Weather Forecasting and Radar Technologies for Landslide Prediction and Mapping: Some Examples in Italy

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UNIFI (Earth Sciences Department, University of firenze) has gathered expertise in different fields of landslide study for many years. In particular, in the framework of the SafeLand project, it is currently working on short-term weather forecasting for shallow landslide prediction and on the development of remote sensing technologies for the detection, monitoring and rapid mapping of landslides and evaluation and development of reliable procedures and technologies for early warning.

Concerning the temporal prediction of hazard assessment, UNIFI is active in the study of methods for the real-time and quasi real-time forecast of rainfall induced landslides. Since the beginning, this has been developed along two, partly independent, research lines: the statistical methods based on rainfall thresholds and the development of advanced probabilistic approaches relying on deterministic schemes. The state of development of probabilistic real-time prediction methods is also very promising and can be summarized in its preliminary outcomes by the European Commission funded project PREVIEW (SEGONI et al., in press), in which a complex operative chain has been devised and set up based on radar rainfall measurements, a soil saturation hydrological model and a simple infinite-slope stability code, and, in its following further advancement, by the introduction of a more sophisticated two-stage geotechnical model coupling an explicit saturation scheme and a slope stability model with cohesion terms and variable depth of detachment surface (CATANI et al., in press). One of the key elements which make the use of such sophisticated models possible is the definition of a distributed computational scheme for the prediction of soil depth at the basin scale, a fundamental parameter in shallow-landsliding initiation (Figure 1). Such model has been recently developed by the UNIFI and it is based on geo-morphometric and geological parameters easily measurable in the field or through remote sensing. Currently under development is the attempt at perfecting the deterministic model with the add-on of a probabilistic definition of the parameters with high spatial variability (see e.g. geomechanical parameters) and porting all the computational code on a parallel processing structure on multi-processor supercomputers.

Nowadays, rapid advances of Earth Observation (EO) are effective tools for landslide mapping, monitoring, management and mitigation. Applications are originating from nearly all the types of sensors available today; the very high spatial resolution obtained by optical systems, which are now in the order of tens of centimeters, the launching of SAR (Synthetic Aperture Radar) sensors purposely built for interferometric applications and with lower revisiting times are all leading to rapid developments that make the field extremely promising. During the last years UNIFI has contributed to research activities regarding the use of interferometric applications, both DInSAR and A-DInSAR, for landslide studies.

UNIFI has largely worked on the applications of Synthetic Aperture Radar interferometry (InSAR) to typical geomorphological problems (CATANI et al., 2005). The application of InSAR to the quantification of landform attributes such as the slope and to the estimation of landform variations has been investigated.

ThePS-InSAR technique has been applied at a regional scale as support for landslide inventory mapping and at the local scale for the monitoring of a single well-known slope movements (FARINA et al., 2006; FERRETTI et al., 2005; CANUTI et al., 2007; CASAGLI et al., 2008; PANCIOLI et al., 2008; HERRERA et al., 2009; CASAGLI et al., 2009). At the regional scale, PS-analysis allowed to update the boundary and the state of activity of the existing landslides and to map new movements. At the local scale, PS-InSAR technique has provided an accurate analysis of the temporal and spatial displacement fields, for the creation of activity maps, and combined with other information, for interpreting the movement geometry (Figure 2).

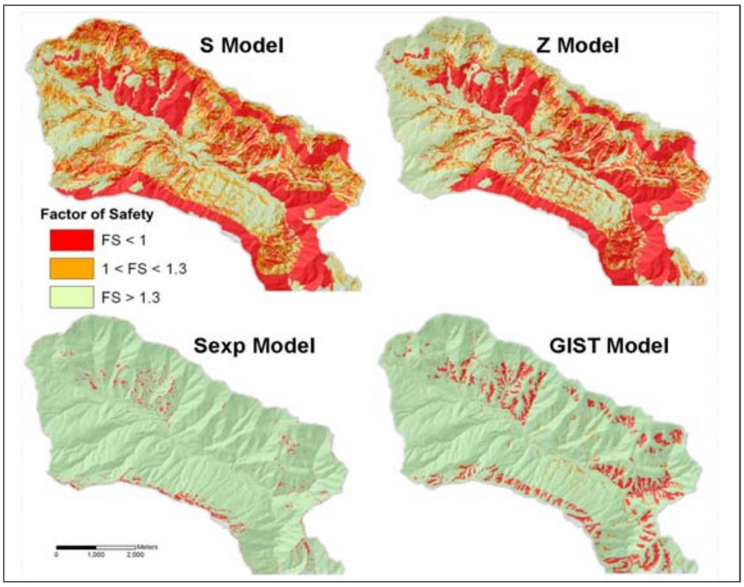

Fig. 1: Factor of safety maps obtained in the Armea basin (Liguria, NW Italy) using four different soil thickness patterns: S Model is based on a linear correlation between soil thickness and slope gradient, Z Model is based on a linear correlation between soil thickness and elevation, Sexp Model is based on an exponential correlation between soil thickness and slope gradient, GIST model (CATANI et al., in press) is based on geomorphometric and geological parameters.

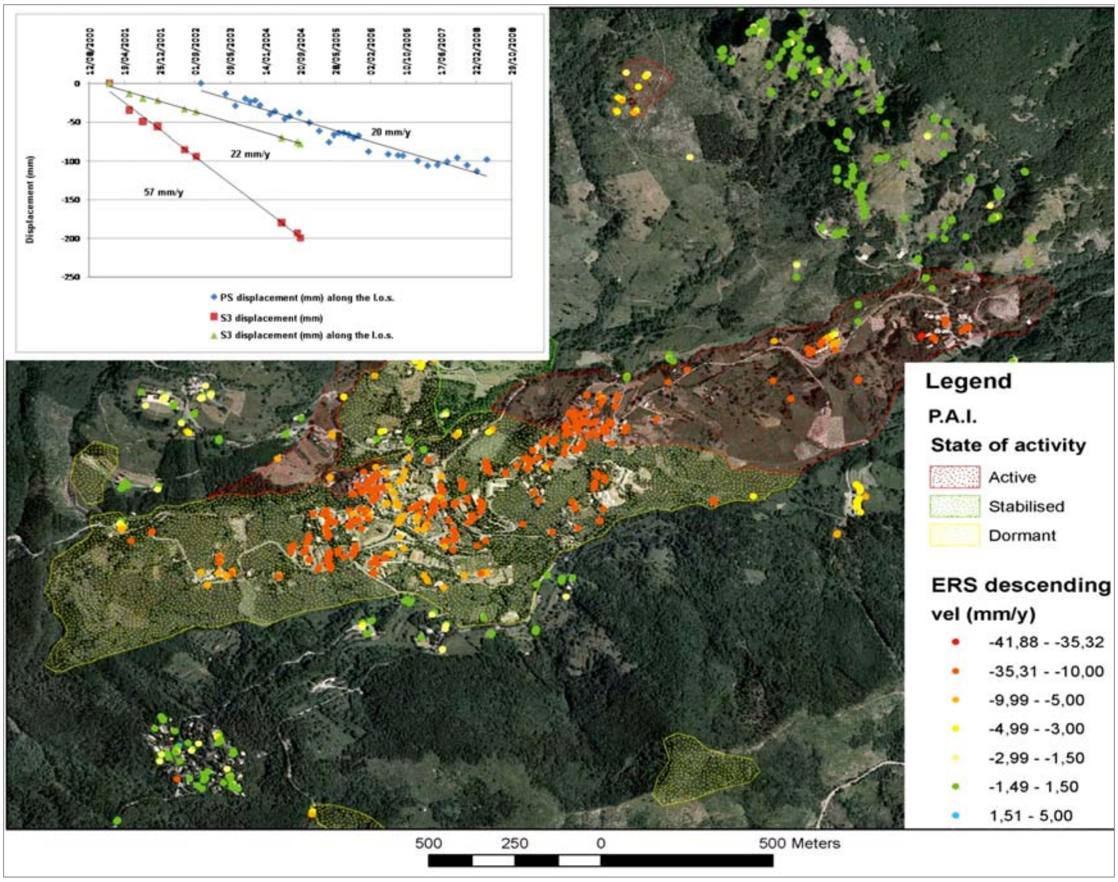

Fig. 2: Landslide monitoring by means of PS-InSAR technique and comparison with in-situ instrumentations.

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