EO-FIN

Monitoring Highway and Railway Networks

Displacement and average velocity maps PSI Sentinel-1 for D18 highway in Rome (Source: Orellana, F., Delgado Blasco, J.M., Foumelis, M., D'Aranno, P.J., Marsella, M.A. and Di Mascio, P., 2020. Dinsar for road infrastructure monitoring: Case study highway network of Rome metropolitan (Italy). Remote Sensing, 12(22), p.3697.).

Product Category

☐ Land Use	☐ Natural Disaster	☐ Coast Management	■ Earth's Surface Motion
☐ Land Cover	☐ Climate Change	☐ Marine	

Financial Domain(s)

☐ **Investment management** ■ **Risk analysis** ☐ **Insurance management** ☐ **Green finance**

User requirements

UN37: Projection of risk to portfolio assets into future

Description

Ensuring the safety and efficiency of supply chains remains a top concern for ongoing monitoring and surveillance of transportation infrastructure, including highways and railways. This assures structural stability and operating safety, as well as preventing corrosion and degradation, which can lead to costly recovery, failures, and collapses. With a high temporal frequency at the network level, on-site survey activities might be demanding, costly and difficult to implement. To tackle these limitations, SAR techniques, such as the persistent scatterers interferometry methods can be used to monitor transportation assets and surrounding environment. This technique offers the advantage of covering vast areas, spanning thousands of square kilometres within a single footprint, while accurately detecting even minor changes in highways or railways infrastructure by measuring vertical and horizontal displacement of the ground.

Spatial Coverage Target

Highway and Railway Networks

Data Throughput

Rapid tasking	☐ High	■ Low
Data availability	☐ High	■ Low

Product specifications	
Main processing steps	Shape file of the highway or railway networks should be acquired. Time series SAR data covers the extension of the network can be obtained from different sources such as Copernicus Sentinel-1 or commercial providers such as TerraSAR-X with the selection based on factors like spatial and temporal resolutions required for the application. When dealing with known vulnerable locations that can be covered by a few images, VHR SAR imagery is suggested. However, for monitoring large areas, the use of Sentinel-1 data is recommended due to its free availability, larger swath width, and lower spatial resolution compared to commercial SAR imagery. Additionally, after detecting failures using Sentinel-1, utilizing VHR SAR imagery is advised to ensure higher accuracies. Then, SAR data should be pre-processed to correct for various artifacts and errors. This step includes calibration, atmospheric corrections, and removing noise caused by factors like topography and vegetation. By comparing the phase components of at least two SAR images captured in different times by using different PSI techniques (based on the application and area of interest) such as PS-InSAR and SBAS, it is possible to calculate ground deformations which had occurred between sensing periods.
Input data sources	Optical: N.A Radar: Sentinel-1, VHR images from different sources like ICEYE, Capella space, and TerraSAR-X Supporting data: N.A
Accessibility	Sentinel-1: freely and publicly available from ESA. SAR VHR imagery: commercially available on demand from EO service providers.
Spatial resolution	Sentinel1: 20m SAR VHR: < 3m
Frequency (Temporal resolution)	Sentinel1: 6 days SAR VHR: Daily
Latency	≤ 1 day
Geographical scale coverage	Globally
Delivery/ output format	Data type: Raster File format: GeoTIFF
Accuracies	Thematic accuracy: 1 to 5 mm Spatial accuracy: 1.5-2 pixels of input data
Constraints and limitations	■ Monitoring large highway or railway networks is challenging and using Sentinel-1 can miss some risk events. ■ SAR signals have limited penetration through certain materials, which can obstruct the measurements of ground movement beneath these surfaces
User's level of knowledge and skills to extract information and perform further analysis on the EO products.	Skills: Ample Knowledge: Ample