Regional Scale PSI (Persistent Scatterer Interferometry) feasibility Map modelled with CORINE Land Cover and Digital Terrain Model: the case of Salzburg

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Introduction

The use of DInSAR advanced techniques is nowadays well-established in the field of landslide monitoring due to both, the robustness of the methods and the availability of new satellite datasets that allow characterising a wider range of mass movements (Wasowski & Bovenga, 2014). In recent years, some European countries like Italy, the Netherlands and Switzerland started to produce Persistent Scatterer Interferometry (PSI) nationwide coverage database. In Great Britain, Cigna et al. (2014) simulated PSI coverage on a national scale by taking into account both ERS and ENVISAT satellite acquisition geometries, the effect of topography on the visibility of the observed targets, and the impact of different land cover types on PSI density (Plank et al., 2010). Considering both, the high susceptibility to landslides of mountainous areas in Austria and the availability of GEORIOS – a complete landslide inventory (Koçiu et al., 2007) – in this paper a similar approach to Cigna et al. (2014) is presented and a priority PSI visibility map (Cascini et al., 2013) using RI index (Notti et al., 2014) is produced.

Data and Methods

The dataset used for this study is rich and manifold. It partly includes proprietary data such as: a 10 m nationwide Airborne Laser Scanning DTM; PSI datasets acquired for Salzburg during the PanGeo project (www.pangeoproject.eu). Moreover, open data like Open Street Map and CORINE land cover are also used for feasibility simulation analysis of PSI targets. Finally, the European JRC forest (Join Research Centre) and the Imperviousness Copernicus services (Copernicus Land Monitoring Services) serve as integrative datasets for the resolution sharpening of CORINE land cover map. Synthetic Aperture Radar (SAR) satellites maintain a specific acquisition geometry with the orbit direction (azimuth) that is roughly north-south (descending orbit) and south-north (ascending orbit) with lateral imaging viewing or Line-Of-Sight (LOS) respectively westward and eastward. This particular side look-angle of acquisition generates, particularly in high relief areas, earth surface distortions such as layover, foreshortening and shadowing.

In order to account for the above mentioned three aspects, in the present study the range index RI (Notti et al., 2010) is applied to the federal Salzburg province. In particular, the analysis of the RI is carried out for ENVISAT and Sentinel-1 satellites. Both of them hold different incidence angles, acquisition geometries and temporal decorrelations. The only major common aspects are concerning the operational C sensor band, which allow penetrating the same thickness of canopy vegetation, and their ground pixel resolutions. All those characteristics, lead to the creation of a first a priority PSI visibility map that does not take into account the land cover classification. Concerning the check of the influence that land cover types have on PSI density, CORINE data were used. Furthermore, a new method was introduced to improve the spatial resolution of those products by fusing CORINE data with sharper European JRC forest map and Imperviousness Copernicus map.

Being the a priori PSI visibility map realised at 10 m resolution, the CORINE standard product (100 m) is sharpened by fusing, in a GIS environment, the JRC forest map (2006) together with the Imperviousness map (2006) to a 20 m resolution. Furthermore, two ERS-ENVISAT PSI datasets for the cities of Salzburg are used as input data for the computation of the PS density over different classes of CORINE land use map. The following step consists of both an improvement of the accuracy

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of CORINE by including sharper European JRC forest map and Imperviousness Copernicus map and the extraction of the number of acquired PSI targets within each land use polygon in order to evaluate the a priori PSI density map for ERS and ENVISAT. As for Sentinel-1, a triple density value in comparison to ERS-ENVISAT is assumed, considering the high revisit time of the new satellite (35 days versus 12 days, increasing to 6 days for Sentinel-1a and Sentinel-1b) and his very similar spatial resolution.

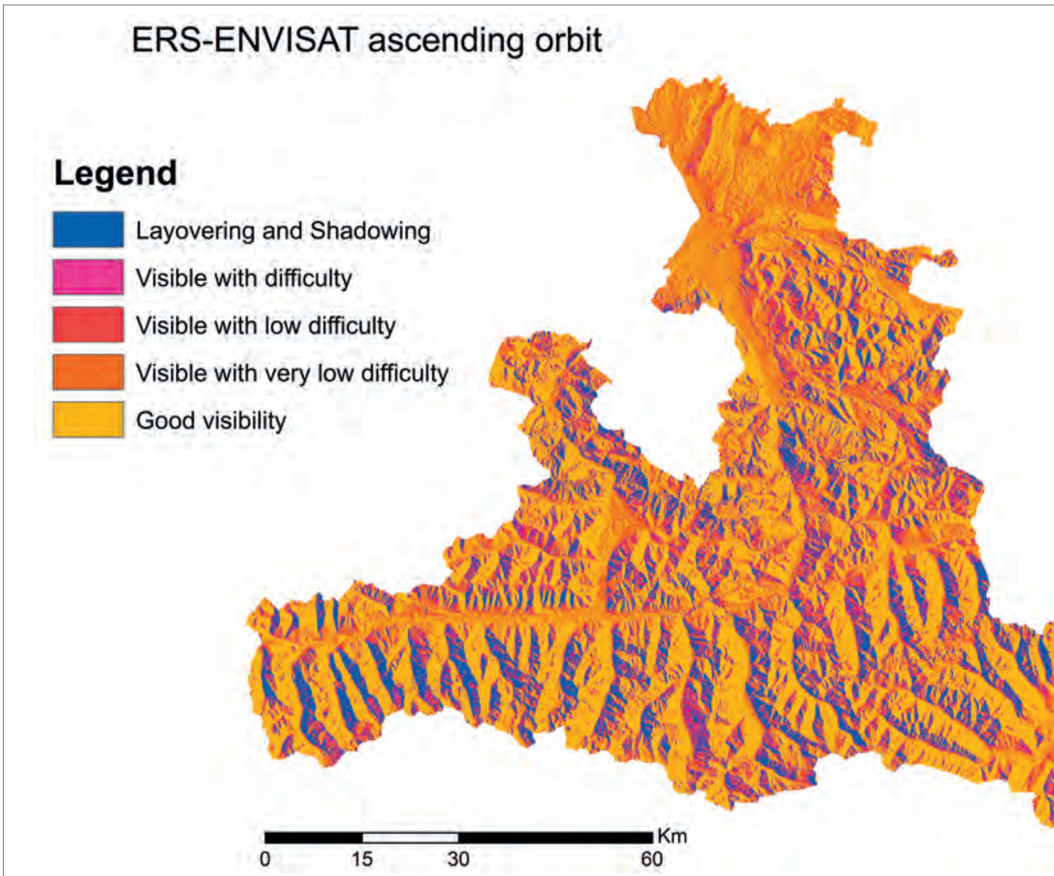
Results

The PSI visibility maps modelled (Text-Fig. 1) allow for the two satellites to evaluate the distribution of areas where translational surface motion could be monitored (“Good visibility”), where due to partial distortion (“Visibility with difficulty”) only vertical displacements can be measured with reliability and slopes completely affected by earth surface distortions (“Not visible”) over Salzburg according to ascending and descending orbit data. Then, thanks to the combination of the modified CORINE Land Cover with the a priori visibility map the “a priori PSI density map” was obtained. This map (Text-Fig. 2) shows this time which land cover portion is more susceptible to the vertical and translational surface motion and it is coupled to the PS probable distribution calculated for each polygon.

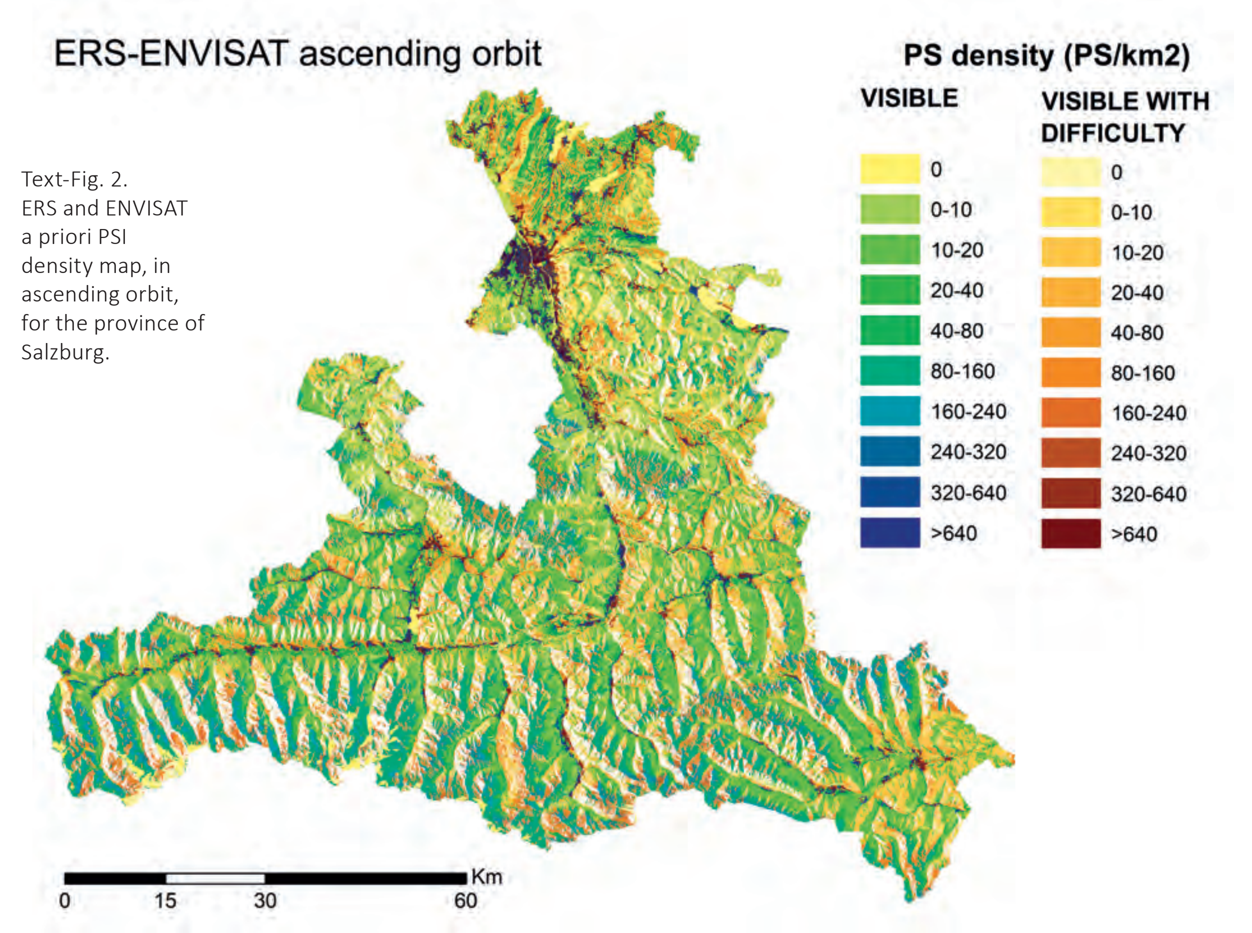
Achievement and future work

At the Department of Engineering Geology of the Geological Survey of Austria (GBA) it is now possible to produce Advanced-DInSAR PSI products on a regional scale using ERS and ENVISAT data. This is particularly useful for retrospective deformation study of mass movements thanks to our experience gained in recent years on interpreting PSI product and on processing SAR data with state-of-the-art software.

Following the proposed approach, in the next future, thanks to the availability of the GEORIOS landslide inventory, the multi-sensor “a priori PSI density map” as well as the free accessibility to a large archive of TerraSAR-X, ALOS-PALSAR, Sentinel-1 and CosmoSkyMed satellites images, it will be possible to select – for different portions of the Austrian reliefs – the sensors whose datasets best fit interferometric applications for landslide analysis purposes.



Text-Fig. 1. ERS and ENVISAT a priori PSI visibility map, in ascending orbit, for the province of Salzburg.



Text-Fig. 2.
ERS and ENVISAT a priori PSI density map, in ascending orbit, for the province of Salzburg.

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