

ENHANCING SUBSIDENCE DETECTION IN LOW-COHERENCE ZONES: QPS-INSAR ANALYSIS OF MACEIO'S SALT MINE COLLAPSE (ID: 140)

Ana Cláudia Teixeira^{1,2}, Matus Bakon^{1,3,4}, Daniele Perrisin⁵ and Joaquim J. Sousa^{1,2}

¹University of Trás-os-Montes e Alto Douro, Vila Real, Portugal; ²Institute for Systems and Computer Engineering, Technology and Science, Porto, Portugal; ³Department of Environmental Economy and Management, Faculty of Management and Business, University of Presov, Presov, Slovakia; ⁴insar.sk Ltd, Presov, Slovakia; ⁵RASER Limited, Unit 609, 9 Wing Hong Street, Lai Chi Kok, Hong Kong, China



Paper

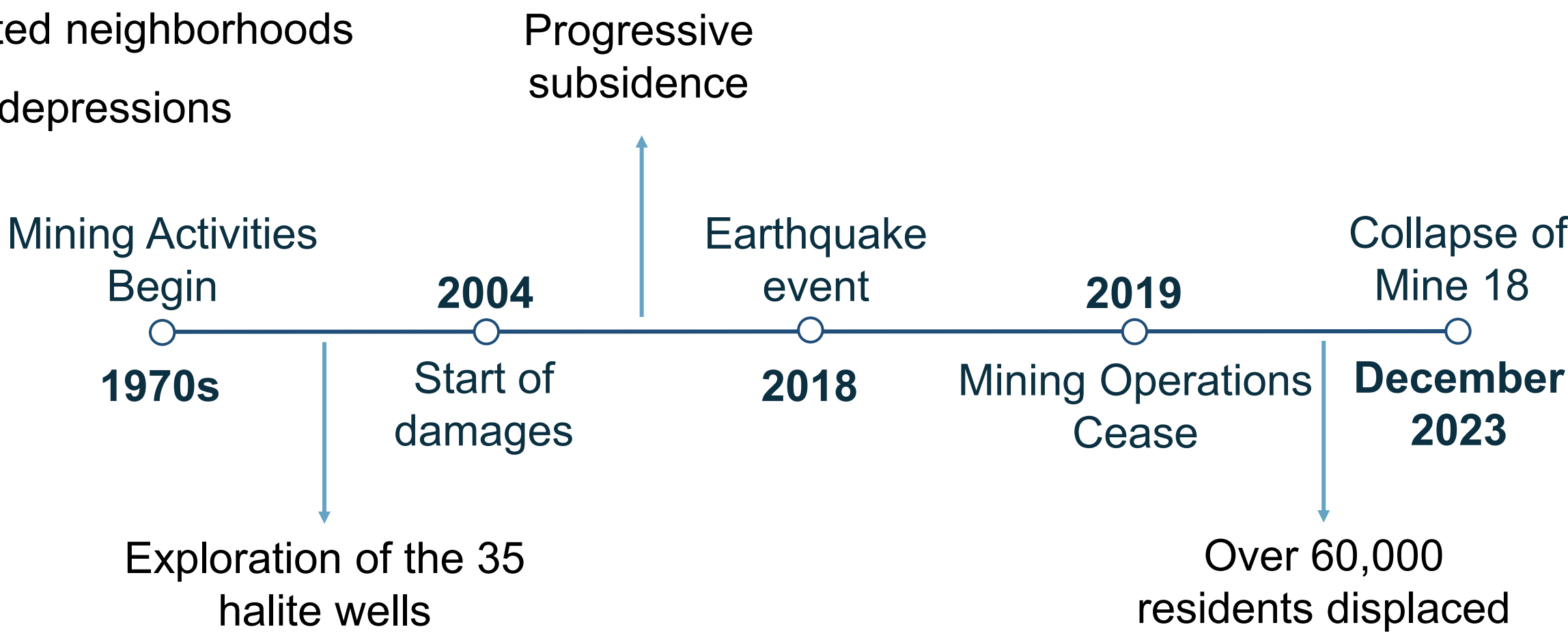


Introduction

Location: Maceió, Northeast Brazil

Geological formations: 35 halite wells located in densely populated neighborhoods

Reported impacts: building cracks, ground fissures, and surface depressions



Objective

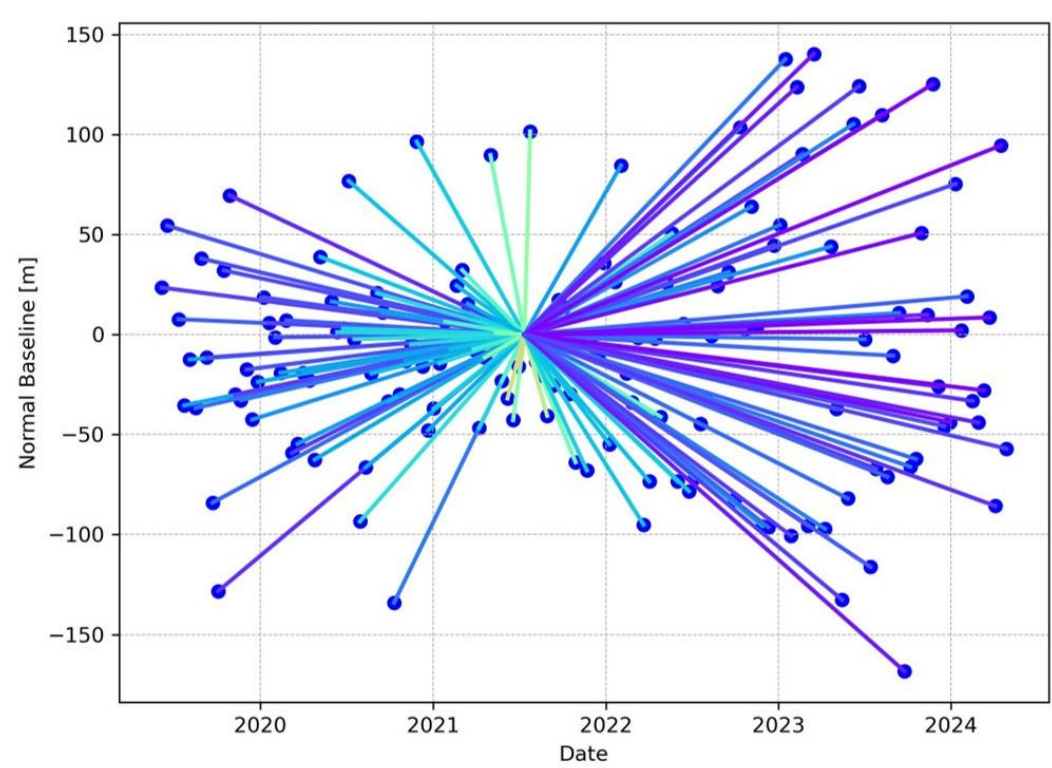
To enhance the detection of ground deformation in low-coherence areas using Quasi-Persistent Scatterer InSAR (QPS-InSAR), and to assess its effectiveness compared to traditional Persistent Scatterer Interferometry (PSI).



Data

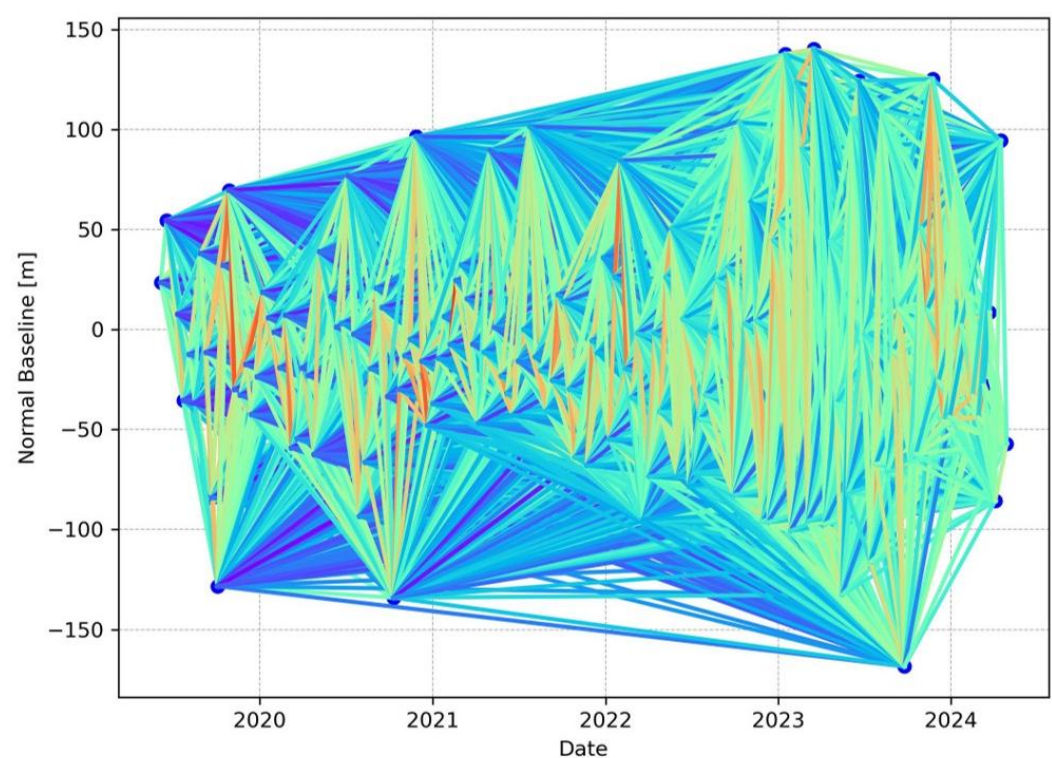
145 Sentinel-1A SAR images acquired between June 2019 and April 2024

The spatial and temporal baseline distribution and interferogram pairs used



PSI

All images were coregistered to a reference image from July 13, 2021

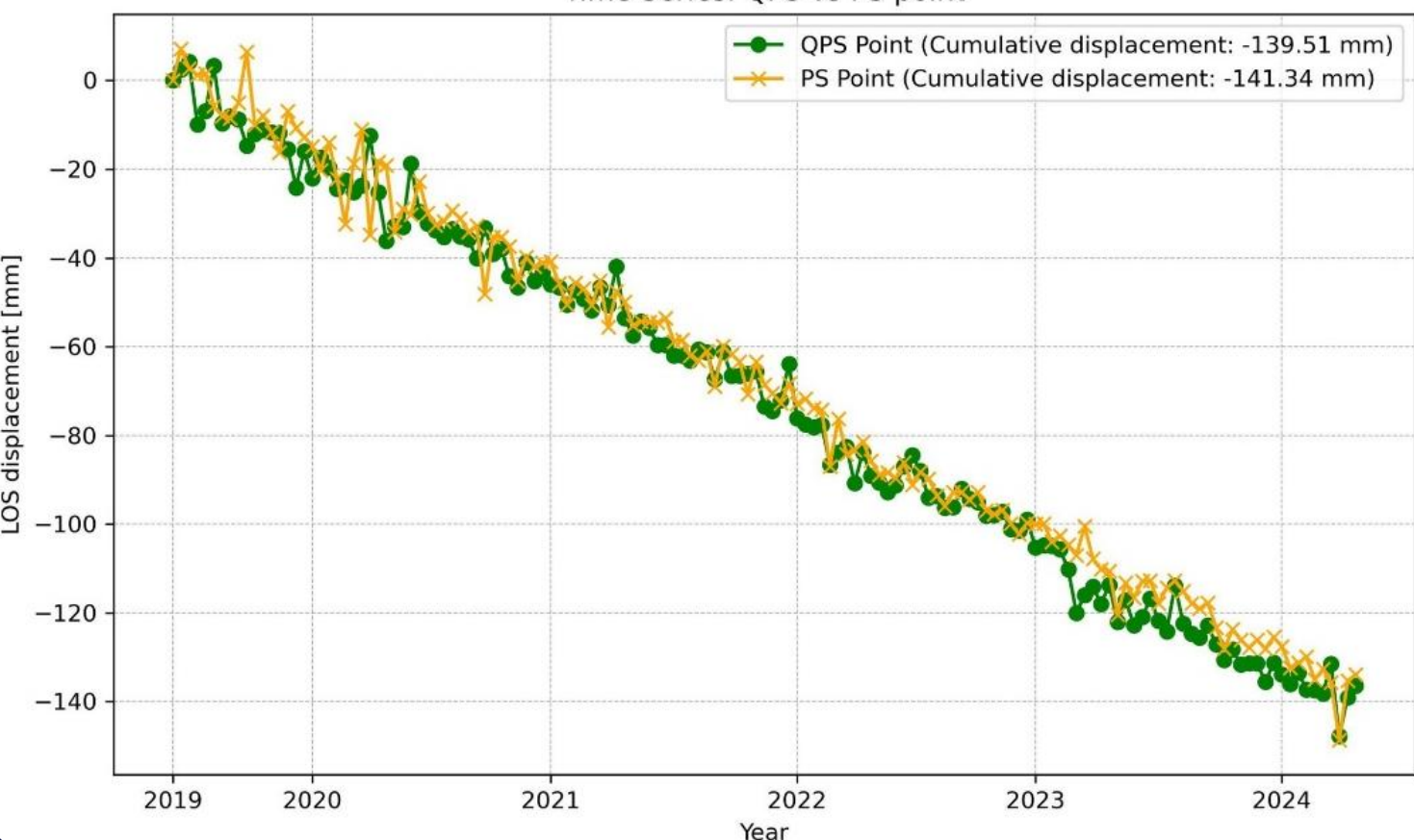
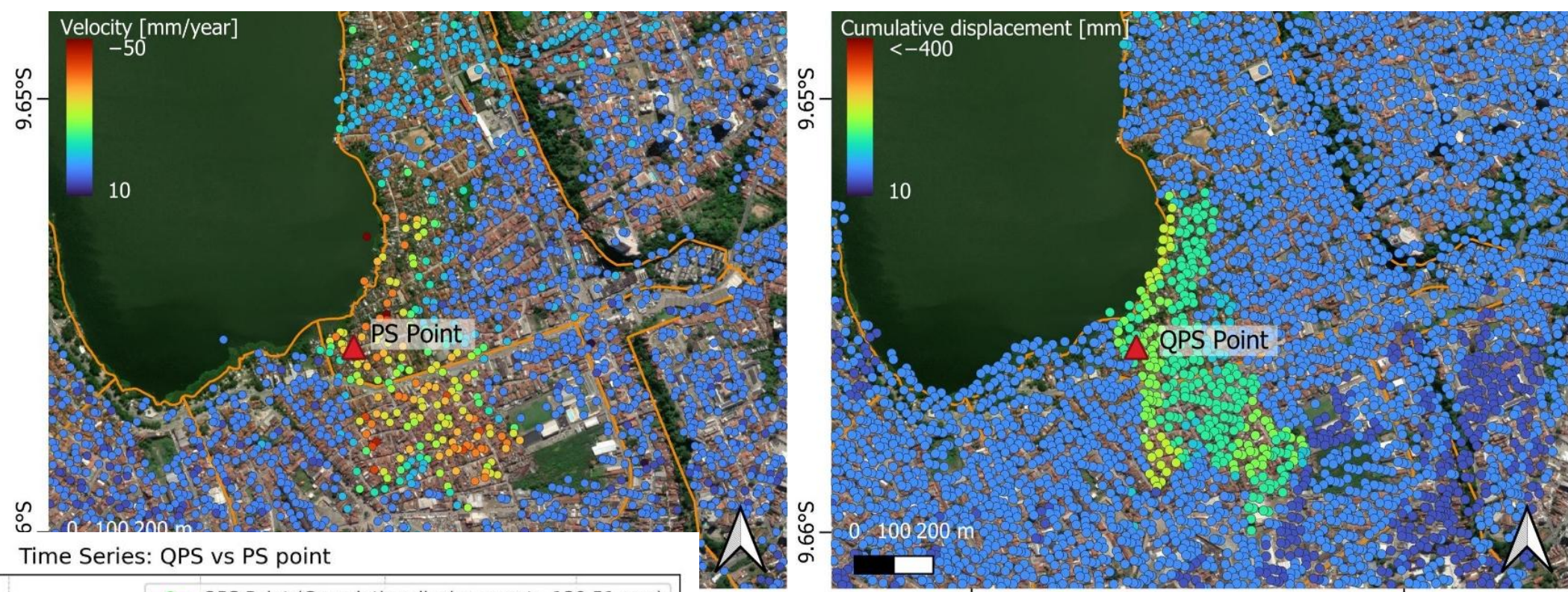


Quasi-PS InSAR

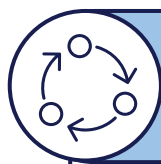
Each image is linked to other images throughout the time series having multi-references



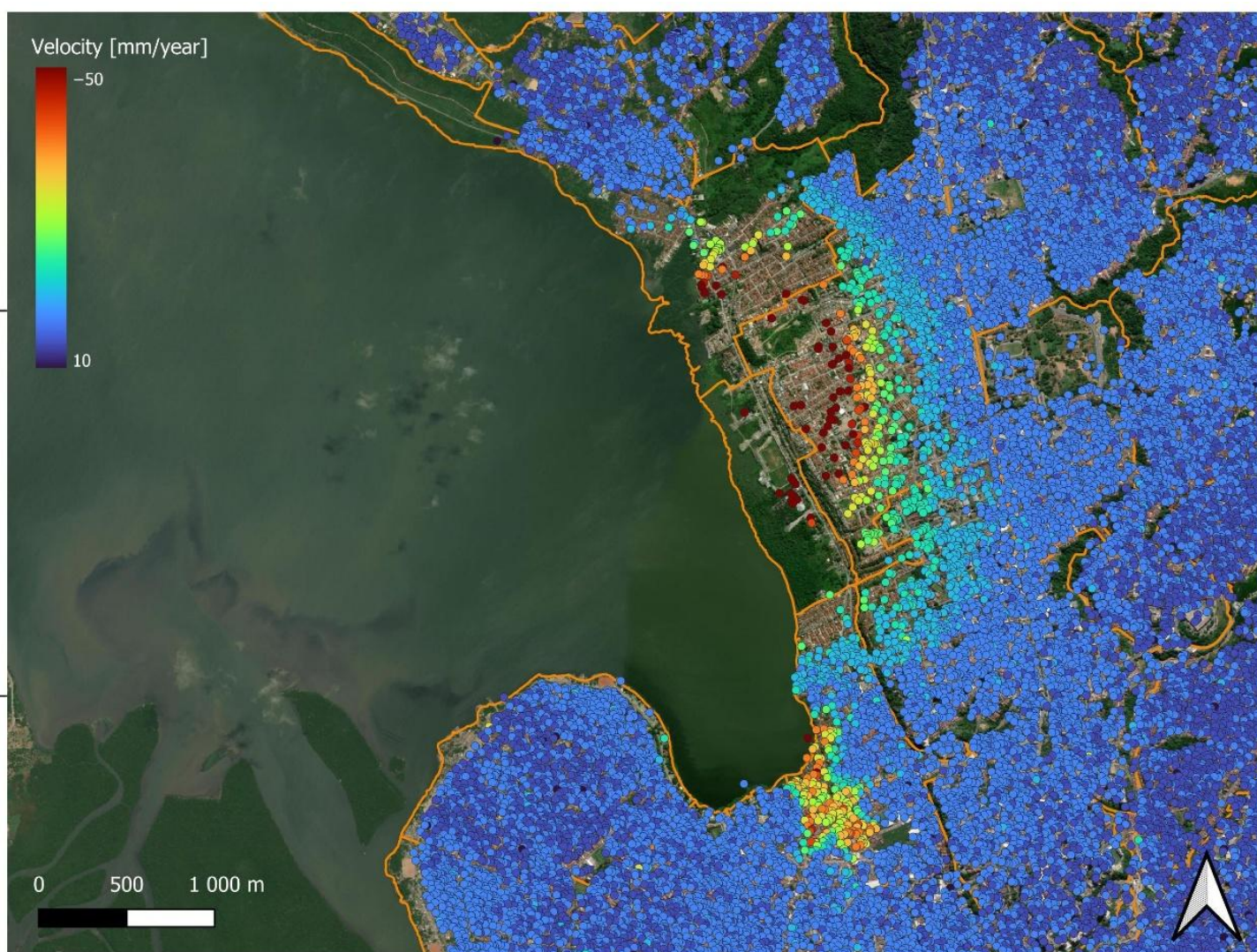
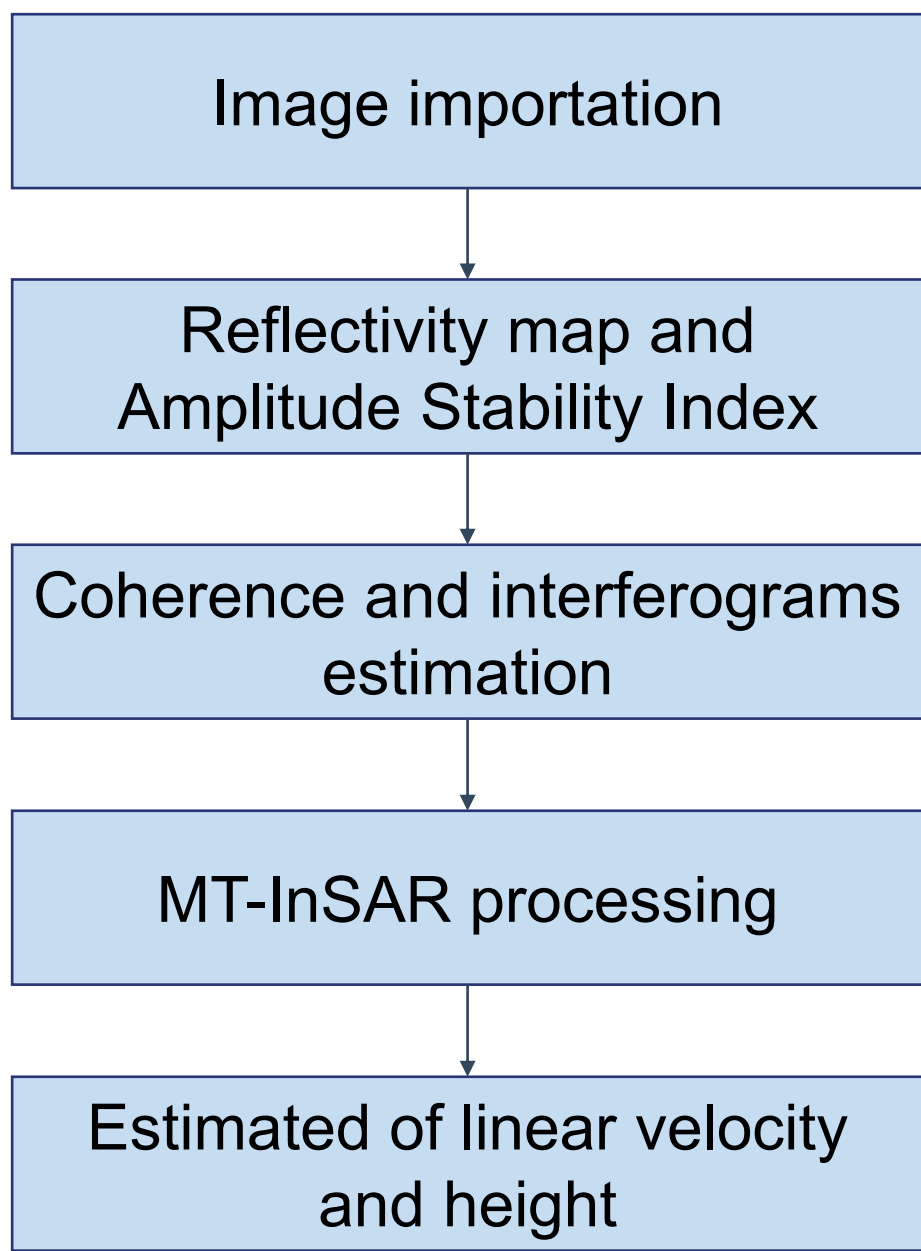
Comparison between the PSI and QSP-InSAR



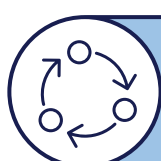
These results demonstrate the reliability and accuracy of the QPS-InSAR method, validating its application in areas where the traditional PS technique may not be effective.



PSI (Persistent Scatterer Interferometry)

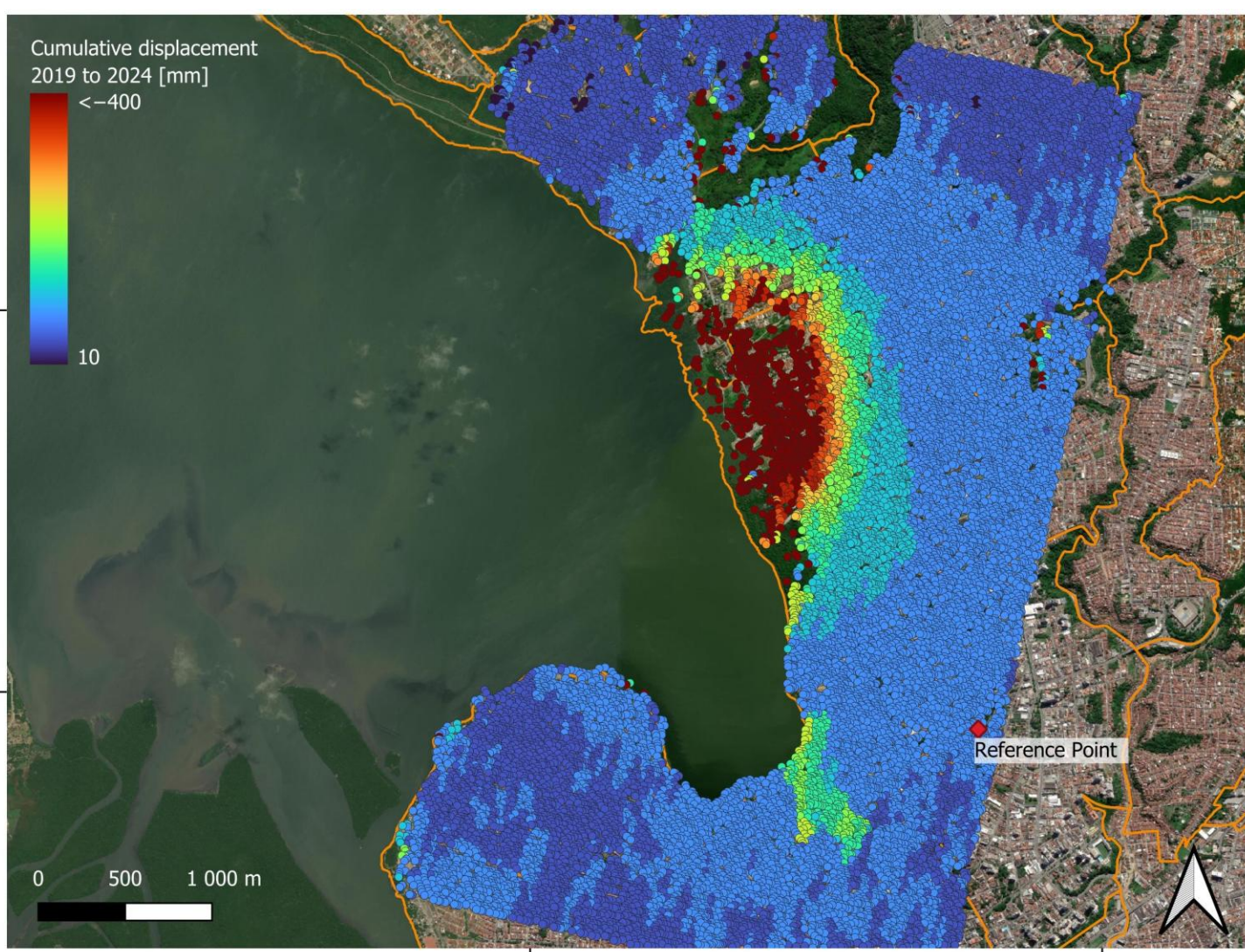


The main region of the mine did not display points on the deformation velocity map due to steep displacement gradients and the low coherence of PS targets, although deformations were evident in the surrounding areas.



Quasi-PS InSAR (Quasi-Persistent Scatterer)

The objective of the multiple connections is to utilize all coherent interferograms, rather than relying solely on those generated from a single reference image. Coherence weighting is also employed in parameter estimation, identifying interferograms with coherent targets, enabling the processing of lower coherence points and increases the number of monitored targets.

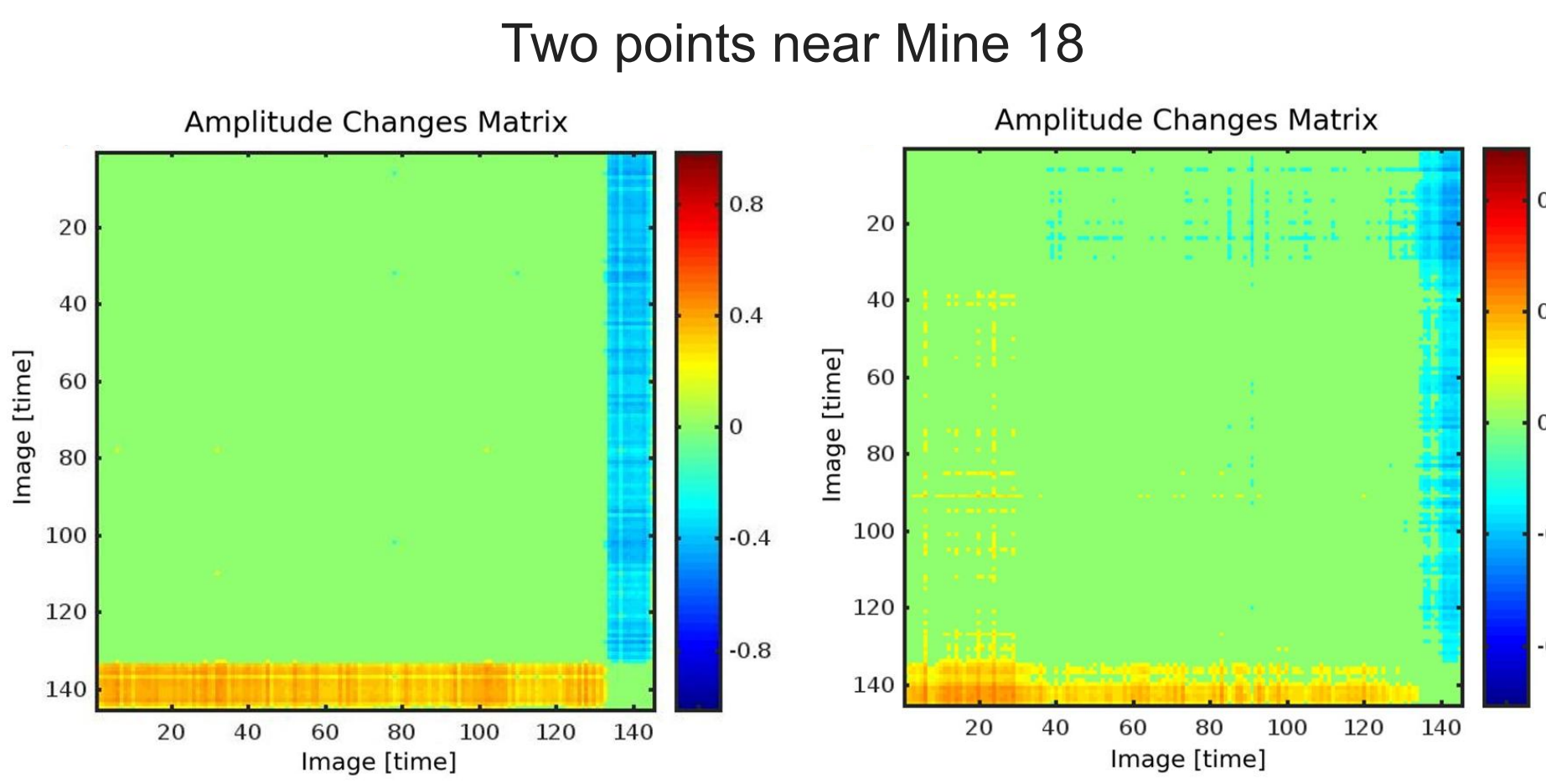


Now, there are a lot of points in the mining area, where the majority of salt wells are located.



Amplitude Analysis

In amplitude change matrix, the intensity of the radar return for each pixel is continuously monitored over time, providing a consistent representation and achieved a detailed spatial understanding of these variations.



Conclusions

- Cumulative displacements from June 2019 to April 2024 were quantified.
- QPS-InSAR proved more effective than PSI in:
 - Increasing the number of monitored targets
 - Capturing deformation in low-coherence areas
 - Providing a clearer chronology of instability events
- This makes QPS-InSAR a valuable tool for monitoring complex subsidence scenarios.



Acknowledgements

This work was conducted under the Dragon 6 cooperation programme between the European Space Agency (ESA) and the Ministry of Science and Technology (MOST) of China.

Supported by FCT – Fundação para a Ciência e a Tecnologia, I.P., under project reference PRT/BD/154871/2023, DOI: 10.54499/PRT/BD/154871/2023