InSAR-based Ground Motion Service of Sweden: evaluation and benefit analysis of a nationwide InSAR service

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Space-geodetic techniques such as Global Navigation Satellite Systems (GNSS) and Syntenic Aperture Radar interferometry (InSAR) are powerful tools to measure and monitor ground surface motion. InSAR has widely been used for the detection and quantification of slow mass movements over the past three decades mainly at the local and regional scales. The high performance and millimeter-level measurement accuracy of radar satellite to provide a dense deformation map at different spatial and temporal resolutions are the key factors to think of using SAR data and InSAR technique as an efficient tool for geohazards motoring system at the nationwide scale.

Sweden has recently joined to the countries having InSAR Ground Motion Service (GMS) at a nationwide scale. The InSAR service of Sweden, which will soon be freely available for users, provides the displacement time-series of measurement points for the entire country. The Swedish GMS project was started last year and is an ongoing collaboration between the Geological Survey of Norway (NGU) and several Swedish organizations (led by the Swedish National Space Agency (SNSA)). The InSAR-based GMS of Sweden has been generated by NGU using Sentinel-1 data (2015–2020) and the Persistent Scatterer Interferometry (PSI) technique. The web-based GMS of Sweden consists of ~1,5 billion time-series measurement points obtained from both descending and ascending satellite orbital modes.

Currently, the Swedish GMS is under evaluation and validation phase and the given plan has been designed to assess the quality or validate the GMS products. We plan to conduct the data validation through two main phases: 1) a cross-comparison between InSAR measurement points and ancillary data such as GNSS, Corner Reflectors (CR), Electronic Corner Reflectors (ECR) and leveling data, and 2) assessment of tropospheric and ionospheric effects on InSAR measurement points. Specifically, we will evaluate different approaches and data for the InSAR tropospheric corrections, such as Very-Long-Baseline Interferometry (VLBI), Water Vapour Radiometry (WVR), and GNSS data at the Onsala Space Observatory (OSO).

In the first phase of validation, leveling data collected in Gothenburg and Stockholm cities, mainly over the residential areas and public transport infrastructures compared to the corresponding InSAR measurements points (vertically converted) for a five-year period. The initial results present a high correlation between two sets of the vertical displacements. The same procedure will be performed for the Kiruna city where the mining activities resulted in a

drastic urban land subsidence. Since the CRs and ECRs have recently been installed in different parts of Sweden, we do not have them as PS points in the current version of the GMS. Therefore, those CR-based measurement points will be used in future accuracy assessments. In the second phase, we investigated the effects of phase delay induced by troposphere on displacement time-series using two approaches, i.e., time-space filtering and using external data (e.g., atmospheric reanalysis data, GNSS, VLBI and Water Vapor Radiometer (WVR)). Recently, European GMS (EGMS) has been released and the Ortho displacement map is now available for users freely. We also evaluated and compared the EGMS-Ortho displacement map with our independent InSAR processing and GNSS data over the Kiruna.

As the InSAR-based GMS can be used to monitor and identify the potential risk of geo-related hazards in Sweden, the society will directly benefit from the outcomes of this project. This open access product will help the stakeholders with decision support for prioritization of risk-reducing measures, and identification of the need for further investigations for areas in danger. The service could also assist municipalities and county administrative boards to have an update information regarding urban areas which are more prone to land subsidence and disruption urban infrastructure.