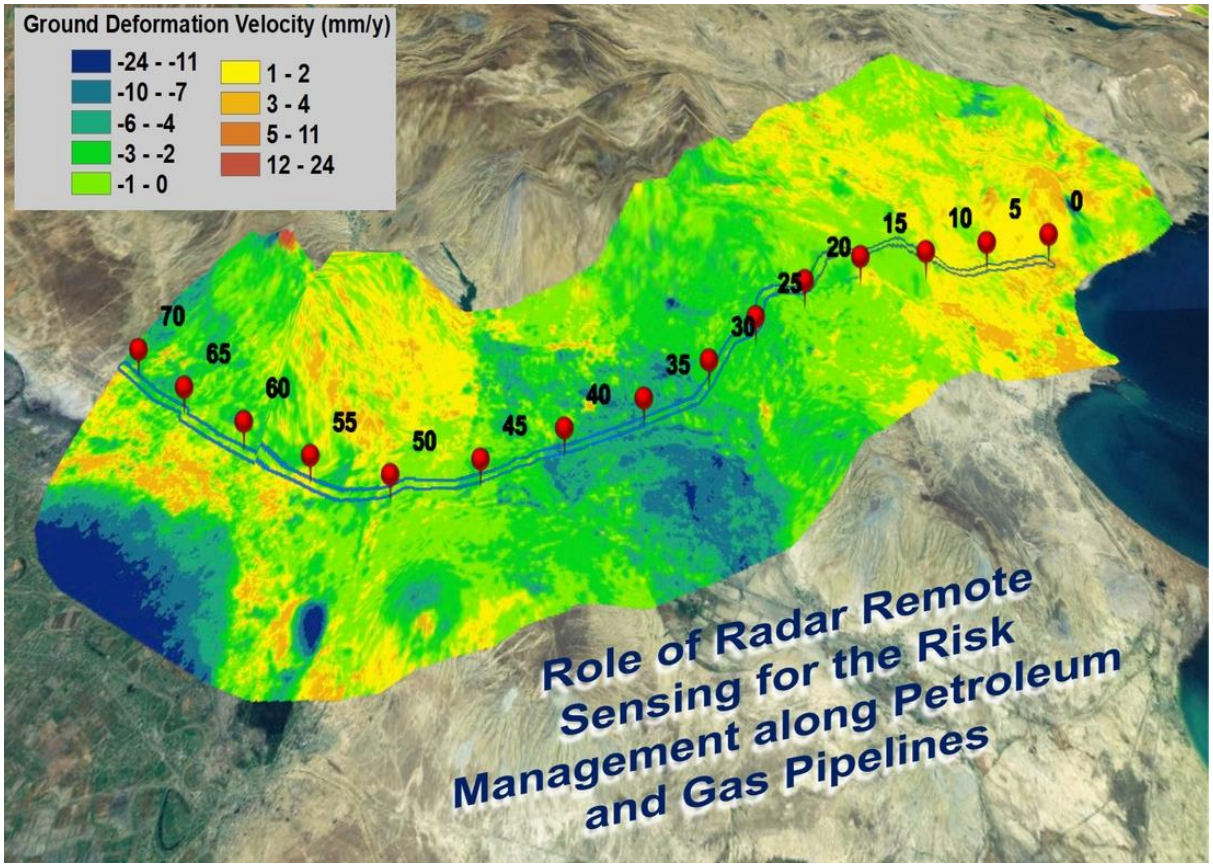
EO-FIN

Surveillance of Oil and Gas Pipelines for Geohazard and Ground Subsidence Vulnerabilities



InSAR technology based on Sentinel-1 to measure surface deformation along oil and gas pipelines in Azerbaijan (Source: Bayramov, E., Buchroithner, M. and Kada, M., 2020. Radar remote sensing to supplement pipeline surveillance programs through measurements of surface deformations and identification of geohazard risks. Remote Sensing, 12(23), p.3934.)

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

Oil and gas pipeline networks commonly extend across vast distances, covering hundreds or even thousands of kilometres. To safeguard pipelines from geohazards and ground movement, close monitoring is essential. Possible threats, such as landslides, seismic events, ground settlement, urban development, vegetation encroachment, and other factors, can lead to pipeline damage. Detecting and monitoring such displacements play a crucial role in cost-effective measures to prevent potential harm. In the past, risk monitoring primarily relied on ground-based systems, LIDAR, and aerial photographs. Although these methods are precise in measuring displacement, they become impractical for cost-effective coverage of entire pipeline networks. InSAR technology offers the advantage of covering vast areas, spanning thousands of square kilometres within a single footprint, while accurately detecting even minor changes in the structure, foundation, or surrounding terrain through repeated measurements to detect horizontal and vertical displacement in the ground. By utilizing multiple footprints, InSAR can effectively monitor entire pipeline networks, identifying thousands of potential hazards with precision ranging from millimetres to centimetres.

Spatial Coverage Target

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Oil and Gas pipelines		
Data Throughput		
Rapid tasking	■ High	☐ Low
Data availability	■ High	☐ Low

Product specifications	
Main processing steps	A shape file of the oil and gas pipeline network should be acquired from the stakeholders. Time series SAR data covers the extension of the network and can be acquired 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, Very High-Resolution (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 pipeline 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 artefacts 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 at different times by using different InSAR techniques (based on the application and area of interest), 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 Satellite-based products: N.A Supporting data: shape file for the oil and gas pipelines network
Accessibility	Sentinel-1: freely and publicly available from ESA. SAR VHR imagery: commercially available on demand from EO service providers.
Spatial resolution	Sentinel-1: 20 m SAR VHR: ≤ 3 m
Frequency (Temporal resolution)	Sentinel-1: 6 days SAR VHR: Daily
Latency	Sentinel-1: ≤ 1 day SAR VHR: ≤ 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 pipeline networks is challenging and using Sentiel-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