Investigate ground motion displacements around German former coal mining areas prior to landslides

NoR project report

Niklas Jordan, 24/10/2023

Project

General introduction

- Landslides present a significant global geohazard, demanding enhanced monitoring methods for effective risk mitigation.

- This project utilised Sentinel-1 interferometry products processed using Persistent Scatterer Interferometry (PSI) to analyse ground displacement rates preceding a major landslide event at Knappensee, Saxony, Germany, in March 2021.

Objectives

Project goals

- The main objective is to investigate ground displacements that occur **prior to landslides** in urban areas in Germany, with a particular focus on former coal mining areas that have been flooded and converted into swimming lakes.
- Reason for this focus is that landslides on the shores of these lakes can cause damage to buildings due to large waves (up to 1.5m) that are created as a result of the landslides.
- Identify spots with similar characteristics with increasing risk of landslides.

The aftermath of the landslide at Knappensee on 11 March 2021. Image by HY-photo Gernot Menzel via Bild.

Damage caused by the displacement wave at Knappensee in Germany. Image by Torsten Richter-Zippack via LR Online.

Method

Usage of Geohazard TEP

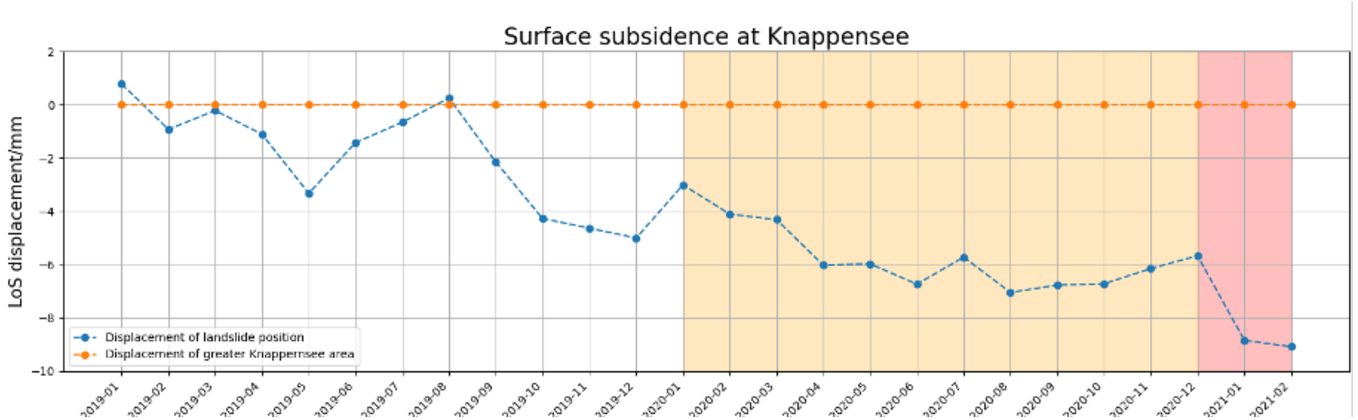
- This study utilized Sentinel-1 interferometry data from European Space Agency satellites to monitor ground deformations. Persistent Scatterer Interferometry (PSI) techniques by using the Geohazard TEP SNAPPING service were used to detect and measure surface changes by analyzing stable radar reflectors in multiple SAR images.

- The project focused on calculating monthly average subsidence at study area from January 2019 to February 2021. Subsidence values were used to analyze vertical ground displacement rates over time, particularly before a landslide event in March 2021.

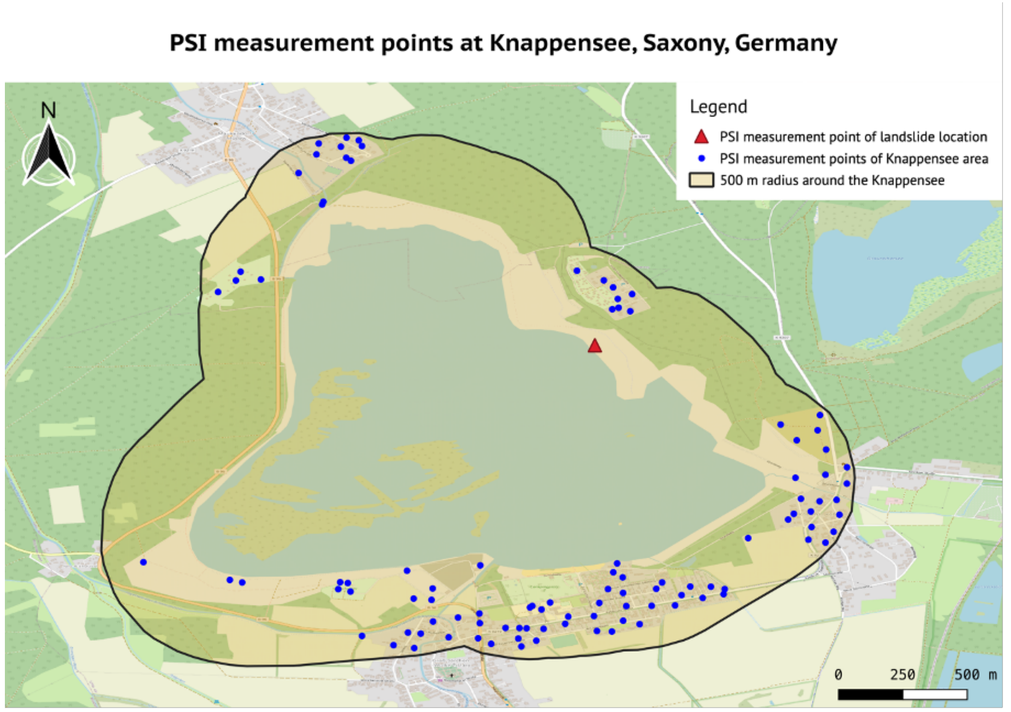
- Seasonal variations in ground displacement were also considered using data from January to December 2019.

Results

Outcome of the project



The chart shows the subsidence measurements. The orange line represents the monthly mean values of the Knappensee area, and the blue line is the landslide location. The surface subsidence is given in millimetres. The orange background indicates the year 2020, which is used for the velocity comparison, and the red background indicates the two months prior to the landslide. It can be clearly seen that there was a substantial increase in subsidence in January 2021, shortly before the landslide.



Map of the Knappensee in Saxony, Germany. Blue dots represent the PSI measurement locations of the Knappensee area, and the red triangle is the PSI measurement on the landslide location. The yellowish shade represents the 500 m radius around the Knappensee.

Highlights

Relevance for society

- Sentinel-1 PSI data was instrumental in tracking the vertical ground displacement rate at the landslide location. The data showed a significant acceleration in the rate of displacement in the two months leading up to the landslide event.
- This acceleration in the displacement rate supports the study's hypothesis that an increase in ground displacement could serve as a precursory sign of impending landslide events.
- These results align with recent studies that have utilised similar satellite-based remote sensing technologies for landslide detection and risk assessment.
- While this study focused on ground displacement rates as an indicator of landslide risk, it acknowledges the multifaceted nature of landslide triggers. Other geological and hydrological variables, such as geological composition, topography, and hydrological conditions, also play crucial roles in landslide susceptibility.