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Using Landslide Failure Forecast Models in Near Real Time: the Mt. de La Saxe case-study

Andrea Manconi and Daniele Giordan
Geohazard Monitoring Group, CNR IRPI, Torino, Italy (andrea.manconi@irpi.cnr.it)

Forecasting the occurrence of landslide phenomena in space and time is a major scientific challenge. The approaches used to forecast landslides mainly depend on the spatial scale analyzed (regional vs. local), the temporal range of forecast (long- vs. short-term), as well as the triggering factor and the landslide typology considered. By focusing on short-term forecast methods for large, deep seated slope instabilities, the potential time of failure (ToF) can be estimated by studying the evolution of the landslide deformation over time (i.e. strain rate) provided that, under constant stress conditions, landslide materials follow creep mechanism before reaching rupture. In the last decades, different procedures have been proposed to estimate ToF by considering simplified empirical and/or graphical methods applied to time series of deformation data. Fukuzono, 1985 proposed a failure forecast method based on the experience performed during large scale laboratory experiments, which were aimed at observing the kinematic evolution of a landslide induced by rain. This approach, known also as the inverse-velocity method, considers the evolution over time of the inverse value of the surface velocity (v) as an indicator of the ToF, by assuming that failure approaches while 1/v tends to zero.
Here we present an innovative method to aimed at achieving failure forecast of landslide phenomena by considering near-real-time monitoring data. Starting from the inverse velocity theory, we analyze landslide surface displacements on different temporal windows, and then apply straightforward statistical methods to obtain confidence intervals on the time of failure. Our results can be relevant to support the management of early warning systems during landslide emergency conditions, also when the predefined displacement and/or velocity thresholds are exceeded. In addition, our statistical approach for the definition of confidence interval and forecast reliability can be applied also to different failure forecast methods. We applied for the first time the herein presented approach in near real time during the emergency scenario relevant to the reactivation of the La Saxe rockslide, a large mass wasting menacing the population of Courmayeur, northern Italy, and the important European route E25. We show how the application of simplified but robust forecast models can be a convenient method to manage and support early warning systems during critical situations.

References:
Fukuzono T. (1985), A New Method for Predicting the Failure Time of a Slope, Proc. IVth International Conference and Field Workshop on Landslides, Tokyo.