Automatic detection of landslides from multi-temporal InSAR analysis

Alessio Rucci[1], Chiara Gervasi[1],
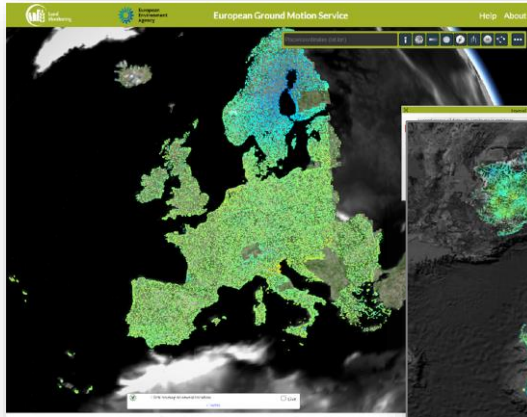Matteo Matteucci[2], Simone Sarti[2] , Francesco Lattari[2]

[1]TRE ALTAMIRA S.r.l., Milano, Italy
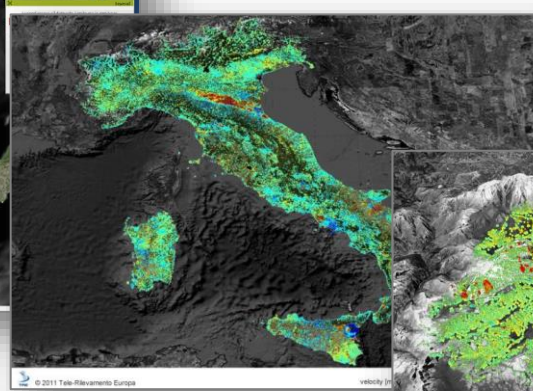[2]Politecnico of Milan, Italy

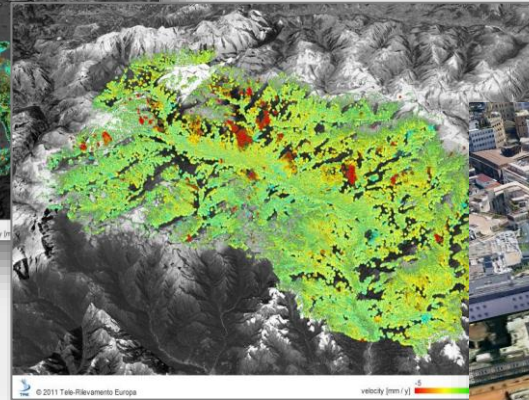WLF 2023
Florence, 17 November 2023

InSAR is a multi-scale technology
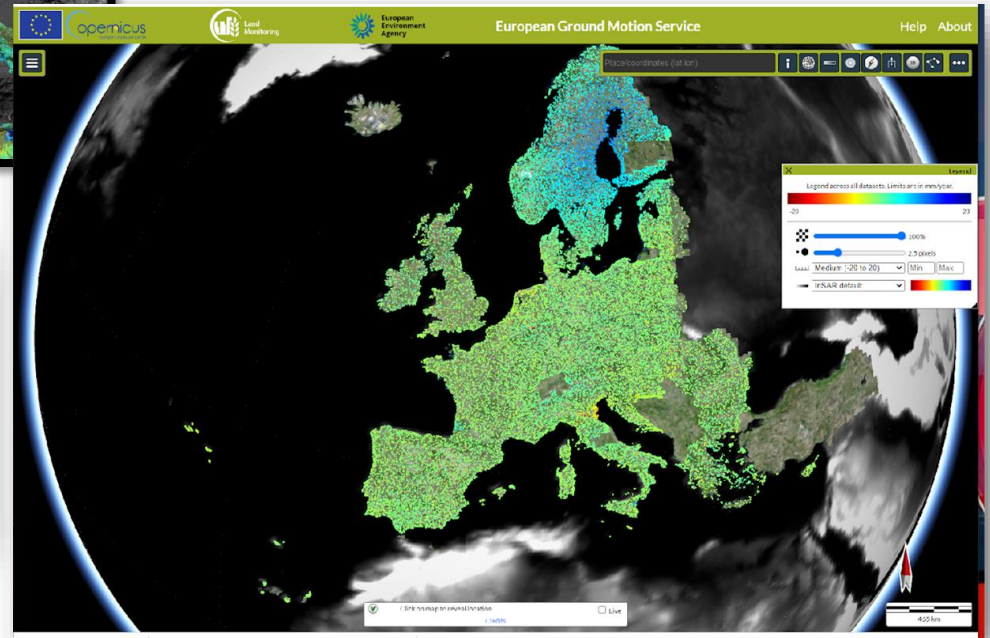
Continental scale

National scale

Regional scale

Individual buildings

Large InSAR databases are getting popular..

https://egms.land.copernicus.eu/
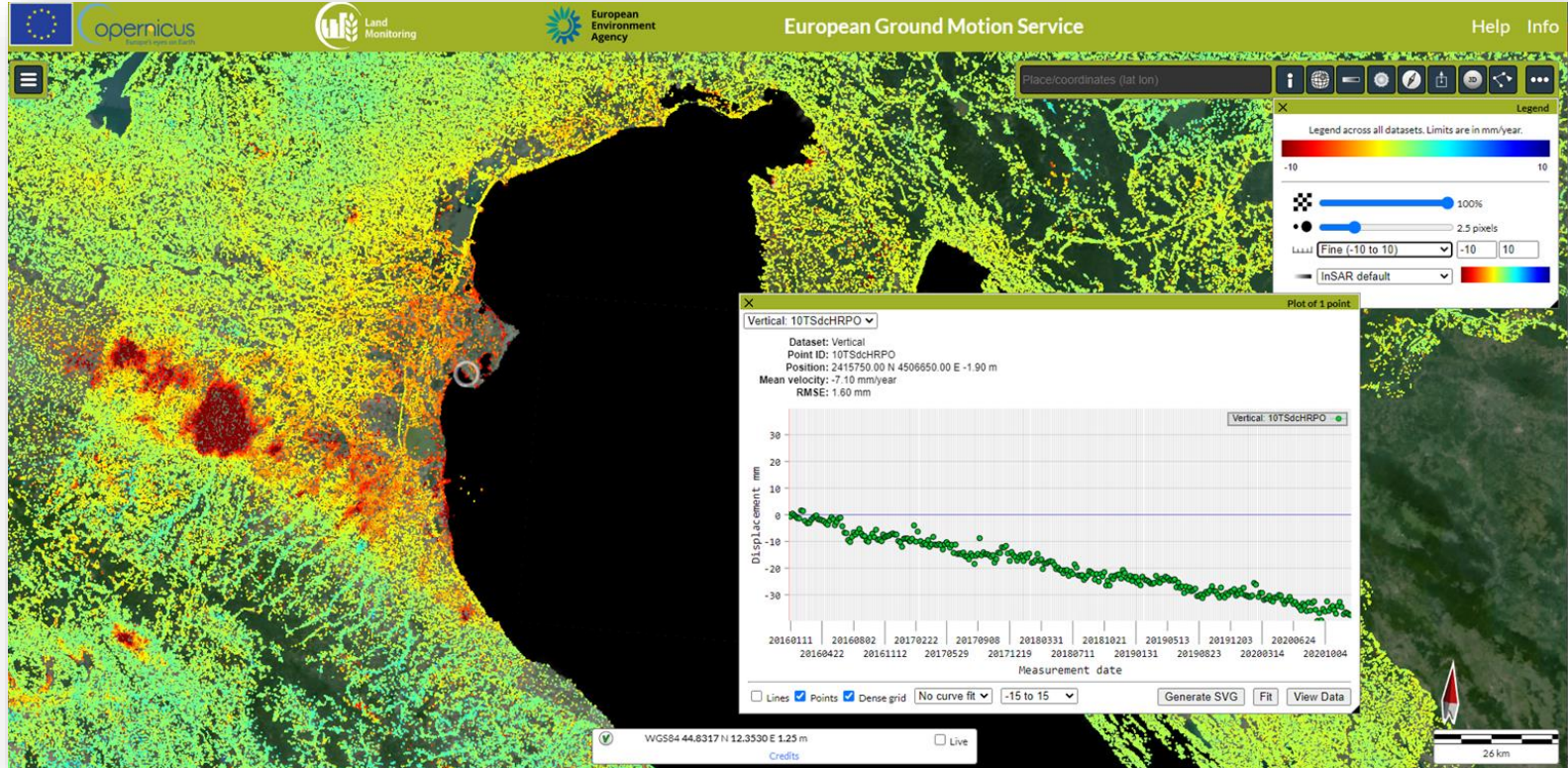
Suitable for…
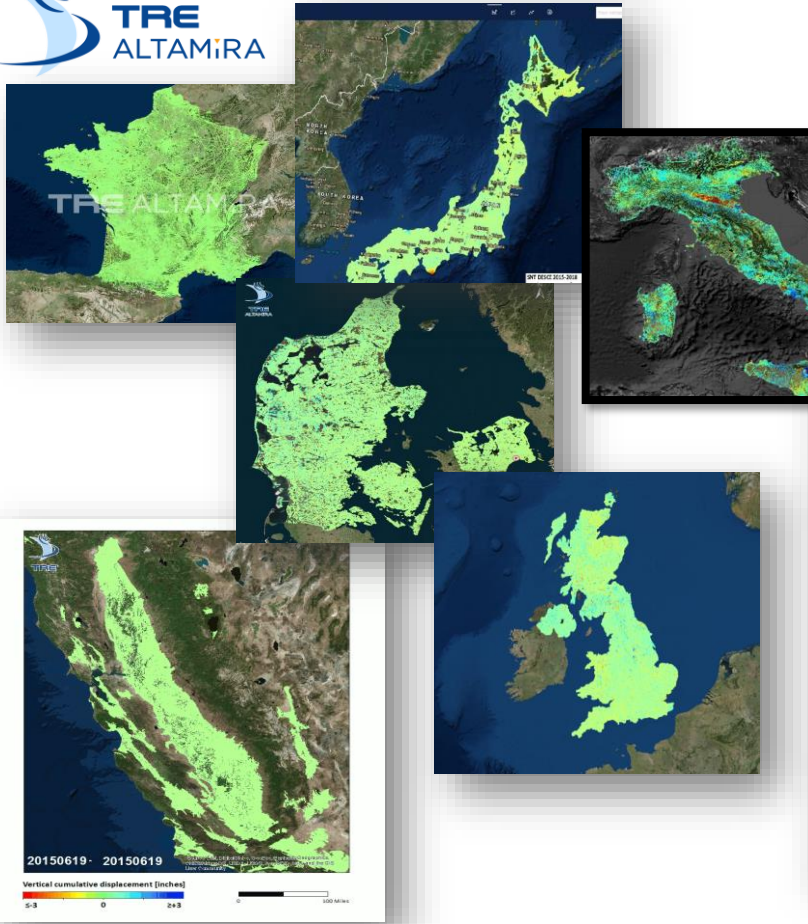
>> Landslide monitoring
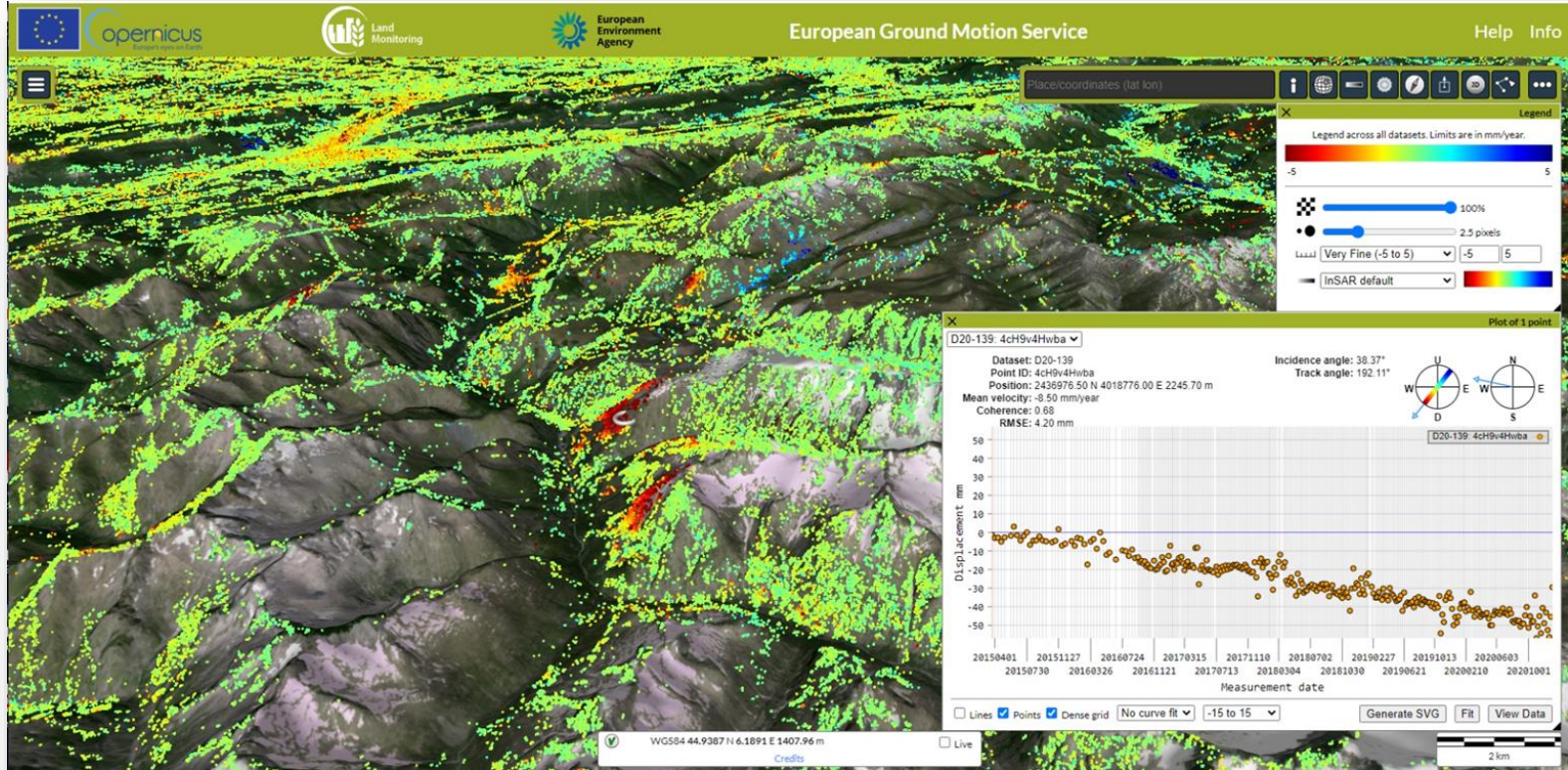
>> Subsidence along coastal areas

Sentinel-1 for continuous monitoring of large areas

Now the technology is mature enough to exploit Sentinel-1 radar data to create a national database of terrain movements.

It can be extremely useful, for Civil Protection authorities, to characterize and address areas prone to risk based on homogeneous and reliable measurements.

Every year

126   People...............casualties

7000   People................displaced

0.5%   PIL...........................is lost

* National landslide risk map

Every day, SqueeSAR® analyses containing millions of points are updated over different areas and delivered to final users.

It is impossible for a final user to check all the delivered time-series at every new update. It becomes necessary to highlight only points where something has changed, based on criteria agreed upon with the final user.
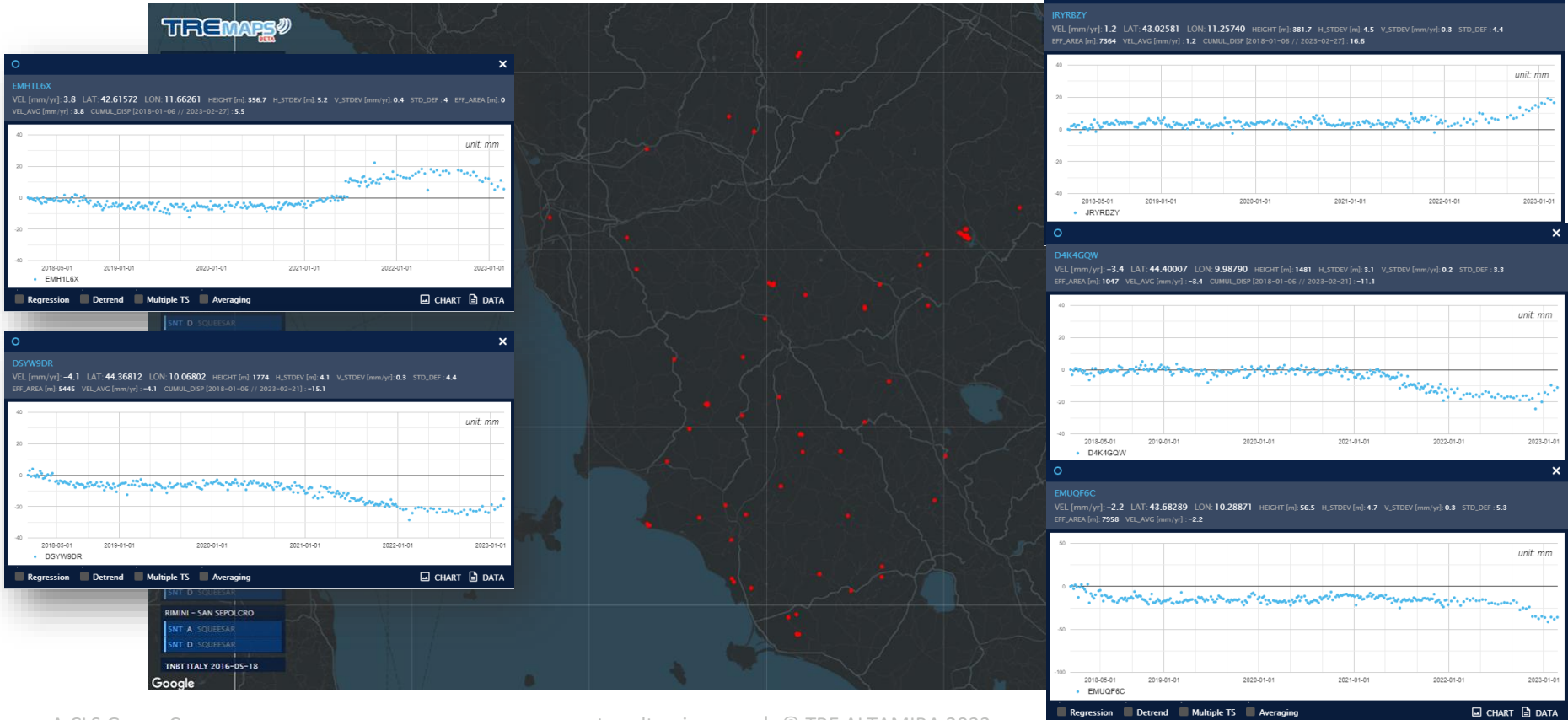
InSAR Time Series Change Point Detection

Within the ESA-funded **MATTCH project**, we have developed a **ML tool** to analyse InSAR Time-Series and identify time intervals showing a change in the average displacement rate. The algorithm is based on a **Bidirectional TG-LSTM.**

Real InSAR Datasets
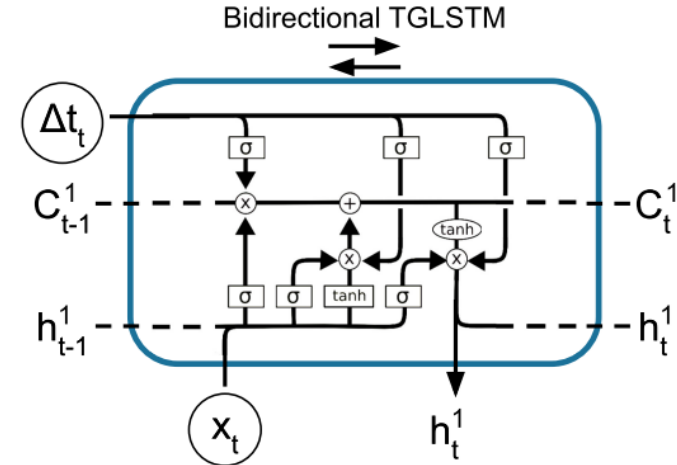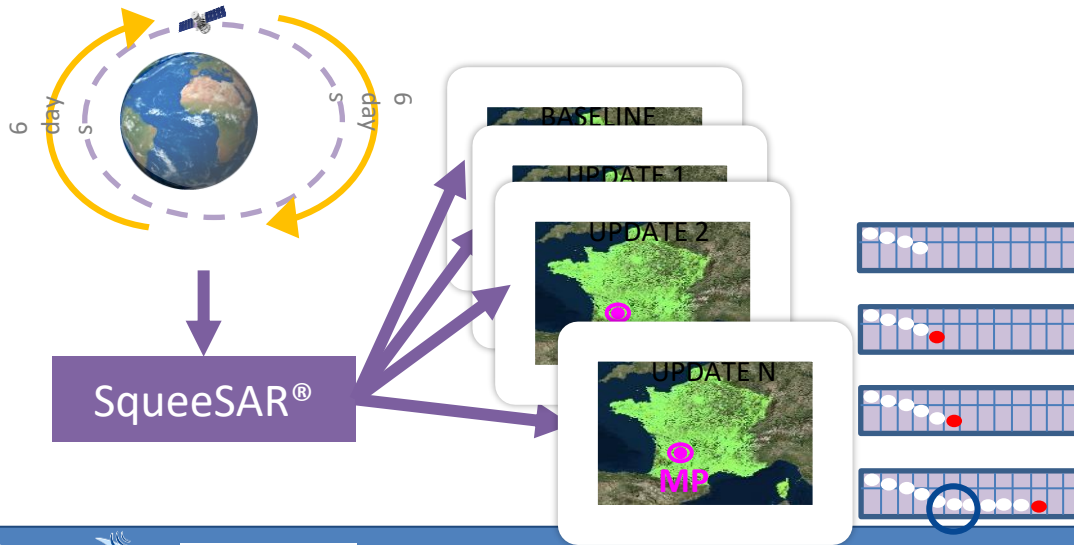
Automatic Detection of Anomalies

What is missing in MATTCH:

» No Spatial Analysis: The Change Point Detection analysis is based on a single point time-series

» No external layers are considered (Optical Images, DEM, etc.)

» No Classification of phenomena triggering ground displacement

Within the **SURFCLASS (**Earth **Surf**ace Deformation Phenomena **Class**ification applying AI methodologies to SAR derived Time Series**) ESA** project we are developing a new DL methodology that will overcome these limitations .

Motion Classification and spatial analysis

SURFCLASS's objective is to provide an automatic classification of displacement against triggering phenomena, through:

>> A Spatial-Analysis of InSAR Time-Series
>> The analysis of external layers, such as:

- Optical Images
- DEM
- Land Cover Map

The classes of the analysis include:

- Landslide
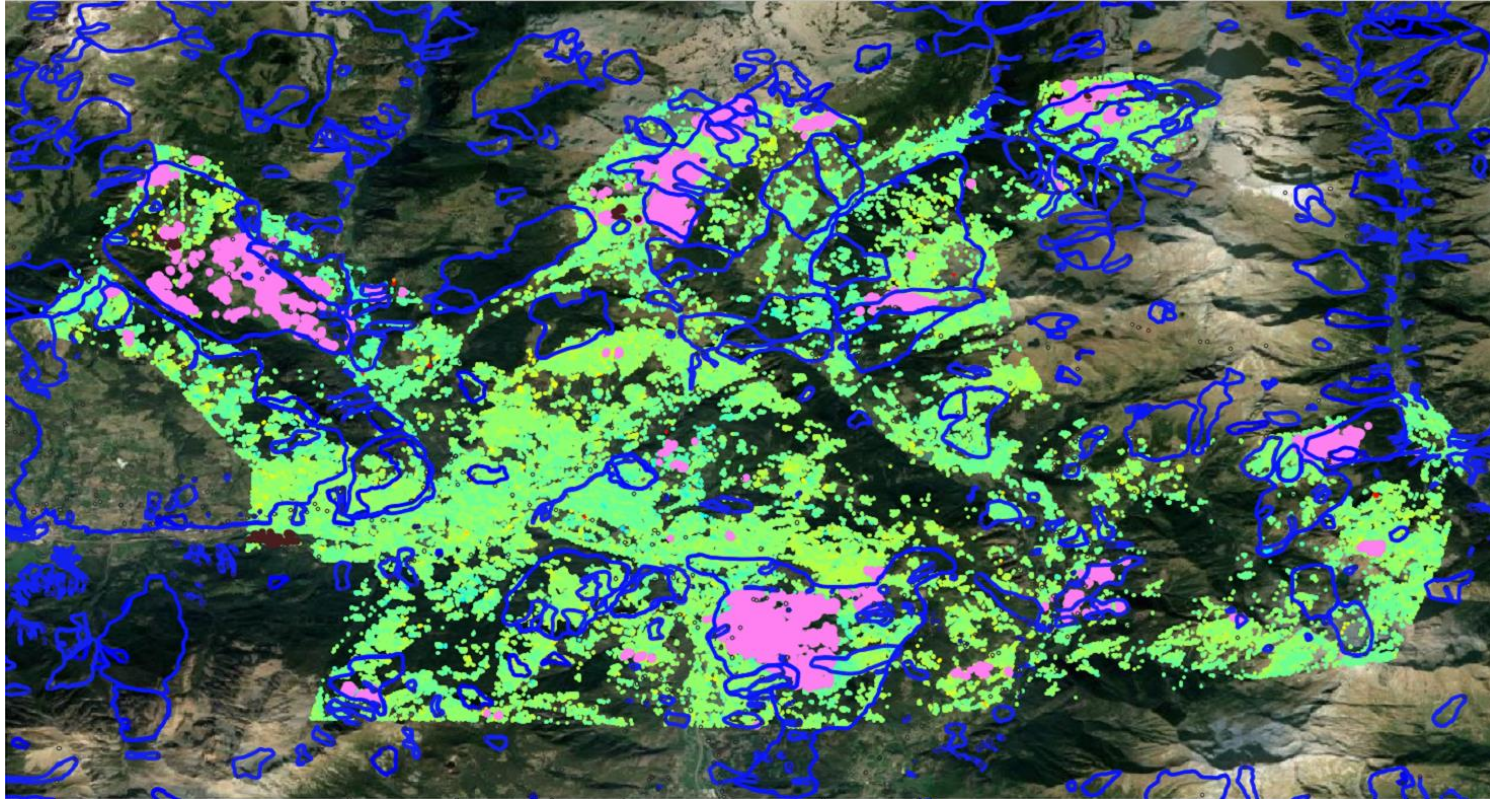- Subsidence
- Mining
- Local Instability

>> To perform a **spatial analysis over a sparse-grid of points** and to analyse the layers together, the **model** employs a **late and hybrid fusion concept through 2 separate streams**, each one with its own architecture.

>> The features from these **2 streams** are merged through **concatenation** and further processed through a **Graph Neural Network** to obtain spatiotemporal features.

Pointwise Encoder

Graph Encoder

Valle D'Aosta Inference examples

-15 [mm/y]   15 [mm/y]
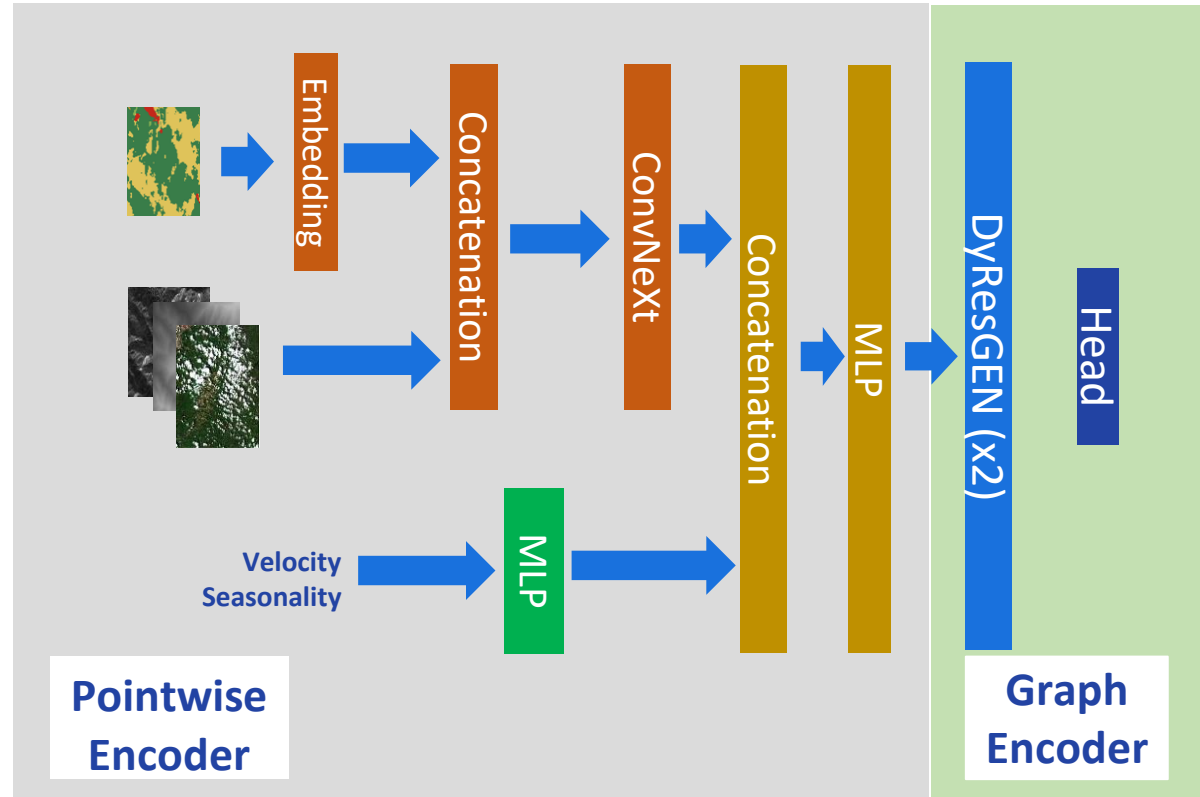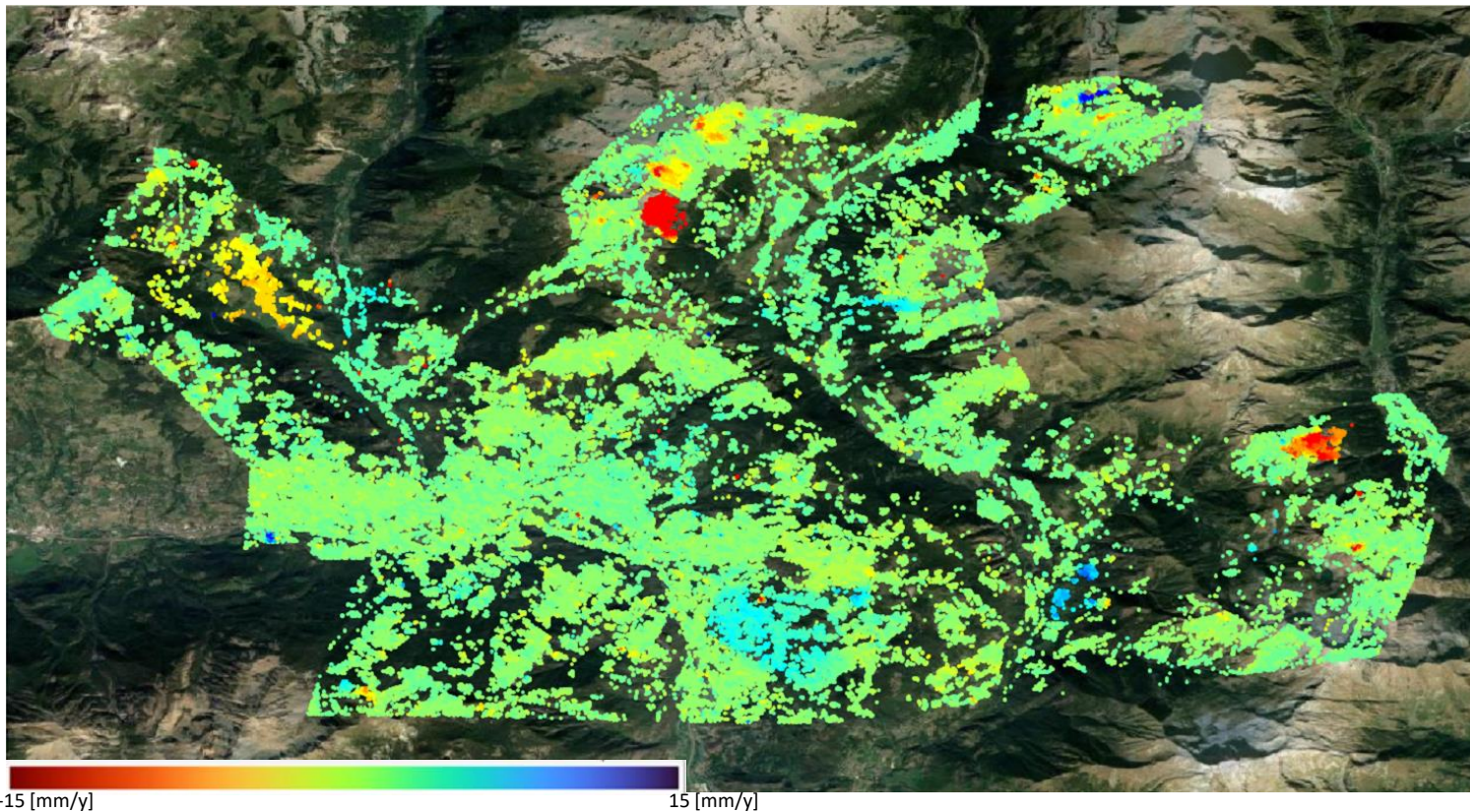
Valle D'Aosta Inference examples

Legend:
- ● Subsidence
- ● Landslide
- ● Minig
- ● Local Instability

Legend:
- 🔴 Subsidence
- 🟣 Landslide
- 🔴 Minig
- ⚫ Local Instability

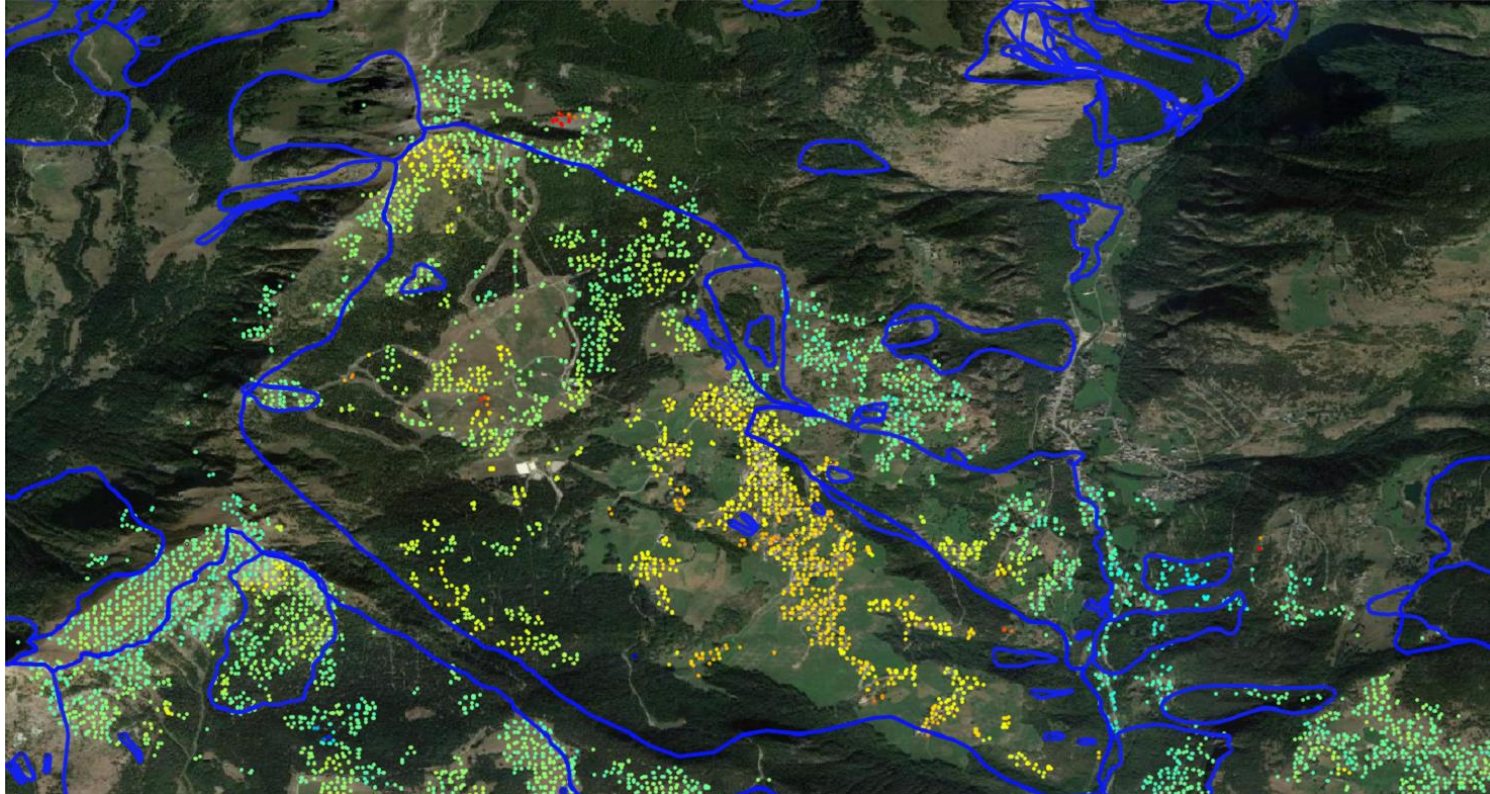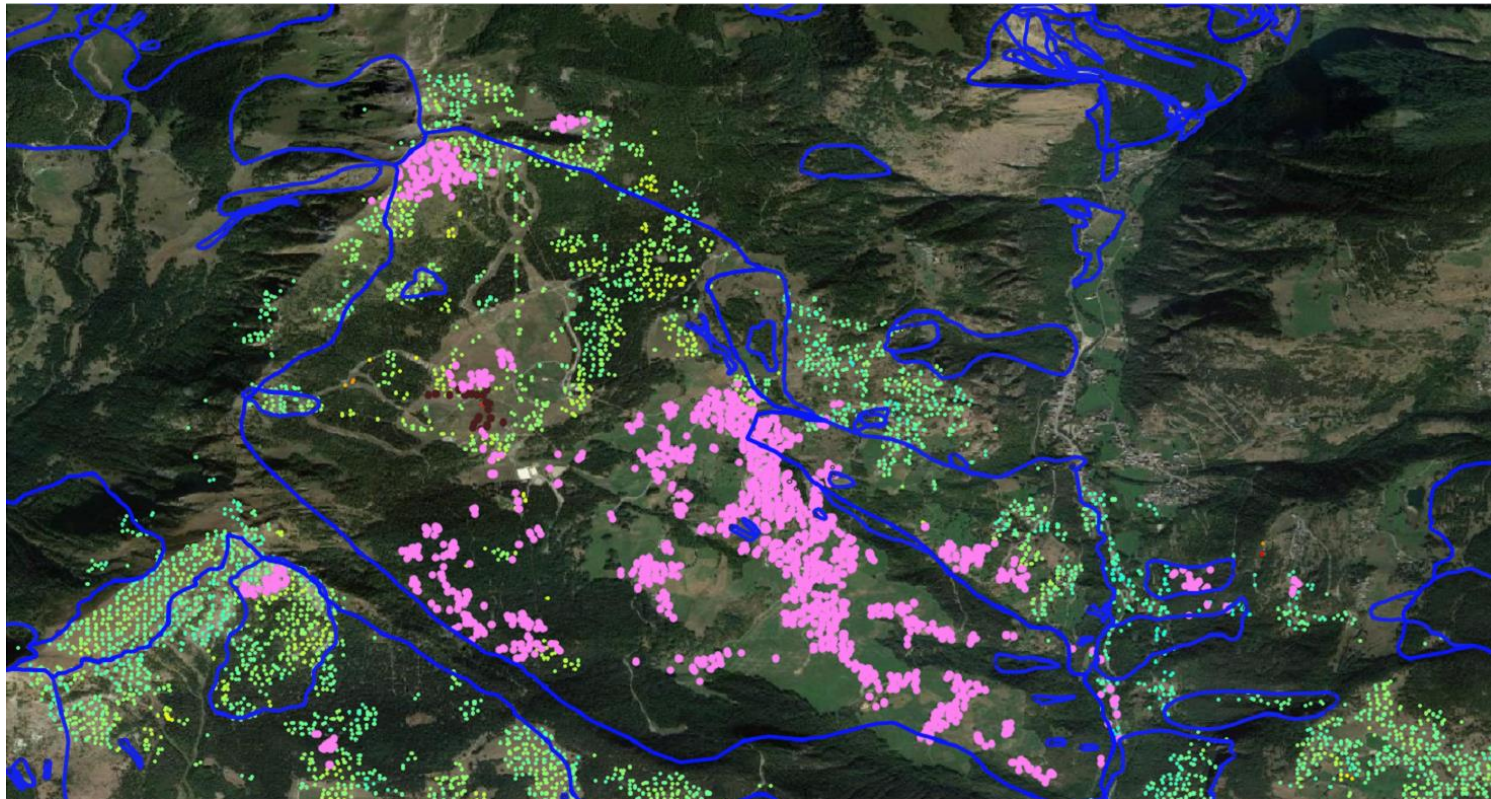# Valle D'Aosta Close Up

Legend:
- 🔴 Subsidence
- 🟣 Landslide
- 🔴 Minig
- ⚫ Local Instability

Legend:
- Subsidence
- Landslide
- Minig
- Local Instability

Legend:
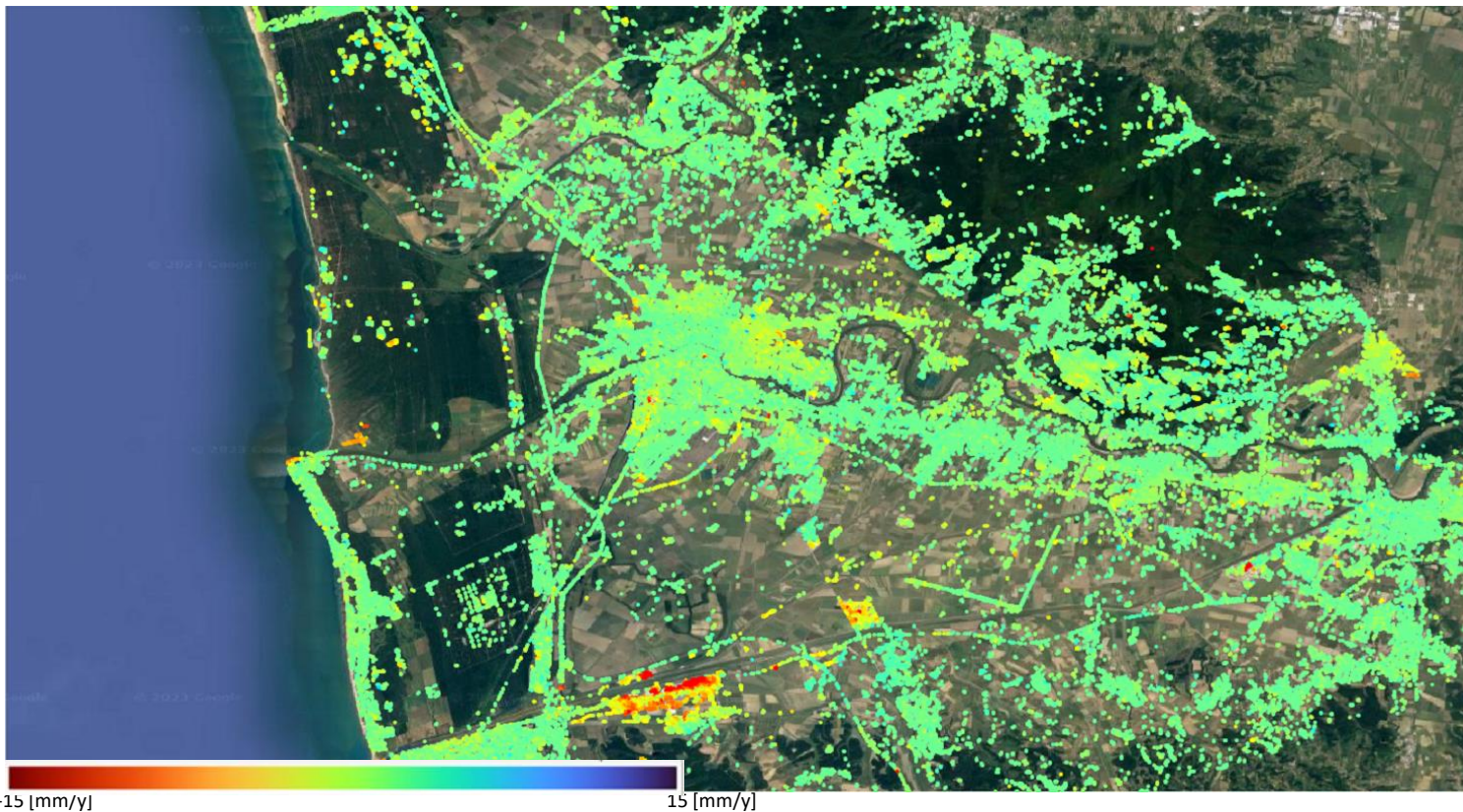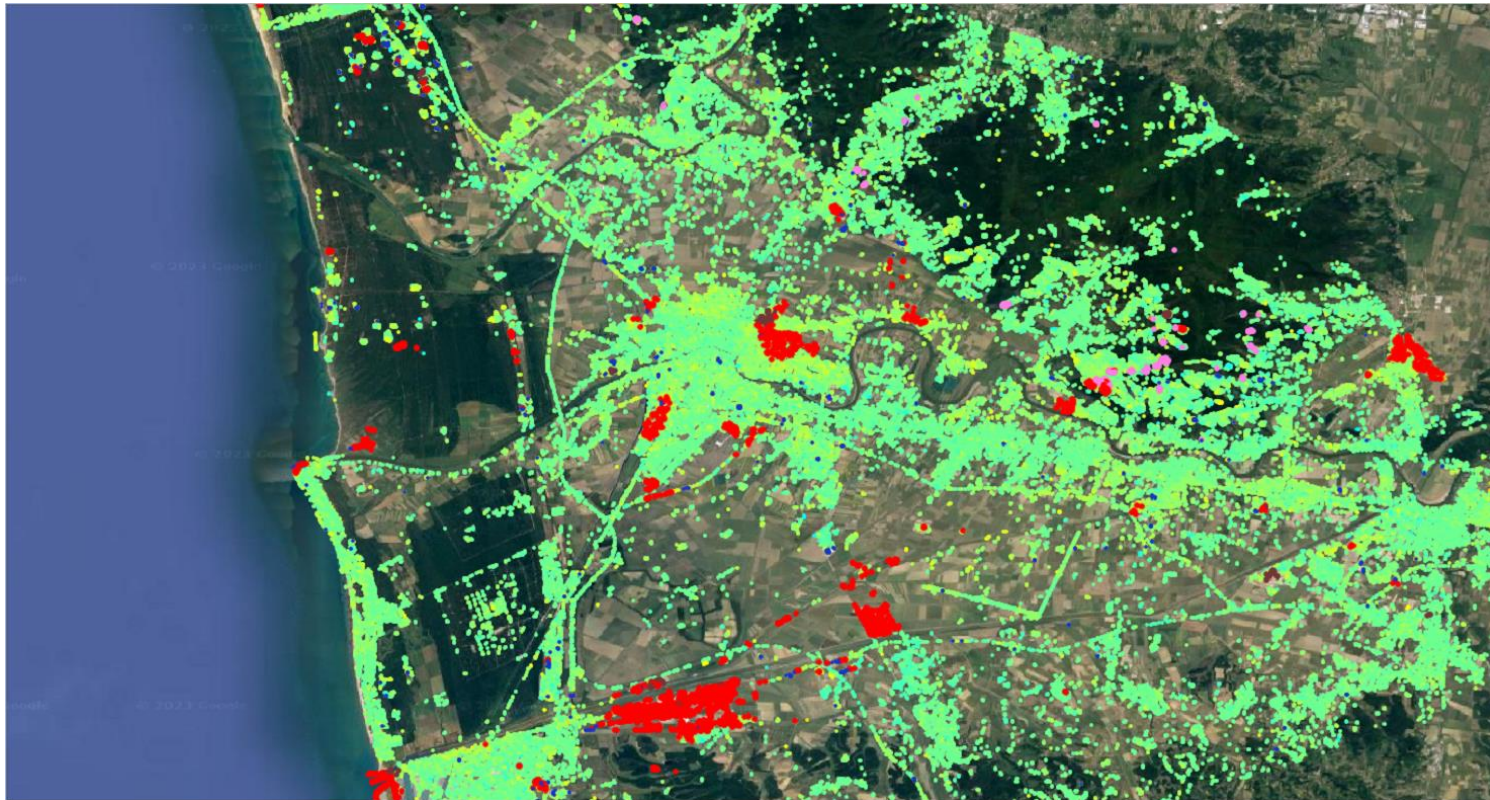- Subsidence
- Landslide
- Minig
- Local Instability

-15 [mm/y]   15 [mm/y]

Legend:
- ● Subsidence
- ● Landslide
- ● Minig
- ● Local Instability

>> Surface deformation phenomena can now be mapped **routinely** on a national (and even continental) scale with satellite SAR data

>> **Data screening tools** are becoming extremely important for data browsing, especially for large scale continuous monitoring projects

>> An automatic tool to detect active landslides starting from InSAR data should support Civil Protection authorities in the monitoring of entire national territories

FUTURE EO-1 EO SCIENCE FOR SOCIETY PERMANENTLY OPEN CALL FOR PROPOSALS

AO10468 - Activity Line 3: Artificial Intelligence for EO

SURFCLASS

Earth **Surf**ace Deformation Phenomena **Class**ification applying AI methodologies to SAR derived Time Series

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