Assessing the state of activity and intensity of slow moving landslides by means of RADARSAT Persistent Scatterer

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Assessing the state of activity and intensity of slow moving landslides by means of RADARSAT Persistent Scatterer Interferometry: Northern Calabria (Italy) case study

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Hilly and mountainous areas are frequently affected by landslide phenomena induced, or even accelerated, by intense rainfalls, strong topographical gradients, inappropriate urban planning and presence of intensely weathered and tectonized terrains. The recognition of the spatial distribution, state of activity and intensity of such natural hazards is necessary to reduce, and eventually prevent, their impacts on the elements at risk.
This work illustrates the contribution of advanced interferometric techniques for identification and mapping of landslide ground displacements at regional scale. In particular, we discuss the potentials of Persistent Scatterer Interferometry (PSI) for the detection and updating of the state of activity and intensity of slow and very slow landslides, using radar satellite images acquired by RADARSAT at medium spatial resolution (i.e. 30 m). The PSI techniques are powerful and fully operational tools for monitoring slow surface displacements on high spatial density grid of point-wise targets (i.e. the PS, Persistent Scatterers), exploiting long series of SAR (Synthetic Aperture Radar) data and providing annual velocities and time series of ground deformation with millimetre accuracy. The case study of Northern Calabria, a 3,931 km2 area located in southern Italy and extensively affected by landslide hazard (more than 850 mapped phenomena), was chosen to test our methodology and evaluate its potentials and limitations for the analysis of slow moving landslides. The use of RADARSAT PSI data usually guarantees a higher spatial density of PS targets (up to 100-150 PS/km2) and a shorter revisiting time (i.e. 24 days) in comparison with ERS and ENVISAT analyses, significantly improving the chance of detecting landslide motions due to their time and space frequencies. We used 154 RADARSAT images acquired in 2003-2010 along ascending and descending orbits in Standard Beam mode, subsequently processed by e-GEOS with the PSP (Persistent Scatterer Pairs) technique, which belongs to the PSI approaches. The pre-existing landslide inventory of Northern Calabria was updated through the integration of conventional photo-interpretation with the radar-interpretation of PS ascending and descending measures. Ancillary data (e.g. topographic, geological, land use maps) and optical images were therefore combined with 2003-2010 multi-temporal ground deformation measures extracted with multi-pass interferometry. In order to evaluate the state of activity and intensity of the phenomena covered by PS data, we used an innovative approach based on the exploitation of activity matrixes and intensity scales, combining 2003-2010 average velocities with the information coming from the pre-existing inventory. The methodology allowed the identification of new landslides, the modification of boundaries of pre-mapped phenomena and also the assessment or updating of their state of activity and intensity (in terms of deformation velocity). Photo-interpretation gave a fundamental contribution for landslide mapping in particular in hilly and mountainous contexts, where dense vegetation causes a low density of radar benchmarks to be identified. The outcomes of this analysis demonstrated the operative usefulness of this innovative methodology for local and regional civil protection authorities for the rapid identification of critical instable areas (i.e. reactivated and active phenomena) through a large scale analysis, and the consequent focusing of countermeasures and mitigation actions according to the distribution and intensity of landslide hazard. Moreover, the Northern Calabria case study highlighted the reliability of this approach, confirming also its exportability to similar geological and geomorphologic scenarios.