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A feasibility study on COSMO SkyMed X-Band application for the monitoring of slow landslides: the deep seated gravitational slope deformation (DSGSD) in the area of Corvara in Badia (Dolomites, Italy)

Christian Iasio (1), Stefan Schneiderbauer (2), Andrea Tamburini (3), and Volkmar Mair (4)

(1) Institute for Applied Remote Sensing, EURAC, Bolzano, Italy (christian.iasio@eurac.edu), (2) Institute for Applied Remote Sensing, EURAC, Bolzano, Italy (stefan.schneiderbauer@eurac.edu), (3) Tele-Rilevamento Europa - T.R.E. s.r.l., Milano, Italy (andrea.tamburini@treuropa.com), (4) Office for Geology and material testing, Province of Bolzano, Cardano (BZ), Italy (volkmar.mair@provinz.bz.it)

The area of Corvara in Badia (Dolomite Alps, NE Italy) is characterized by high relief, with slopes dropping from over 3000 m in altitude (Sella and Puez- Gardenaccia) down to about 1500 m. The steep topography has triggered intense gravitational slope modelling throughout the Holocene, favored by recent tectonic activity and climatic context. Well-documented geological studies have demonstrated causal links between Holocene climate and environmental changes, and phases of slope instability that affected slopes of the Col Alto-Pralongià, generating the Col Alto, Arlara and Corvara landslides.

The complex mass movement that resulted from the coalescence of these three landslides is centered directly uphill from the modern town of Corvara. The Corvara landslide represents an ongoing threat for roads, buildings and infrastructure, and is nowadays used as a ski slope in winter. It has come to be one of the main tourist centers of the Alta Badia Valley in the Dolomites.

In order to prevent hazard and severe economic losses, the Province of Bolzano has integrated results from ground GPS measurements, collected over the last 10 years, with geophysical and geognostic surveys. This effort provided an accurate 3D landslide model with a relative mass balance. In spite of the detailed geometric characterization, the relationships between groundwater balance and displacement velocity, as well as their seasonal trends, require further investigation.

This contribution presents preliminary results of the LAWINA project, funded by ASI (Italian Spatial Agency) and implemented by EURAC, in close cooperation with the Office for Geology and material testing of the Province of Bolzano. Additional methods for mass movement monitoring and detection based on SAR derived EO data are tested. The persistent scatterer interferometry (PSI) technique has proven its usefulness to detect small displacements over long time intervals and large areas. Historical ENVISAT and RADARSAT archives allowed a preliminary assessment concerning the amount of scatterers available along the slopes of Col Alto-Pralongià and the potential accuracy by PSI outcomes. Results were judged not good enough to add new information.

The family of SAR satellites have been complemented in the last years by the high resolution COSMO SkyMed (CSK®), operated by the Italian Space Agency (ASI), mounting X-band sensors (wavelength $\sim$3 cm). Several applications already revealed the advantage offered by the high geometric and radiometric resolution and the short revisit time of the CSK® constellation to the analysis of environmental risk management, such as floods and earthquake events.

Within the scope of the LAWINA project, PS techniques exploiting CSK® X-Band data are analyzed in order to test the counterbalanced results from the advantage of higher spatial and temporal resolution against the potentially problematic shorter wave length.

The project deals mainly with the active Corvara landslide, investigated through the analysis of current CSK® scenes. The SqueeSAR™ algorithm, recently developed at T.R.E., generating permanent and distributed scatterers, is tested and validated by new GPS measurements collected during the project.

The added value of the project consists in applying low-cost, low-impact solutions to increase back-scattering points suitable for high resolution X-band data for monitoring surface movements along slopes at high altitude. Located in a non-urban area with dominant pastures and grasslands, these slopes commonly feature a very low number of strongly reflecting objects. The installation of various passive reflectors as reliable scatterers are being tested in this highly touristic environment.

The importance of user involvement during the planning and design phases is highlighted, and a preliminary assessment of the feasibility and criticality for operational use of X-band-based PS techniques for landslide monitoring

is provided.