Brisa Autoestradas

Usage of satellites to observe surface displacements on slopes

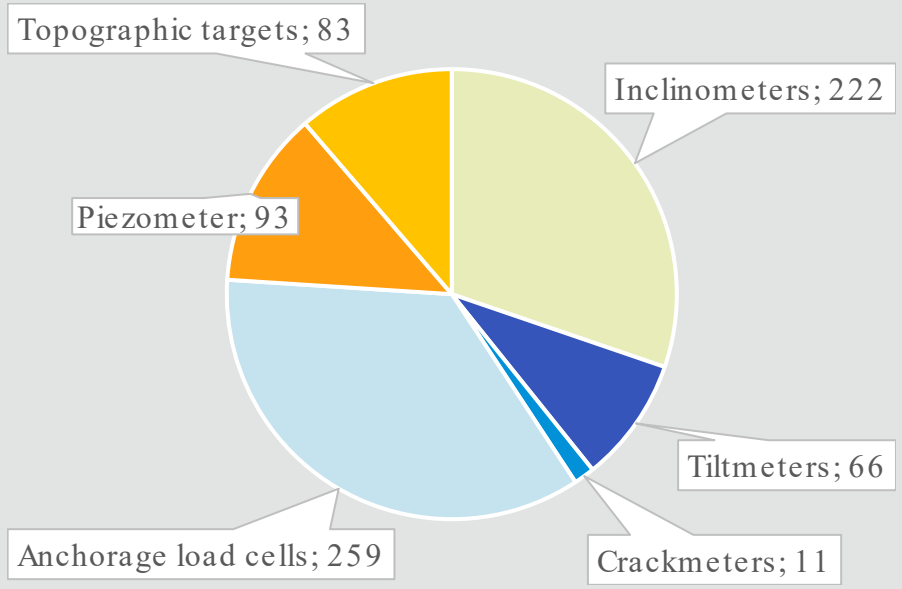
- the A10 motorway use case

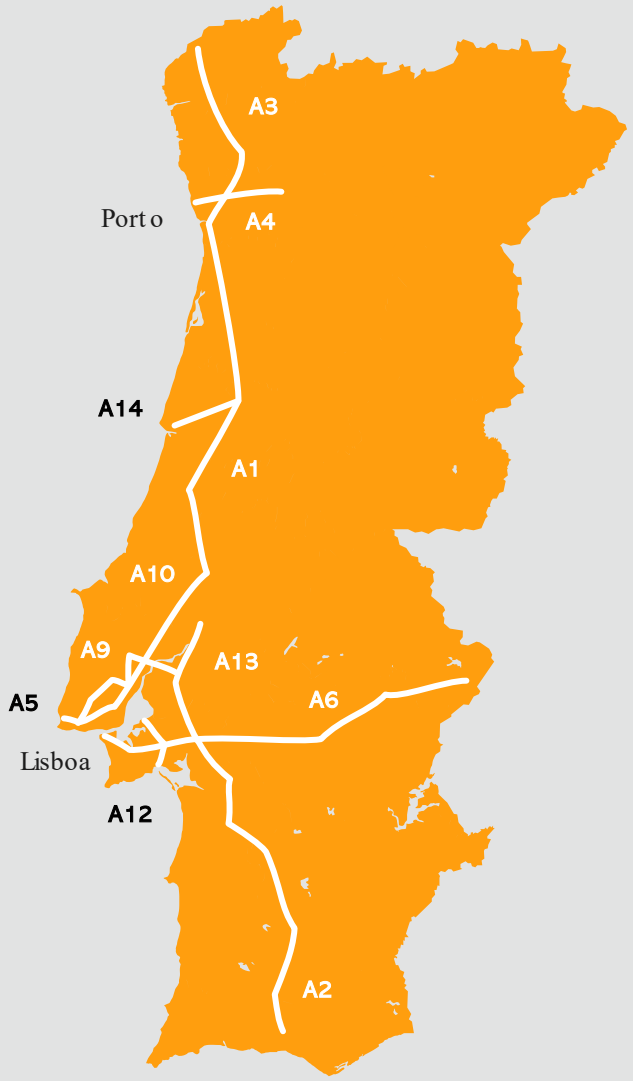
Miguel Cruz – Brisa Autoestradas

Brisa Highways

Operation and management of 1.357 km of road network

- + 10 000 geotechnical assets
- + 700 monitoring devices
- +1000 km visual inspections / year

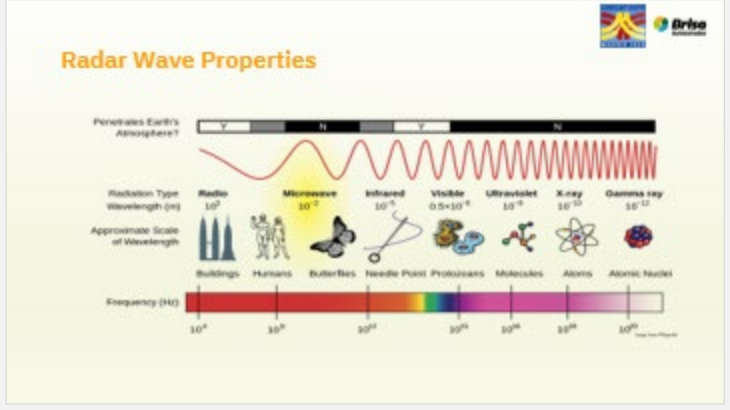




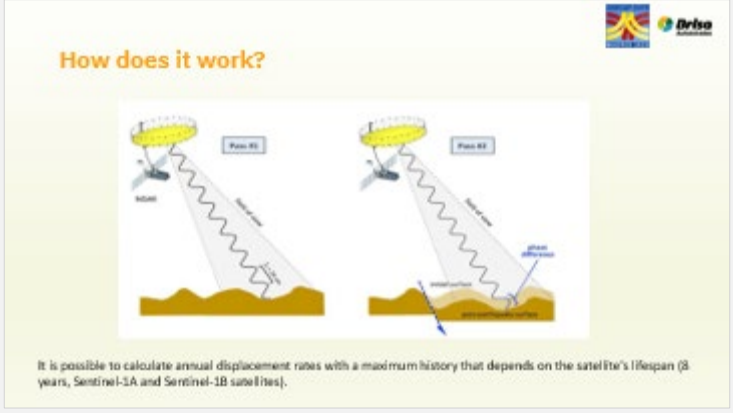
Interferometric Synthetic Aperture Radar

HOW DOES IT WORK?

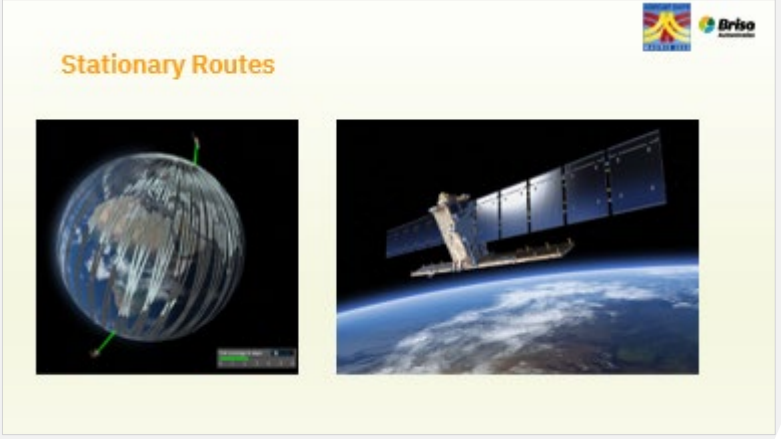
Radar Wave Properties



Interferometric Processing



Stationary Routes



Radar Wave Properties

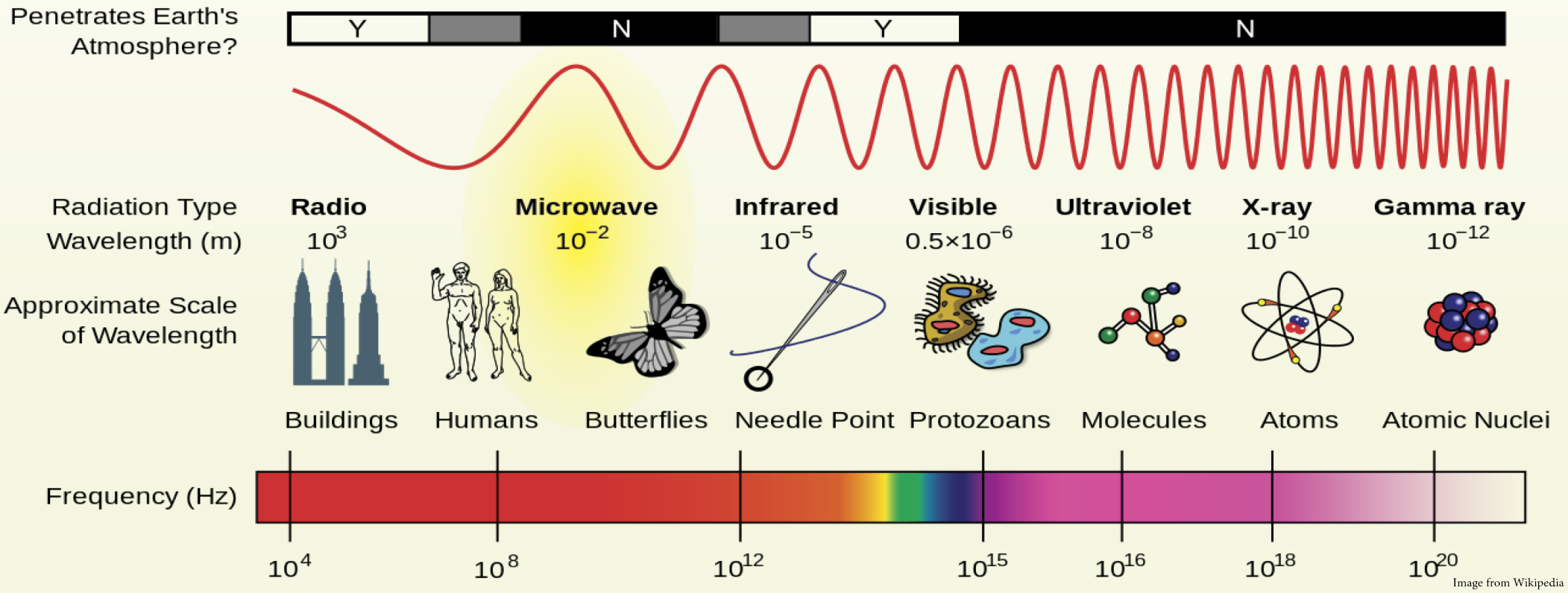
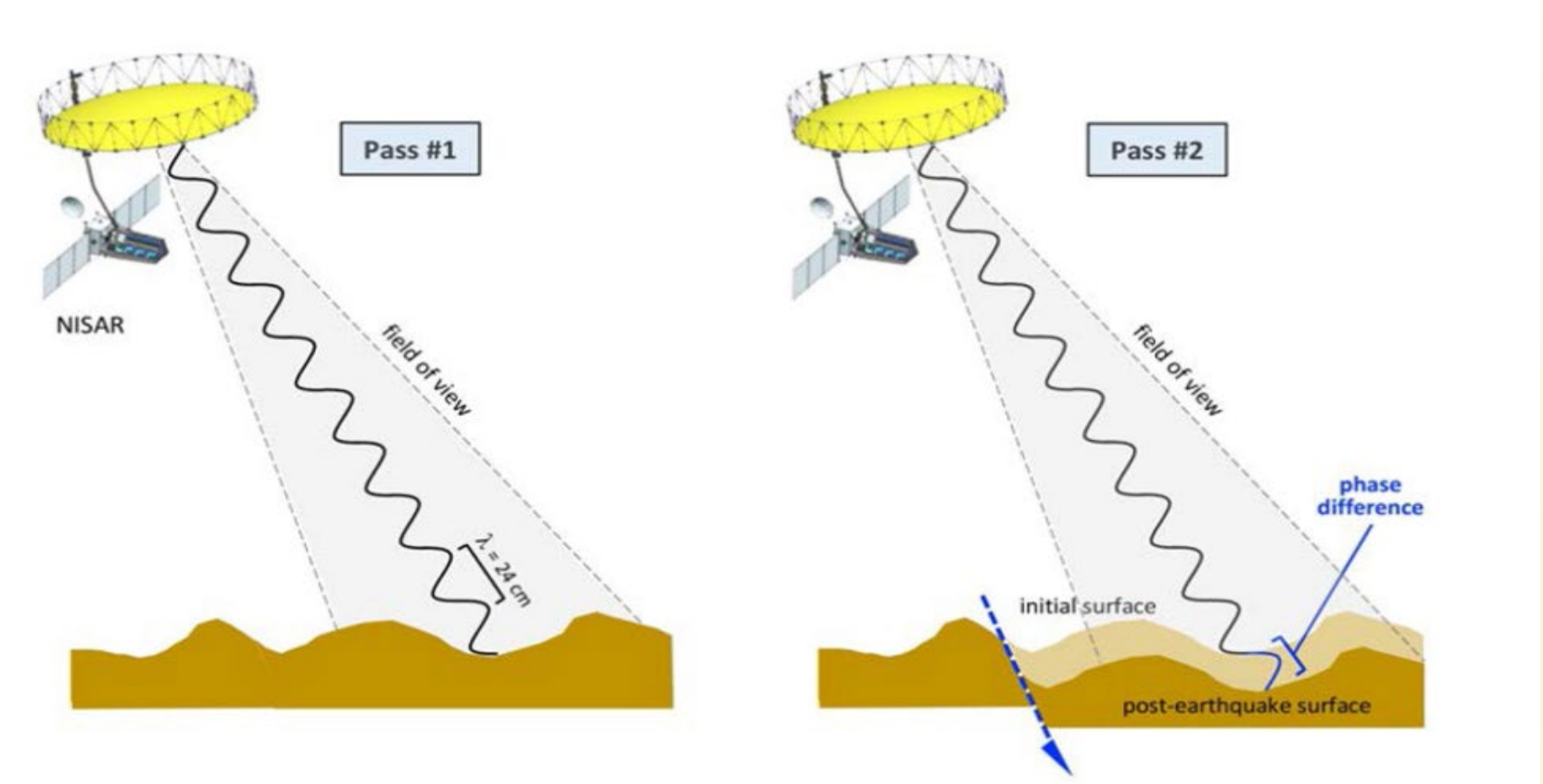


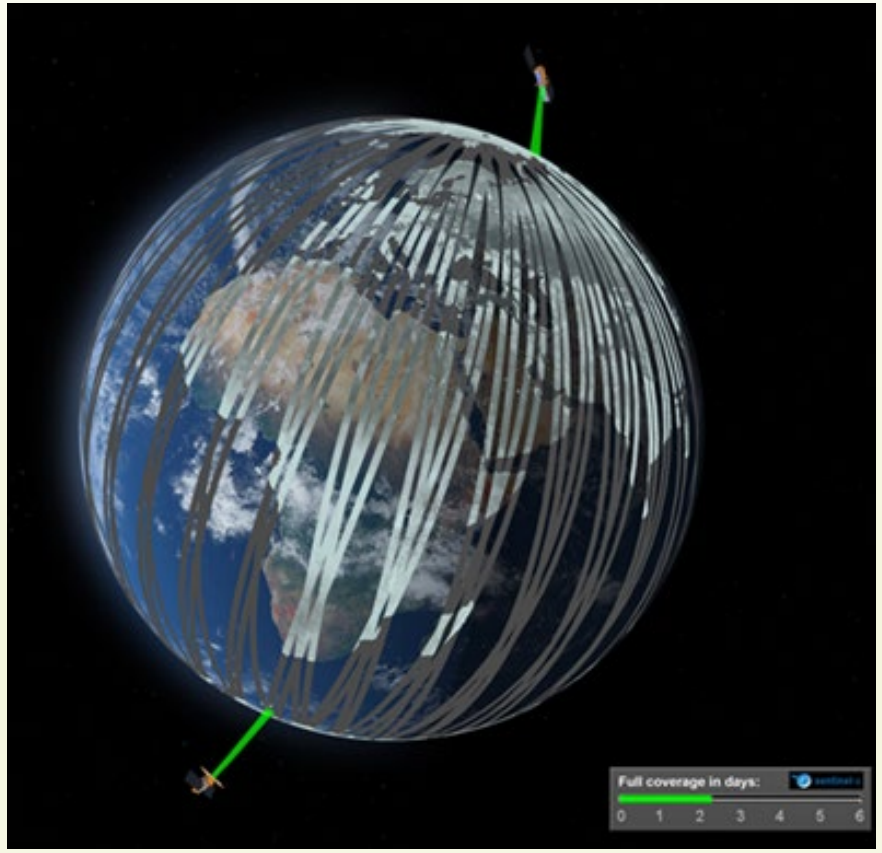
Image from Wikipedia

How does it work?



It is possible to calculate annual displacement rates with a maximum history that depends on the satellite's lifespan (8 years, Sentinel-1A and Sentinel-1B satellites).

Stationary Routes



General Application of InSAR Technique

- Natural Hazard Monitoring
- Environmental Monitoring
- Infrastructure Monitoring
- Resource Management

Sweden, 2023

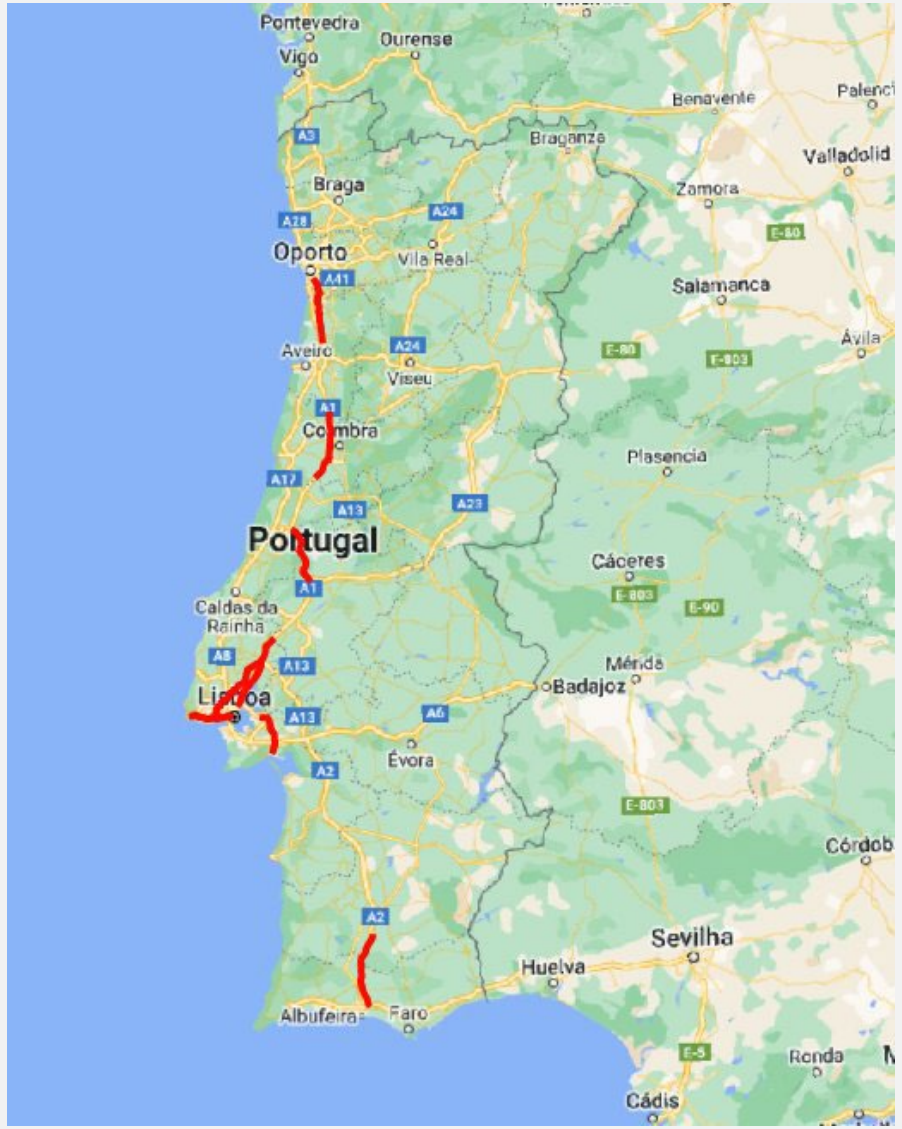
Application of InSAR Technique in Brisa's Motorways

First Approach: Observing Large Areas and Defining Risk Zones

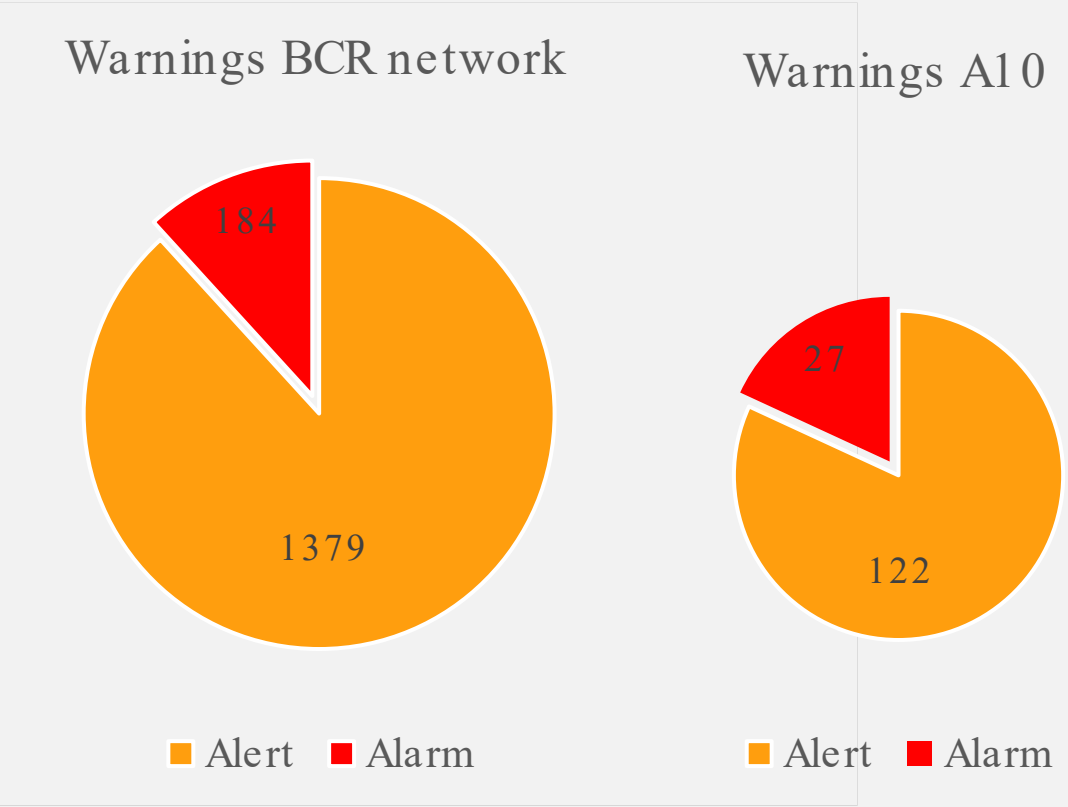
↳ Create a warning system that activates when certain thresholds are surpassed:

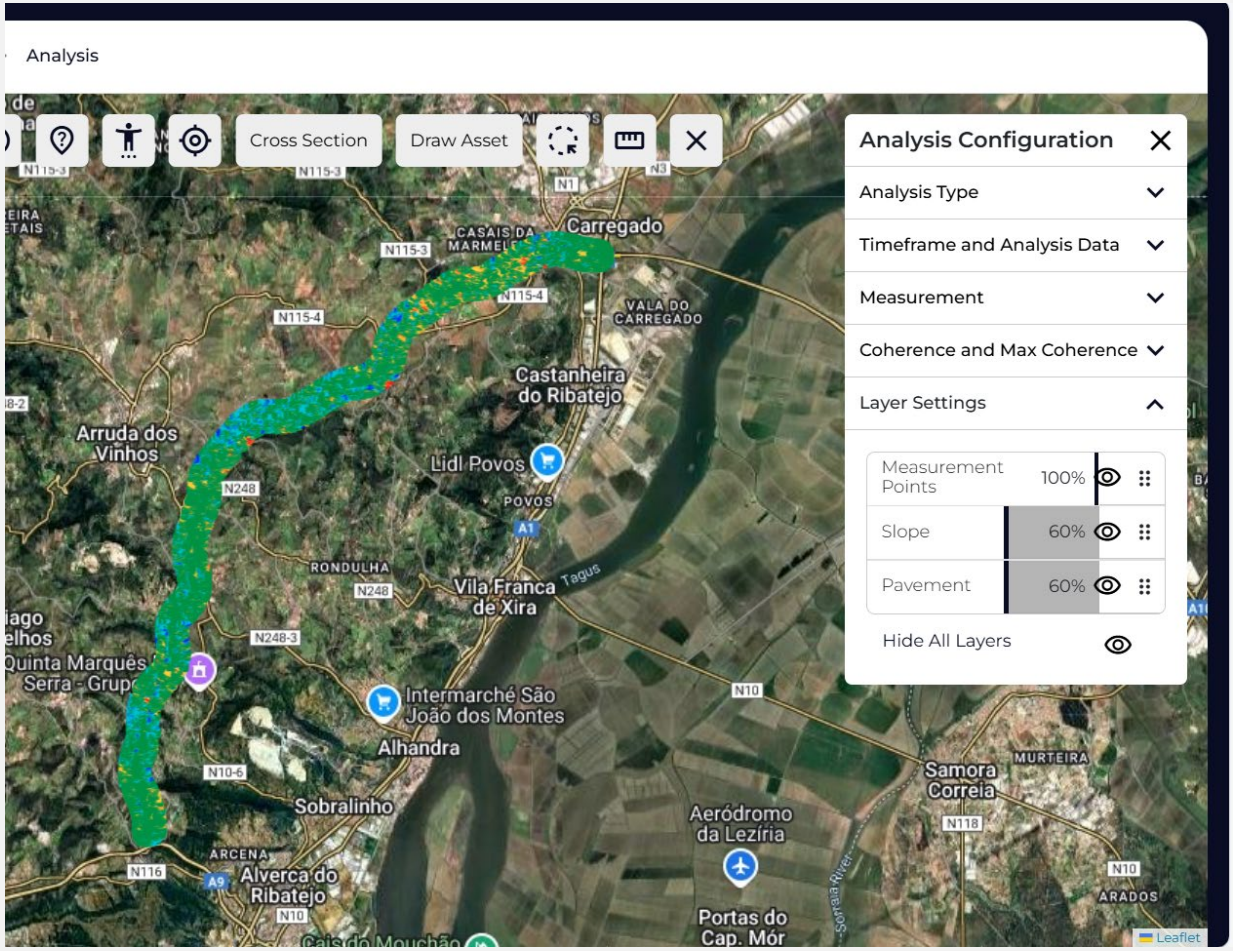
Anual Displacement rate:	
Alert	$10\ mm < \Delta h,v < 30\ mm$
Alarm	$\Delta h,v > 30\ mm$

Accumulated displacement:	
Alert	$30\ mm < \Delta h < 50\ mm \mid 10\ mm < \Delta v < 20\ mm$
Alarm	$\Delta h > 50\ mm, \Delta v > 20\ mm$

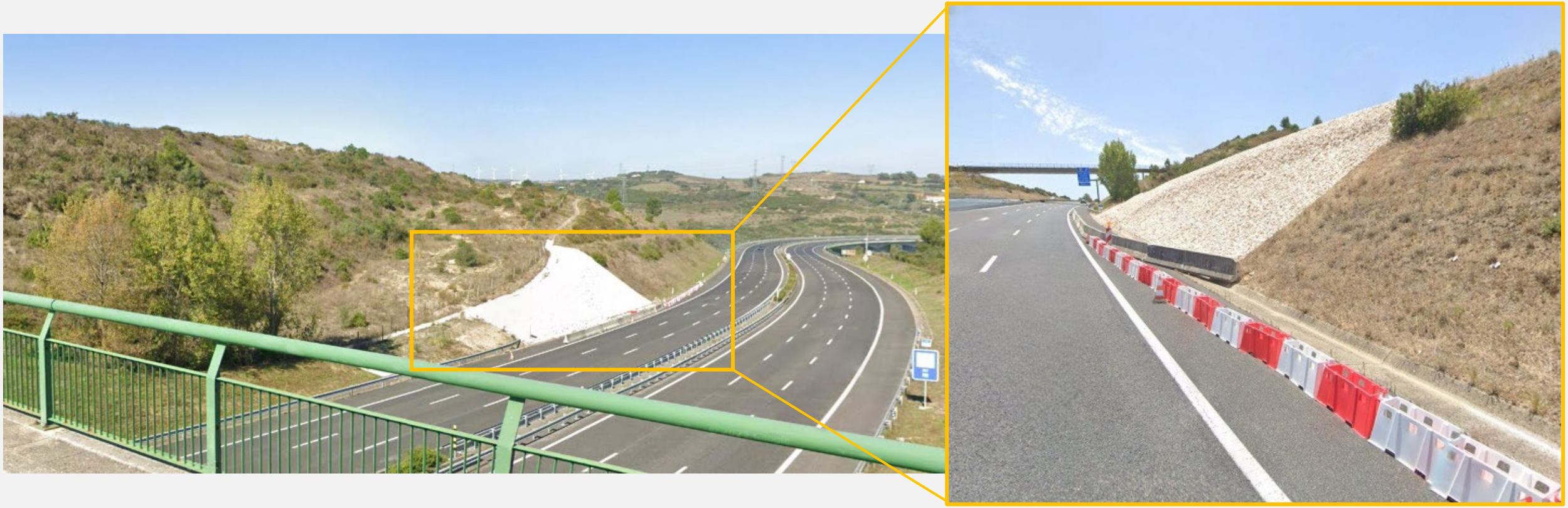


Application of InSAR Technique in Brisa's Motorways

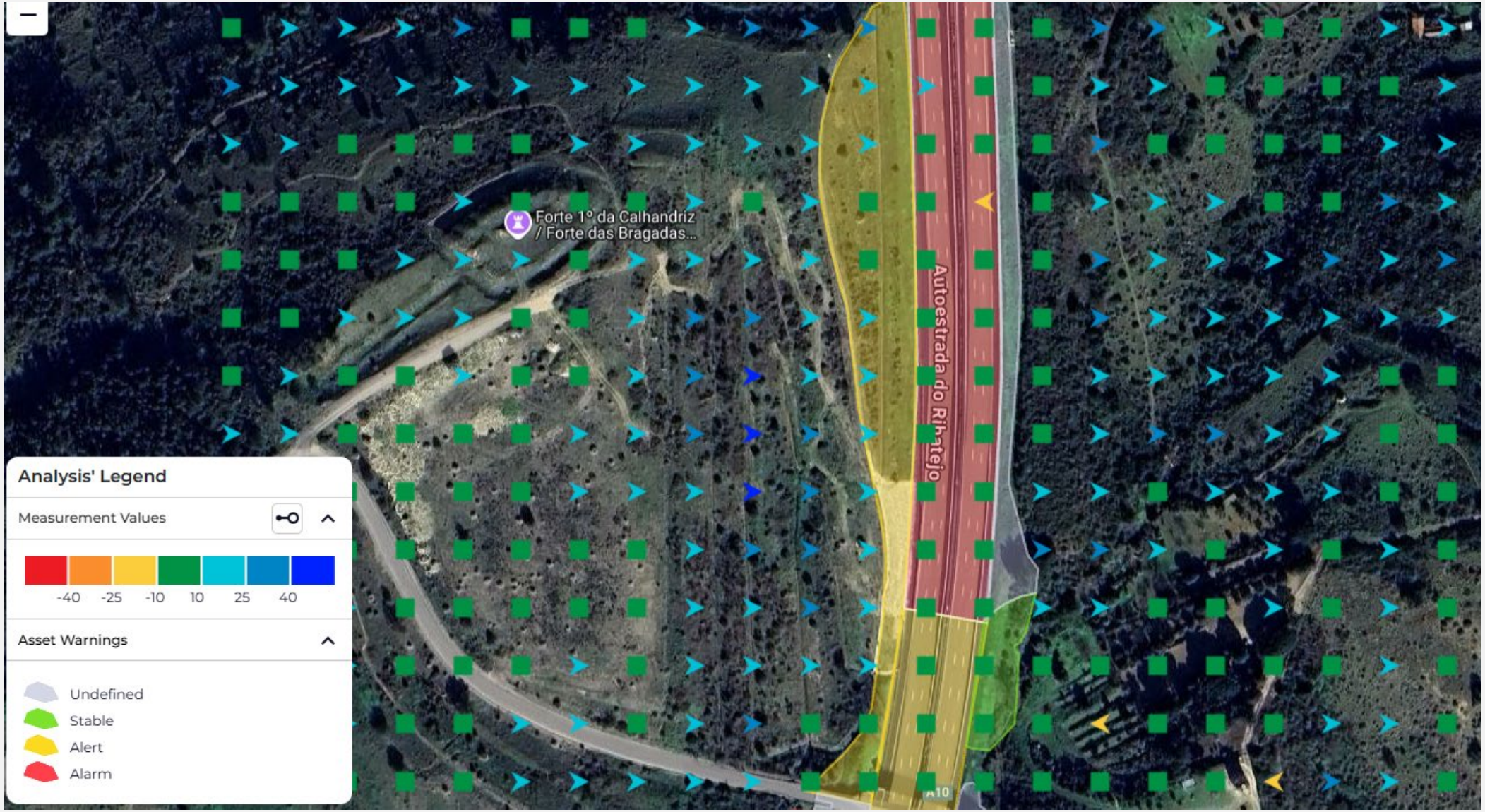




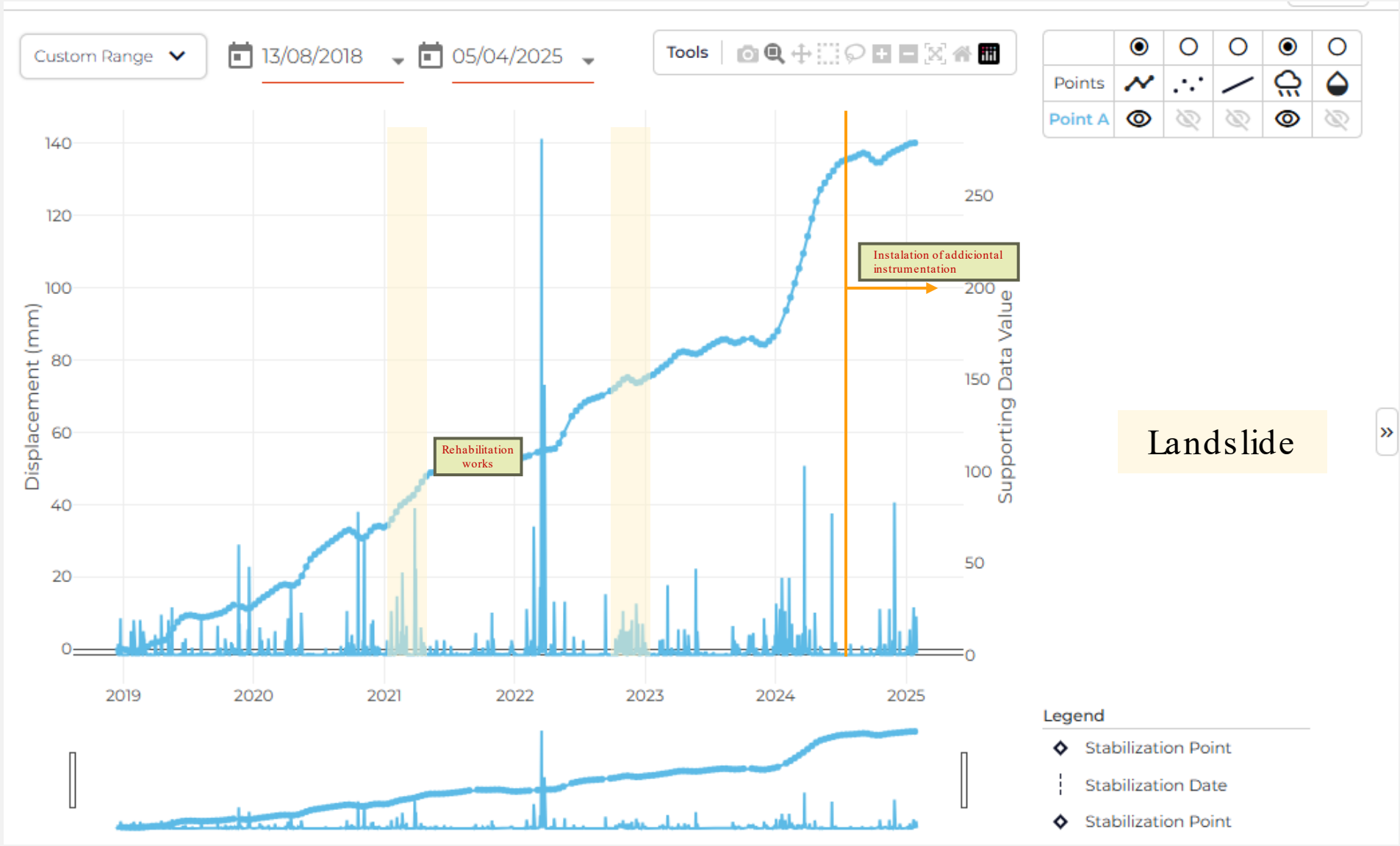
Application of InSAR Technique – A10 km 2+000



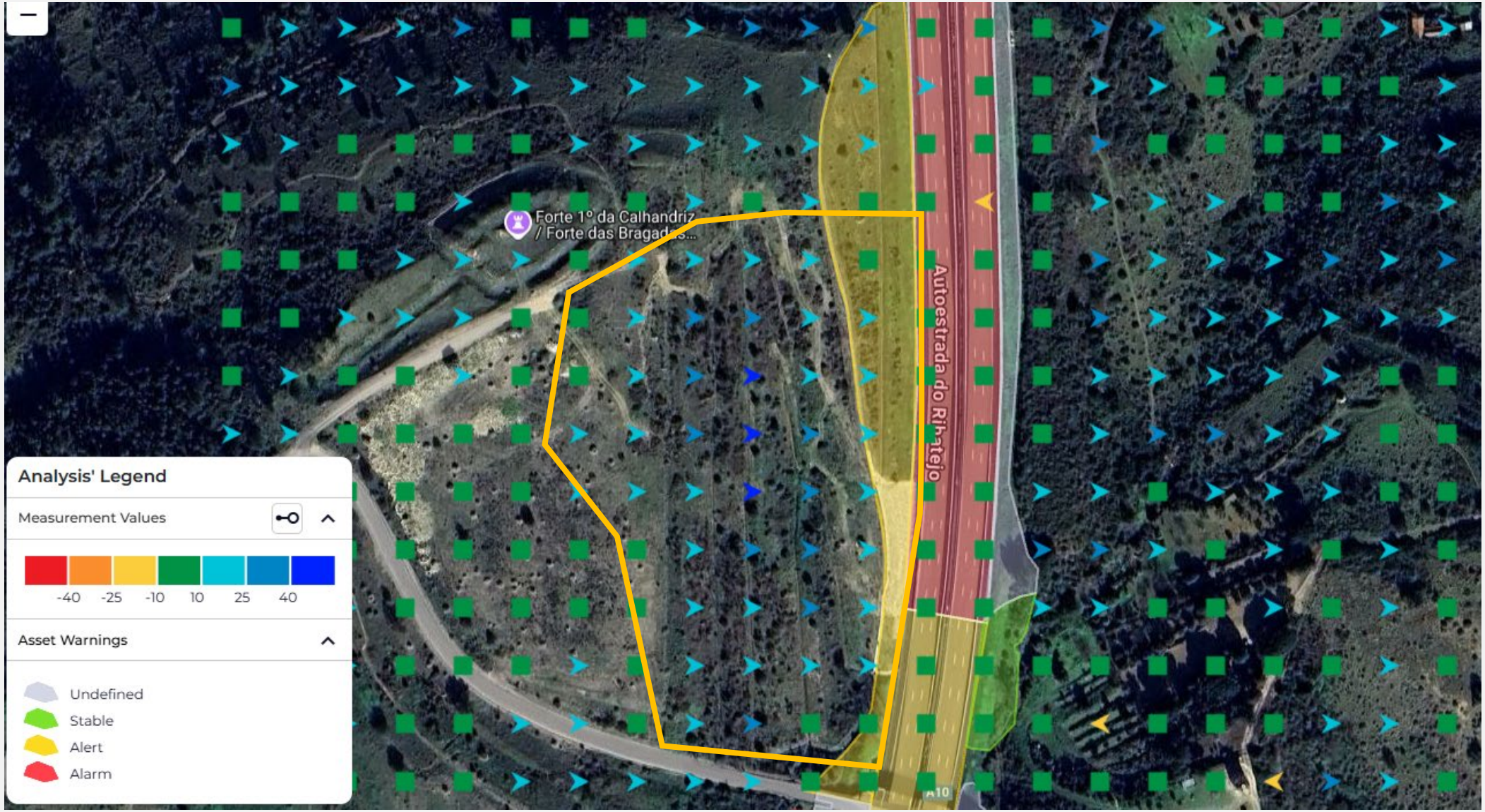
Application of InSAR Technique – A10 km 2+000



Application of InSAR Technique – A10 km 2+000



Application of InSAR Technique – A10 km 2+000



Conclusions

- Limitations in slopes with **vegetation.** ✗
- This technique allows us to observe **displacement trends** rather than specific displacement values. ✓
- To create an alert and alarm system, it doesn't seem possible to base it on specific displacement thresholds. ✗
- The system might have to be defined with **time-based thresholds**, e.g. alert if 12 months with positive displacement rates. ?
- Will be used as a **complement to other slope monitoring techniques**. ✓

Thank you!