# Natural hazards risk management in highways

## *An experience from Portugal*


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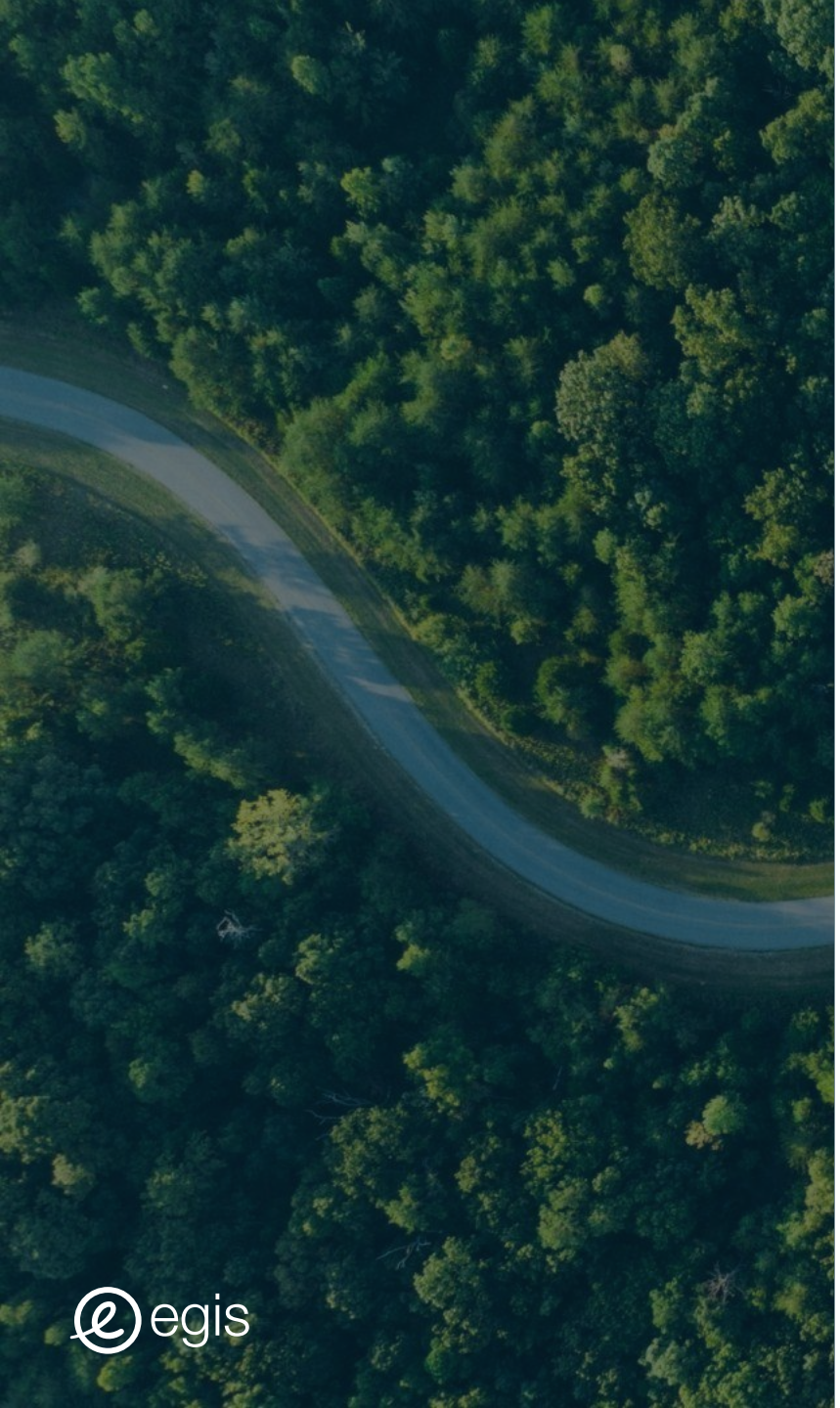
**6th June 2024**

IMAGINE
CREATE
ACHIEVE
*a sustainable future*



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# Introduction

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## 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

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02

# Description of the project

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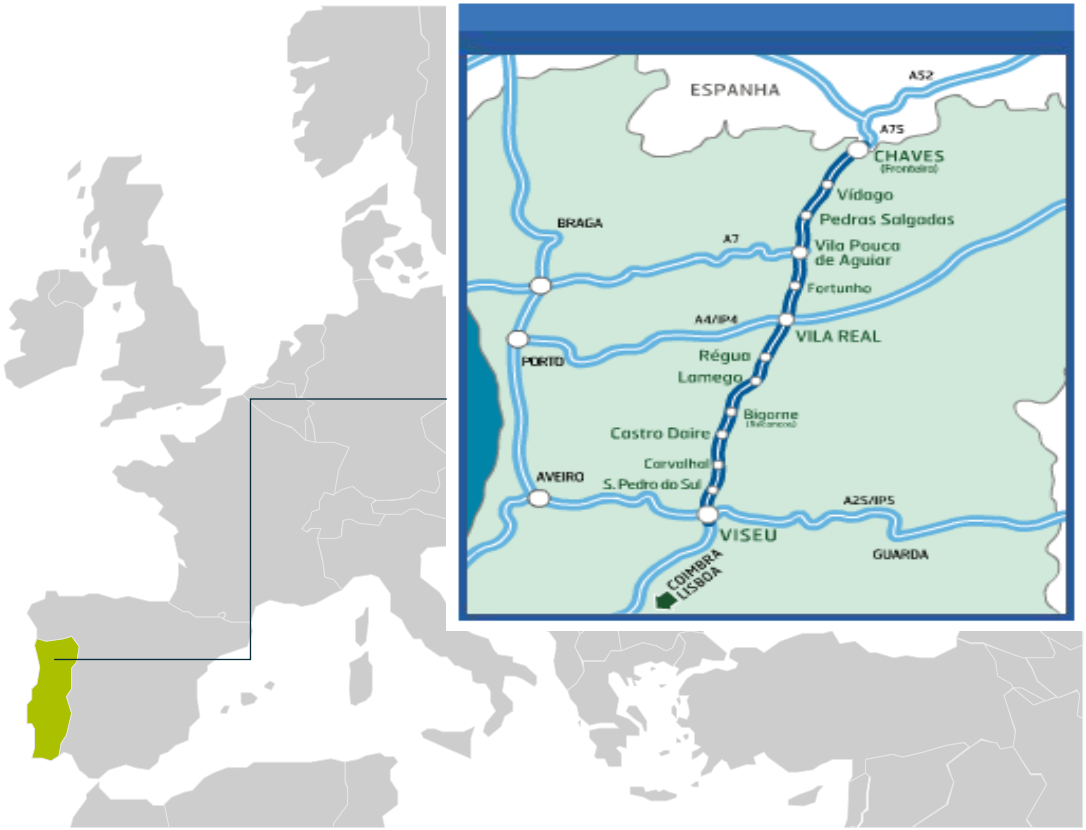
## A24 Motorway (Portugal)

- 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

A24 MOTORWAY LOCATION



03

# Geotechnical Structures Management System

# Geotechnical Structures Management System


## Inspections

- Periodic visual inspections
- 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


**March 2019**

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# Measuring Ground Motion with InSAR

## A24 Case Study (Portugal)

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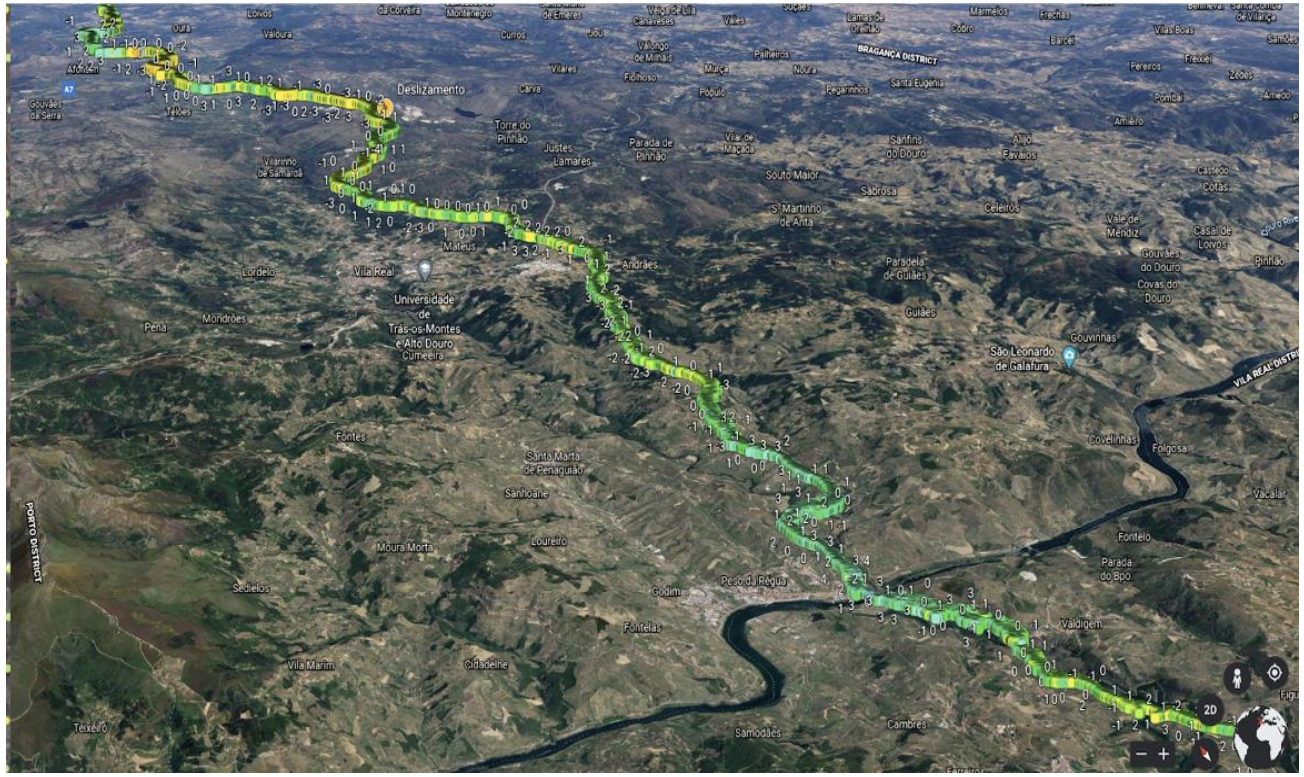
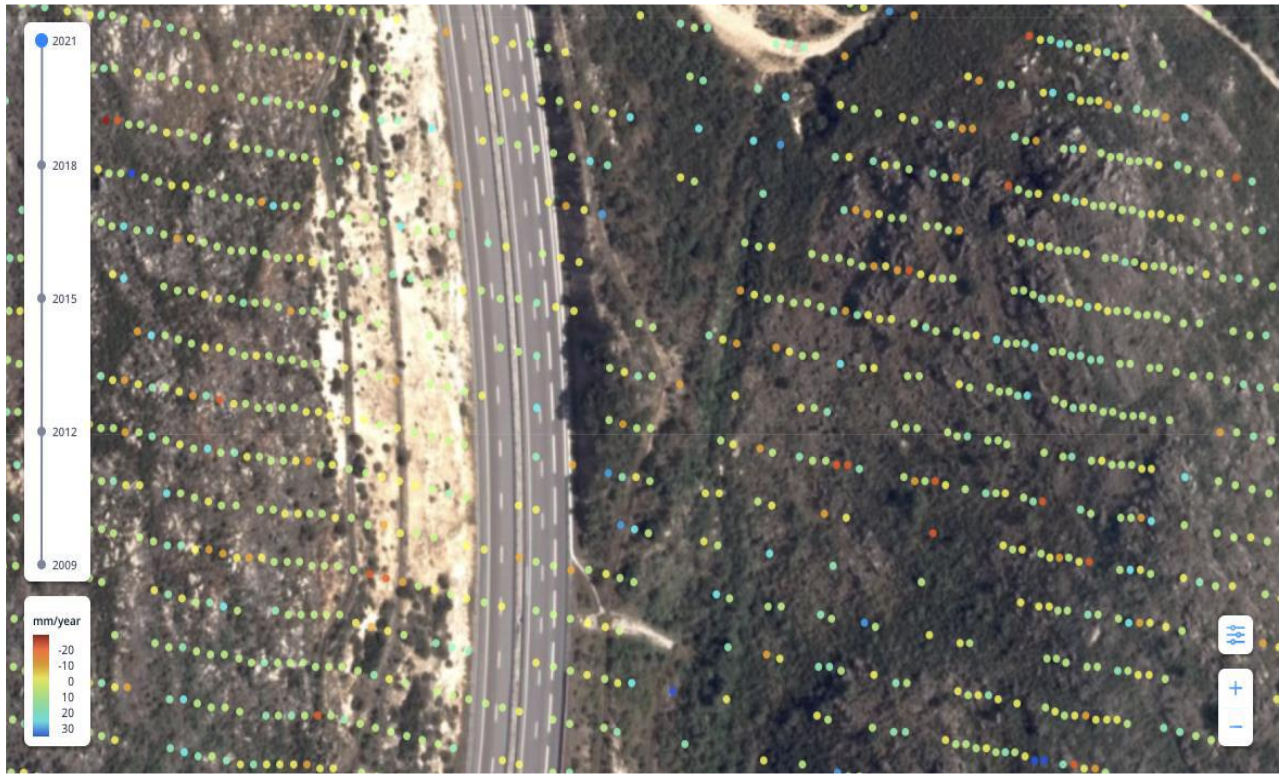
# Measuring Ground Motion with InSAR – A24 Case Study




## 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**

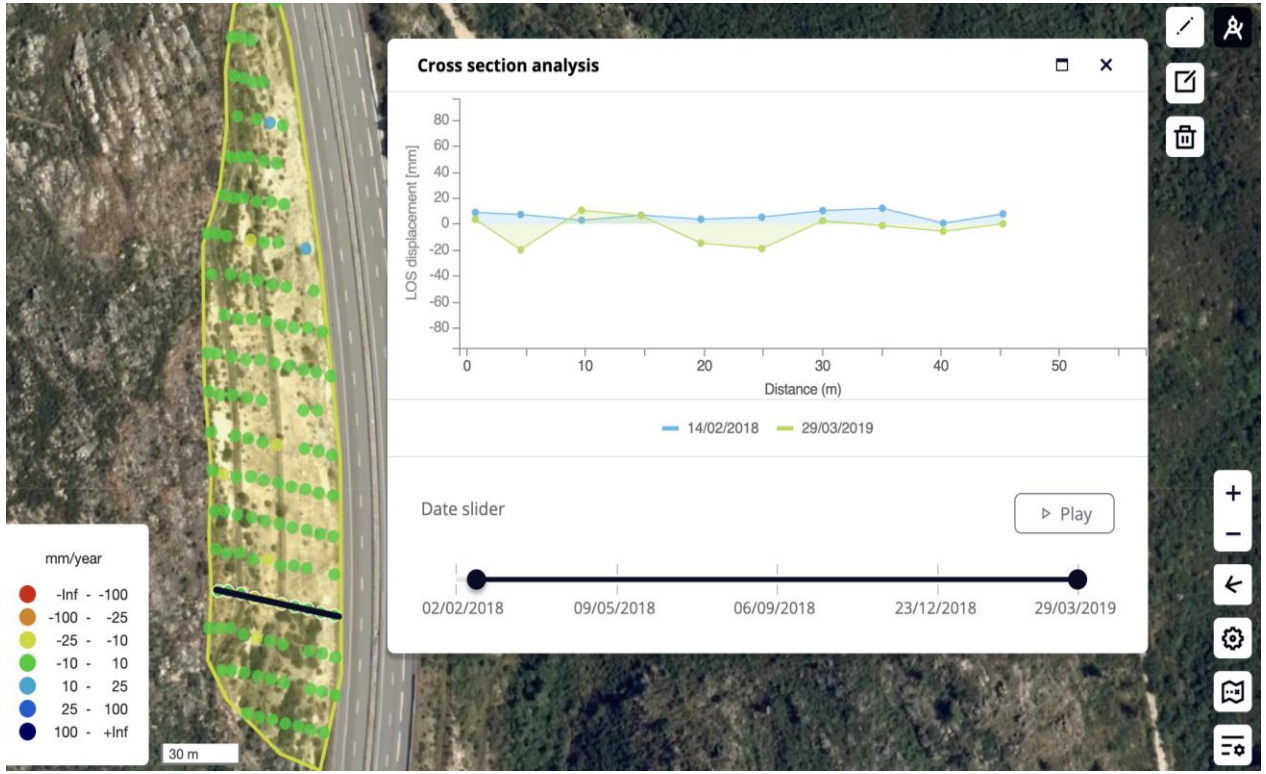
# Measuring Ground Motion with InSAR – A24 Case Study




## 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

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# Conclusions

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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

## 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)
- 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
  - **Normalized Difference Vegetation Index-NDVI**

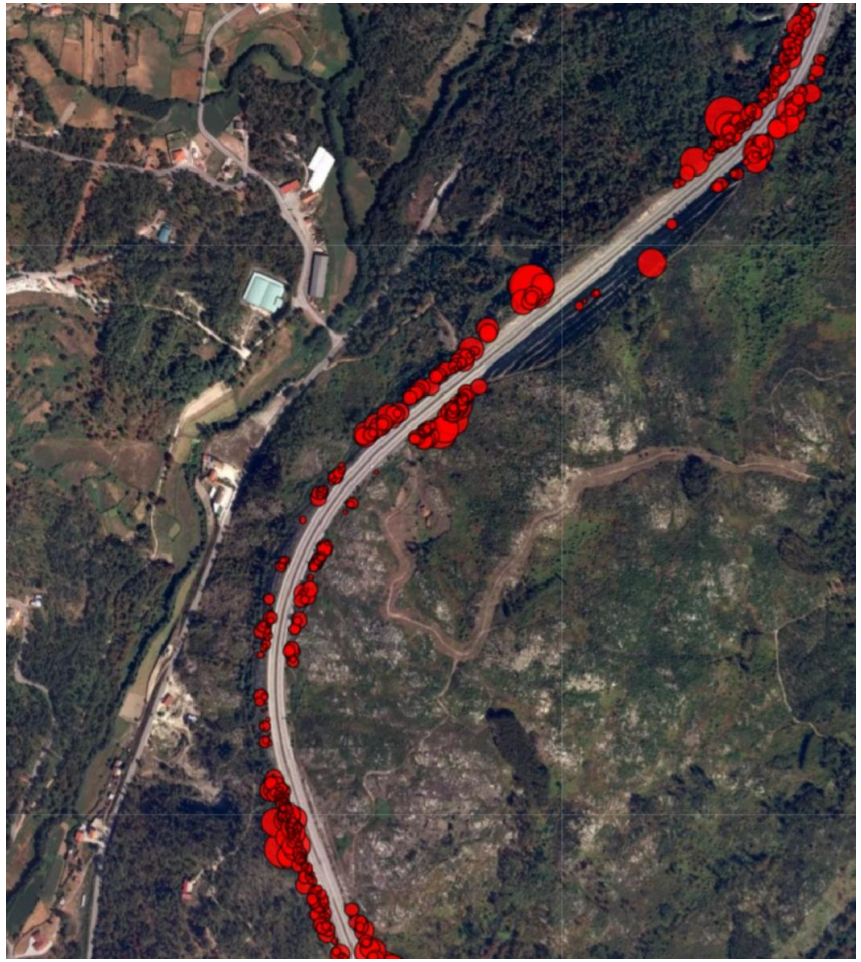
    Quantify the **amount of chlorophyll**, which is the element responsible for the green of the vegetation
  - **Tree detection with AI**

    High accuracy definition of polygons encircling the trees
  - **Dead Tree detection**

    The **correlation** between **NDVI** and **tree detection** makes it possible to detect dead trees
  - **Tree Height & Fall Radius + Vitality**

    Detecting tree height from shadow using AI and trigonometry formulas
  - **Vegetation intensity per KP**

    Identify the primary vegetation type adjacent to the road at each kilometer



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