results in large numbers of false and missing alarms. A possibility for improving the forecasting reliability of LEWS may be to add hydrological information to the thresholds implemented in LEWS, so to explicitly take into account hydrological processes and meteorological forcing.

Generally, landslides are triggered by a pore water pressure increase, which is directly connected to water accumulation within the slope. In the case of landslides triggered in shallow unsaturated soil covers, considering soil moisture at the onset of rainfall has been shown to allow significant improvement of landslide prediction. In fact, soil moisture is related to a number of non-linear hydrological processes (e.g. infiltration, drainage, evapotranspiration). Different approaches can be used for providing soil moisture estimates, such as in situ measurements (e.g. with TDR probes), modelling and remote sensing. This latter technique is capable to provide soil moisture estimates at regional scales. Several remote techniques have been developed in the last decades for the retrieval of soil moisture from microwave, optical and thermal satellite sensors. The major limitations are: the very shallow soil layer (still less than 5 cm thick) that is sensed from satellites; the very low quality under certain surface conditions (dense vegetation, snow). However, near real-time satellite information about soil moisture of larger soil depth is rapidly becoming available.

In this study, a preliminary investigation aimed at assessing the potential of soil moisture information for improving landslide forecasting is carried out, exploring the possible range of information available from current and future remote sensing technology. The analysis performed by coupling a stochastic rainfall generator with the vertical 1D Richards' equation, implemented within the HYDRUS 1D software, so to simulate the hydrological response of a slope during a 1000 years long synthetic rainfall series. The results of the simulations allow to study the relationship between soil moisture at various depths, rainfall characteristics, and the attainment of landslide triggering conditions, which can lead to the definition of effective hydro-meteorological thresholds for landslide initiation, exploiting remotely sensed soil moisture information.

In particular, the study refers to the slope of Cervinara, around 40 km northeast of Naples (Italy), characterized by a fairly regular inclination around 40°, and covered by shallow pyroclastic deposits (with thickness between 2.0m and 2.5 m) laying upon a fractured limestone bedrock. Along this slope, in the night between 15 and 16 December 1999, an intense rainfall event (325 mm in 48 h) triggered a catastrophic flow-like landslide.