NATURAL HAZARDS RISK MANAGEMENT IN HIGHWAYS WITH SATELLITE DATA

THE CASE OF A24 (PORTUGAL)

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ASECAP DAYS
BRUSSELS 2022

AGENDA

01. INTRODUCTION

02. DESCRIPTION OF THE PROJECT

03. GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

04. MEASURING GROUND MOTION WITH INSAR: A24 CASE STUDY

05. CONCLUSIONS

INTRODUCTION

A24, Portugal

01.

INTRODUCTION

Periodic visual inspections of geotechnical structures

- Important way of characterizing their condition status, identifying possible defects and scoping works required to maintain their performance during their life cycle

Imperceptible movements to the human eye may occur

- Important to implement an appropriate system that enables early detection of possible destabilization

Goal

- Adoption of a mixed asset management approach, based on periodic visual inspections and monitoring of various types, in order to understand stability and plan interventions in the event of initial states of destabilization

DESCRIPTION OF THE PROJECT

A24, Portugal

02.

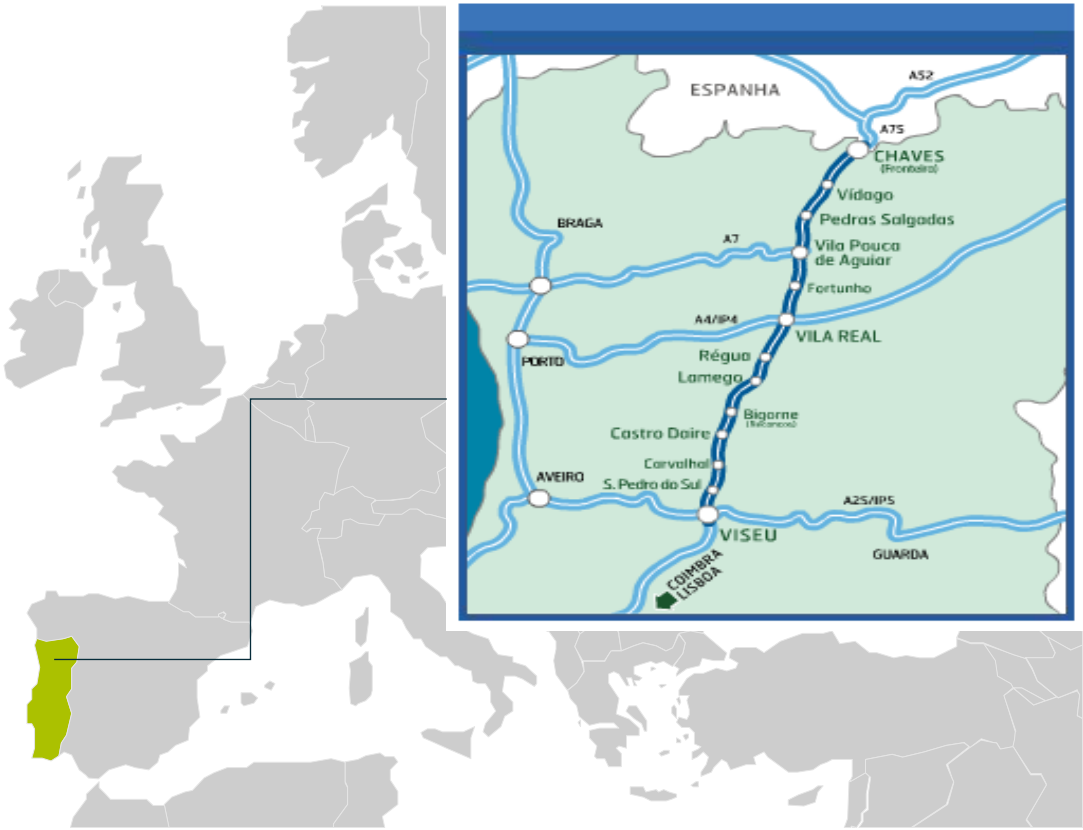
DESCRIPTION OF THE PROJECT

A24 MOTORWAY

(CONTRACT 2000-2030)

- 157 km, 2x2 lanes (mountainous motorway)
- 26 interchanges (3 for service areas)
- 70 viaducts / bridges
- 4 tunnels
- 145 retaining walls
- 86 reinforced slopes
- 1069 slopes
- 82 gantries
- 11 treatment basins
- > 7000 vertical signs.

A24 MOTORWAY LOCATION



GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

A24, Portugal

03.

GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

01. Inspections

02. Monitoring

GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

INSPECTIONS

- Periodic visual inspections
  - Daily
  - Routine
  - Detailed
  - Exceptional
- Output
  - Conservation state
  - Defects
  - Works required

GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

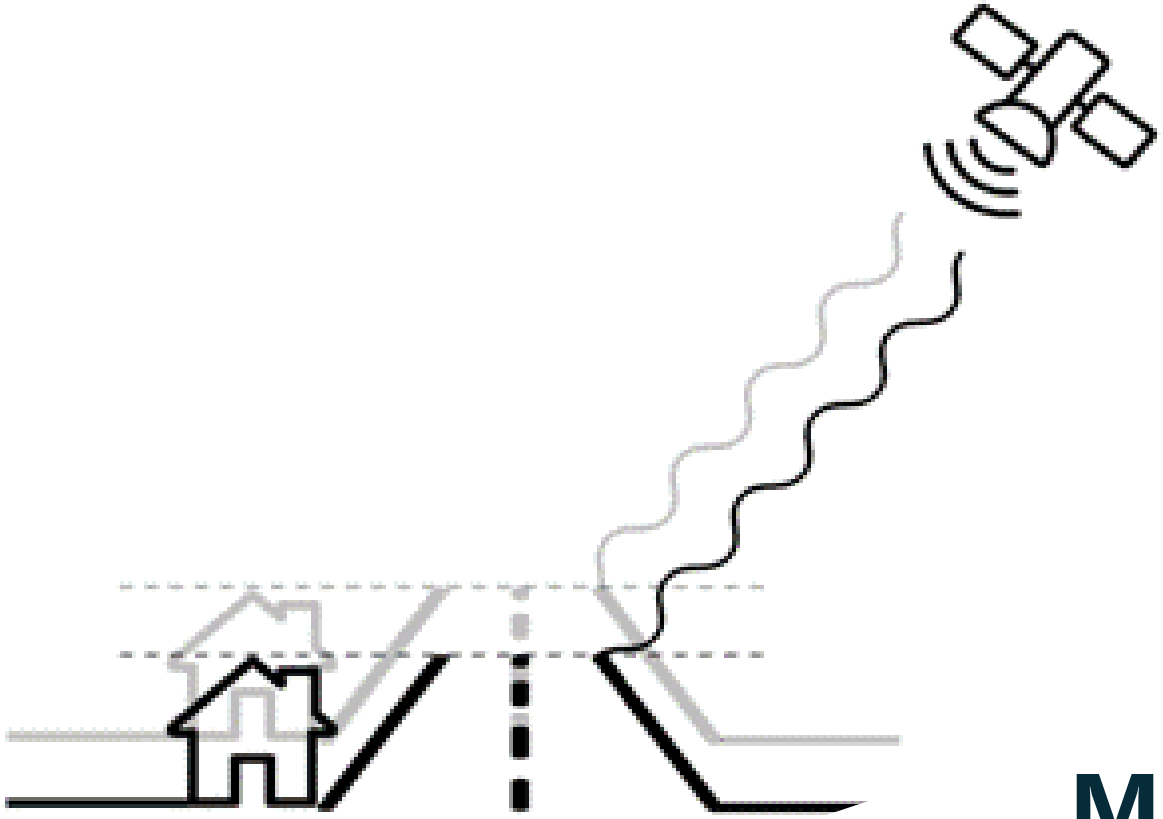
MONITORING

- Along with the inspections, monitoring is carried out:
  - Topographic
  - Inclinometer
  - Piezometer
  - Laser scan
  - Specific

GEOTECHNICAL STRUCTURES MANAGEMENT SYSTEM

However…it may not be enough!

March 2019



MEASURING GROUND MOTION WITH INSAR

Case study: A24, Portugal

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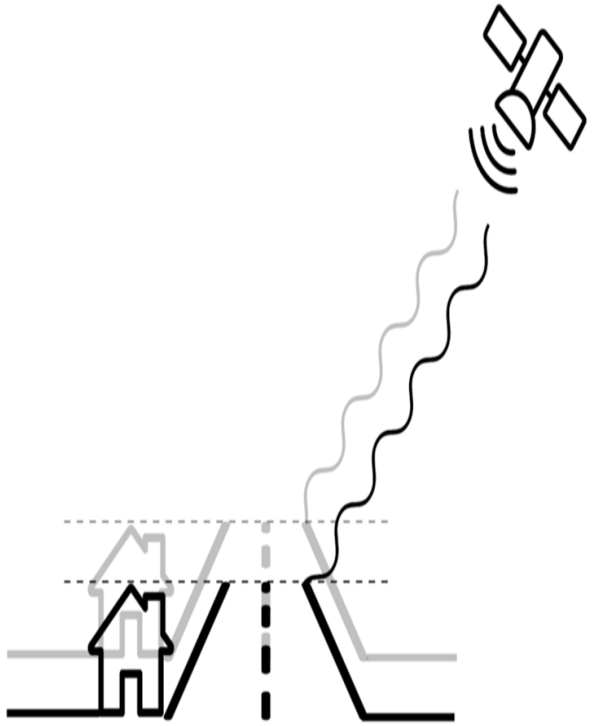
MEASURING GROUND MOTION WITH INSAR
A24 CASE STUDY



MEASURE

GROUND MOVEMENT

SAR INTERFEROMETRY

Advanced remote sensing techniques are used to detect ground deformation and monitor slope stability and subsidence throughout road and railway networks.

SENTINEL-1 SATELLITES

- Resolution: 5x20 meters
- Monitoring frequency: up to 6 days
- Accuracy: 4-6 mm

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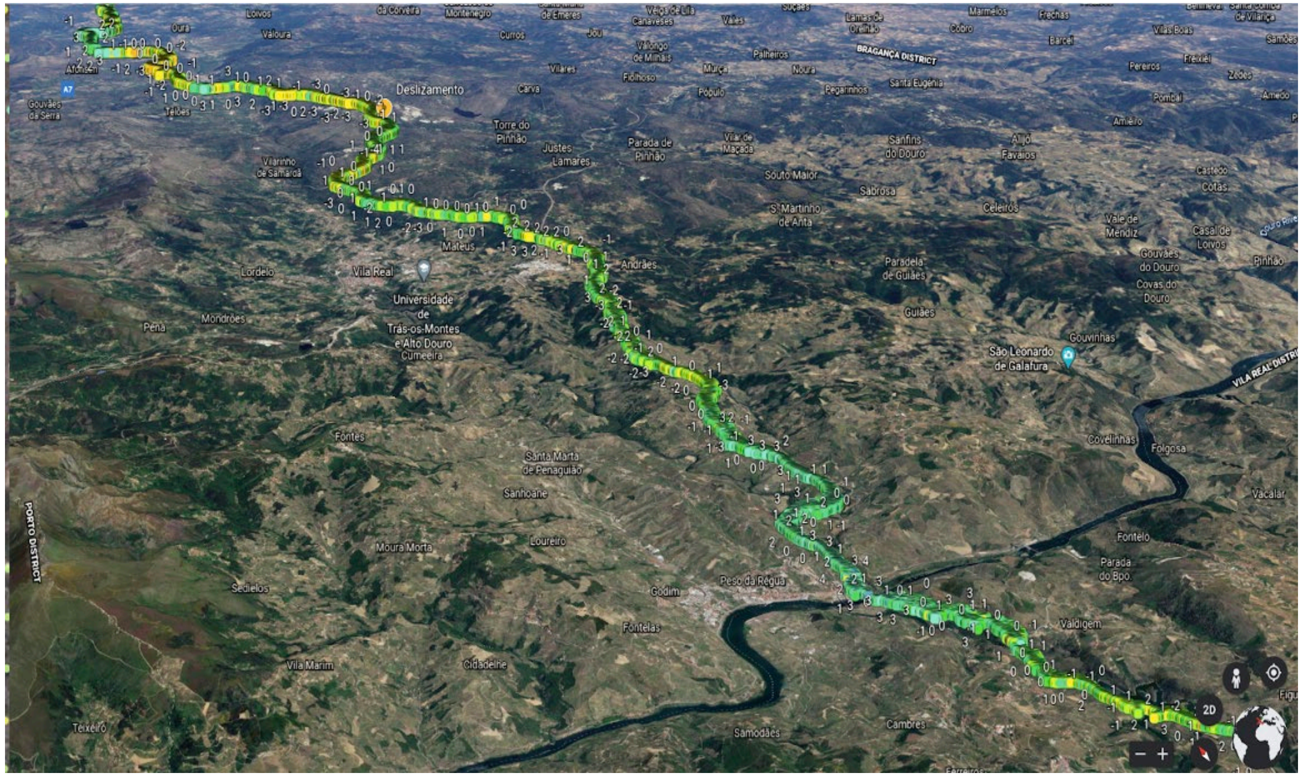
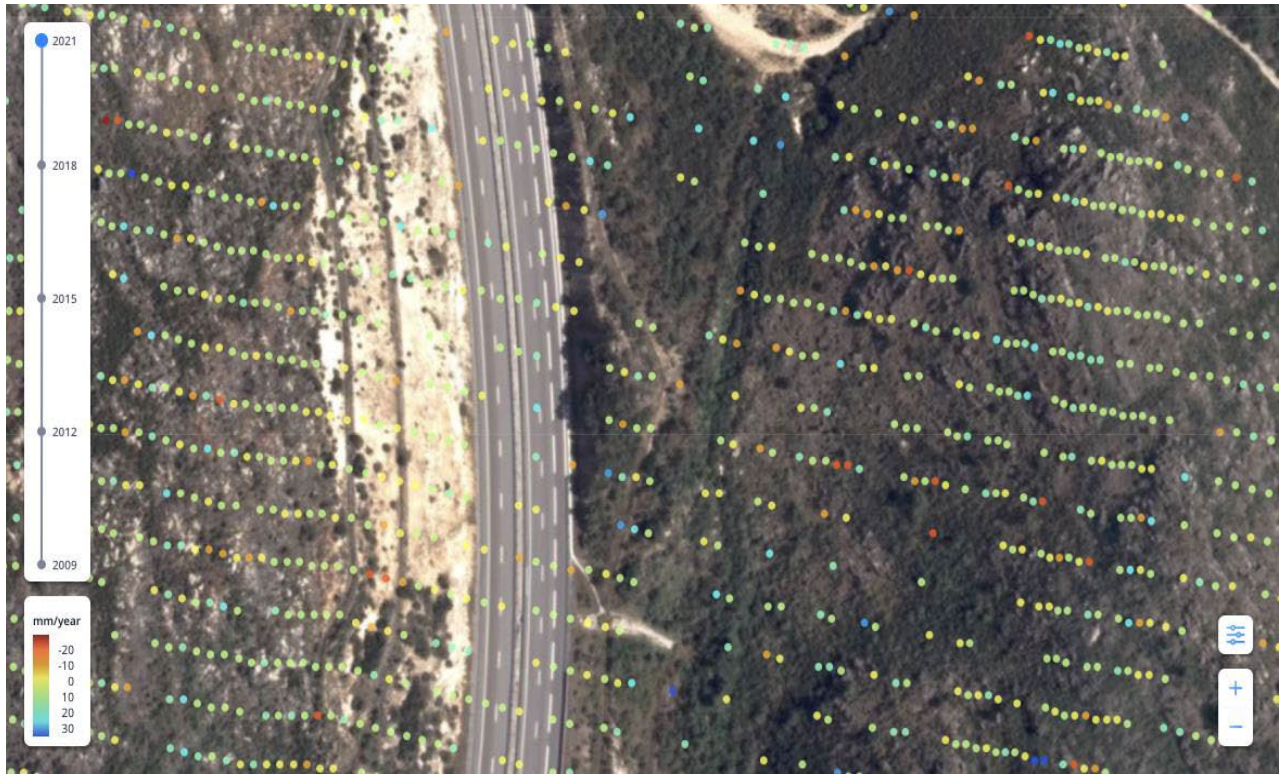
MEASURING GROUND MOTION WITH INSAR A24 CASE STUDY



OVERVIEW

- **Blind test**
- Analysis of **157 km** of motorway over a **1-year** period (March 2018-March 2019)
- Over **100.000 measurement points** obtained
- Identification of **11 areas** with cumulative displacement values between **2-5 cm**

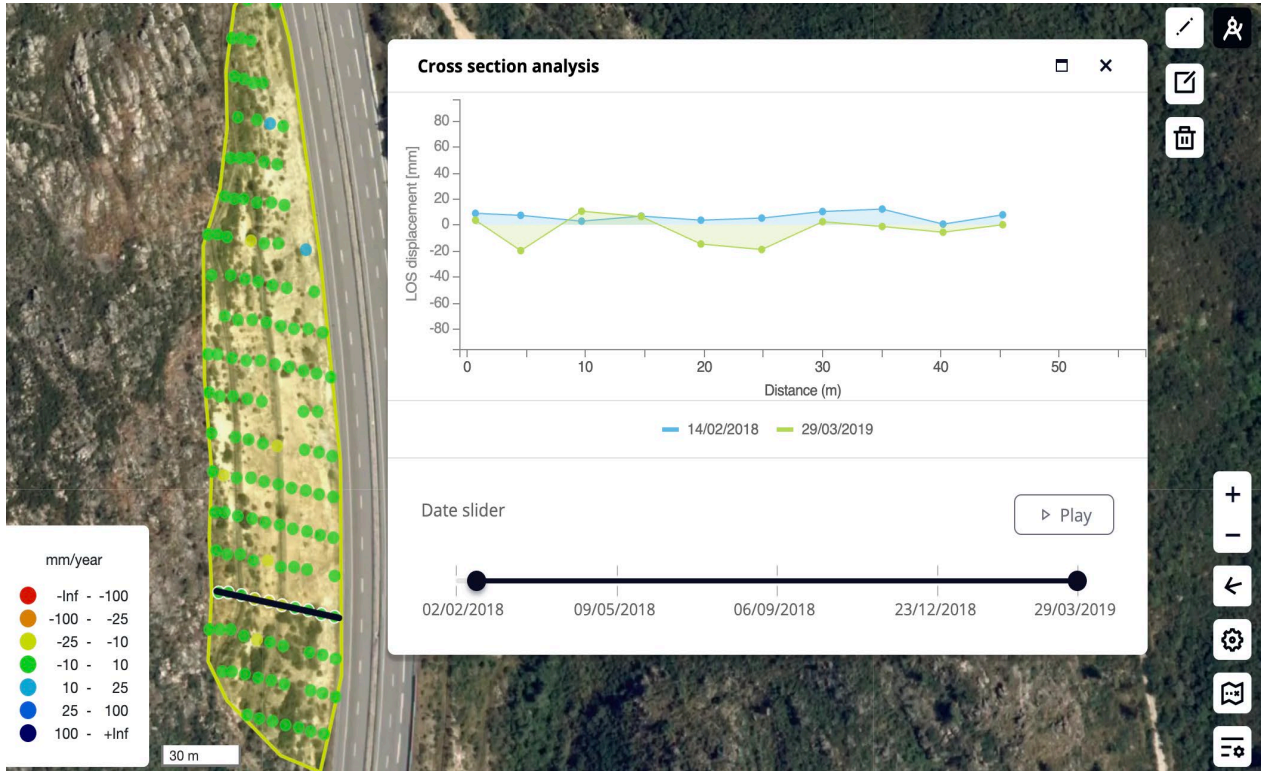
MEASURING GROUND MOTION WITH INSAR
A24 CASE STUDY



SLOPE WITH LANDSLIDE

- **Over 80 measurement** points obtained
- **32 measurements** per point over a **1-year** period

MEASURING GROUND MOTION WITH INSAR
A24 CASE STUDY



SLOPE WITH LANDSLIDE

- **Greater instability detected** on south edge of the slope, with a maximum **displacement velocity of 22.33 mm/year**
- **Failure** detected on **last 2 measurement** dates

CONCLUSIONS

A24, Portugal

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CONCLUSIONS

SATELLITE DATA USAGE

- The **experience** performed with **satellite data** proved that it **was possible to predict** the landslide **before** the major event

CONCLUSIONS

MAIN ADVANTAGES

Safety

- Enables the detection of destabilization in early stages

Budget reduction

- Enables planning of smaller proactive interventions

Budget prediction

- Enables prediction of mid-long-term interventions

CONCLUSIONS

MAIN ADVANTAGES

Traffic constraints reduction

- Ultimately, the road will not be closed for traffic, reducing the impact for the road users

Risk

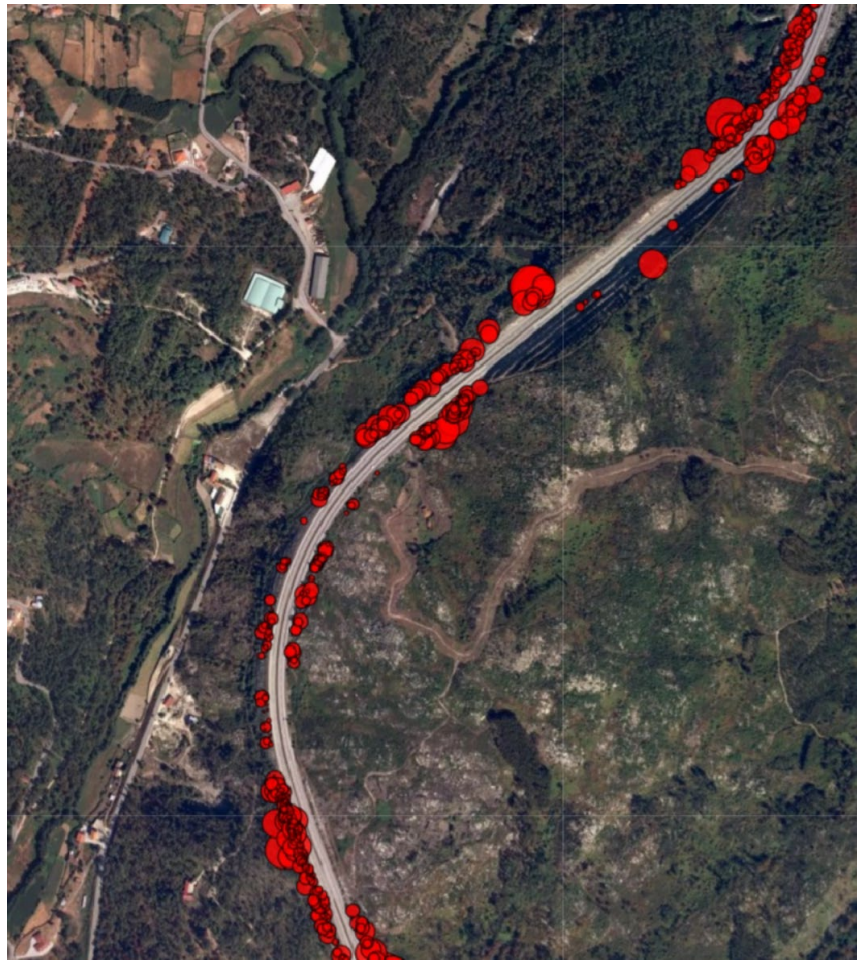
- Enables development of more risk-based approach to inspection regime

CONCLUSIONS

ONGOING NEW EXPERIENCES

VEGETATION MANAGEMENT

- Uses High-Resolution optical data
- Vegetation and tree detection using machine learning techniques
- Tree height measurement and estimated area of impact (accuracy of 1-2 meters)
- Continuous monitoring of vitality indexes
- Species identification



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