Landslides Investigated by A-DInSAR Methods: From the Feasibility Analysis to Detailed Dynamics Characterization.

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The herein presented study has been carried out in a portion of a basin located in the central sector of the Apennines, between the Maiella Mountain and low-hilly area in the Abruzzo Region (Italy). The area is about 15 sq m in size and it is crossed by the Dendalo stream. From the morphological point of view, the landscape is featured by a hilly structure with altitude ranging from 150 m and 440 m a.s.l., and gentle slopes frequently affected by gravitational instability processes.
The basin, North-South oriented, falls within the Periadriatic Marche-Abruzzo basin, built on Plio-Pleistocene marine deposits. The geological substrate of the investigated basin is characterized by the Mutignano Formation, a marine Plio-Pleistocene sequence characterized by silty clay containing sand which gradually increases towards the upper part of the formation. The terms of Pleistocene transition are represented by clays and conglomerates and can be found mainly on the top of reliefs in the right bank of the Dendalo stream. Continental Quaternary formations characterized by debris and colluvial materials, mainly of gravitational and alluvial genesis, also outcrop in the basin.
From the structural point of view, the area is rather regular and homogeneous, mainly due to extensional tectonic that has displaced all the outcropping Plio-Pleistocene sequences. This tectonic setting is expressed primarily through normal and high-angle transtensional faults, with slips ranging from a few meters to a few tens of meters.
landslides were identified and mapped. More than 95 landslides affecting the study area, have been recognized thanks to field surveys and multi-temporal analysis of aerial photos from 1954 to 2002. More specifically the area is interested by translational and rotational slides (37%), earth-flows (6%) and complex mass movements (56%). Landslides surface ranges from very few hundreds sqm to some sq km. Landslide deposits are related to the mobilization of pelitic and psammitic lithologies belonging to the Mutignano Formation, especially in the middle and lower portions of the slopes.
A feasibility analysis of A-DInSAR investigation on the recognized landslide have been performed by FAST method that takes into account both "interferometric" parameters and "landslide" parameters thus providing a quantitative estimate. Moreover, FAST results also include the identification of the most suitable SAR images (in terms of stack and acquisition geometries). Four different datasets have been used to characterize the landslides historical displacements. Specifically, ERS1-ERS2 and Envisat satellite data both in ascending and descending orbit acquisition geometry have been selected for the period 1992-2010.
The SAR data have been processed through SARPROZ, a specifically developed software tool for multi-image InSAR analyses such as PS and QuasiPS (QPS). For this case study two different approaches have been used: i) standard PS analysis where velocities are evaluated applying a linear trend model; ii) local analyses of small areas, performed for most interesting zones, which allows to achieve higher accuracy in displacements estimation, and, especially, to detect non liner trends. It is worth noting that non-linear movements are considered crucial for a suitable investigation of the landslide processes affecting the investigated area.
Thanks to the long-term data available (1992-2010) displacements information allowed to refine the landsides mapping and to derive the state of activity. In addition to the standard PS analysis, four areas of particular interest have been also analysed by a local analysis, particularly suited to detect displacements with non-linear behaviour through time.
The analysis performed through the integration of field surveys, aerial photos investigation and A-DInSAR allowed to achieve a complete knowledge framework on the study area. Multi-temporal aerial photographs analysis allowed to identify landslides activity in the Dendalo basin since 1954 but it was not enough to quantify the temporal evolution and displacement rate of the landslides. Thanks to PS local area analyses, it was possible to better define the state of activity and especially the temporal evolution of some observed phenomena. This aspect is crucial for a proper planning aimed to reduce landslide hazard. Specifically, the EST-facing slopes show a more intense and continuous activity both in the period 1992-2001 and 2003-2010.
Another aspect to remark is the usefulness of the execution of local analysis, which allowed the accurate and reliable determination of the displacements for the most critical areas.
It is, however, fundamental to highlight the importance of different source of data (eg. both ascending and descending acquisition geometry for A-DInSAR) especially for basin-scale analysis where different phenomena in terms of dimension, orientation, displacements rate have to be investigated.
This study has been carried out in the frame of the CAT-1 project "Landslides forecasting analysis by displacements time series derived from Satellite and Terrestrial InSAR data" (ID: 9099).