Monitoring deformation processes of Provadia salt depot area

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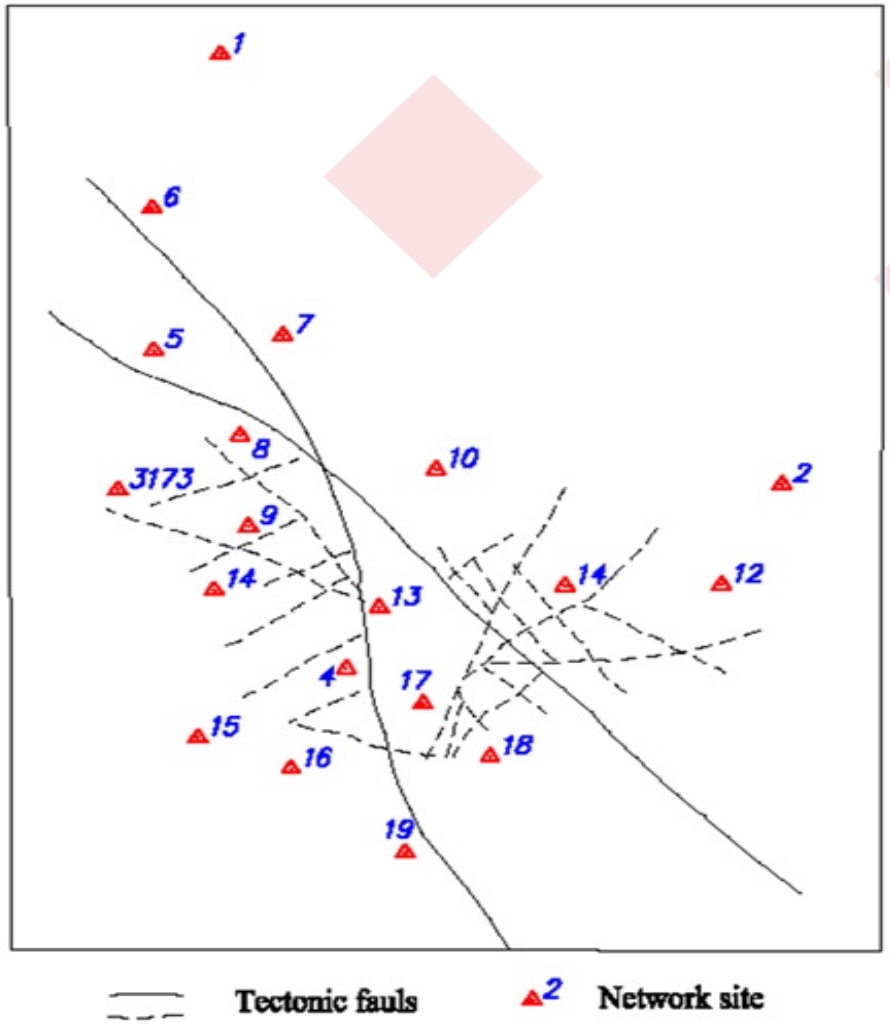
Introduction

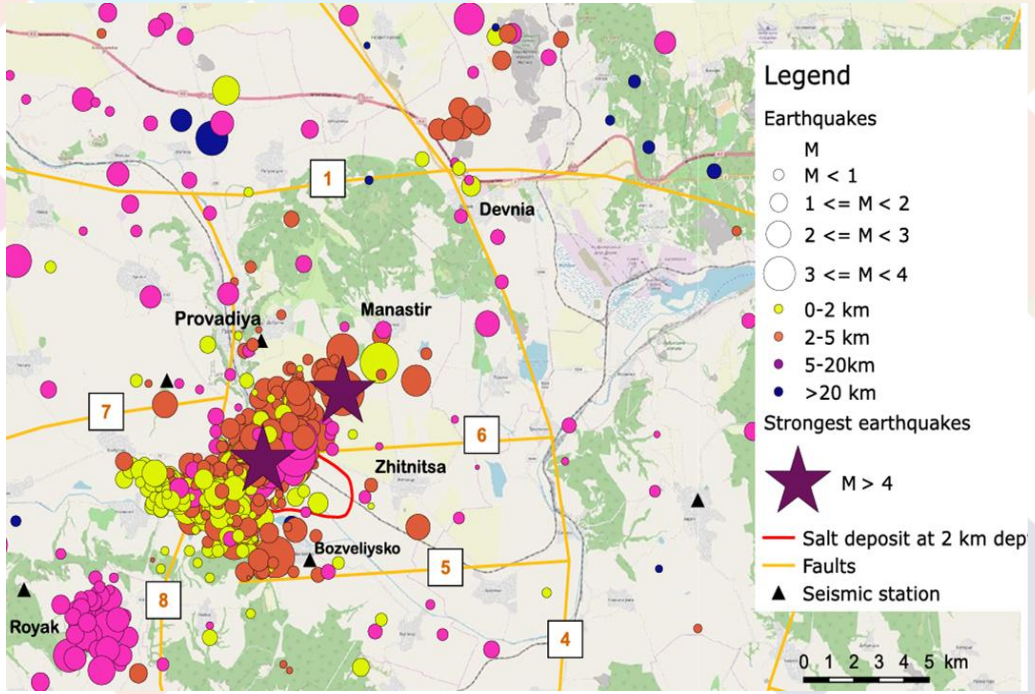
The object of our research is the determination of the deformations of the earth's surface in the area of the Provadia salt depot (NE Bulgaria). It has been intensively exploited for industrial salt extraction since 1954.

The prehistoric archaeological center of Provadia-Solnitsata, which is located within the boundaries of the salt body has European Heritage Label .

EUROPEAN HERITAGE LABEL

Seismological and tectonic settings of the area





Two networks have been established over the last four decades – seismological and geodetic networks to study ground motions from tectonic movements (two faults).

Methods and data

Geodetic methods

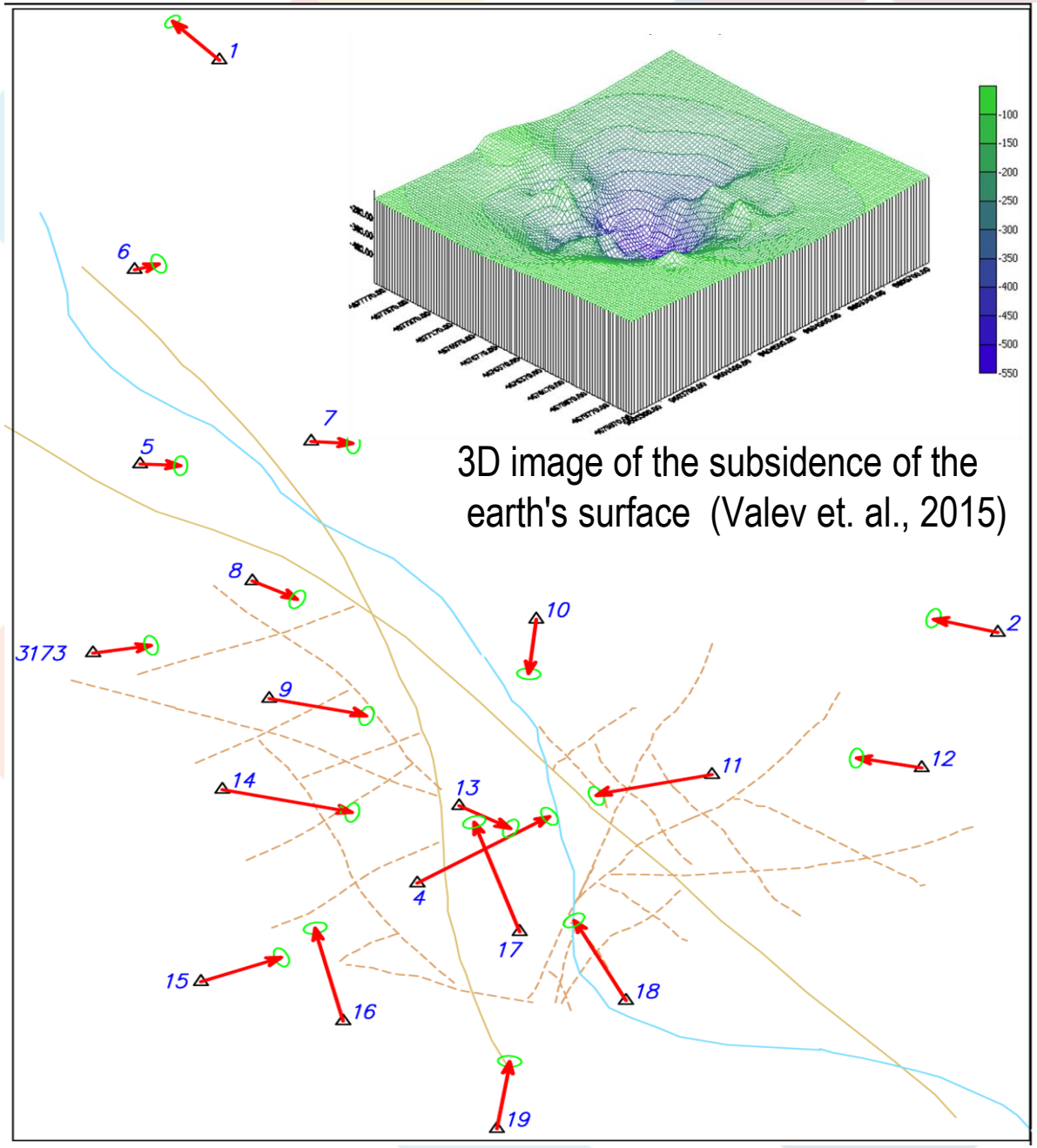
Local geodynamic network of 26 pillars.

Periodical (each year) measurements: GPS, horizontal directions, EDM distances, leveling, and astronomical azimuths.

The results shown are from a combined adjustment of all these measurements for each cycle.

Between 1990 and 2016, the largest benchmark subsidence, 875mm, was observed in the central part of the deposit. The subsidence of the other benchmarks ranges from 250 mm to 500 mm.

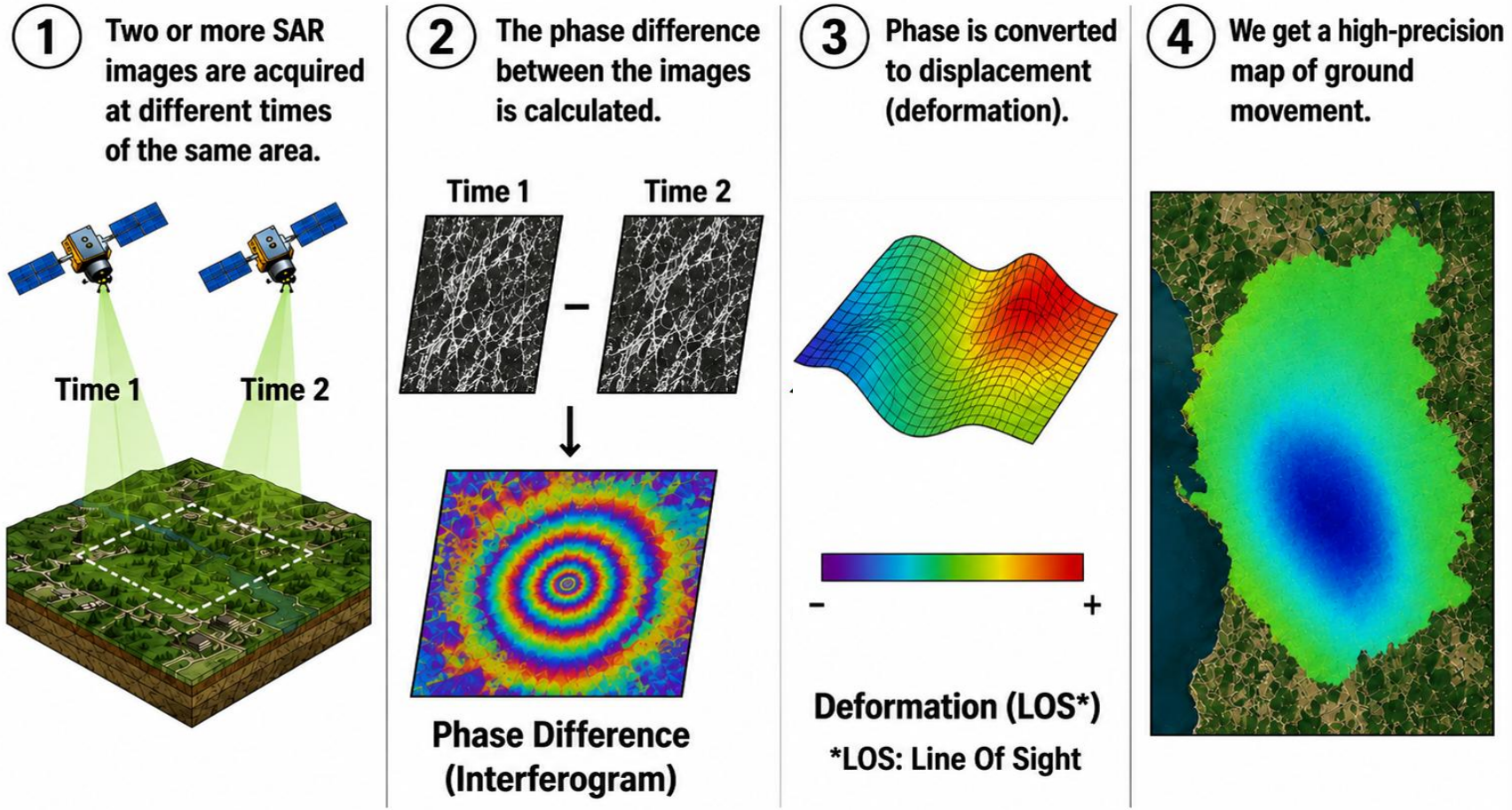
Points 4, 11, 14, 16, 17, and 18 show horizontal maximum velocities ranging from 12.6 to 18.5 mm/year.



3D image of the subsidence of the earth's surface (Valev et. al., 2015)

Relative velocities in the region of Provadia salt depot (Atanasova, 2015)

Methods and data



InSAR

Sentinel 1 data over 6 or 12 days, scanning the Earth's surface

EGMS Data

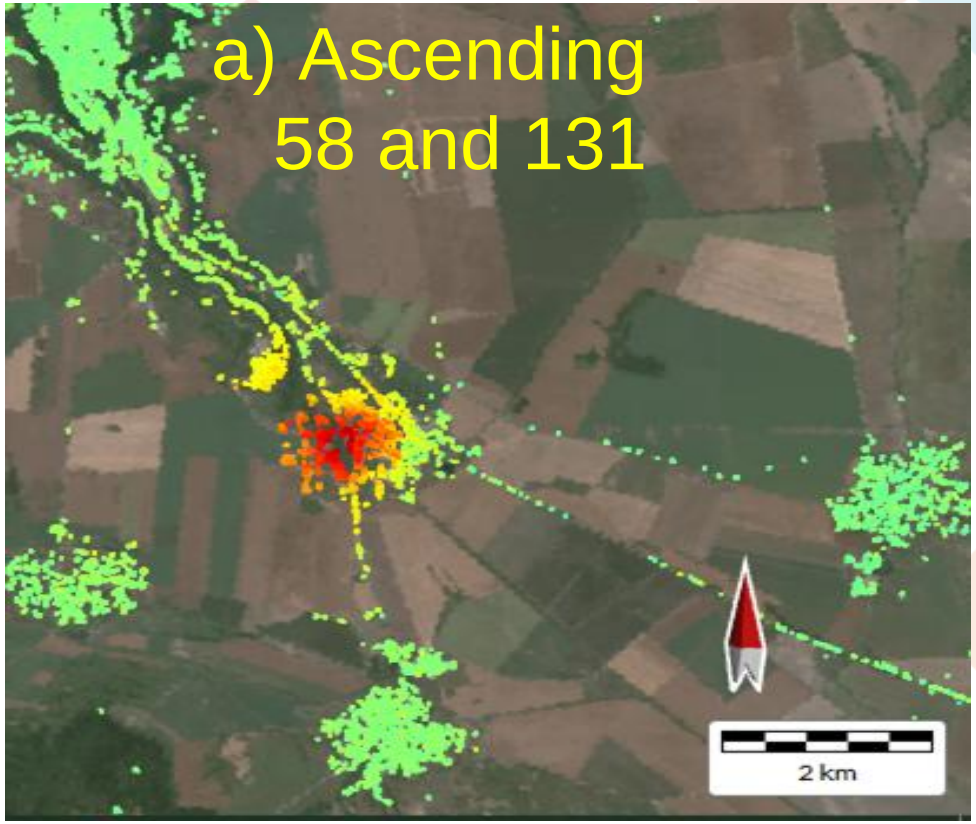
The European Ground Motion Service (EGMS), part of the Copernicus Land Monitoring Service (CLMS), provides free pan-European ground motion data to support local and regional ground deformation analyses

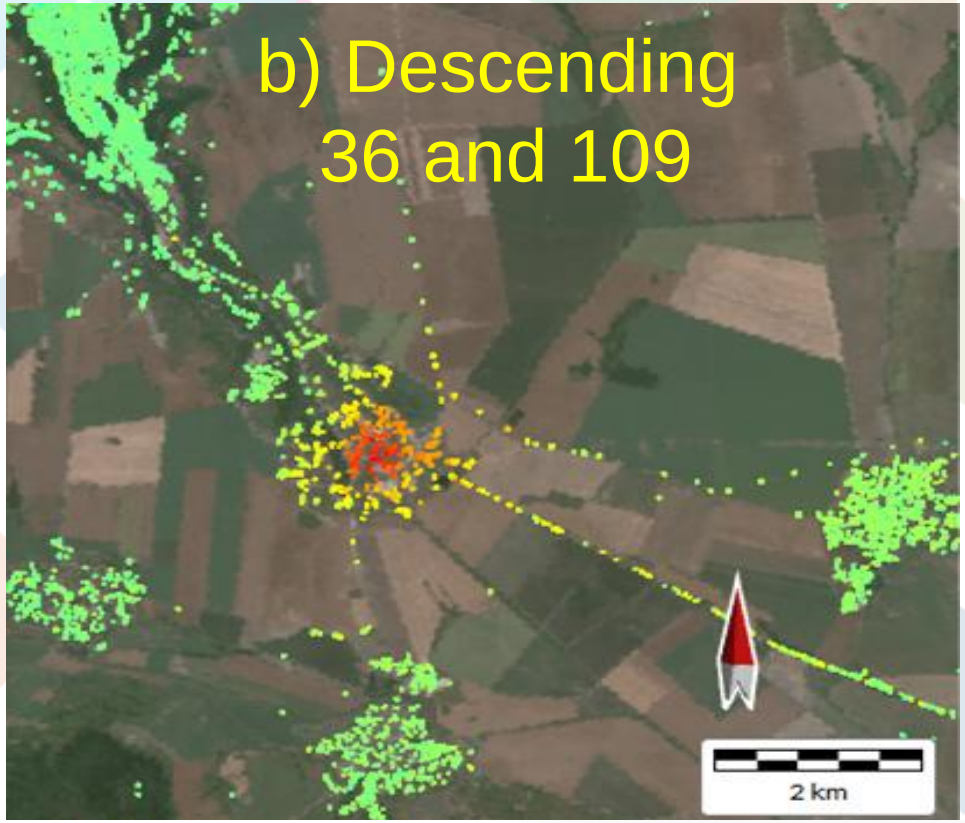
MT-InSAR
time series Jan2019-Dec2023

https://egms.land.copernicus.eu/

Results

Mean LOS velocity (mm/year) time series Jan 2019-Dec2023 based on EGMS data





Legend across all datasets. Limits are in mm/year.

-40 40

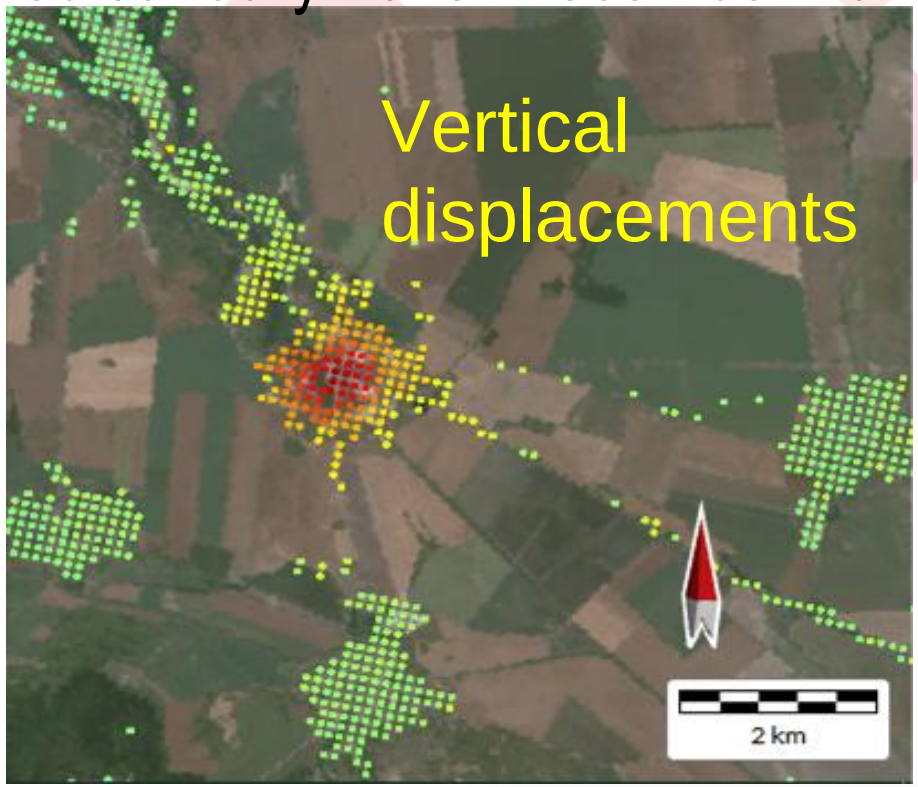
Legend across all datasets. Limits are in mm/year.

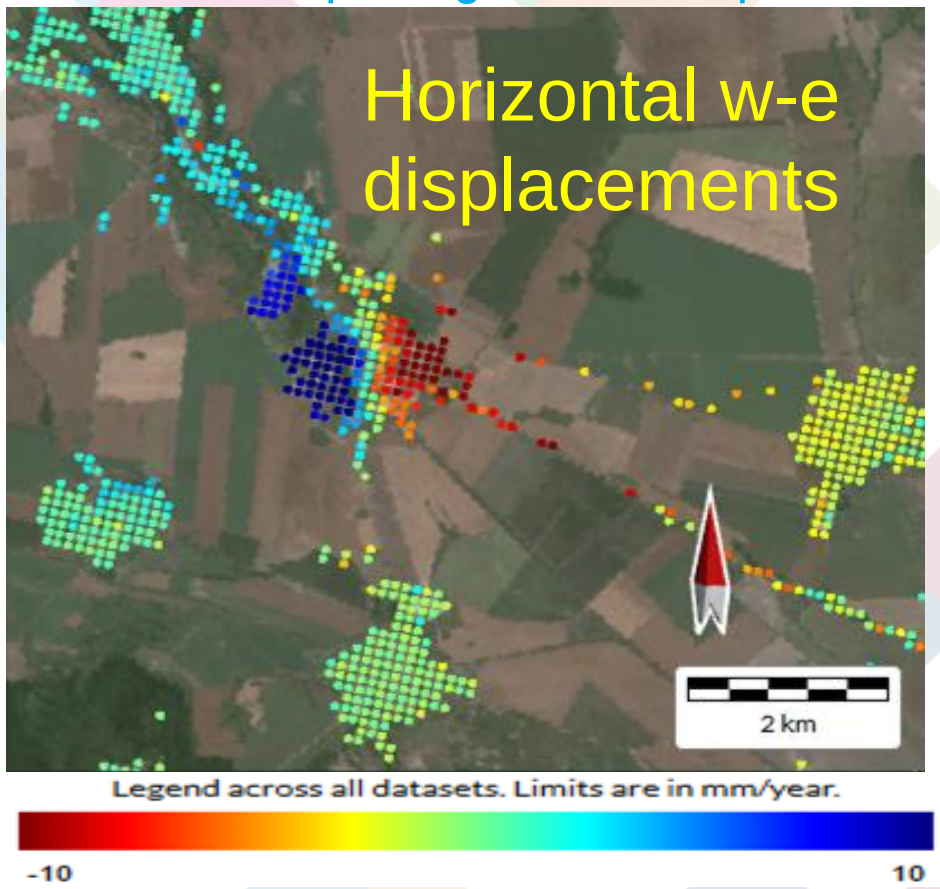
-40 40

https://egms.land.copernicus.eu/

Results

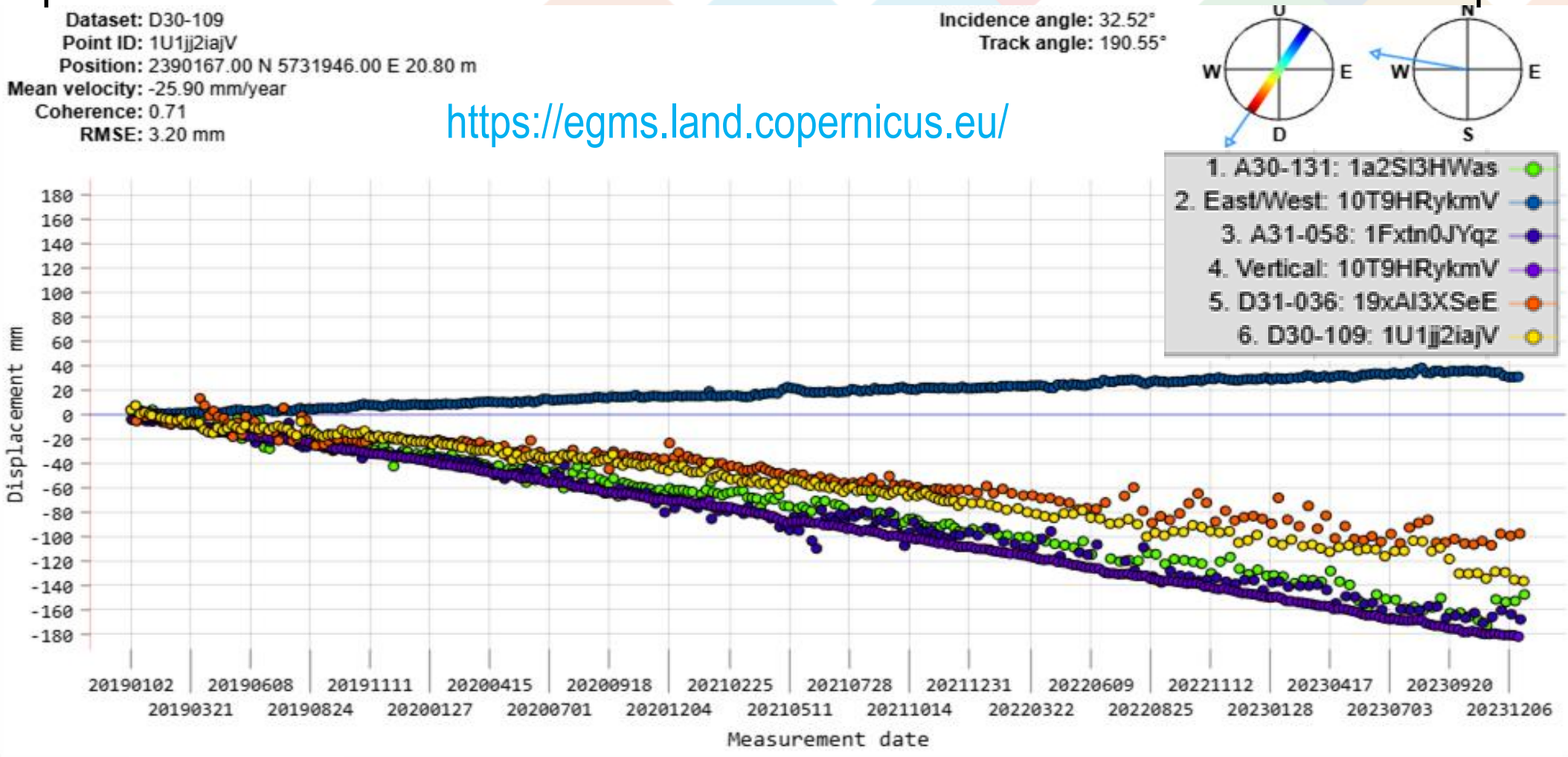
Mean vertical and horizontal east–west displacements derived from MT-InSAR for the period January 2019–December 2023, based on EGMS https://egms.land.copernicus.eu/





Results

Displacements derived from MT-SAR time series based EGMS data from point 17



Conclusion

- This study demonstrates the application of MT-InSARto monitor subsidence associated with technogenic processes.
- A case study of the Provadia salt deposit illustrates the effectiveness of satellite radar interferometry as a routine, space-based tool for assessing structural stability by analyzing vertical and horizontal ground displacements.
- The EGMS results reveal current subsidence conditions and confirm MT-InSAR's reliability for long-term monitoring of surface deformation.
- The deformations are not uniform across the area due to multiple faults, differences in rock breeds, and variations in salt extraction in individual zones and drilling chambers.
- The comparison of displacements derived from the EGMS model with those obtained from the combined adjustment of geodetic measurements shows good agreement.
- InSAR demonstrates substantial potential for future applications.
- MT-InSAR as a powerful, cost-effective tool for proactive risk management

The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG

2nd relevant SDG

3rd relevant SDG

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