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Multi-Hazard Analysis for the Estimation of Ground Motion Induced by Landslides and Tectonics

Rubén Iglesias (1), Fifame Koudogbo (1), Francesca Ardizzone (2), Alessandro Mondini (2), and Christian Bignami (3)

(1) Altamira-Information, Barcelona, Spain, (2) CNR IRPI, Perugia, Italy, (3) INGV, Roma, Italy

Space-borne synthetic aperture radar (SAR) sensors allow obtaining all-day all-weather terrain complex reflectivity images which can be processed by means of Persistent Scatterer Interferometry (PSI) for the monitoring of displacement episodes with extremely high accuracy.

In the work presented, different PSI strategies to measure ground surface displacements for multi-scale multi-hazard mapping are proposed in the context of landslides and tectonic applications. This work is developed in the framework of ESA General Studies Programme (GSP). The present project, called Multi Scale and Multi Hazard Mapping Space based Solutions (MEMpHIS), investigates new Earth Observation (EO) methods and new Information and Communications Technology (ICT) solutions to improve the understanding and management of disasters, with special focus on Disaster Risk Reduction rather than Rapid Mapping. In this paper, the results of the investigation on the key processing steps for measuring large-scale ground surface displacements (like the ones originated by plate tectonics or active faults) as well as local displacements at high resolution (like the ones related with active slopes) will be presented. The core of the proposed approaches is based on the Stable Point Network (SPN) algorithm, which is the advanced PSI processing chain developed by ALTAMIRA INFORMATION.

Regarding tectonic applications, the accurate displacement estimation over large-scale areas characterized by low magnitude motion gradients (3-5 mm/year), such as the ones induced by inter-seismic or Earth tidal effects, still remains an open issue. In this context, a low-resolution approach based in the integration of differential phase increments of velocity and topographic error (obtained through the fitting of a linear model adjustment function to data) will be evaluated. Data from the default mode of Sentinel-1, the Interferometric Wide Swath Mode, will be considered for this application.

Regarding landslides applications, which typically occur over vegetated scenarios largely affected by temporal and geometrical phenomena, the number of persistent scatterers (PSs) available is crucial. The better the density and reliability of PSs, the better the delineation and characterization of landslides. In this context, an advanced high-resolution processing based on the use of the Non-Local Interferometric SAR (NL-InSAR) filtering will be evaluated. Finally, since SAR systems are only sensitive to the detection of displacements in the line-of-sight (LOS) direction, the importance of projecting final PSI displacement products along the steepest gradient of the terrain slope will be put forward. The high-resolution COSMO-SkyMed sensor will be used for this application.

The test site selected to evaluate the performance of the techniques proposed corresponds to the region of Northern Apennines (Italy), which is affected by both landslides and tectonics displacement phenomena. Sentinel-1 (for tectonics) and COSMO-SkyMed (for landslides) SAR data will be employed for the monitoring of the activity within the area of interest. Users of the DRM (Disaster Risk Management) community have been associated to the project, in order to, once validated the algorithms, further evaluate the proposed solution considering selected trial cases.