Geophysical Research Abstracts
Vol. 18, EGU2016-14765-1, 2016
EGU General Assembly 2016

Landslide movement mapping by sub-pixel amplitude offset tracking – case study from Corvara landslide

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Despite the advantages of Differential Synthetic Aperture Radar Interferometry (DInSAR) methods for quantifying landslide deformation over large areas, some limitations remain. These include for example geometric distortions, atmospheric artefacts, geometric and temporal decorrelations, data and scale constraints, and the restriction that only 1-dimentional line-of-sight (LOS) deformations can be measured. At local scale, the major limitations are dense vegetation, as well as large displacement rates which can lead to decorrelation between SAR acquisitions also for high resolution images and temporal baselines.

Sub-pixel offset tracking was proposed to overcome some of these limitations. Two of the most important advantages of this technique are the mapping of 2-D displacements (azimuth and range directions), and the fact that there is no need for complex phase unwrapping algorithms which could give wrong results or fail in case of decorrelation or fast ground deformations. As sub-pixel offset tracking is highly sensitive to the spatial resolution of the data, latest generations of SAR sensors such as TerraSAR-X and COSMO-SkyMed providing high resolution data (up to 1m) have great potential to become established methods in the field of ground deformation monitoring.

In this study, sub-pixel offset tracking was applied to COSMO SkyMed X-band imagery in order to quantify ground displacements and to evaluate the feasibility of offset tracking for landslide movement mapping and monitoring. The study area is the active Corvara landslide located in the Italian Alps, described as a slow-moving and deep-seated landslide with annual displacement rates of up to 20 m. Corner reflectors specifically designed for X-band were installed on the landslide and used as reference points for sub-pixel offset tracking. Satellite images covering the period from 2013 to 2015 were analyzed with an amplitude tracking tool for calculating the offsets and extracting 2-D displacements. Sub-pixel offset tracking outputs were integrated with DInSAR results and correlated to differential GPS measurements recorded at the same time as the SAR data acquisitions.