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Short Communication
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Monitoring of Landslides in Southern Italy by Means of Differential SAR Interferometry

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Short Communication

The Italian territory is strongly affected by ground instability phenomena, due either to the geology and the geomorphology of its territory, and to the poor physical-mechanical properties of the involved materials. In particular, slow-moving landslides, often characterized by intermittent kinematic, are among the most widespread in Central and Southern Italy [1]. Unfortunately, nowadays severe damage due to this kind of disasters are still recorded, which makes their monitoring an issue of paramount importance. One of the most important innovations in monitoring is surely represented by the remote sensing. Among the recent techniques the Differential Interferometry SAR (DInSAR) demonstrated its validity and efficacy as an useful tool for mapping and analyzing ground movements [2-4]. Here, a dataset of Very High Resolution (VHR) TerraSAR-X images has been used, which cover almost the whole Crotone Province (Southern Italy). Many cases of landslides are reported in this area, as for instance the study area of Cirò town. Cirò settlement extends on an elongated-shaped hill, NE-SW oriented. The historic center was established on sandstones, belonging to the Scandale Formation. The latter is lithologically composed of shallow-marine, medium-to fine-grained deposits, characterized also by sub vertical and intensively jointed cliffs. The landslide-prone condition, especially in the SW facing slope, is due to the geological setting, where the relationship between sandstones and the underlying clayey Argille del Ponda formation, characterized by different permeability, strongly conditioned the water circulation.

Here, in fact, in the night of February 1 and 2, 2011, a landslide occurred in one of the main access road to town center, damaging and forcing people to abandon five houses.

According to the Cruden and Varnes classification [5] the movement is defined as a rotational slide evolving in earth flow. The landslide crown is almost vertical, about 5m deep, which excavated the foundation system of three houses, while the landslide body is characterized by an extension of about 250m down slope, and 120m of width. It is a reactivation of a well-known phenomenon,

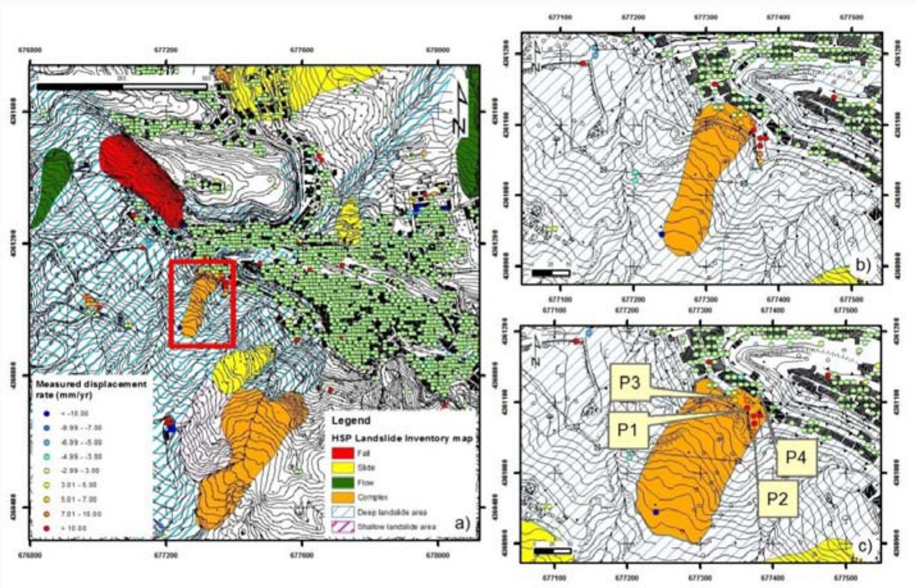

Figure 1: a) Displacement rat map; b) detail of the landslide; c) enlargement of the landslide identified by DInSAR data.

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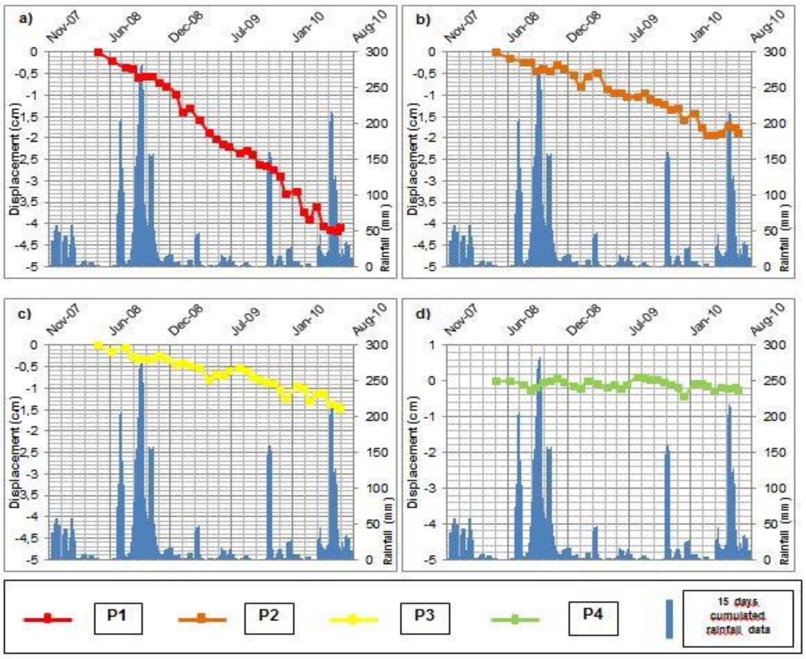

Figure 2: Comparisons between time-series of displacement and cumulative rainfall recorded.

included in the entirely unstable SW-facing slope, as reported by the Calabria Basin's Authority in the Hydrogeomorphological Setting-Plan (HSP), realized in 2001. One of the most important instability factors is surely represented by the copious rainfalls occurred in this area. In fact, in the days immediately preceding the triggering phase, a cumulated value of rainfall equal to 287mm has been recorded, with a daily maximum of 125mm.

The dataset available for this paper is composed of 35 TerraSAR-X images acquired over descending orbit, spanning the time from April 2008 to June 2010 and it was processed through the SUBSOFT processor, developed at the UniversitatPolitecnica de Catalunya of Barcelona, on which the Coherence Pixels Technique (CPT) is implemented [6,7].

Interferometric results have shown several targets located on the top of the landslide body, indicating displacement rates up to 20mm/year (Figure 1a), thus confirming the active state of the landslide, asreported in the 2001 HSP. Moreover, DInSAR processing, jointly used with a geological-geomorphological survey, made possible to redraw the landslide boundary, which now delimits and area of about 24500m^2, a figure almost twice as large as previously known. By comparing the 2001 landslide body and that resulting from this study, a retrogressive and a widening trend can be recognized (Figure 1b and 1c). Another noticeable result is represented by the comparison between time series, derived from the DInSAR processing, and the precipitations occurred in this area, in the same time-span (Figure 2). It is, in fact, possible to realize that the acceleration phase of the movement corresponds to intense and long rainfall events, unlike during periods with scarce rainfall, when a slowdown of the movement can be noticed. This remark agrees with the general behaviour of slow and intermittent landslides, where a strong cause-and-effect relationship between rainfalls and velocity of the instability phenomena may be noticed. It is also worth to underline that, being the TerraSAR-X database antecedent to the landslide's reactivation; the SAR results are able to recognize precursor stages of a future slope failure. This achievement confirms the ability of SAR techniques to represent powerful monitoring and prediction tools, making it a valuable aid for public administrations and stakeholder.

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