

# The COSMO-SkyMed system: unique capabilities for managing Cultural Heritage needs

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**EO for Cultural and Natural Heritage**





# COSMO-SkyMed

- Italian constellation of large SAR (Synthetic Aperture Radar) satellites
- Ownership



- Manufacturing and operations



- World-wide commercialization



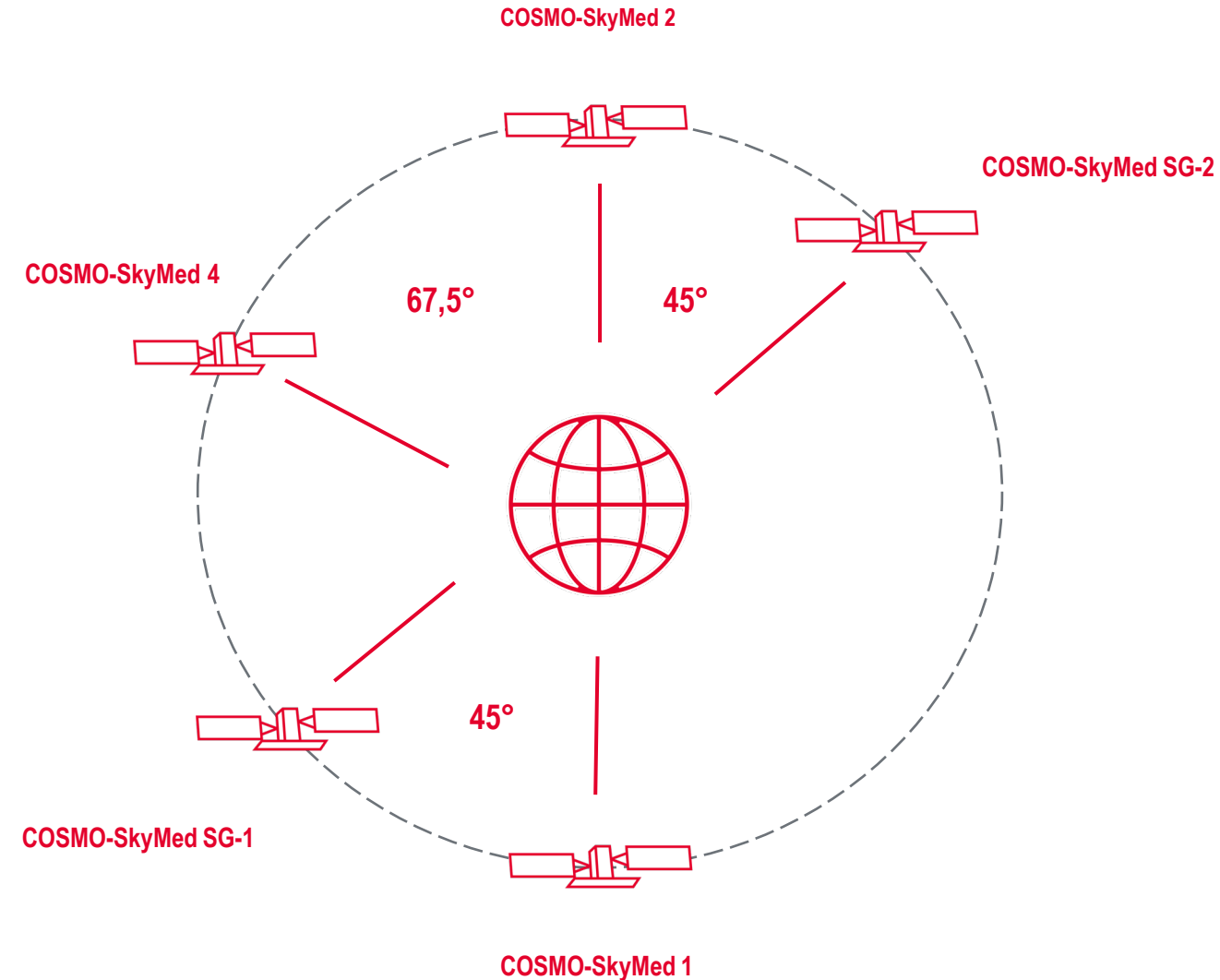
# COSMO-SkyMed history

- 4 satellites of the first generation (CSK) were launched between 2007-2010
  - CSK-3 decommissioned in May 2022
  - Other 3 satellites fully operational
- 2 satellites of the second generation (CSG) were launched in 2019-2022
  - Guarantee program continuity
  - Improved capabilities
- 2 additional second generation satellites will be launched in 2025-2026



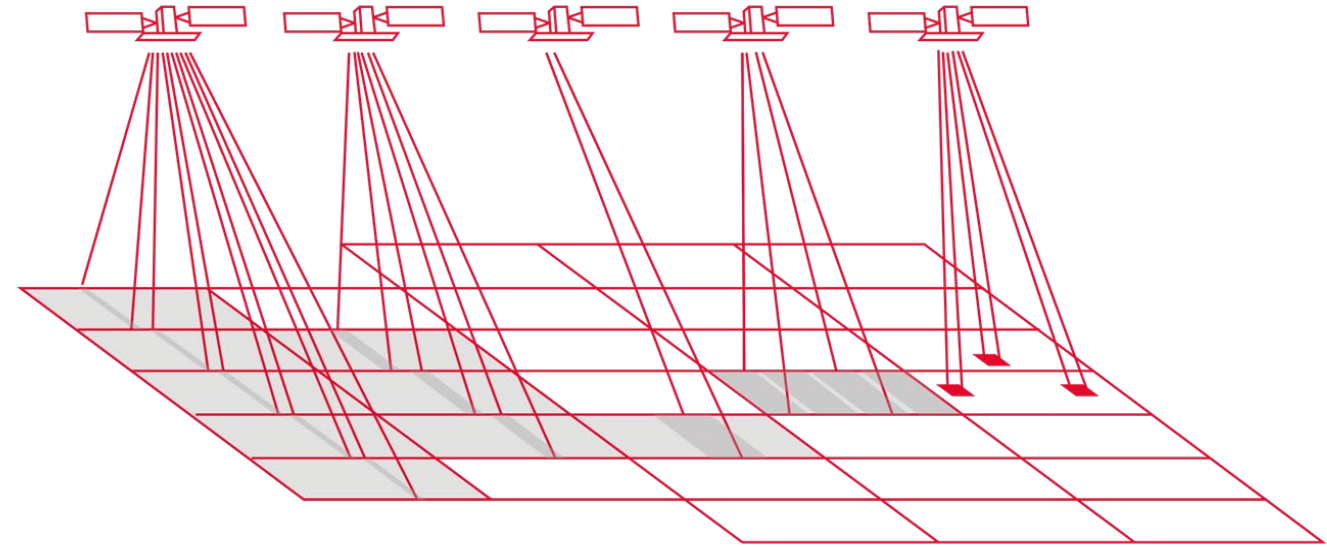
# COSMO-SkyMed in orbit

- All CSK and CSG satellites are placed on the same sun-synchronous orbit:
  - Ascending acquisitions at about 6 AM local time
  - Descending acquisitions at about 6 PM local time
- This configurations allows a 12-hours revisit globally:
  - Multiple ascending and multiple descending acquisitions every day, using different geometries
- Especially designed to guarantee interferometric capability, on the 16-days cycle orbit



# Imaging modes

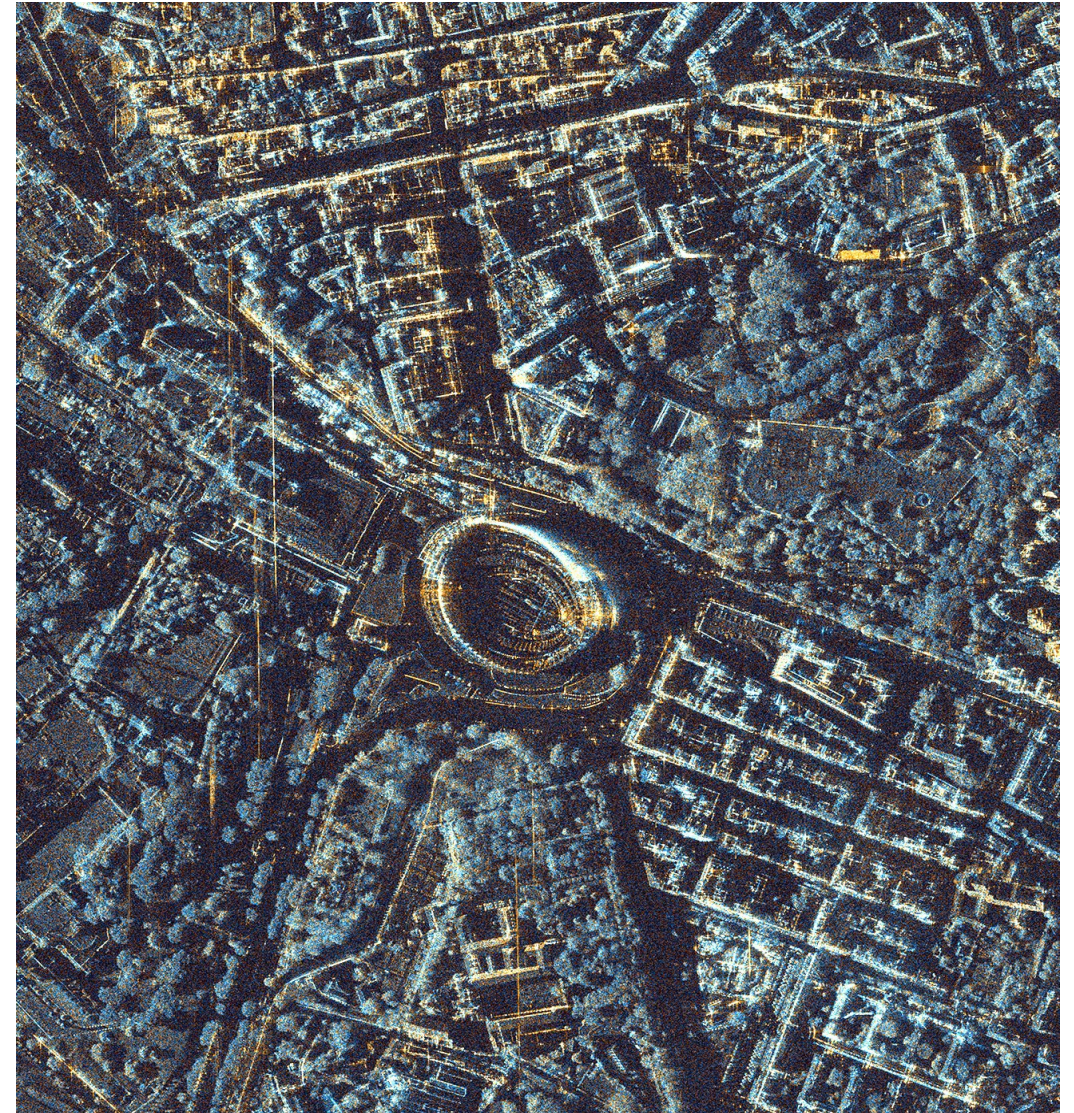
- Each satellite can acquire different imaging modes, for different applications
  - **ScanSAR:** 100-200 Km wide swaths to monitor large areas, typically on the sea
  - **Stripmap:** 40 Km wide swaths, to monitor areas with 3 m resolution
  - **Spotlight:** scenes at very high resolution (0,3 – 1 m) for precise detection and monitoring
- For each imaging is possible to select the preferred polarization (HH, VV, HV, VH)
- Different processing levels for different applications
  - Level 1A, 1B, 1C, 1D





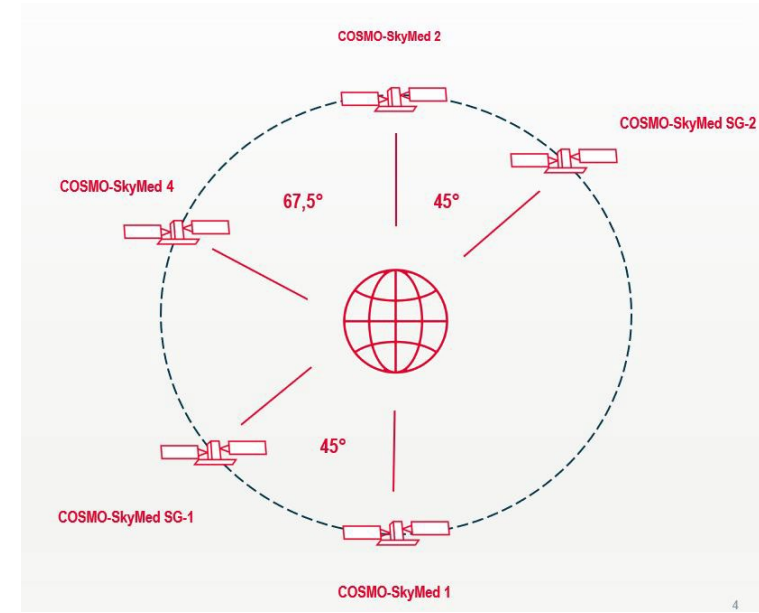
# CSG advantages

- Better resolution
  - More power for range direction improved capability to detect smaller details
- Better image quality
  - Less noise, no need to multilook
- Better geolocation accuracy
  - Also for NRT acquisitions
- Dual and Quad pol capabilities
  - Is like having 2-4 acquisitions at the same price
  - Allows to generate RGB images

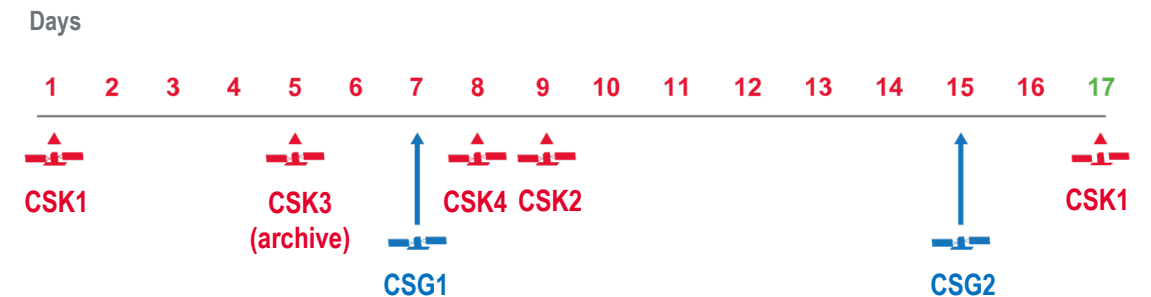


# Interferometric capabilities

- Spotlight and Stripmap modes allow to make interferometric acquisitions
  - Same exact acquisition geometry, with precise orbit determination
  - Possibility to analyze long history of acquisitions (where there are archived data) or start new series with tasking orders
- Stripmap modes allow to make interferometry between CSK and CSG
- In a 16-days cycle, possible to have 3 CSK and/or 2 CSG interferometric acquisitions



## INTERFEROMETRIC REVISIT:





# COSMO-SkyMed archive

- COSMO-SkyMed archive contains >2M acquisitions done in the last 17 years
- Several interferometric acquisitions over interesting targets
  - MapItaly project by ASI / Italian Civil Protection
  - Customer orders
  - Interferometric **background** mission over several targets world-wide, including all the cities having > 200K inhabitants & UNESCO Sites



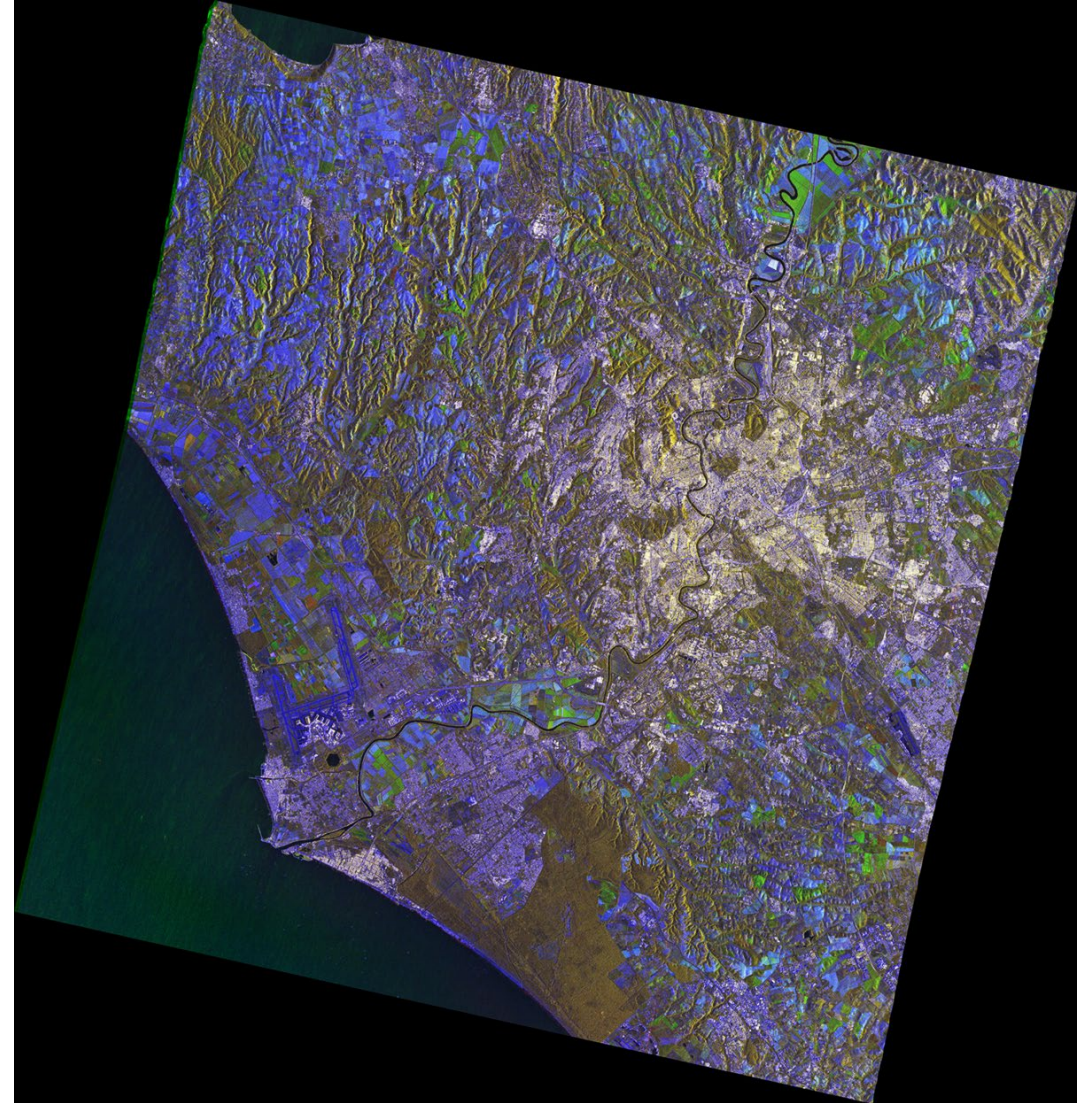


# MTC – Multi-Temporal Coherence

- RGB color image showing
  - Date 1
  - Date 2
  - Coherence between the 2 dates
- Perfect choice to make a precise change detection analysis

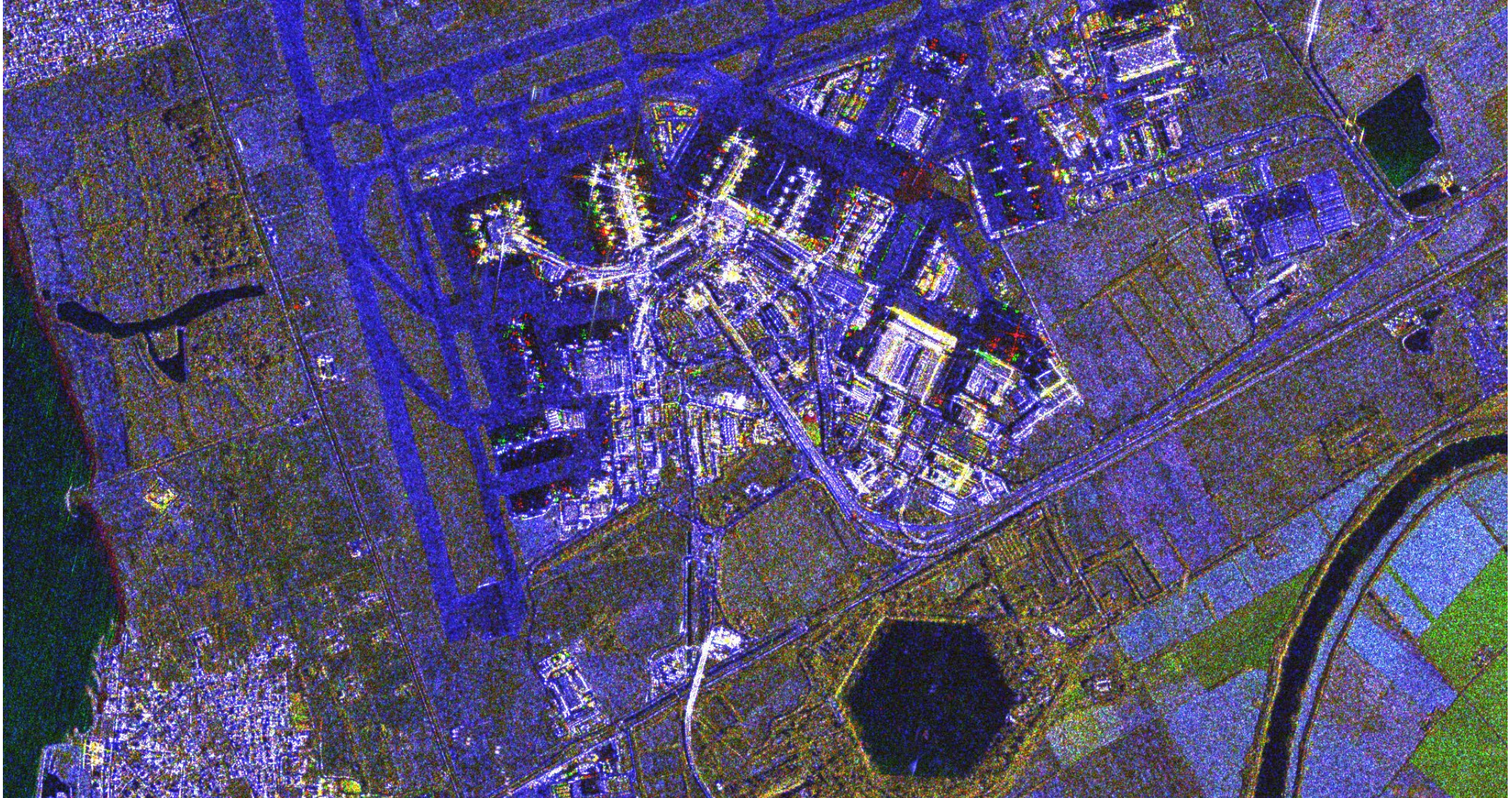
40x40 Km Stripmap scene over Rome

- Date 1 = 10/01/2022
- Date 2 = 26/01/2022





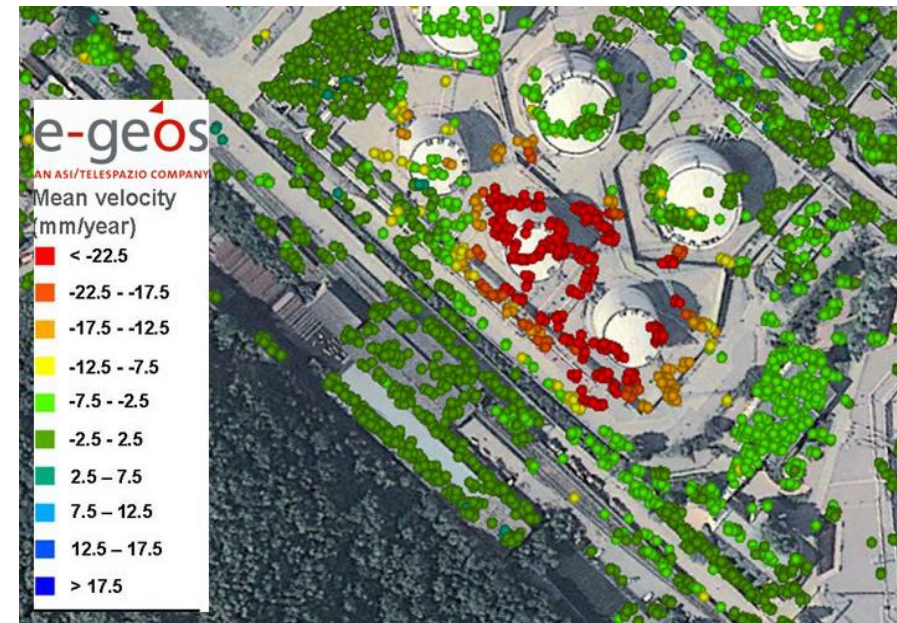
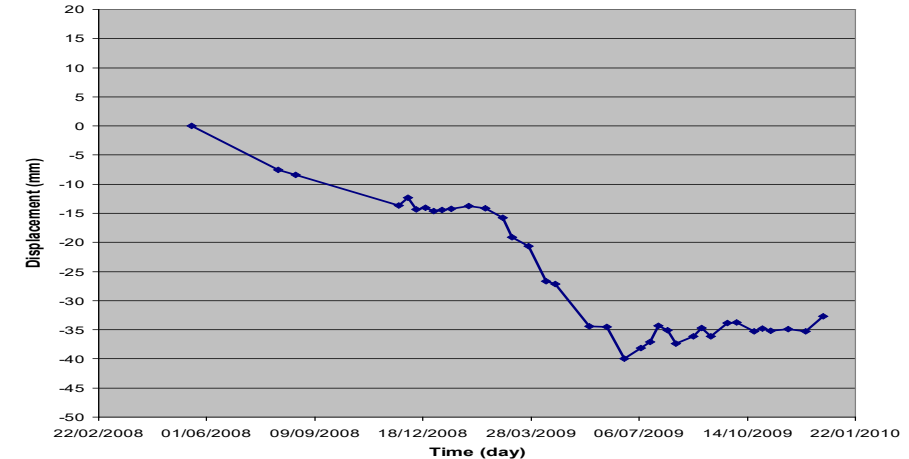
# MTC – Multi-Temporal Coherence





# PSP-IFSAR

- The PSP-IFSAR technology provides millimetric measurement of ground displacements from series of satellite SAR data. The PSP measurements are obtained on objects exhibiting stable radar backscattering properties over time, called persistent scatterers (PS). Typically, PSP dense measurements (thousand per square km) are obtained over scarcely vegetated and non-cultivated natural terrains, or corresponding to man-made or natural structures such as buildings, rocks, etc. The provided product includes:
  - **PS position:** the measured position (cartographic or geographic coordinates and heights) of each identified PS point
  - **PS mean velocity:** the mean velocity of each PS between the first and the last SAR acquisition
  - **PS temporal evolution:** the PS displacement at each acquisition date in the analysed period



# PSP-IFSAR

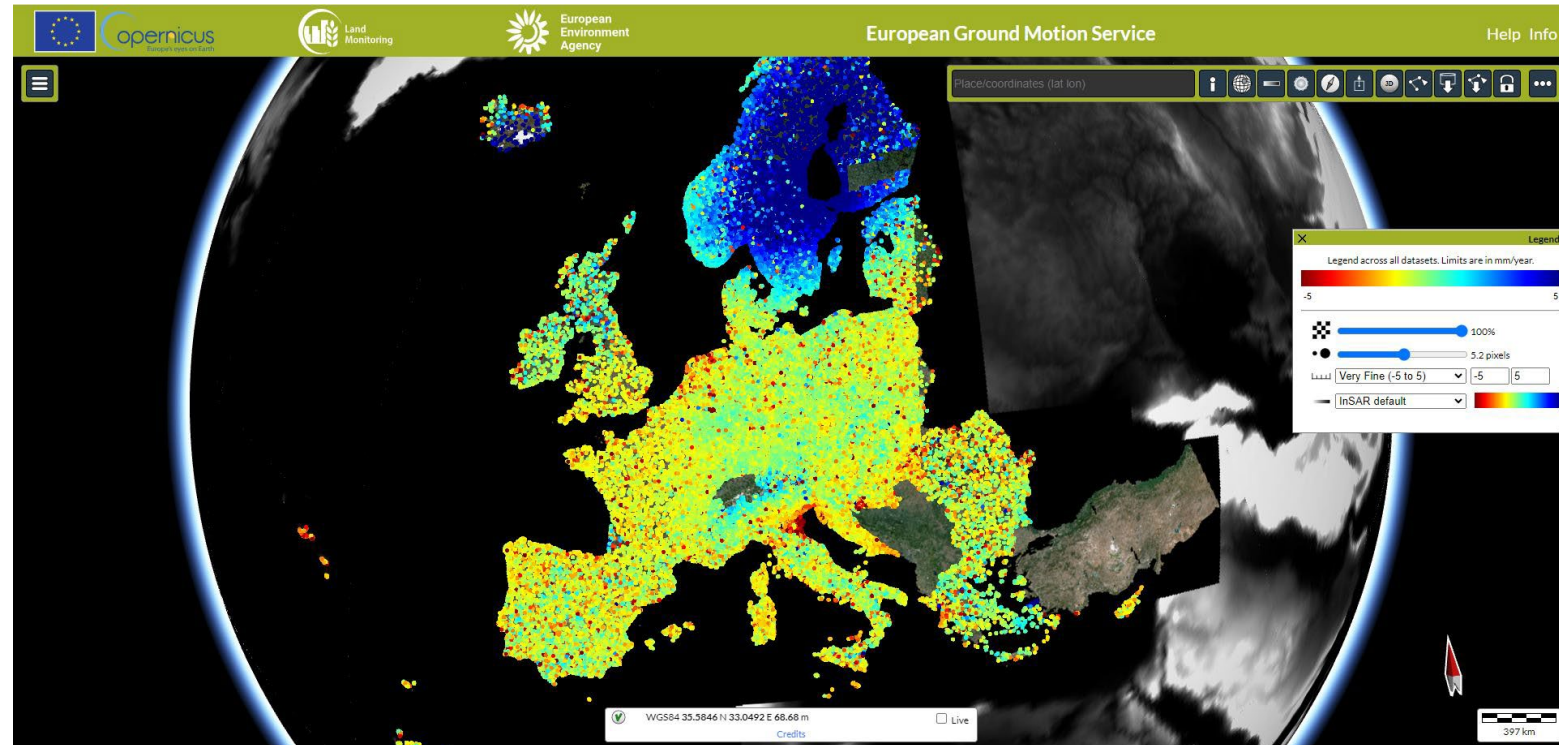
- The PSP-IFSAR technology can be used to monitor several natural and man-made events:
  - Buildings stability
  - Ground subsidence
  - Landslides
  - Earthquakes and volcanic phenomena
- Which could impact on:
  - Archaeological sites
  - Historical buildings
  - Bridge
  - Monuments
  - Landscapes
  - ...





# European Ground Motion Service

- Global European PSP analysis done using Sentinel-1 data
- <https://egms.land.copernicus.eu/>
- Work carried out by an international consortium led by e-GEOS



- COSMO-SkyMed guarantees higher resolution, especially useful over urban areas and man-made structures



# PSP-IFSAR



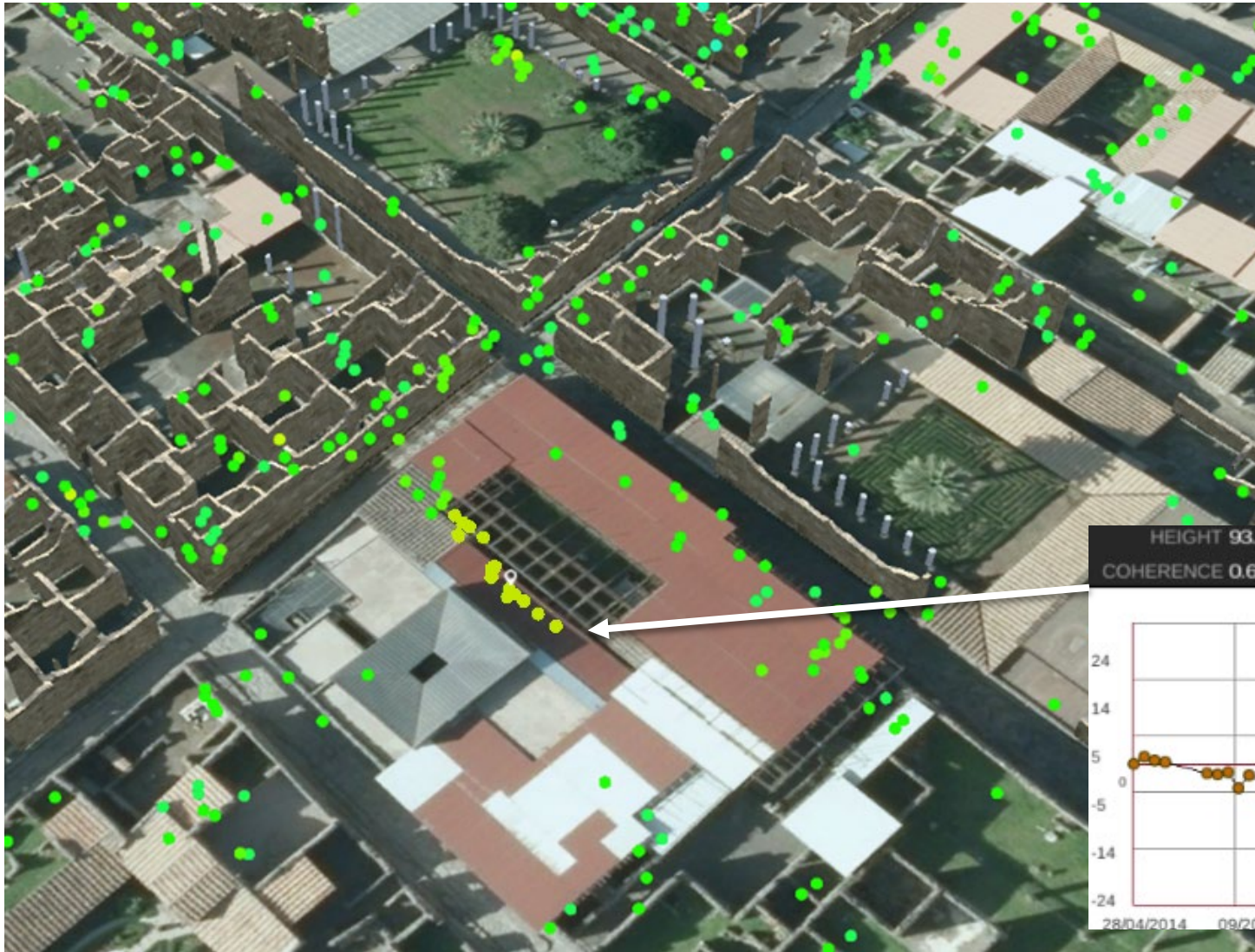
Thermal dilatation effects on London Bridge, London







# PSP-IFSAR



*Pompei, Casa dei Vettii*

The *Casa dei Vettii* has been renovated (including replacing the roof). The PSP-IFSAR analysis performed during the renovation works has identified small deformations on the roof.

The on-field survey carried out by ISPRA has confirmed the presence of a support beam of the roof which needed to be replaced.





# Hydraulic and Hydrogeological Risk Analysis

INSAR used to characterize ground stability and identify hot spot(s)

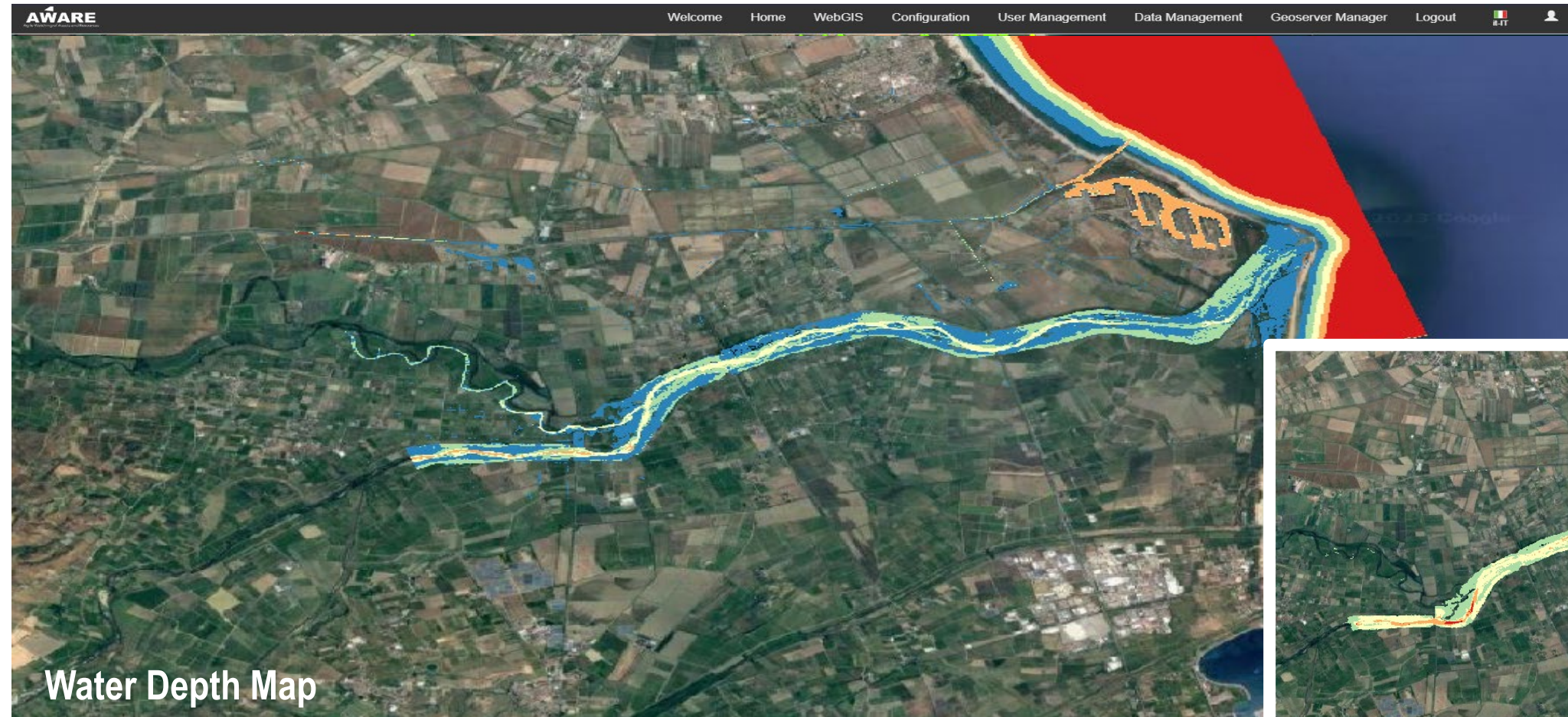


Subsidence close to the Archeological Area, Sibari (CS)



# Hydraulic and Hydrogeological Risk Analysis

Hydraulic Flood Model (meteo data + AI)



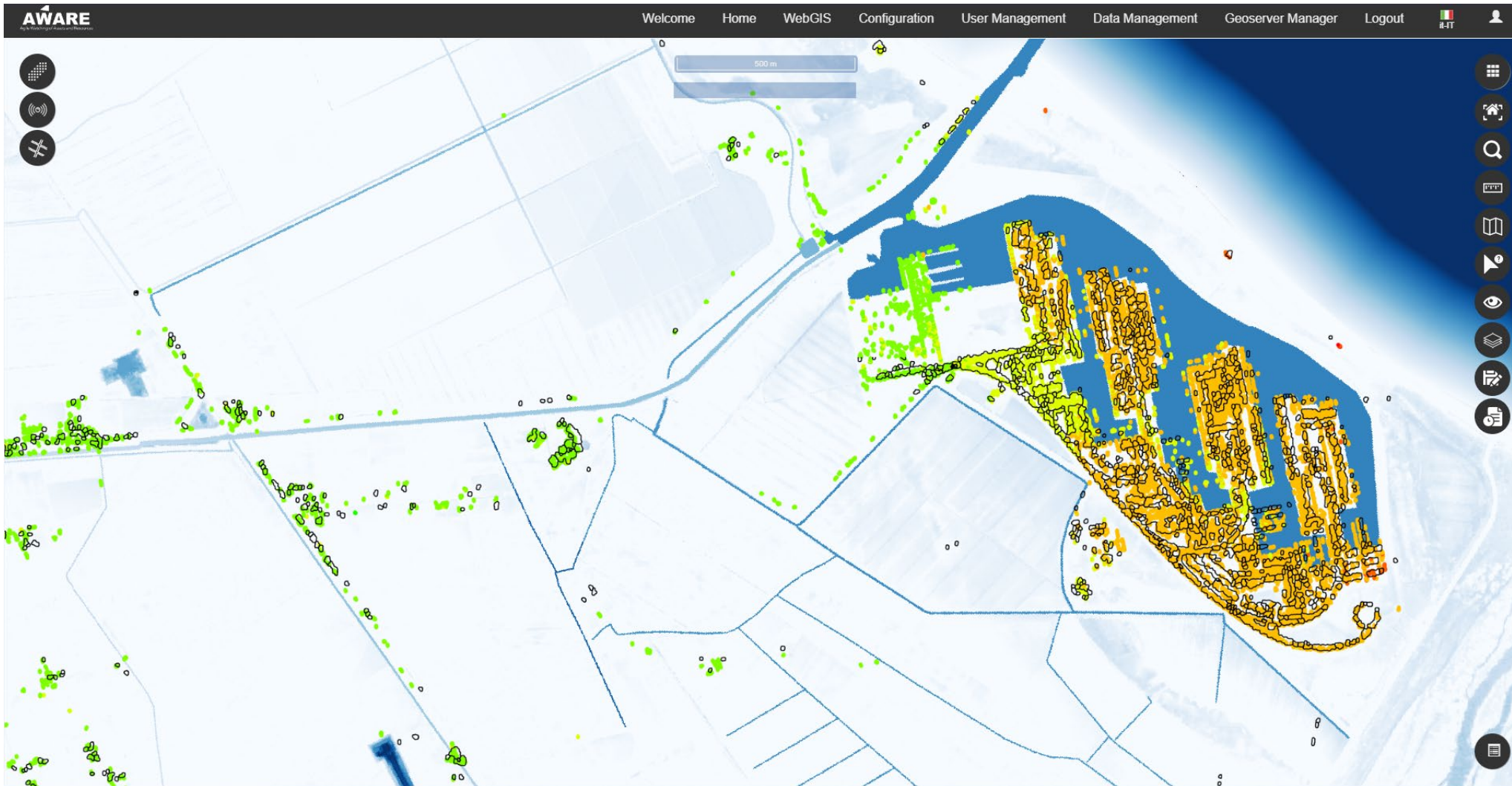
Subsidence close to the  
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# Hydraulic and Hydrogeological Risk Analysis

## INSAR + Hydraulic Flood Model



Subsidence close to the  
Archeological Area, Sibari (CS)



# e-geos

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