



Satellite radar interferometry for mapping and monitoring ground instabilities

Federico Raspini

Matteo Del Soldato

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Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



Who I am

Federico RASPINI

Department of Earth Sciences of the University of Firenze

federico.raspini@unifi.it

- Associate Professor in Physical Geography and Geomorphology at the Earth Sciences Department, University of Florence
- Chair Associate of the UNESCO Chair on Prevention and sustainable management of geo-hydrological hazards, University of Florence
- Lecturer of Applied Geomorphology within the Courses of Geological Sciences and Technologies at the University of Florence
- Visiting researcher at the University of Athens, 2013
- Current interest: landslide, remote sensing, risk assessment



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Satellite Interferometry

Radar-interpretation: products, applicability and limitations

02

The past: archive elaboration

Mapping and “one-shot analysis”

03

The present: wide area monitoring system

The Sentinel-1 constellation

04

The future: continental scale

Early warning system based on indicators of instabilities

05

Data availability

Open portal and web application for data access and management

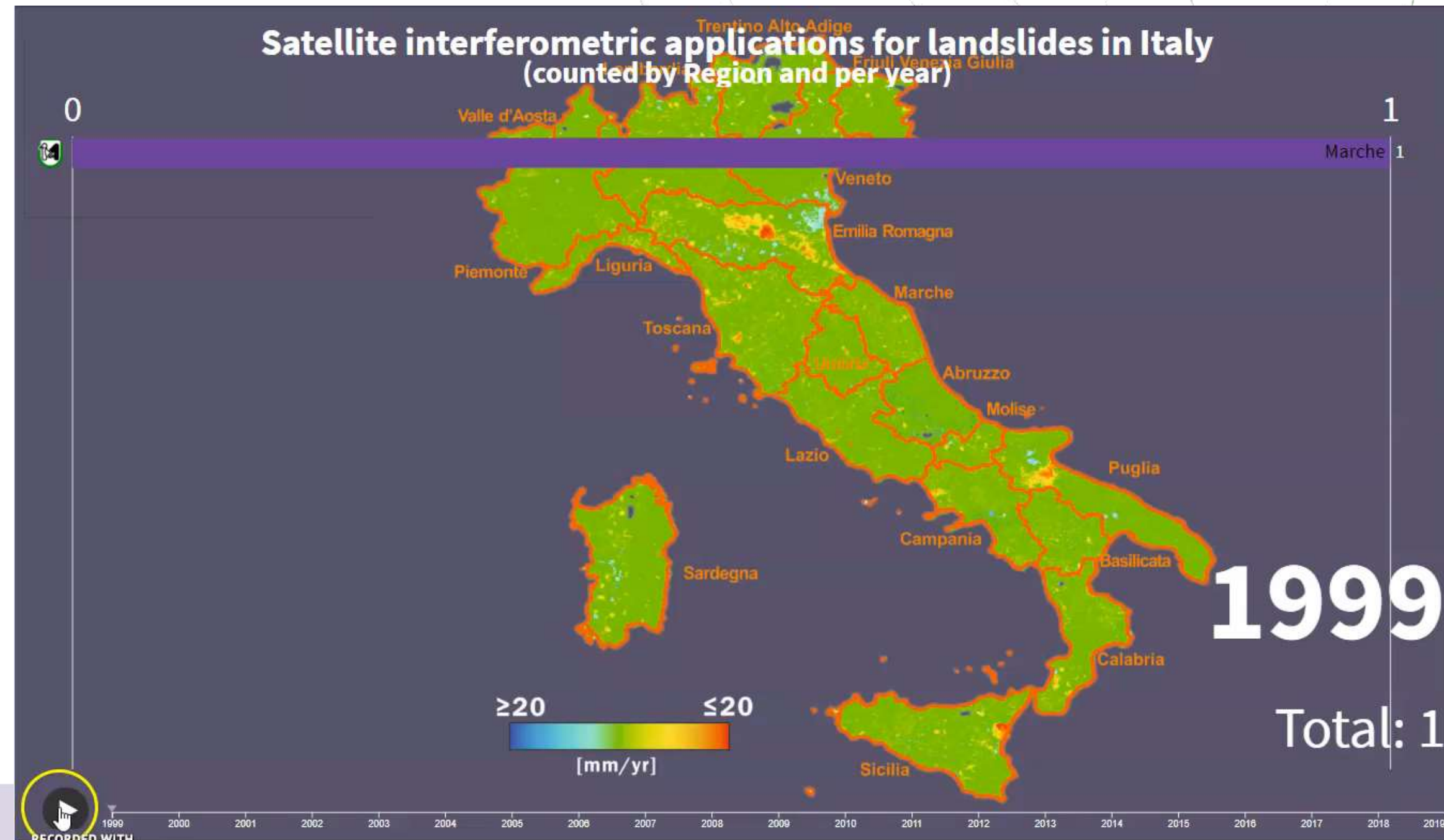
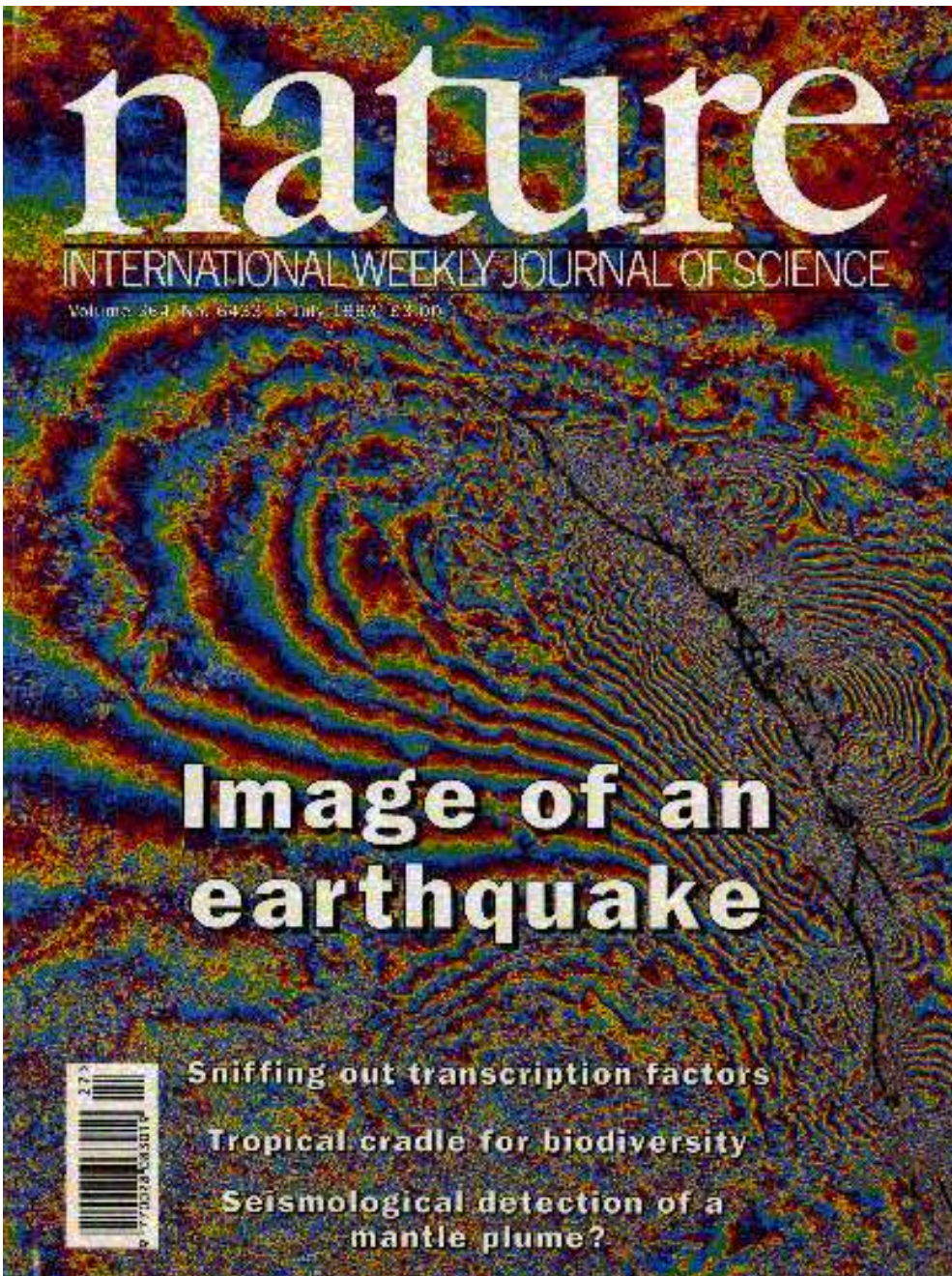
Introduction

The displacement field of the Landers earthquake mapped by radar interferometry

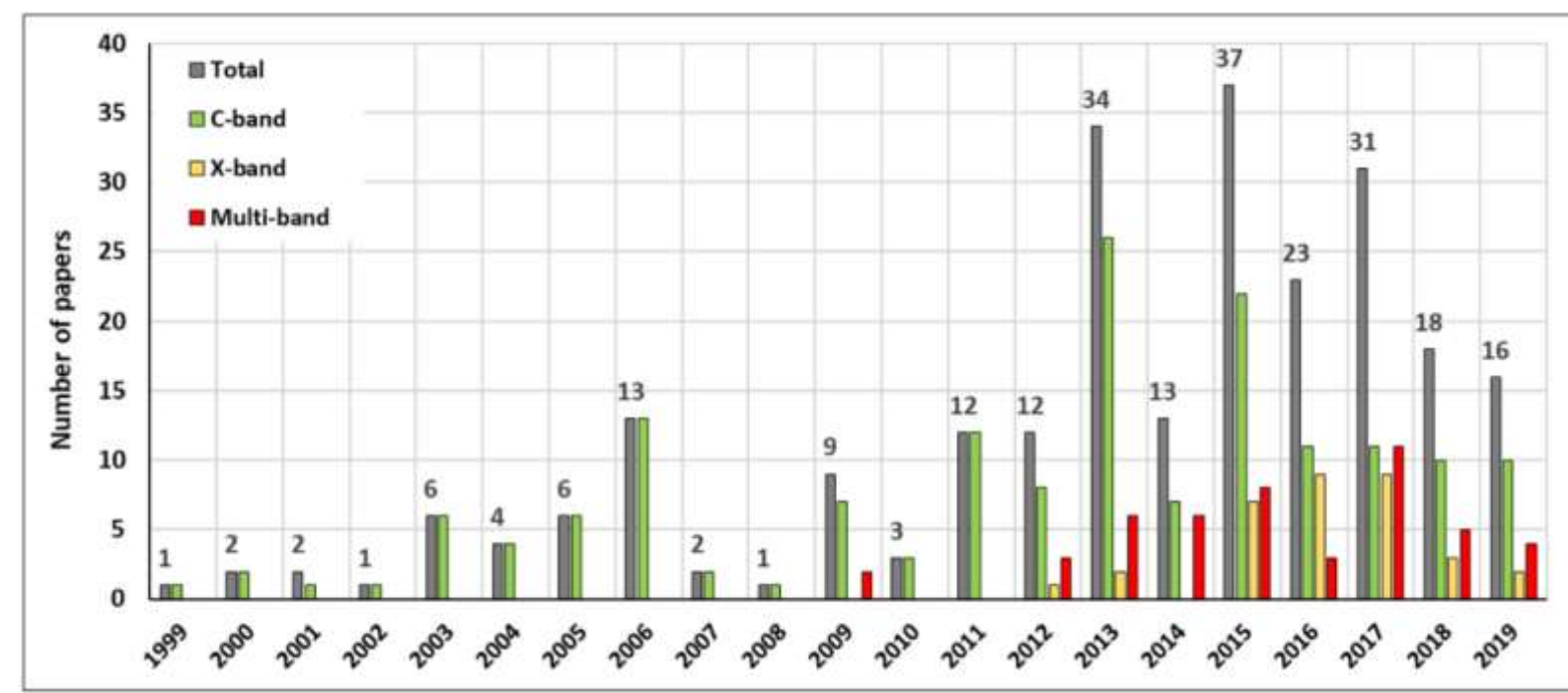
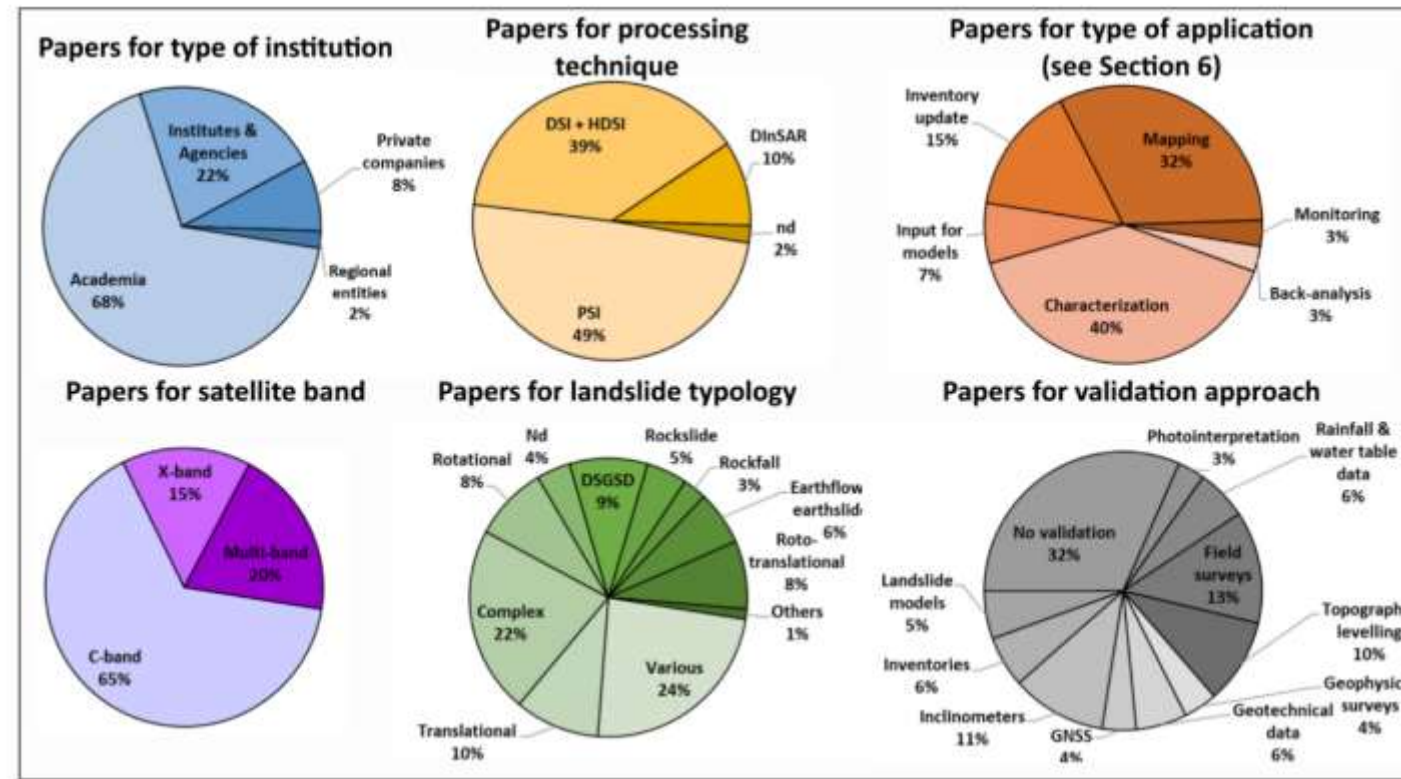
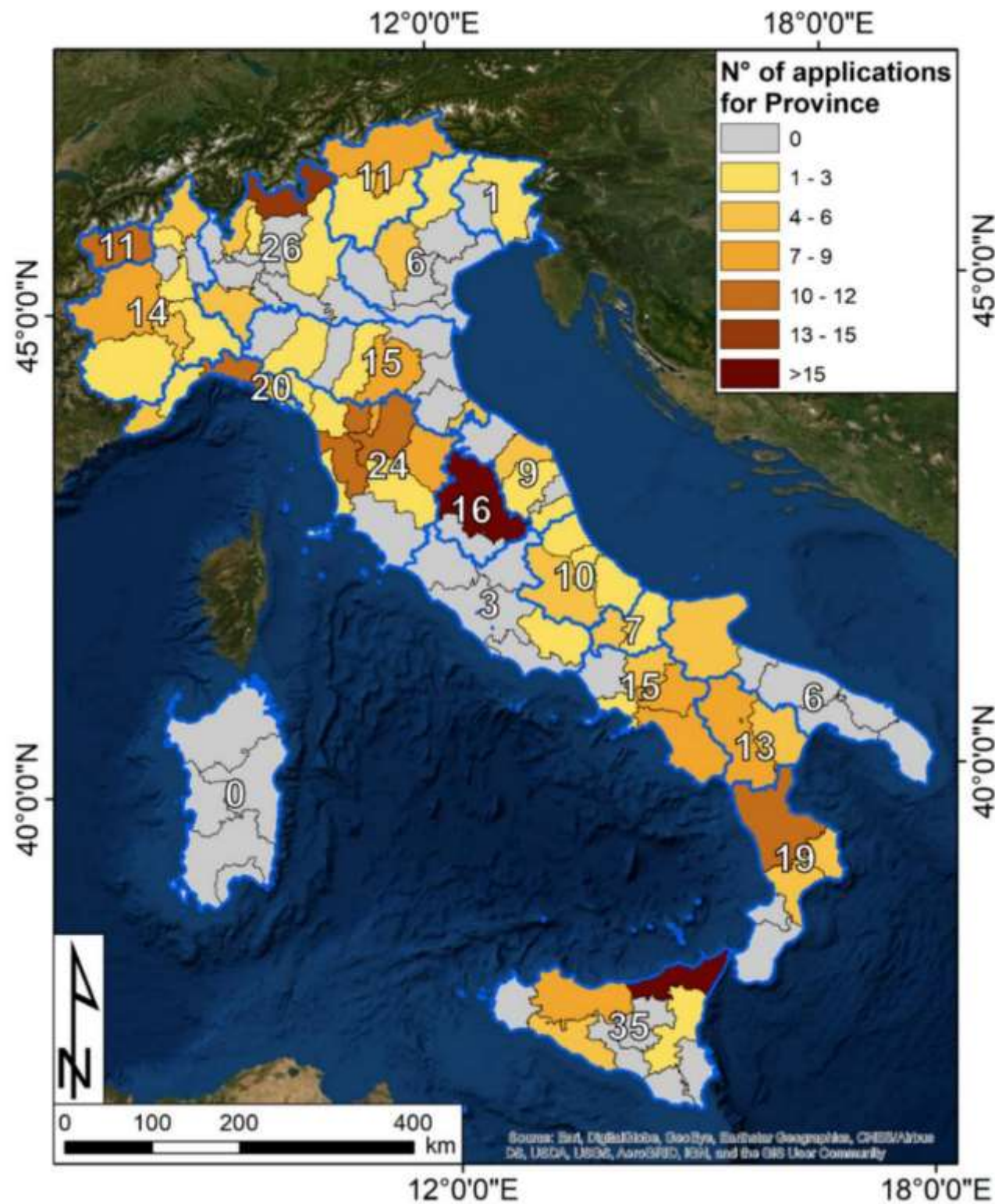
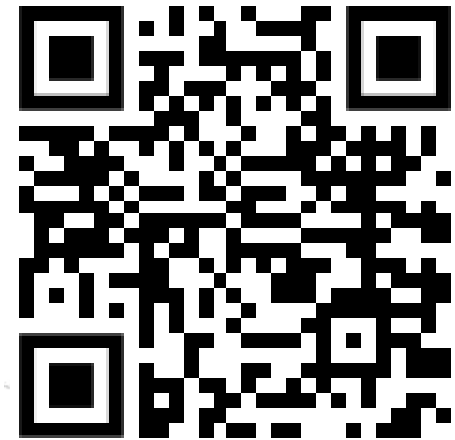
Didier Massonnet, Marc Rossi, Cesar Carmona, Frederic Adragna, Gilles Pletzner & Kurt Feigl

Review of satellite interferometry for landslide detection in Italy

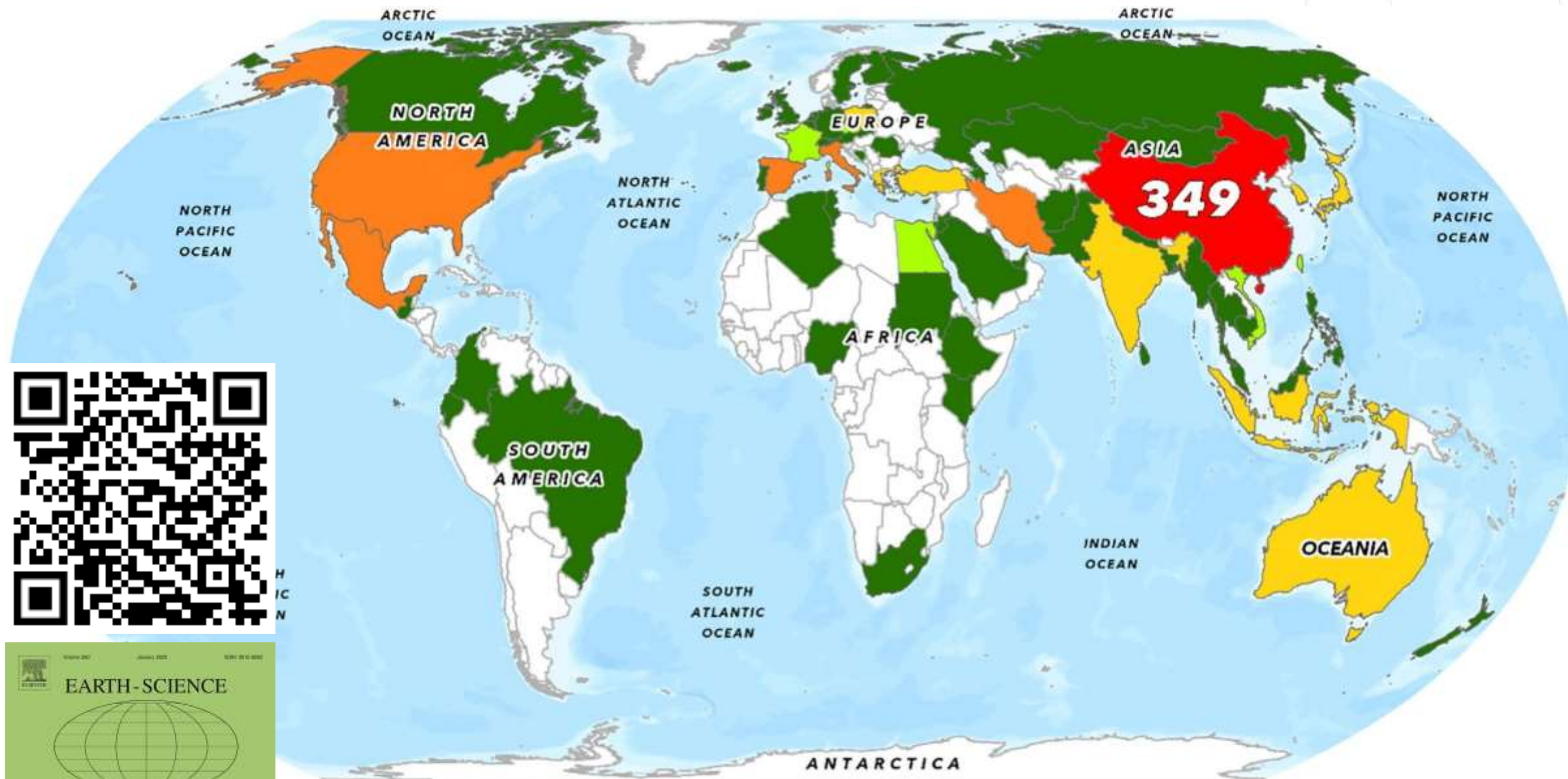
Lorenzo Solari, Matteo Del Soldato, Federico Raspini, Anna Barra, Silvia Bianchini, Pierluigi Confuorto, Nicola Casagli, Michele Crosetto



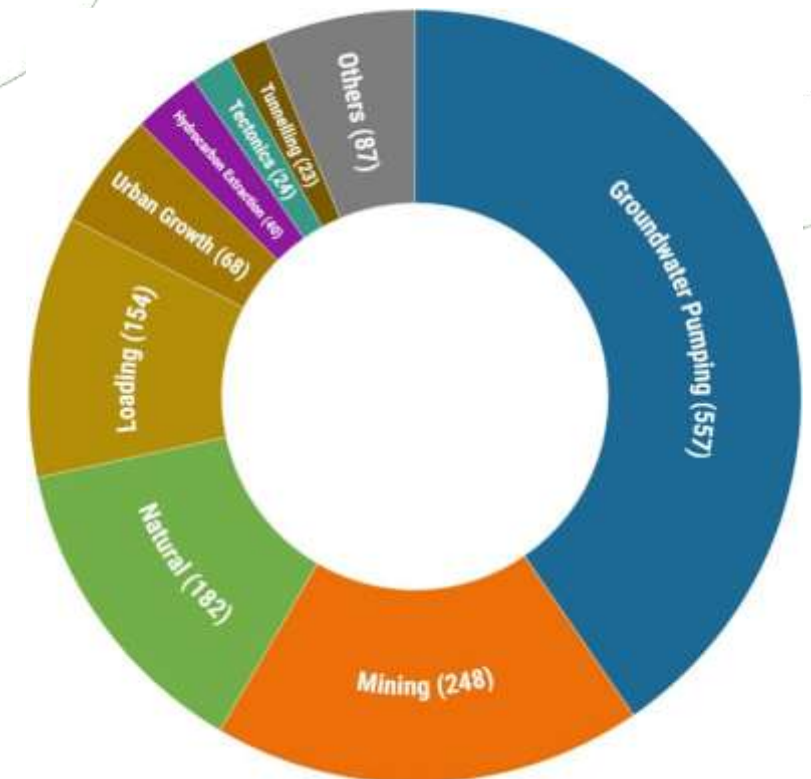
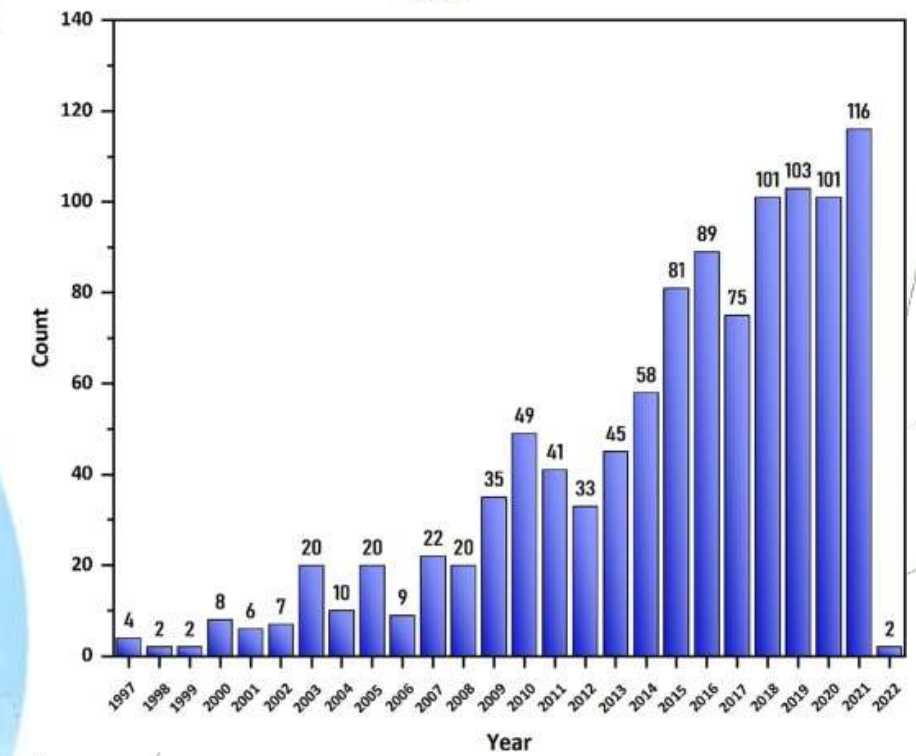
Introduction



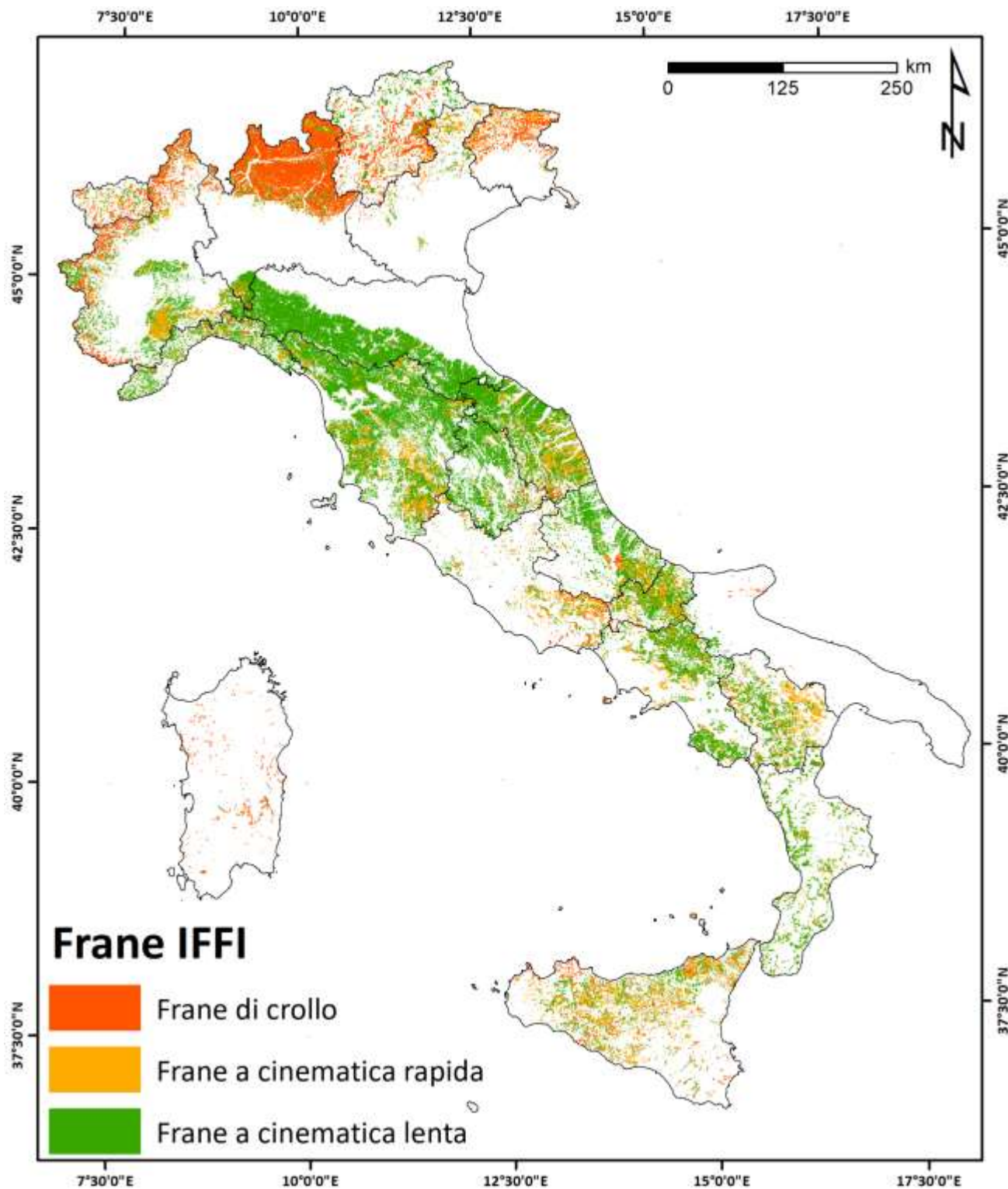
Introduction



Geographical distribution of study areas (number per country)



Introduction



Landslide risk areas
about 2 millions of mapped
landslides
about 10.000 areas at very high
risk

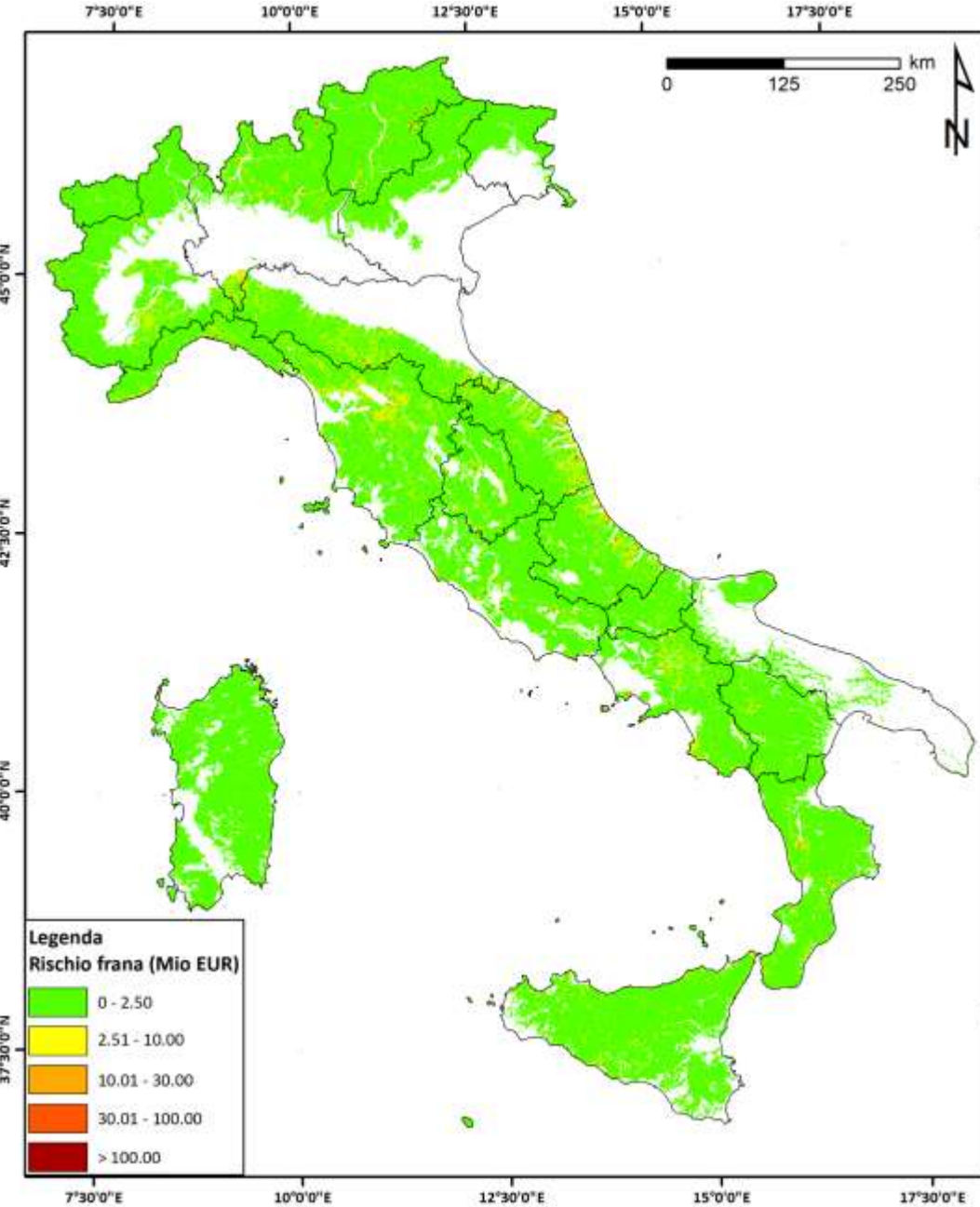
Social impact (100 years)
About 4000 events affecting
people
12.600 deaths
700.000 evacuees

Economic impact
2 billions each year (0.15% del
GDP) of direct damages
4-5 billions each year (0.3% del
GDP) of indirect damages

Urban areas at risk
1.306 areas to be stabilized
323 to be relocated
77 billions of potential loss

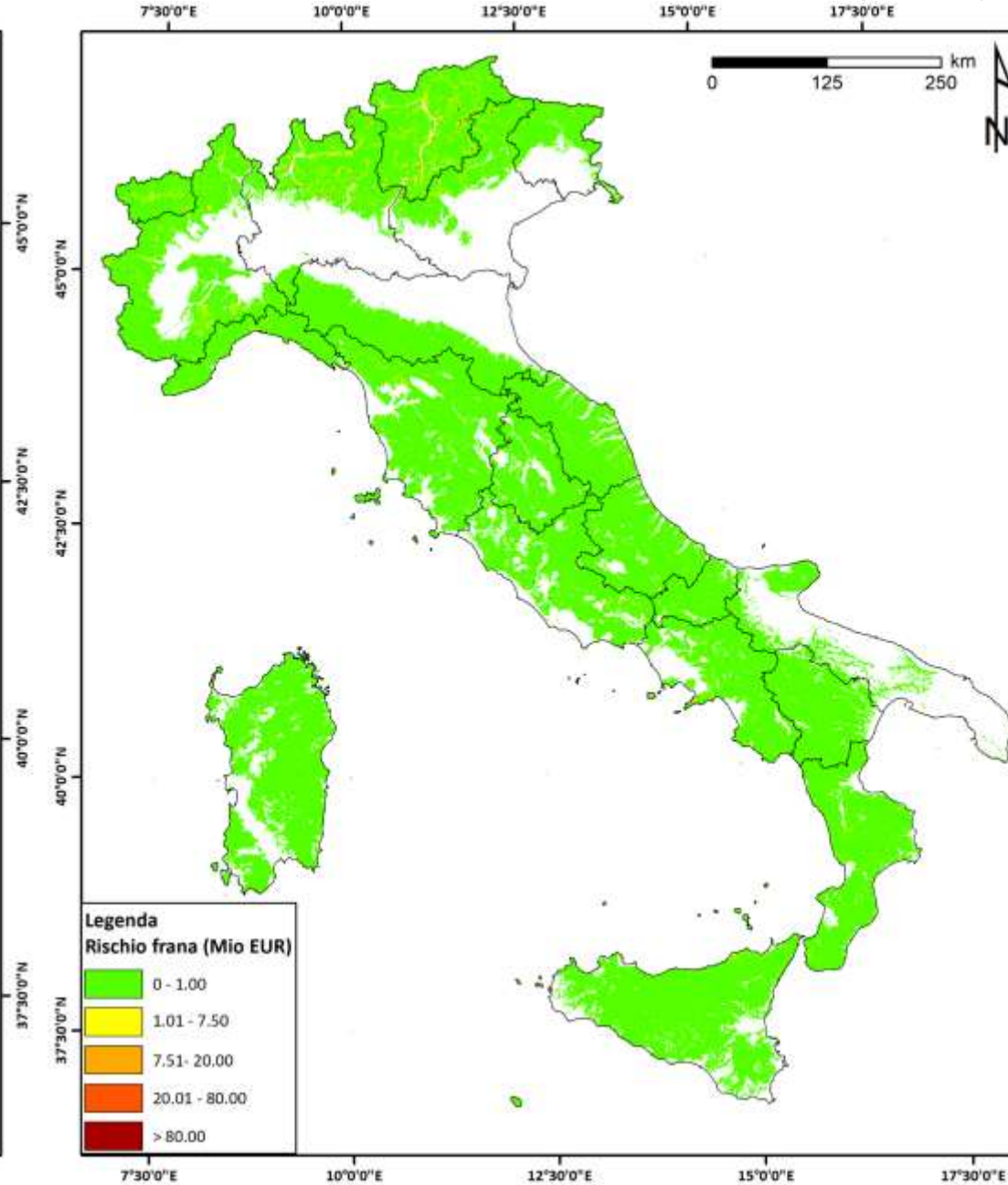


Introduction



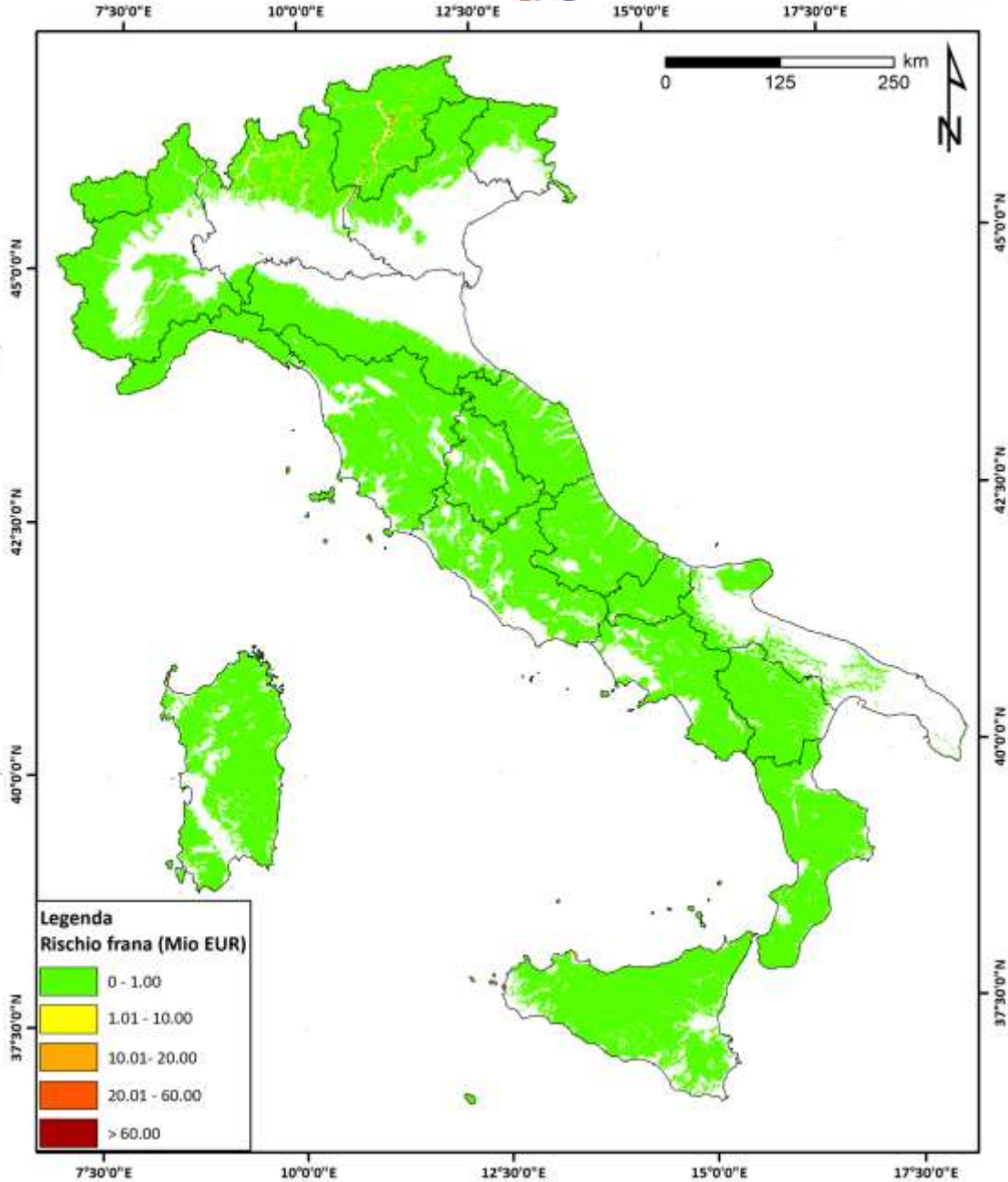
Slow-moving landslide

Highest risk (€): 269 mln
Total risk (€): 112 mld
Mean risk (1km² cell) (€): 521 K



Rapid-moving landslide

Highest risk (€): 240 mln
Total risk (€): 30 mld
Mean risk (1km² cell) (€): 138 K



Rockfall

Highest risk (€): 438 mln
Total risk (€): 21 mld
Mean risk (1km² cell) (€): 98 K

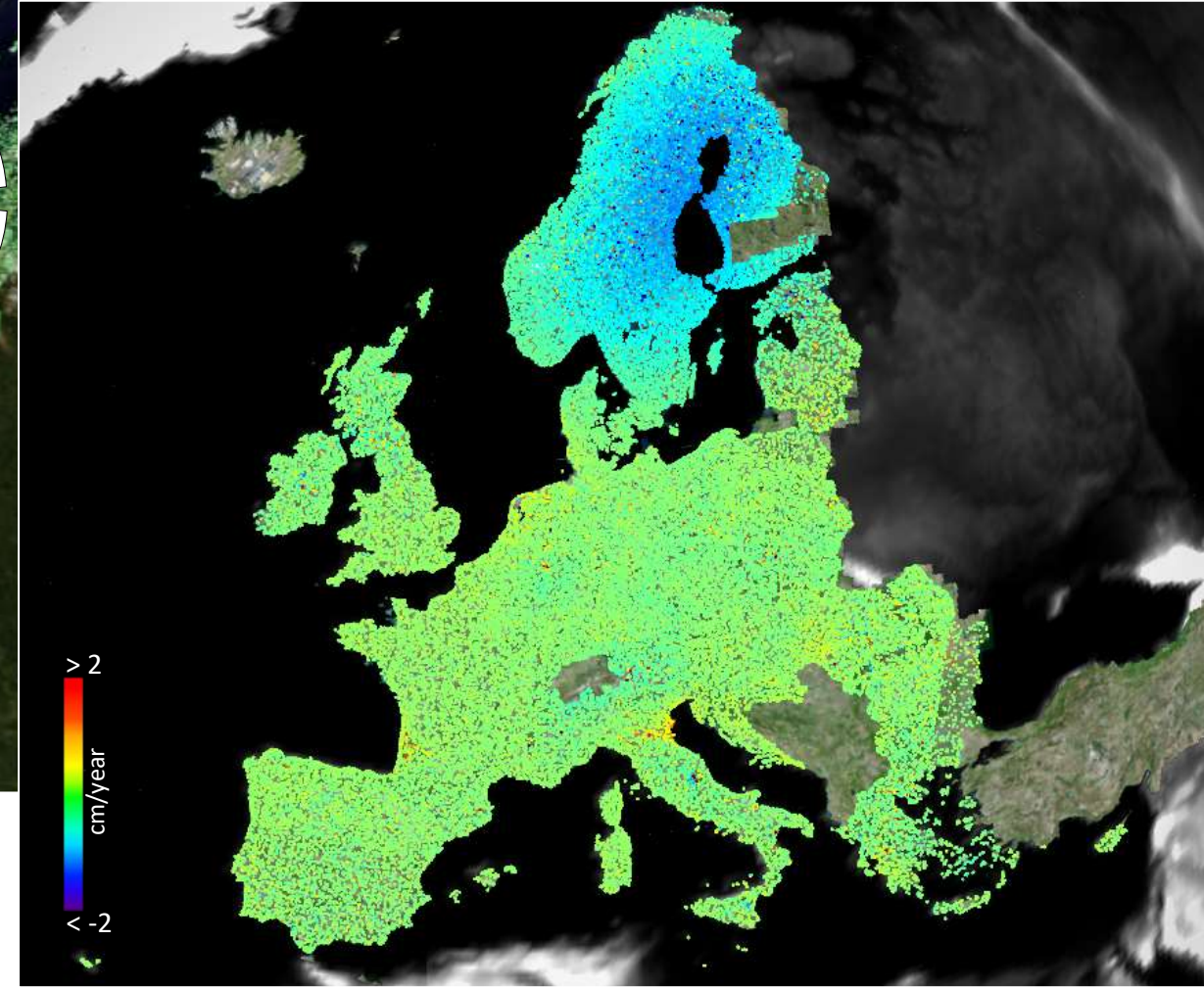
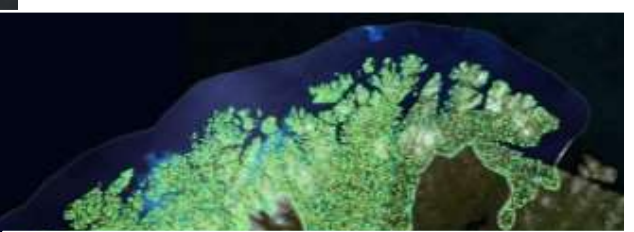
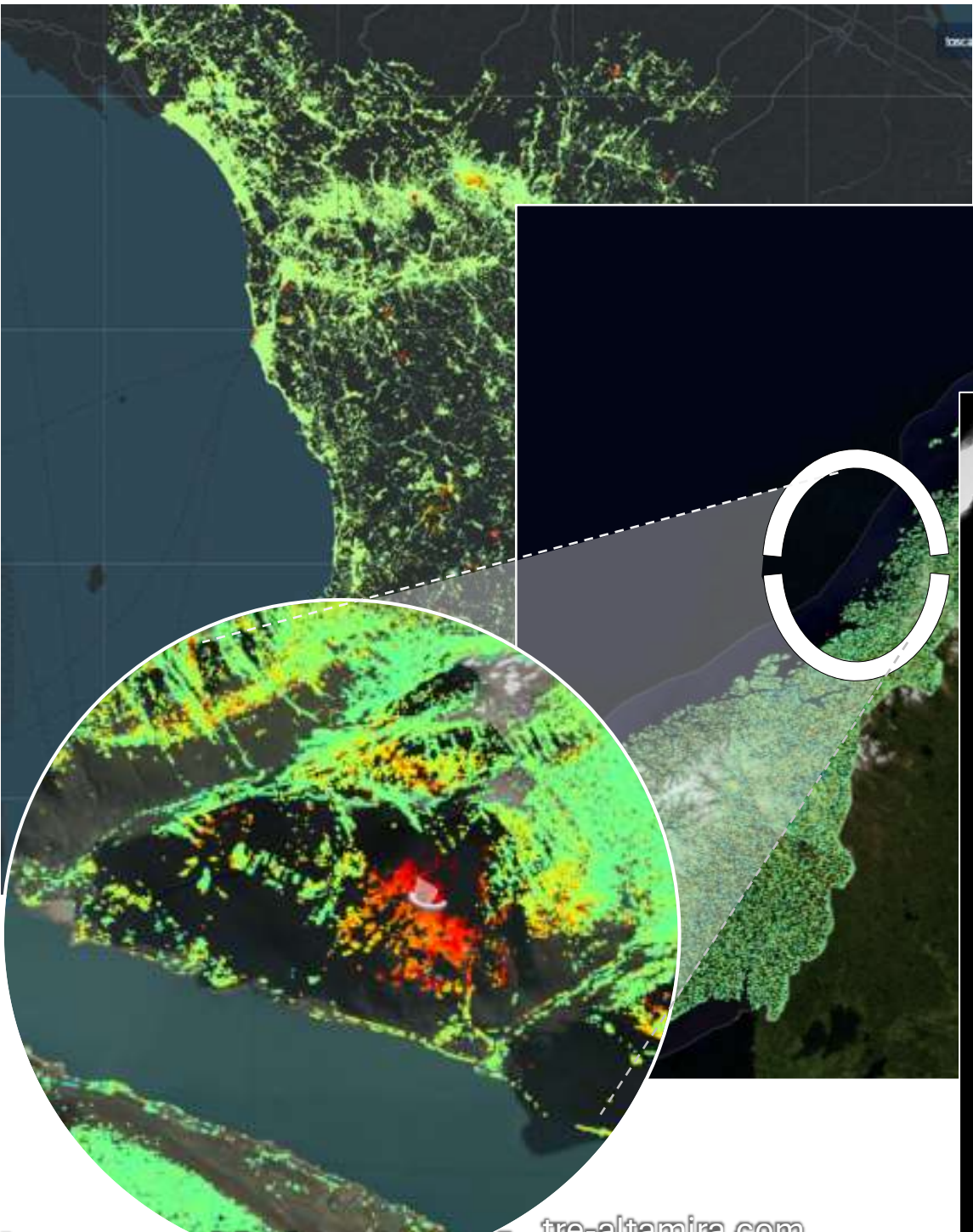
Introduction

- Local to regional Scale

- National scale

- Continental scale:
European ground
motion Service
(EGMS)

How can we manage
such amount of data?



Images, modified, courtesy of: tre-altamira.com
insar.ngu.no

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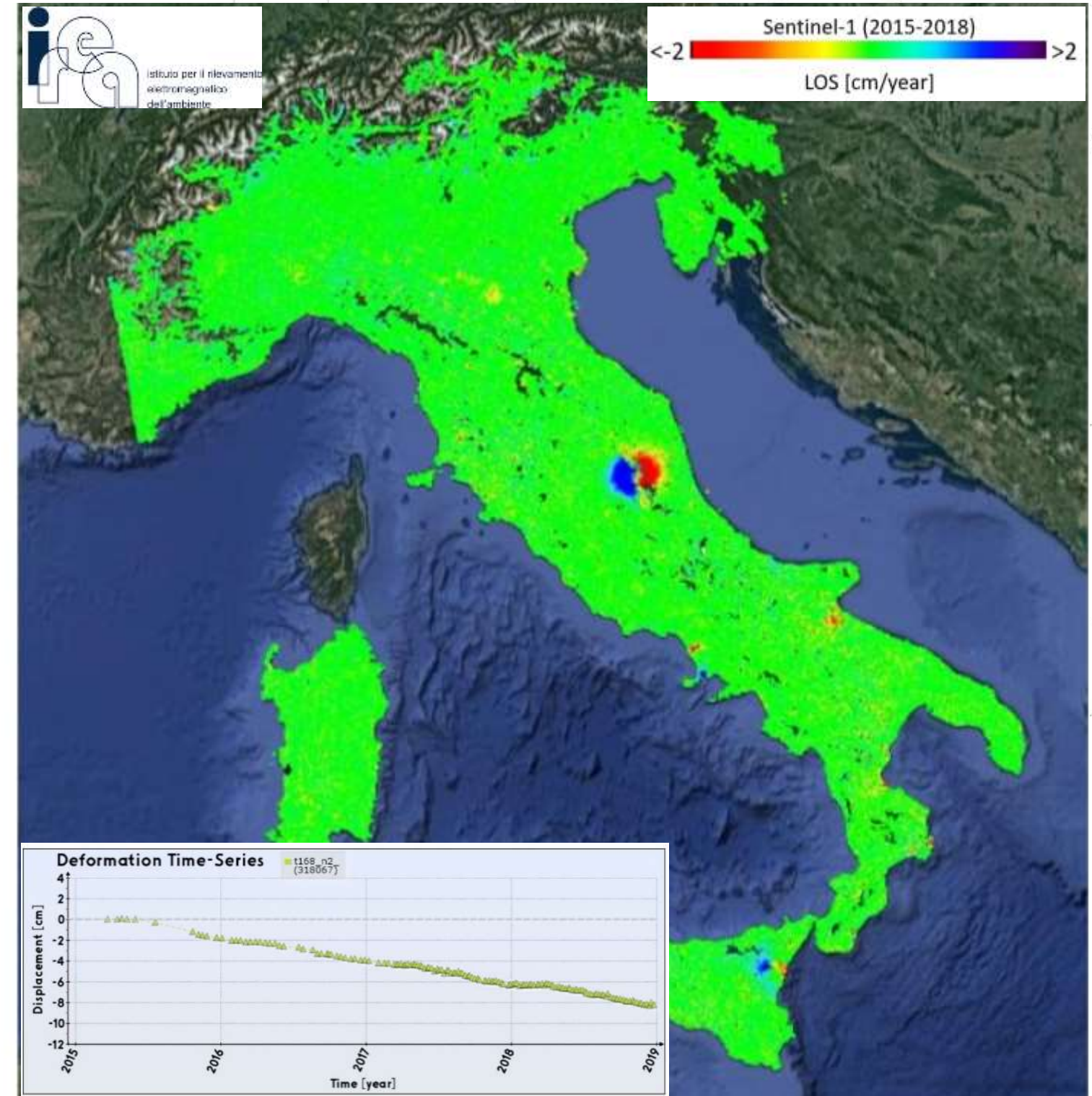
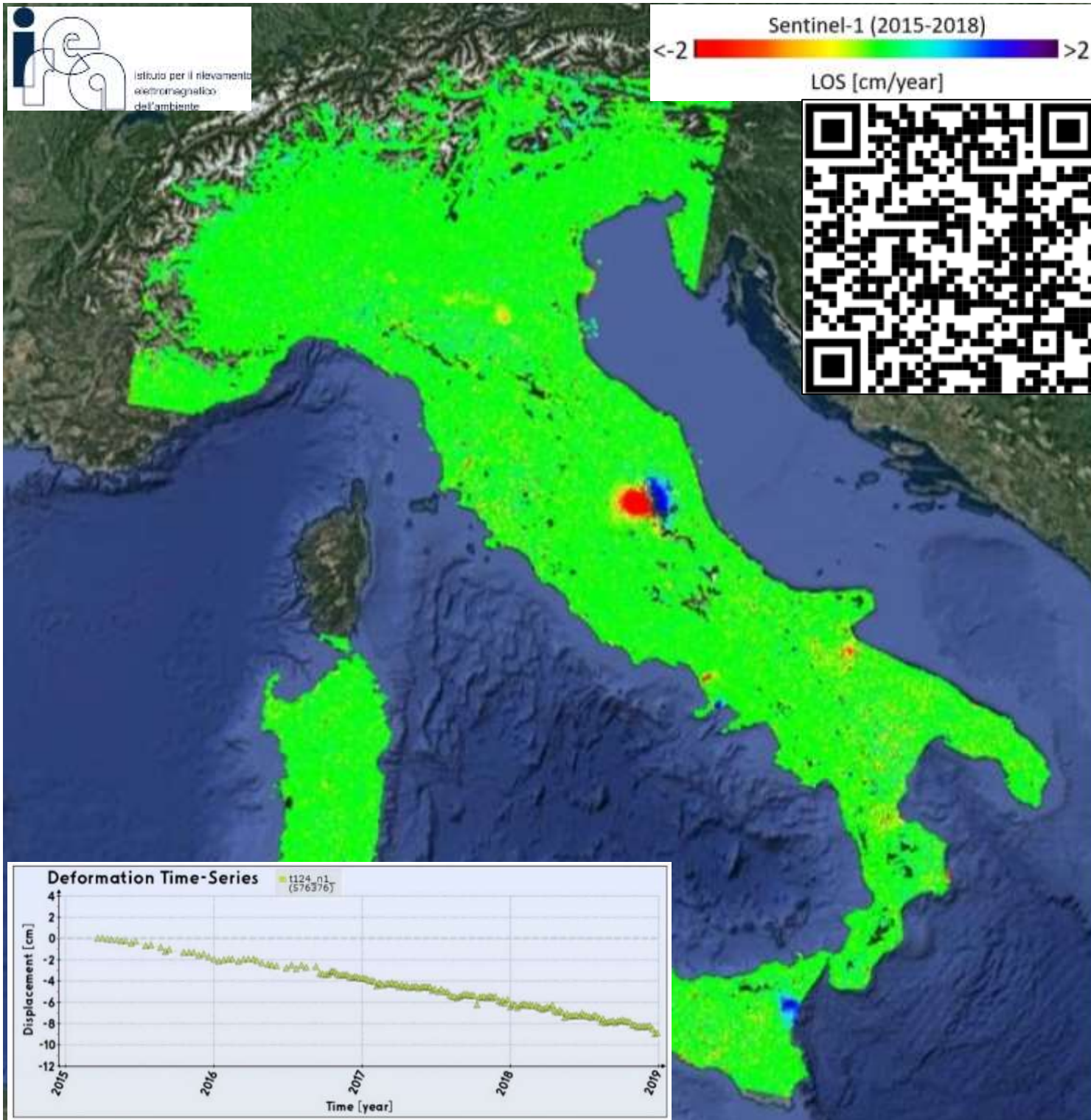
Early warning system based on indicators of instabilities

05

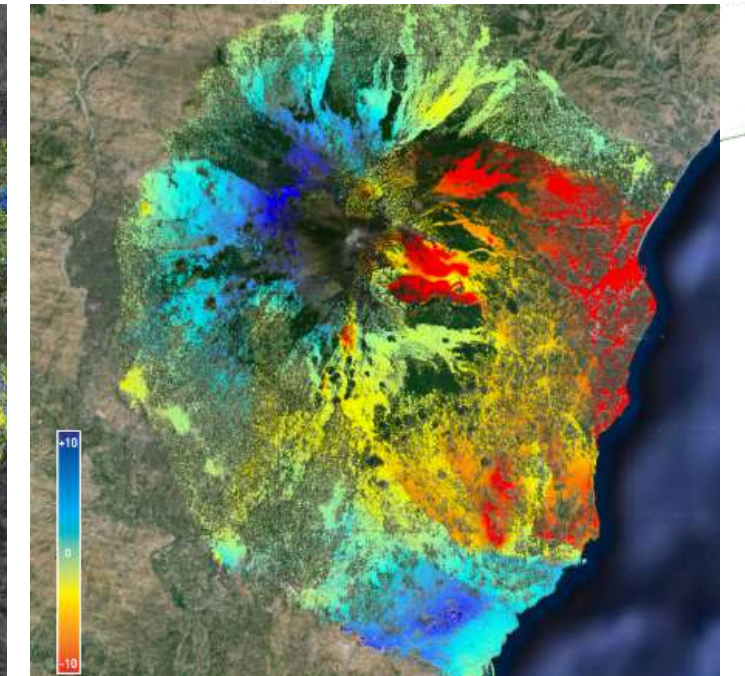
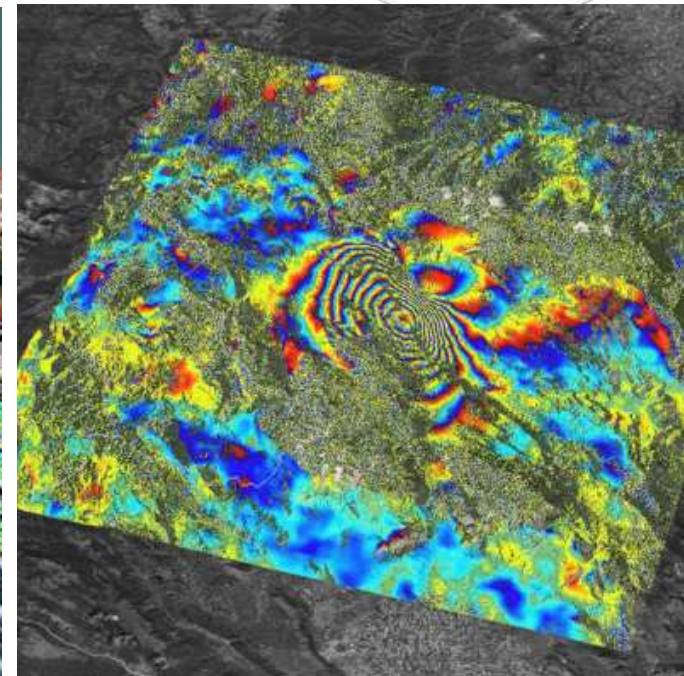
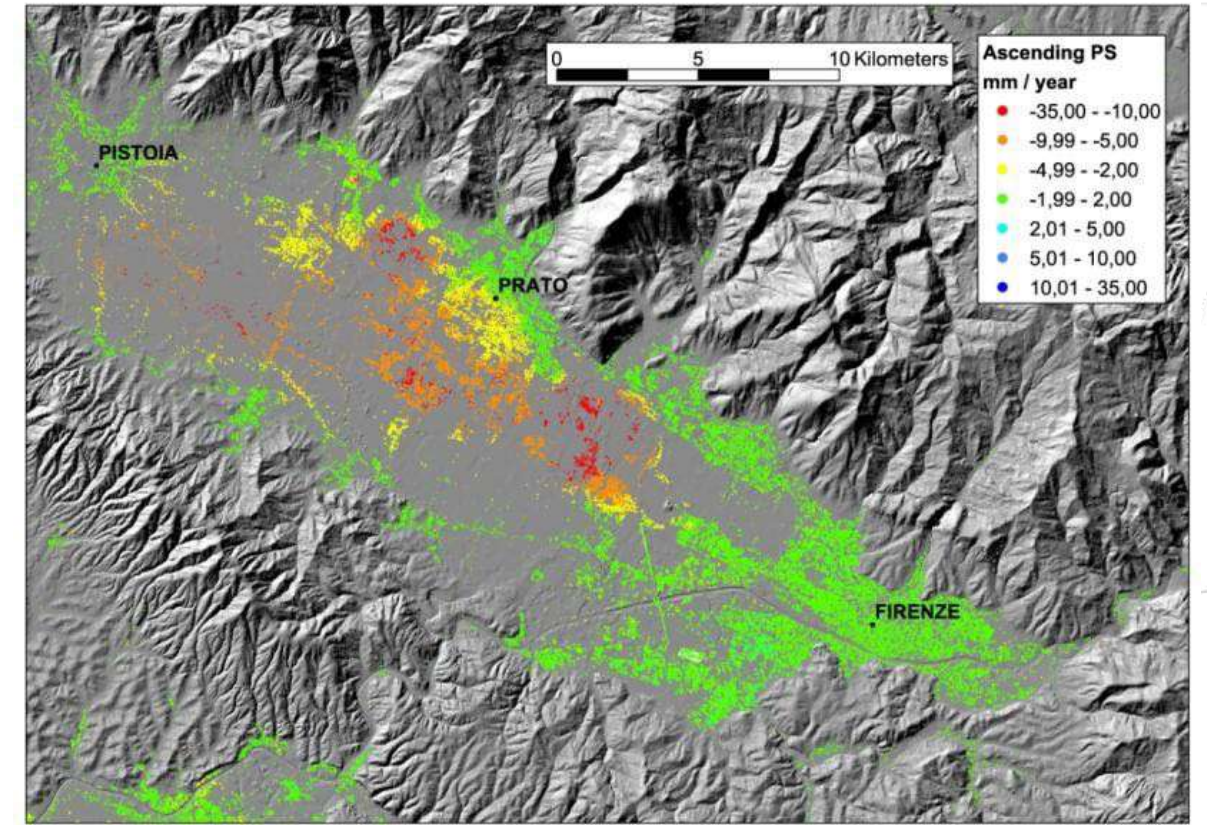
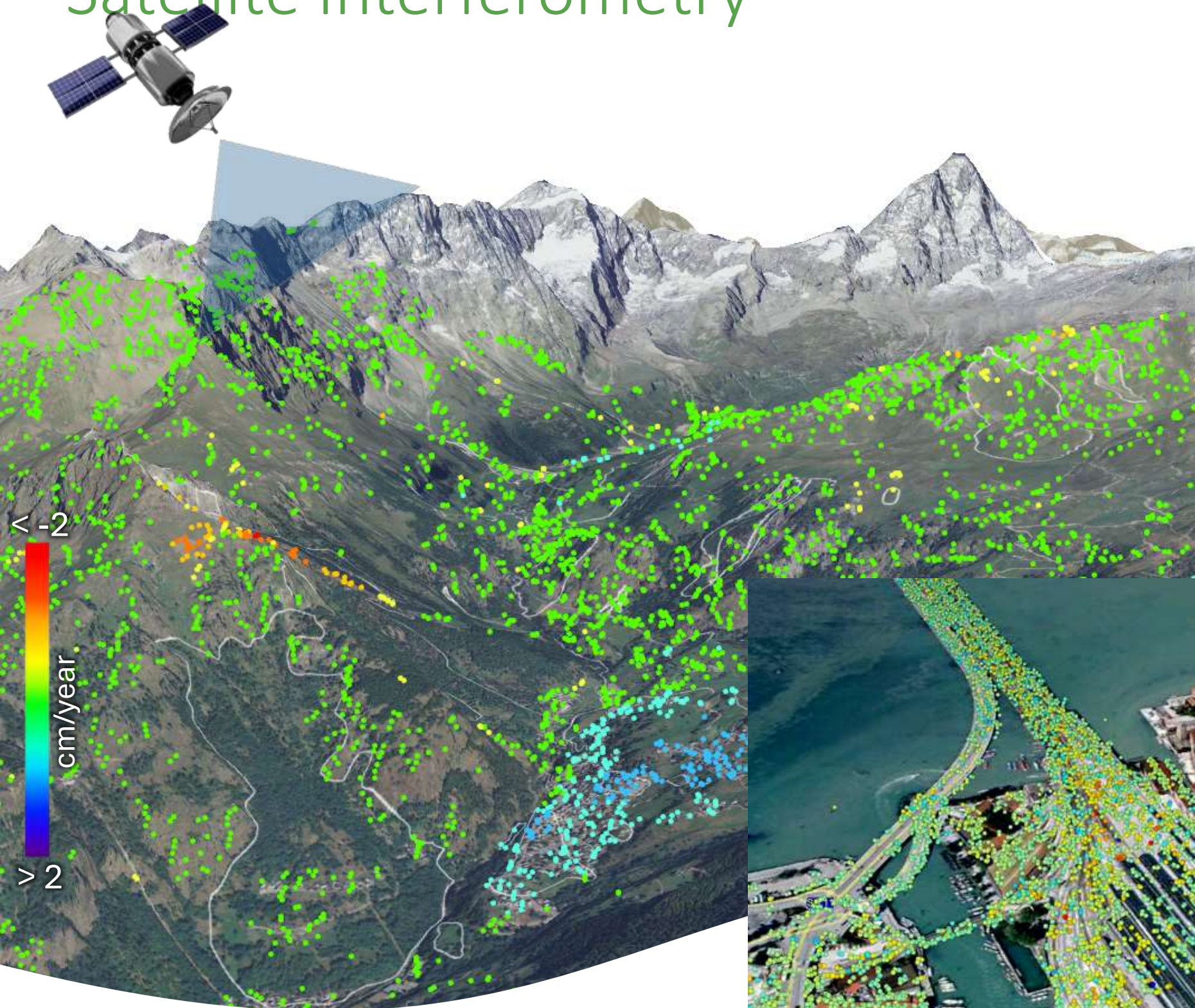
Data availability

Open portal and web application for data access and management

Satellite Interferometry



Satellite Interferometry

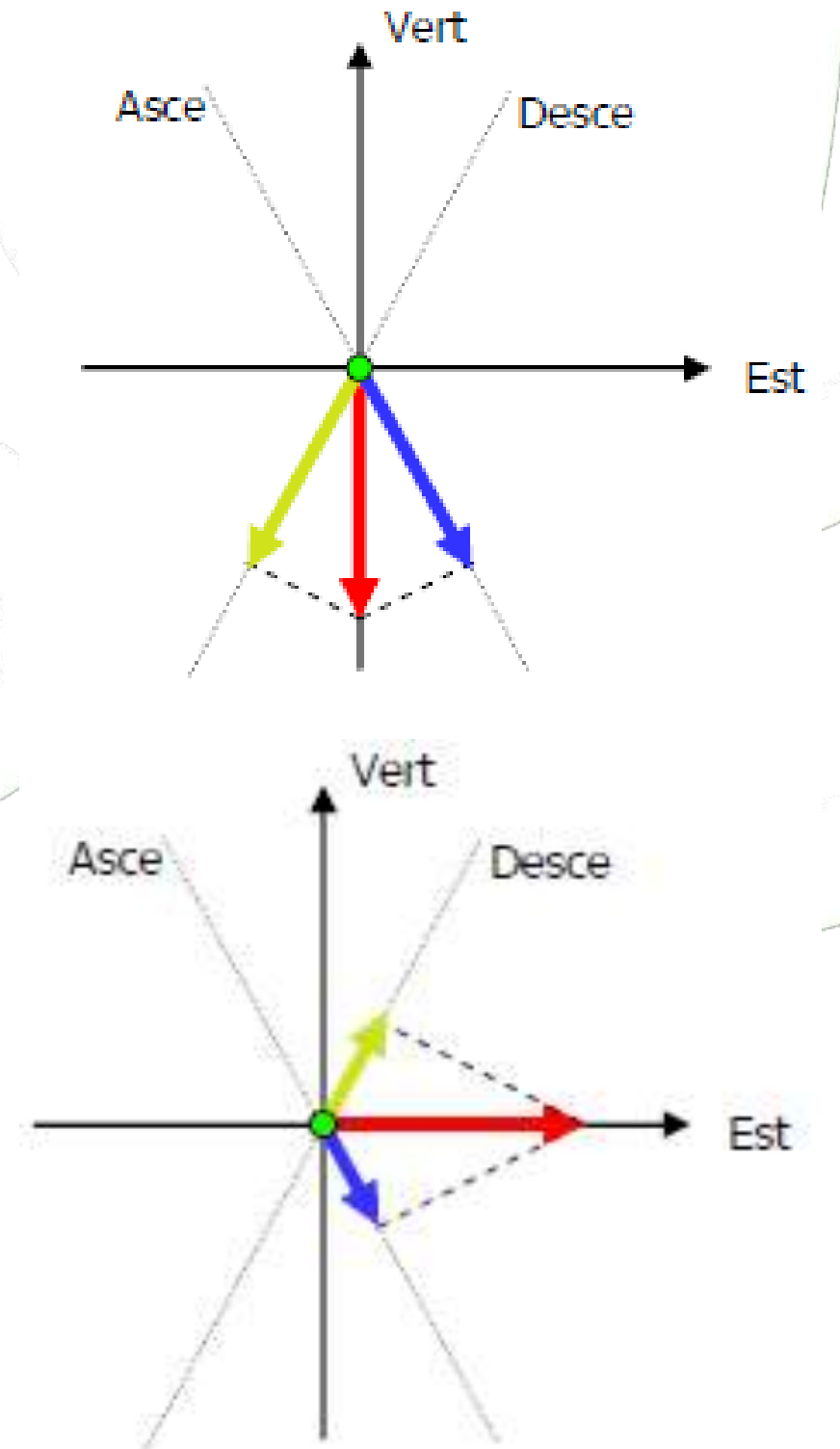
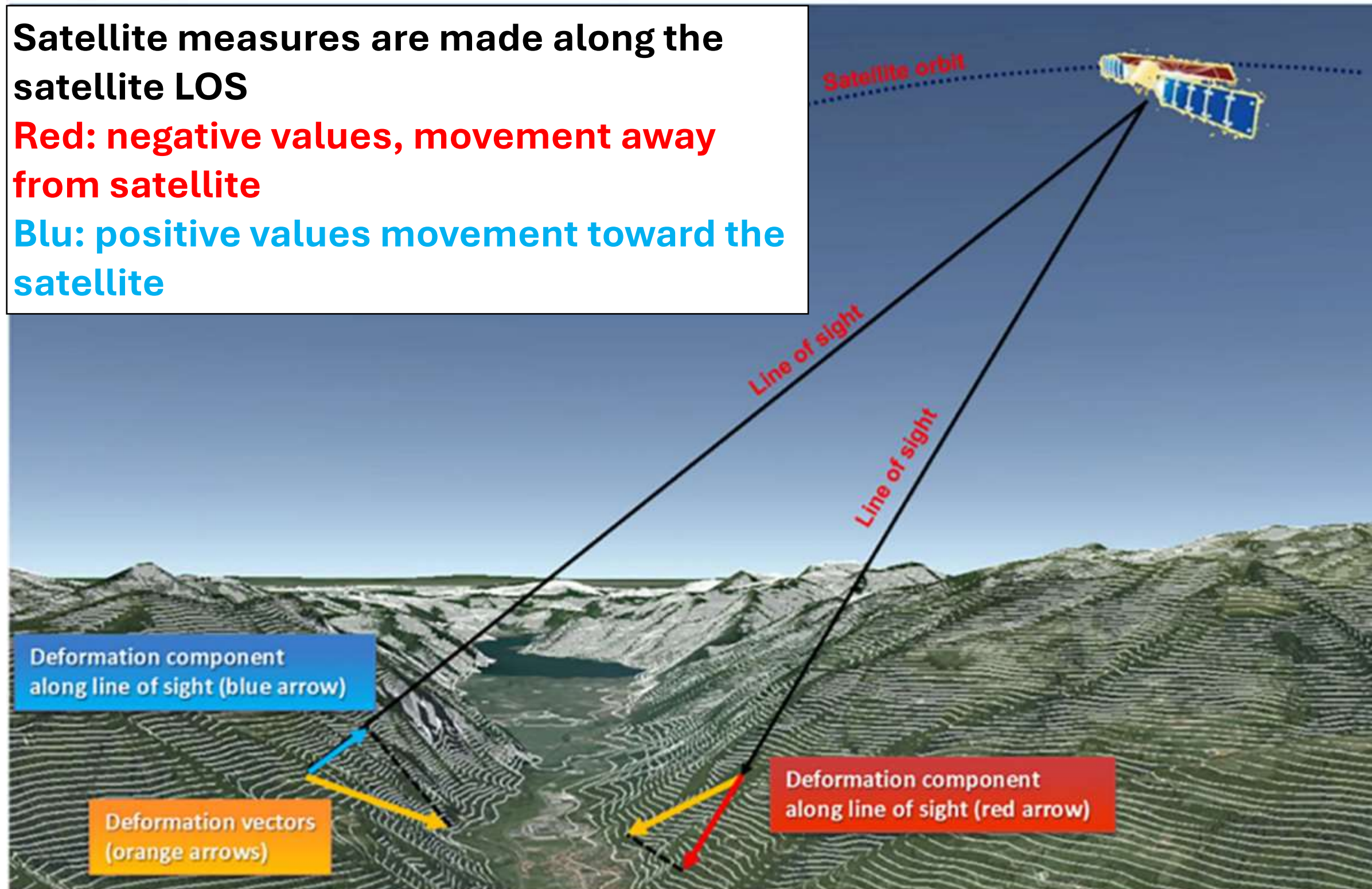


Satellite Interferometry

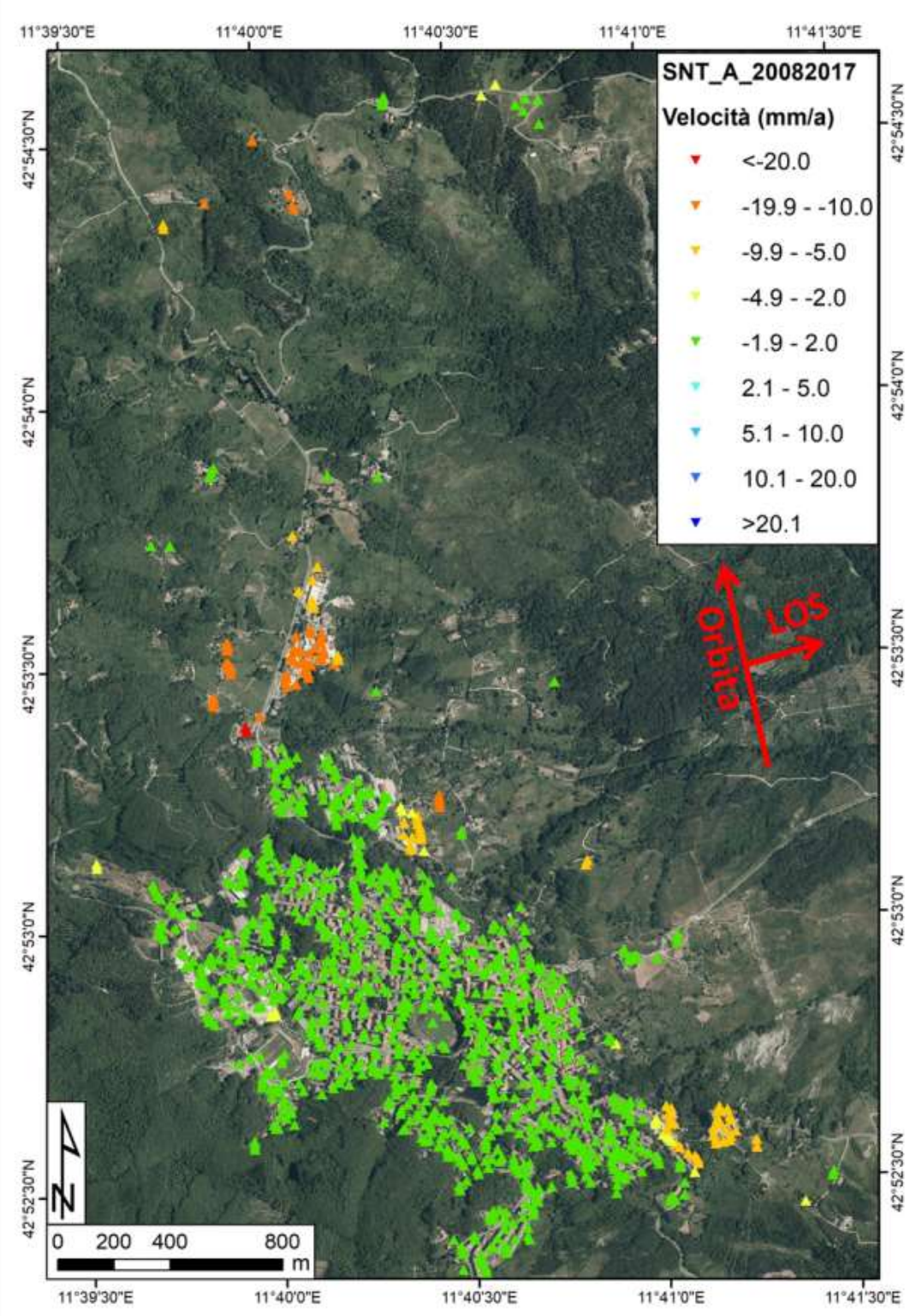
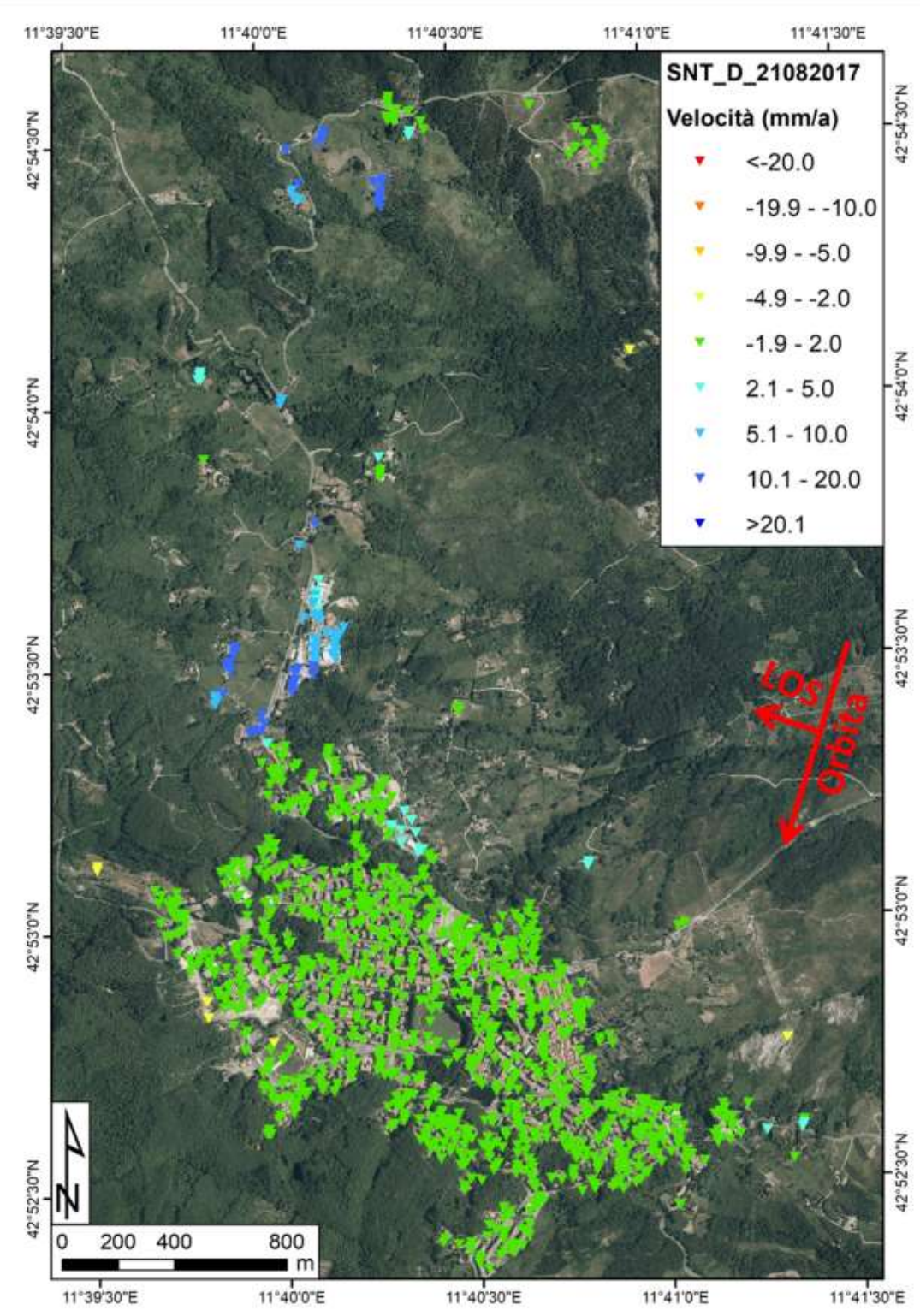
Satellite measures are made along the satellite LOS

Red: negative values, movement away from satellite

Blue: positive values movement toward the satellite



Satellite Interferometry

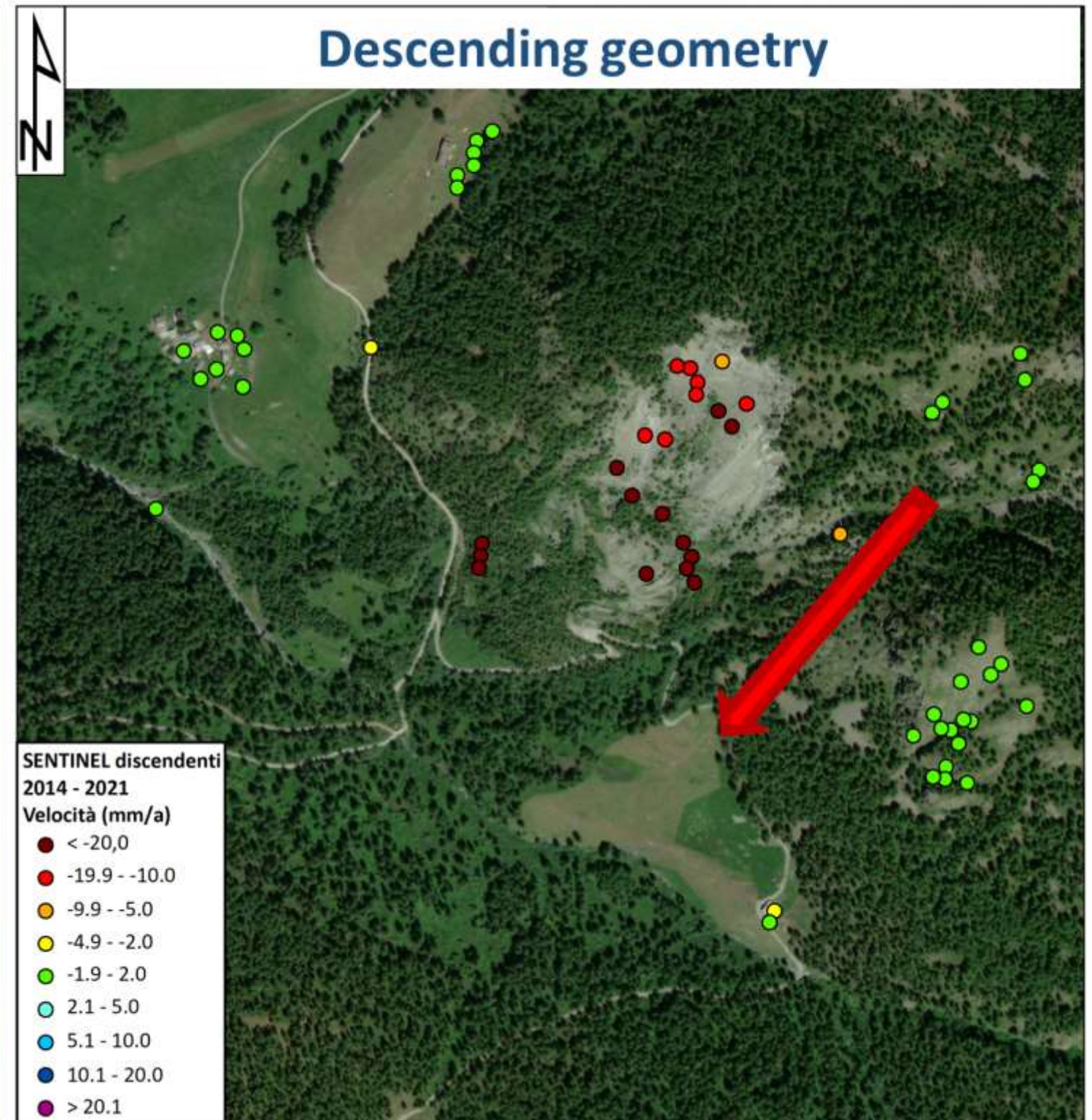
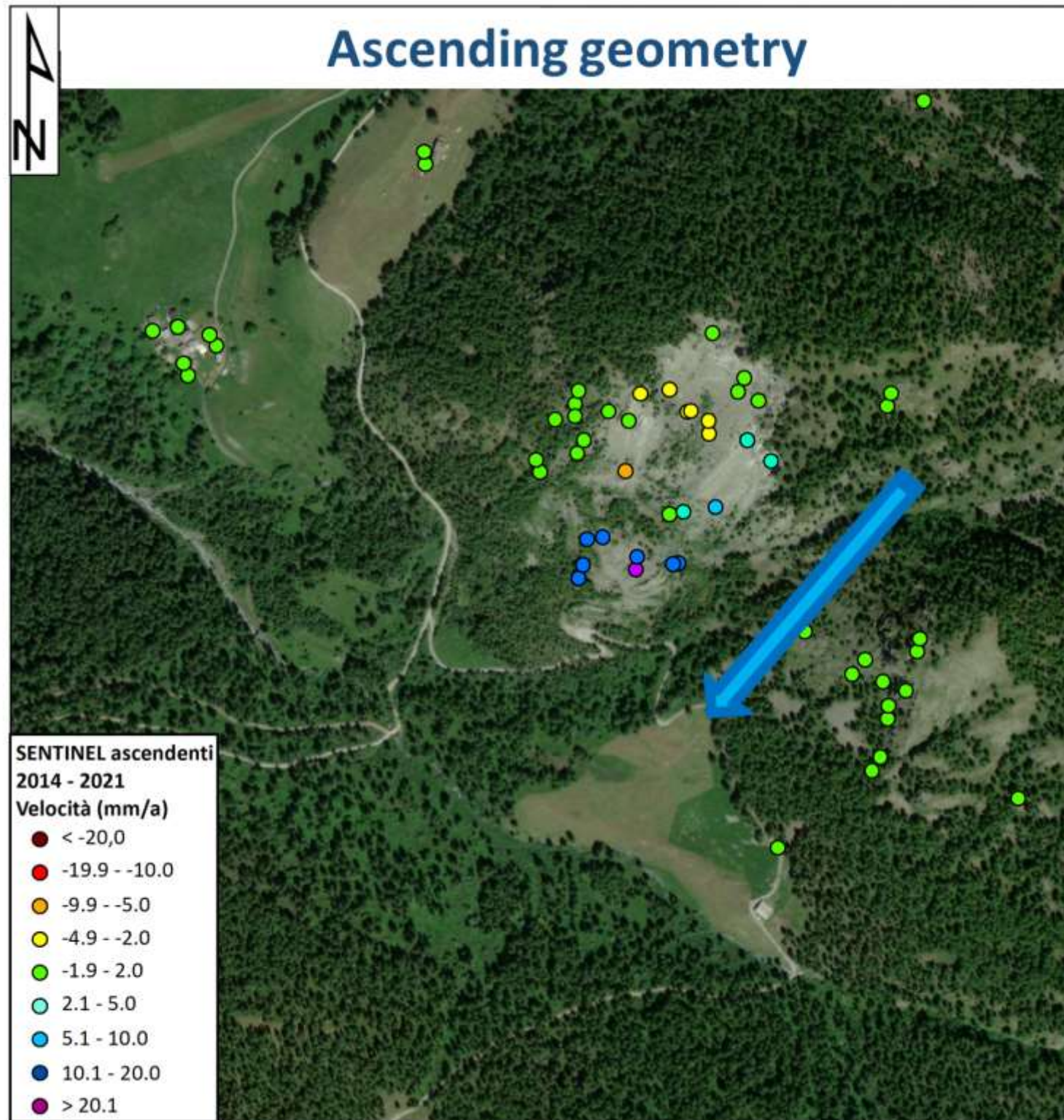


Output products: relative measurements

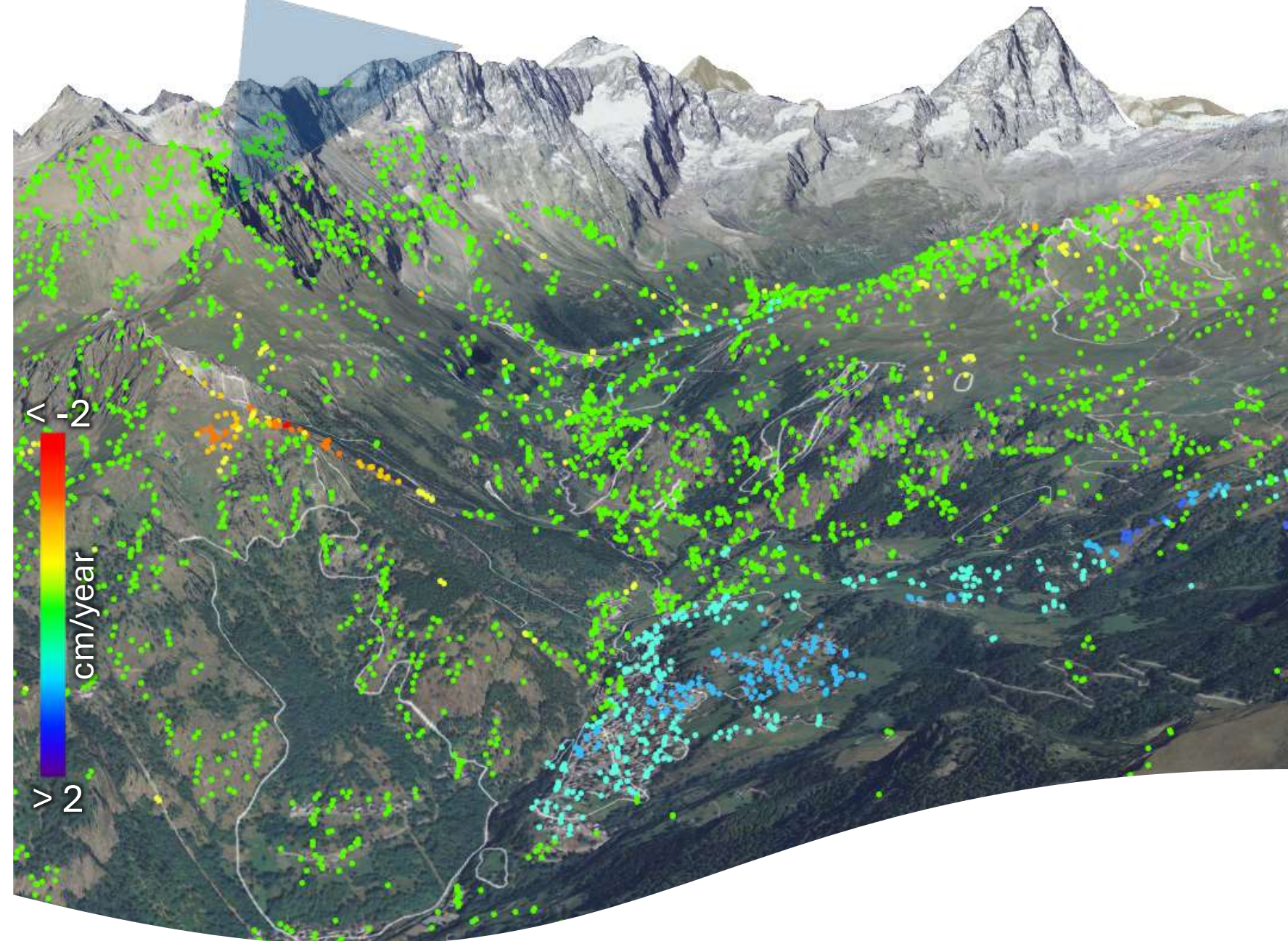
Satellite Interferometry



Satellite Interferometry



Satellite Interferometry



| Class | Velocity (<i>Cruden & Varnes, 1996</i>) |
|------------------------|---|
| <i>Extremely slow</i> | < 16 mm/yr |
| <i>Very slow</i> | 0,016 – 1,6 m/yr |
| <i>Slow</i> | 1,6 m/yr - 13 m/month |
| <i>Moderate</i> | 13 m/month – 1,8 m/h |
| <i>Rapid</i> | 1,8 m/h - 3 m/min |
| <i>Very rapid</i> | 3 m/min - 5 m/s |
| <i>Extremely rapid</i> | > 5 m/s |

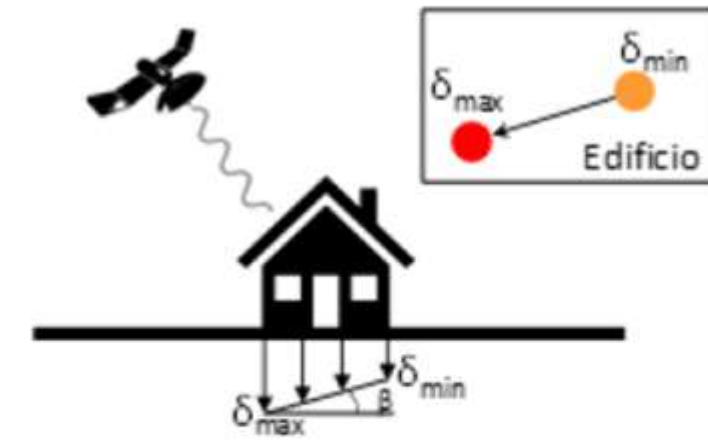
| Type of movement | Type of material | Interferometry applicability |
|--------------------------|--------------------------|------------------------------|
| <i>Fall</i> | <i>Rock/debris/earth</i> | NO |
| <i>Toppling</i> | <i>Rock/debris/earth</i> | NO |
| <i>Slide</i> | <i>Debris/earth</i> | YES |
| | <i>Rock</i> | YES |
| <i>Flow</i> | <i>Earth</i> | <i>Partially</i> |
| | <i>Debris</i> | NO |
| <i>Lateral spreading</i> | <i>Rock/debris/earth</i> | <i>Partially</i> |



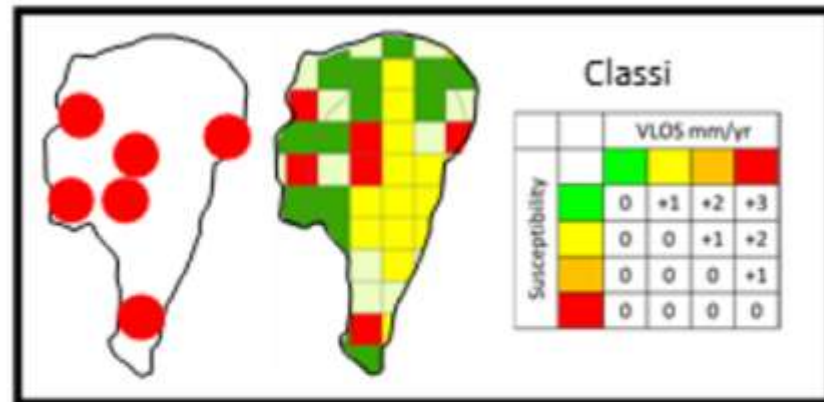
Local scale monitoring for single landslide



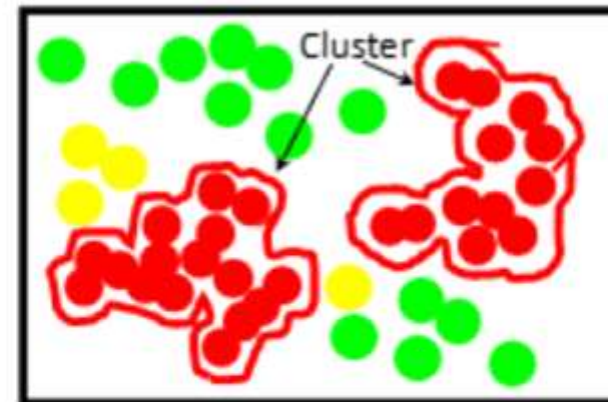
Updating of landslide inventory



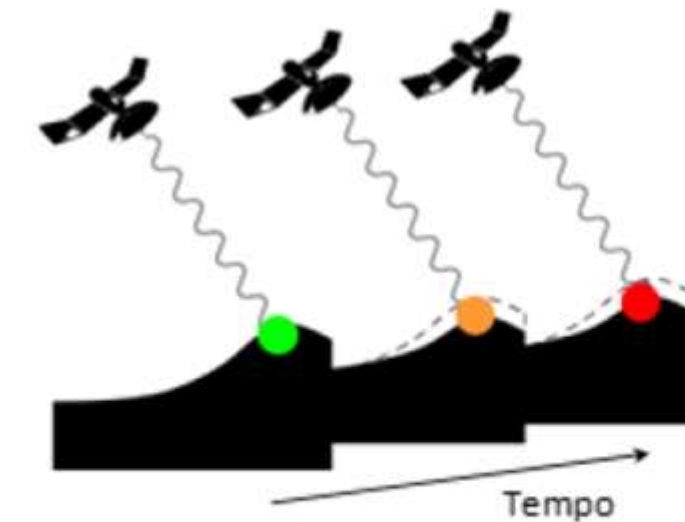
Analysis of differential settlement



Landslide intensity assesment
Landslide susceptibility



Hot spot mapping at wide scale



Continuous monitoring.
Anomalies detection

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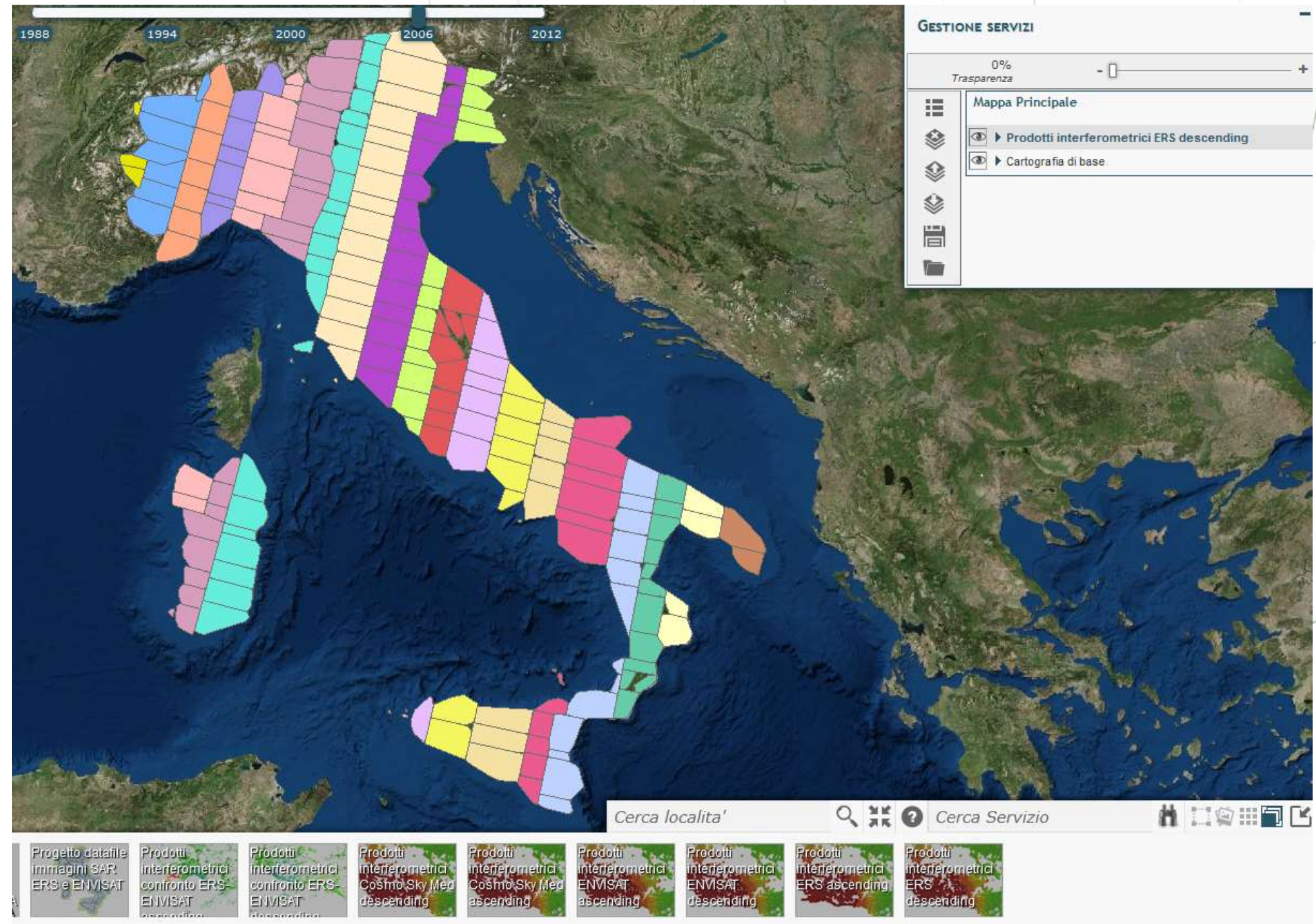
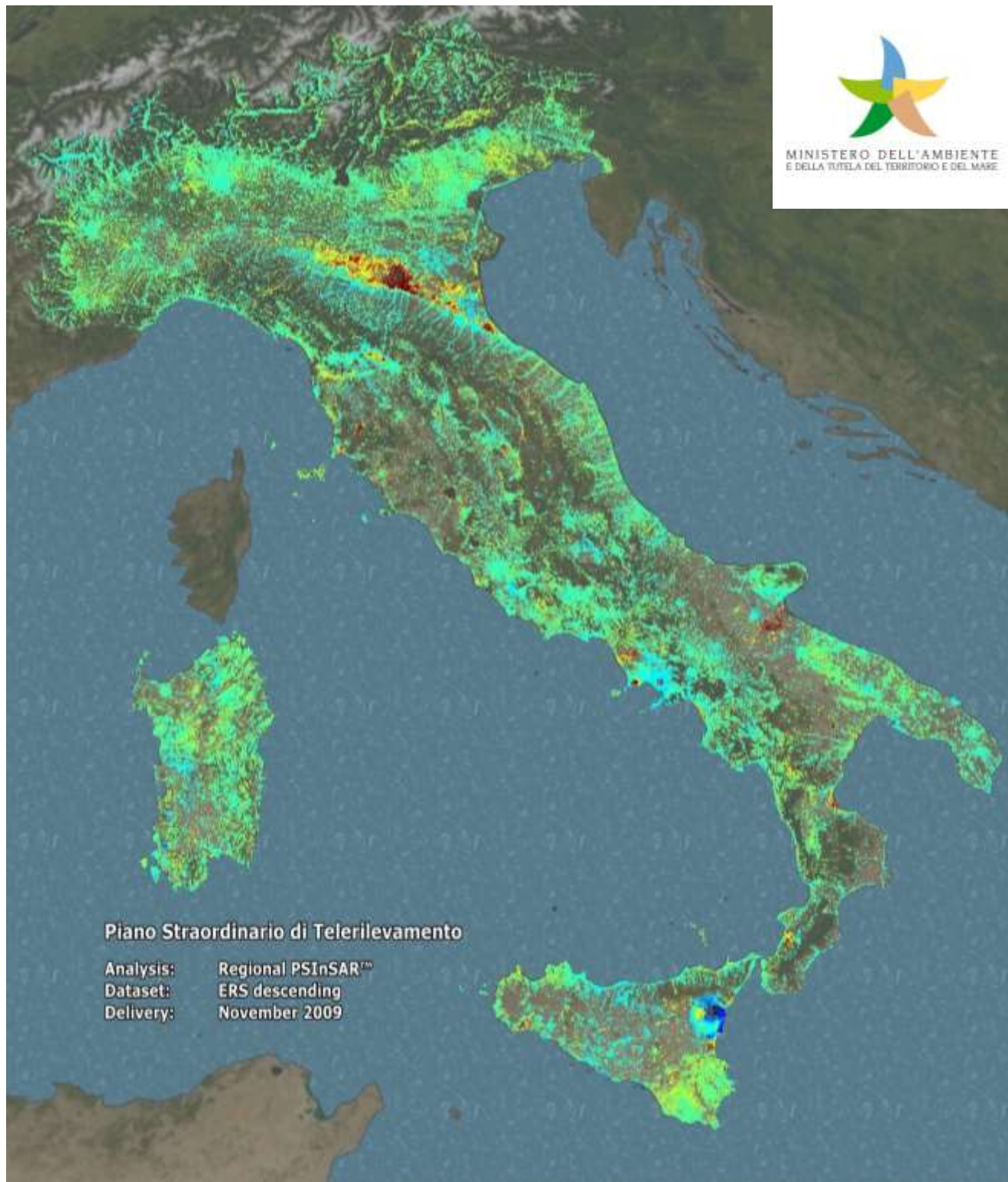
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Data availability

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The past: archive elaboration



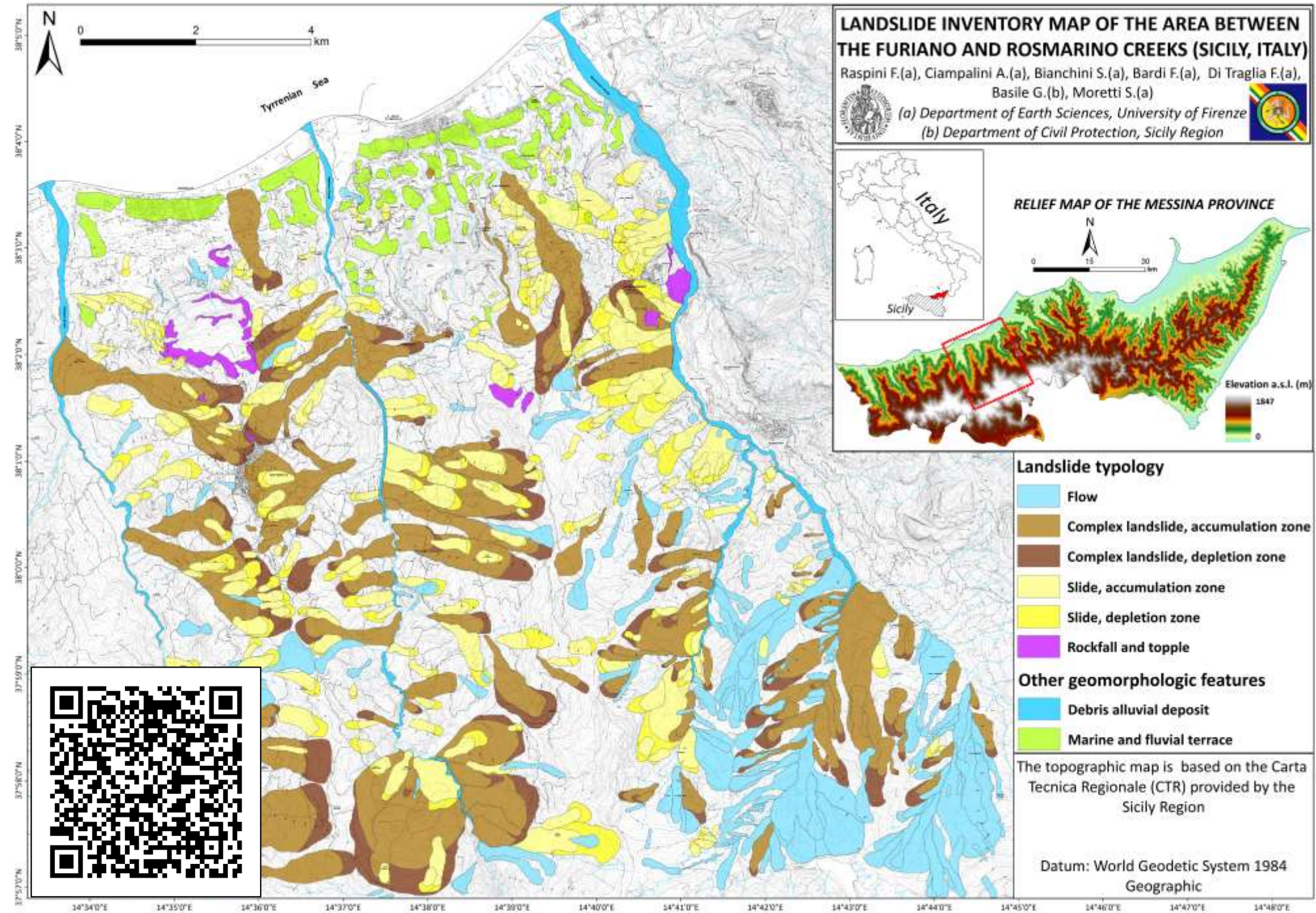
<http://www.pcn.minambiente.it/viewer/>

The past: archive elaboration

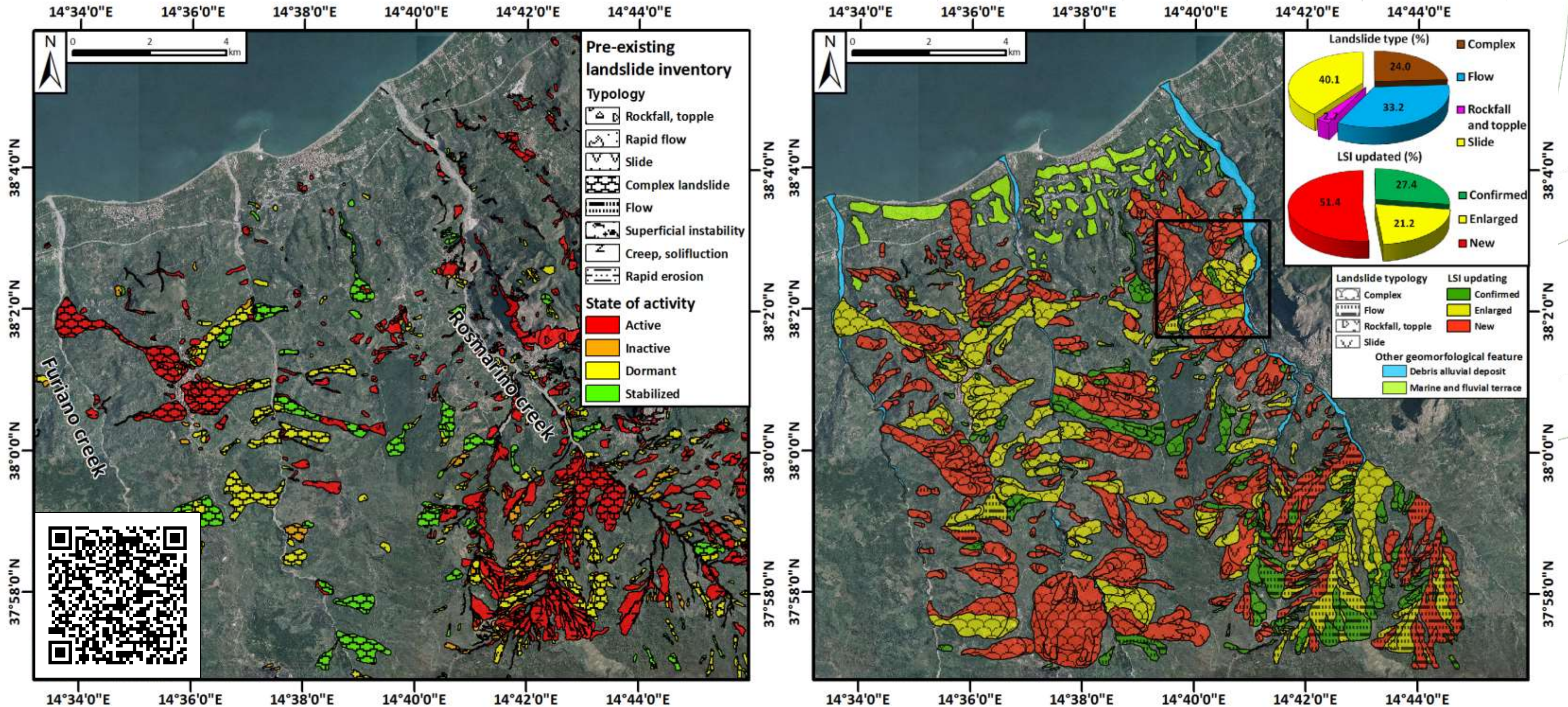
Italy



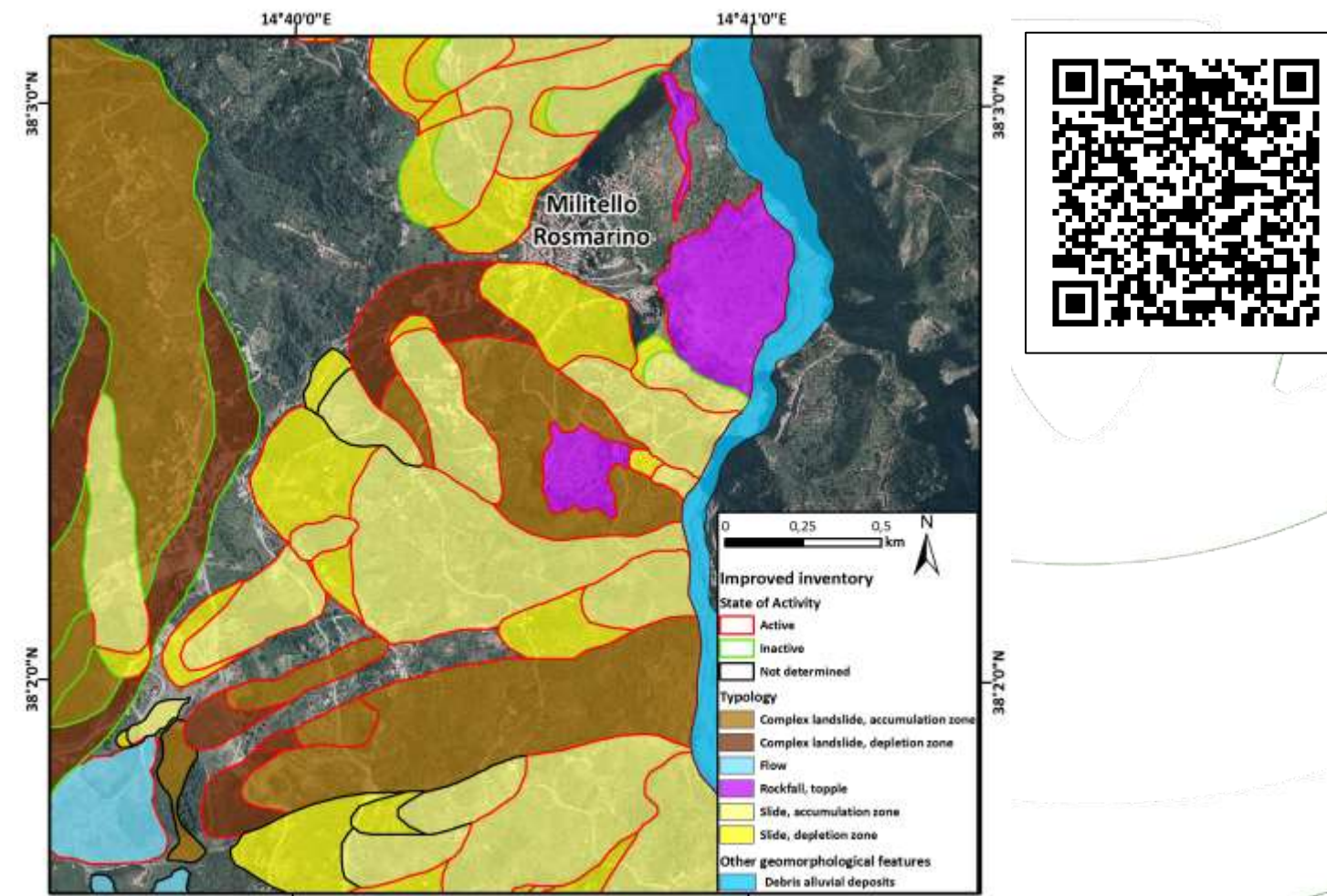
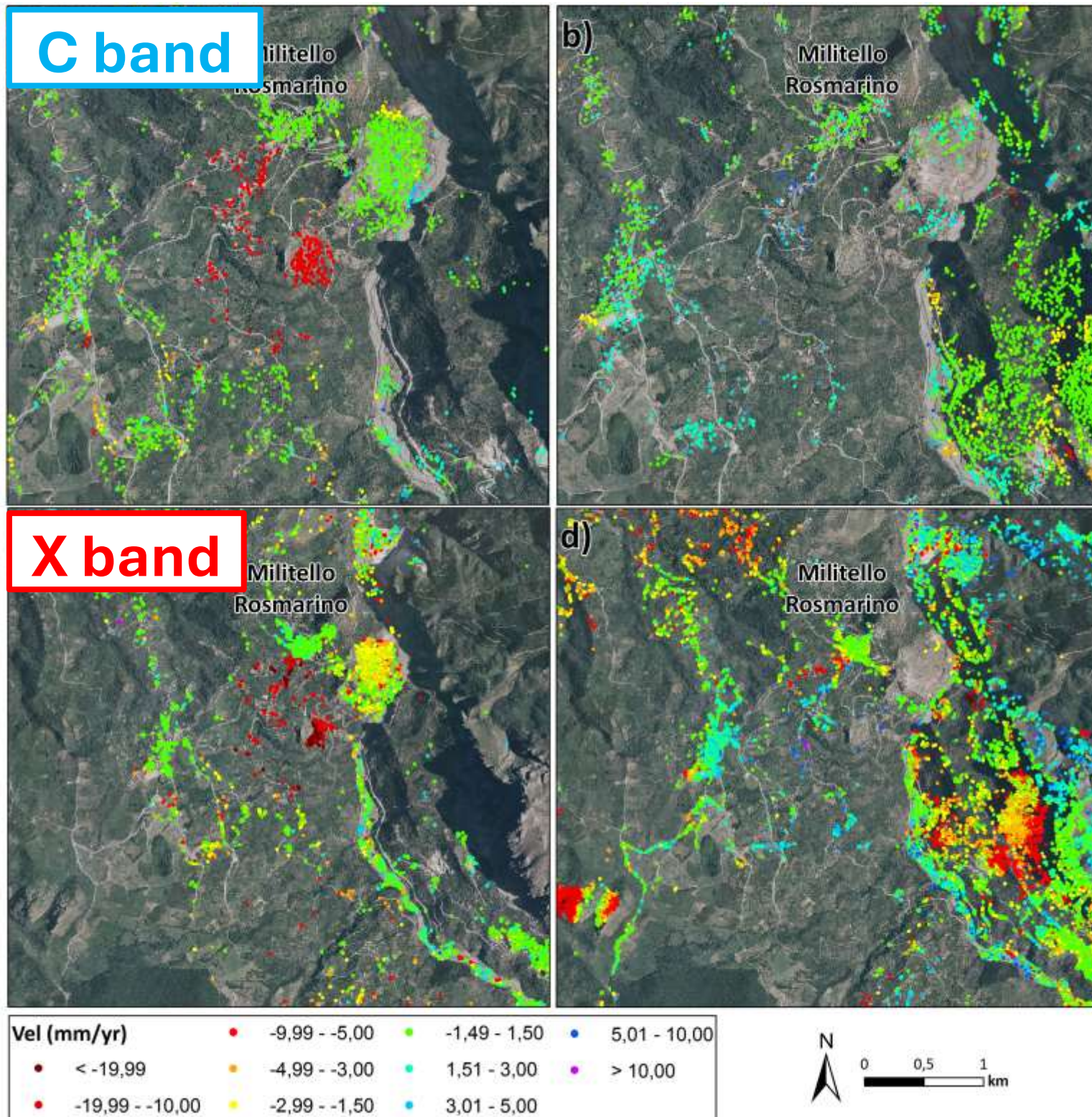
InSAR data for the update of regional landslide inventory maps



The past: archive elaboration



The past: archive elaboration



| Land use | Satellite interferometry applicability | | |
|---|--|--------------------|-------------------|
| | X band (3.1 cm) | C band (5.6 cm) | L band (23 cm) |
| <i>Artificial surfaces</i> | YES | YES | YES |
| <i>Agricultural surfaces, bare soil, rocky outcrops</i> | YES | YES | YES |
| <i>Forest and seminatural areas</i> | NO | NO | YES |
| <i>Wetlands and water bodies</i> | NO | NO | NO |

The past: archive elaboration

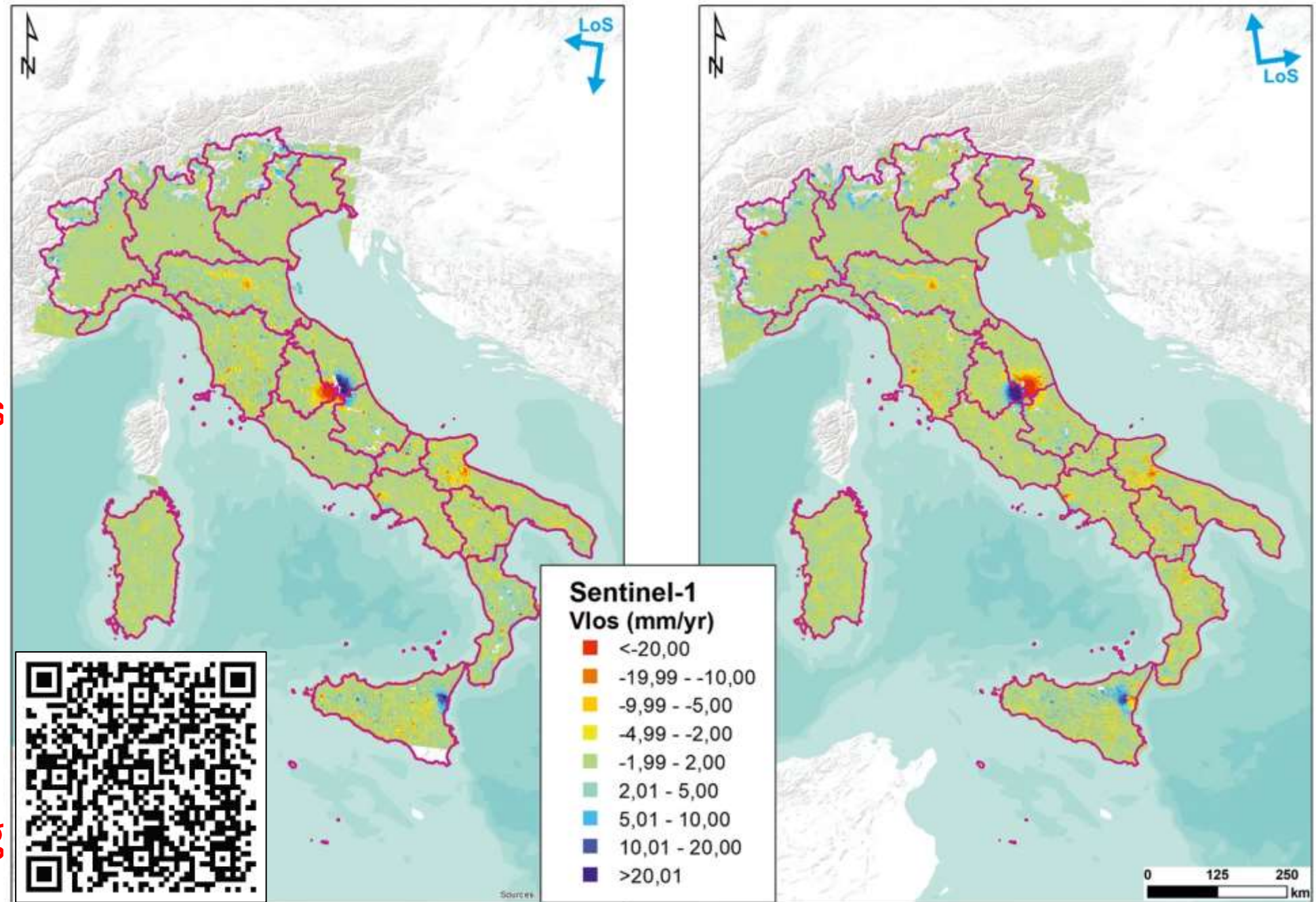
Italy



InSAR data for the update of national landslide inventory maps

Landslide risk areas
about 2 millions
of mapped
landslides

Social impact
(100 years)
About 4000
events affecting
people

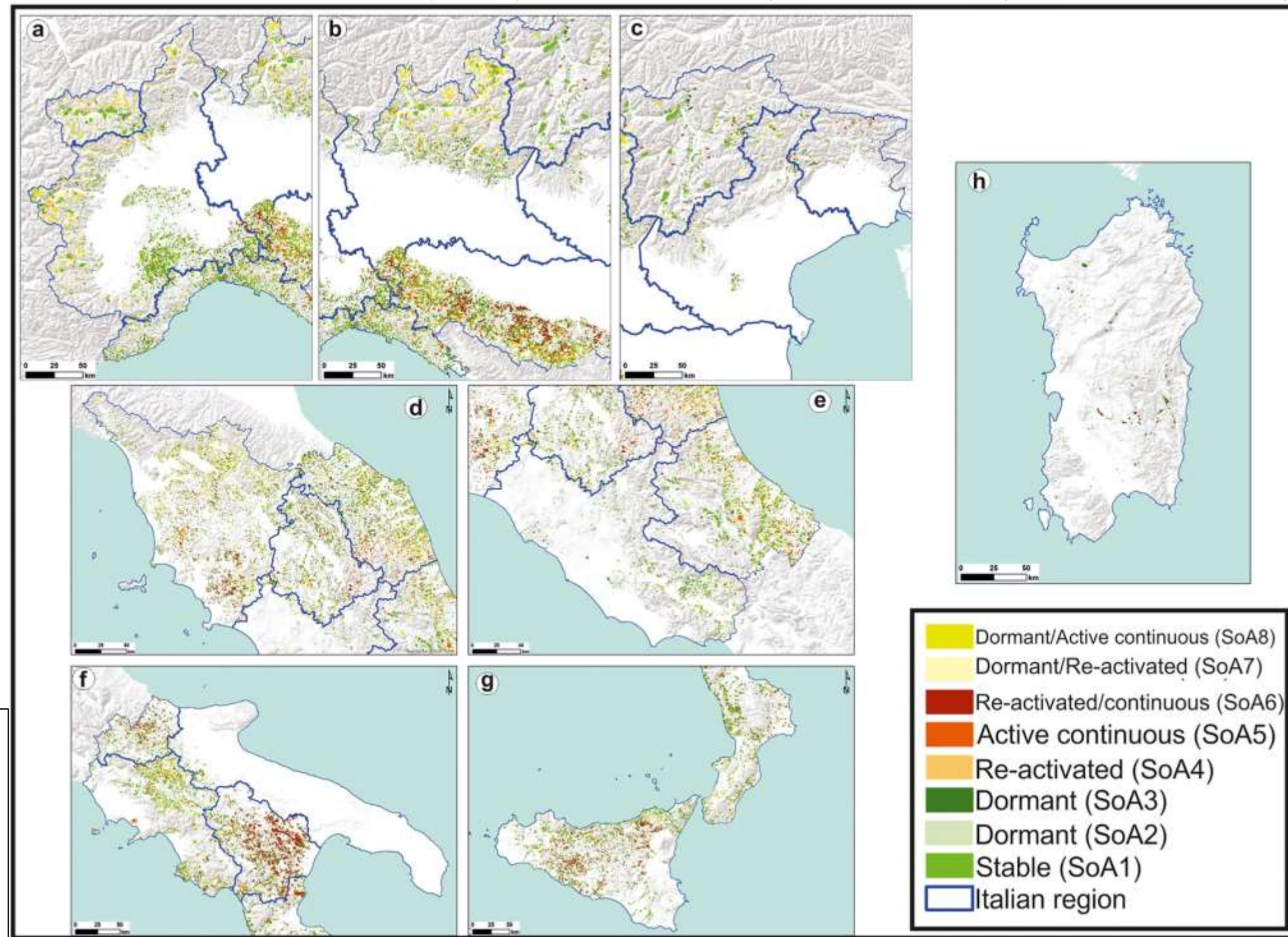
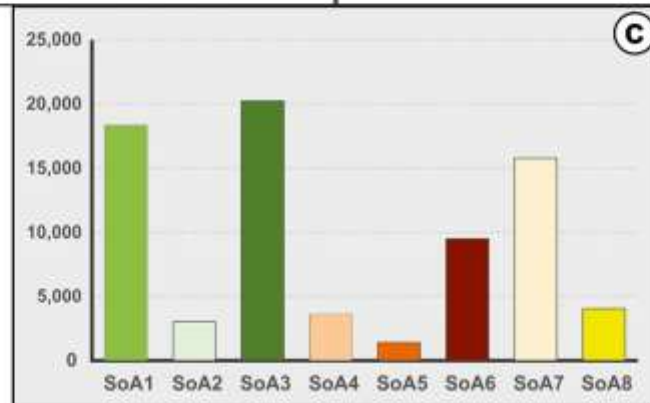
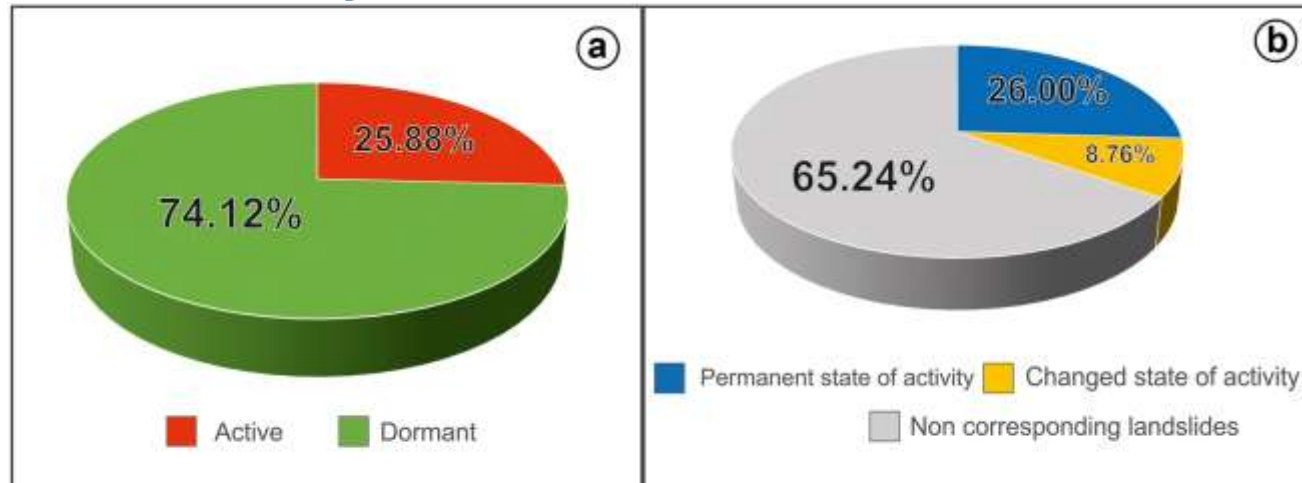


The past: archive elaboration

Italy



InSAR data for the update of state of activity



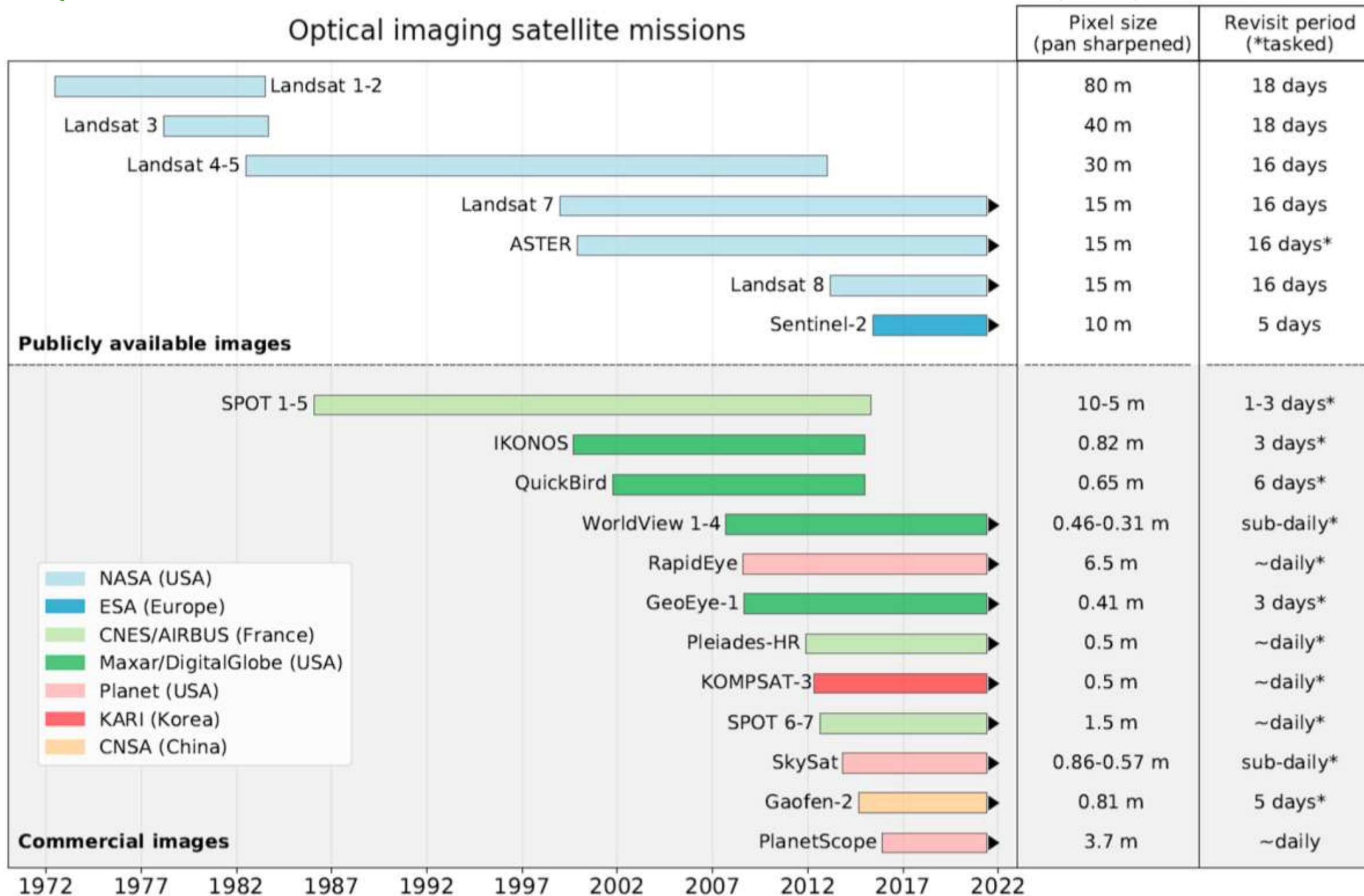
56,000 landslides
26% were classified as active

The past: archive elaboration

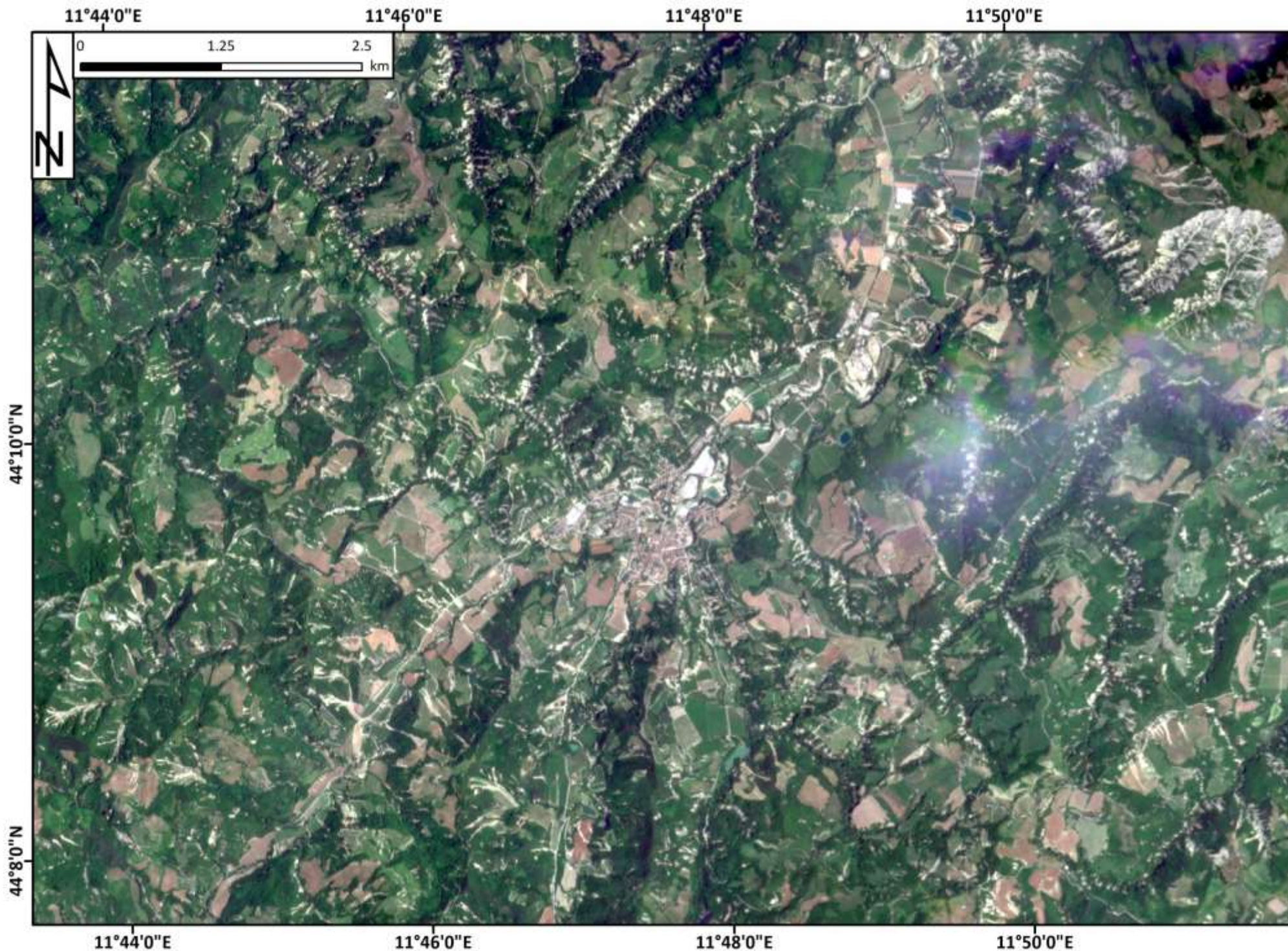
Italy



The past: archive elaboration



The past: archive elaboration



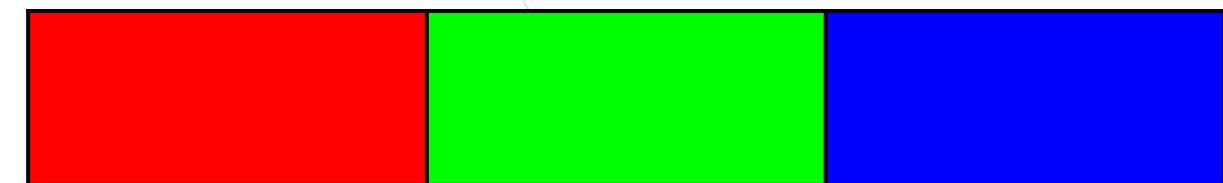
Planet images

Resolution: 3x3 m

Pre-event: 27 April 2023

Post event: 23 June 2023

True color composit

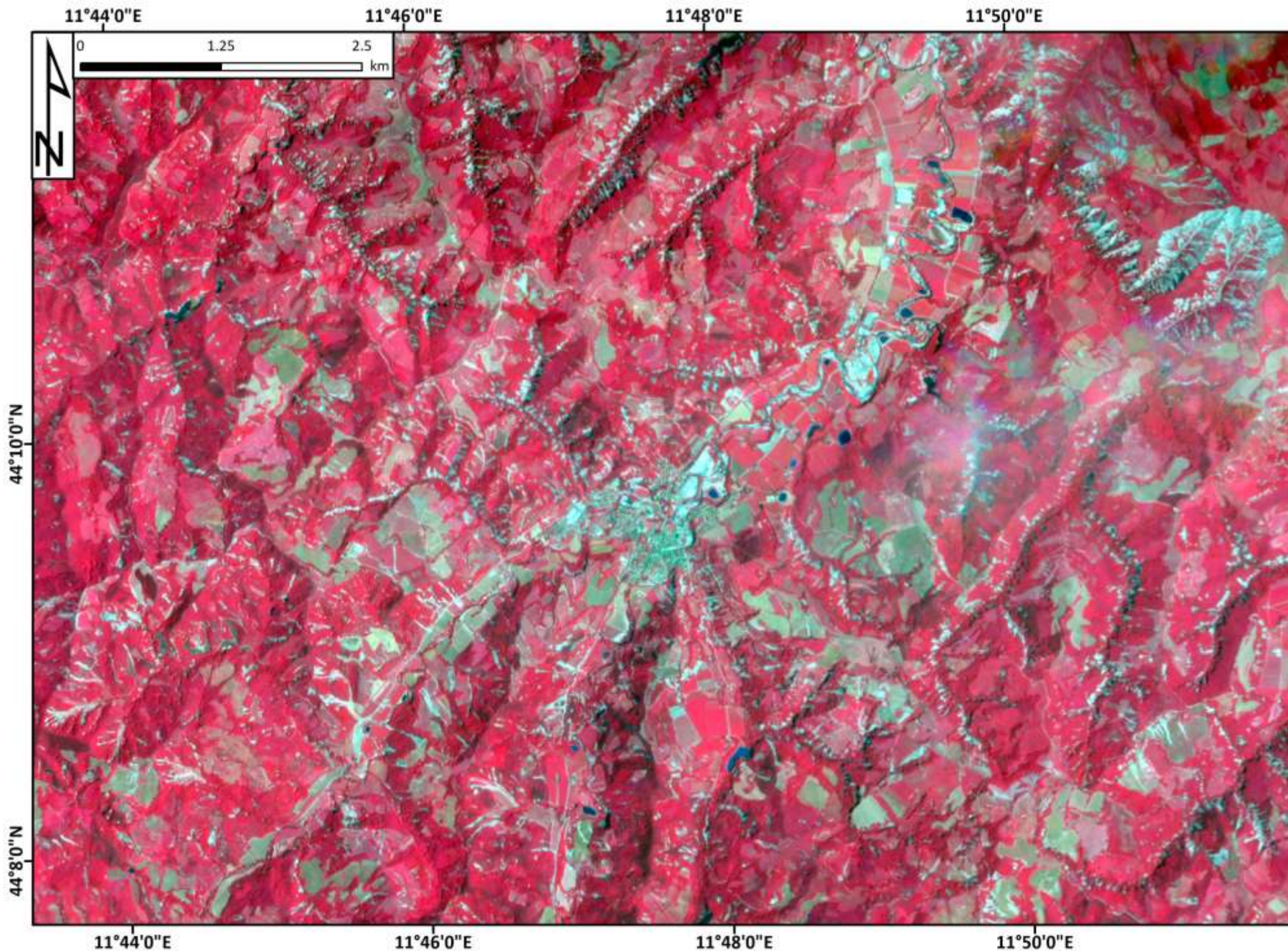


Red

Green

Blue

The past: archive elaboration



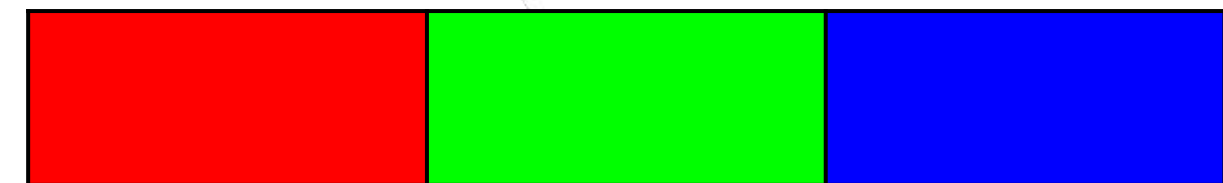
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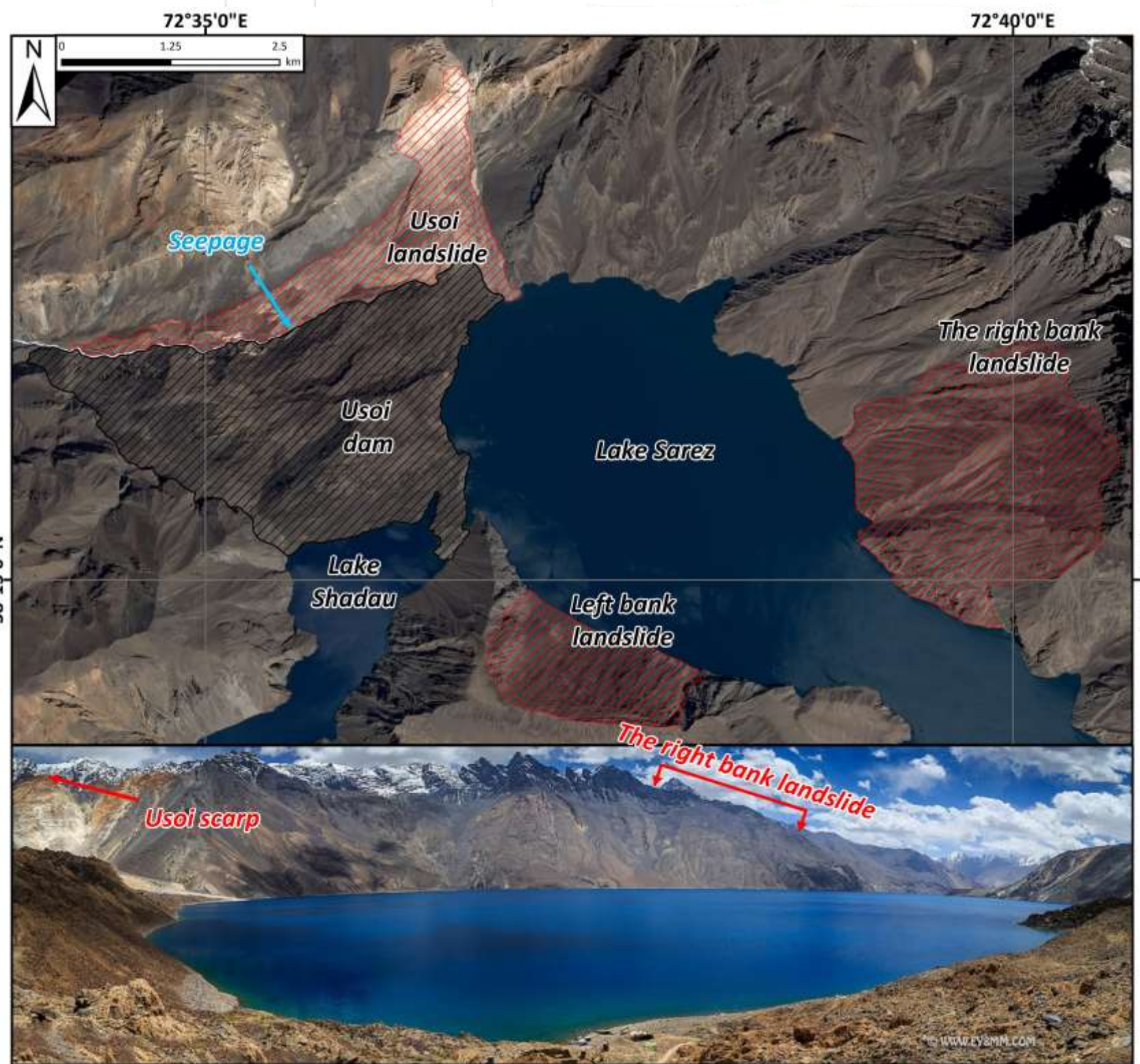
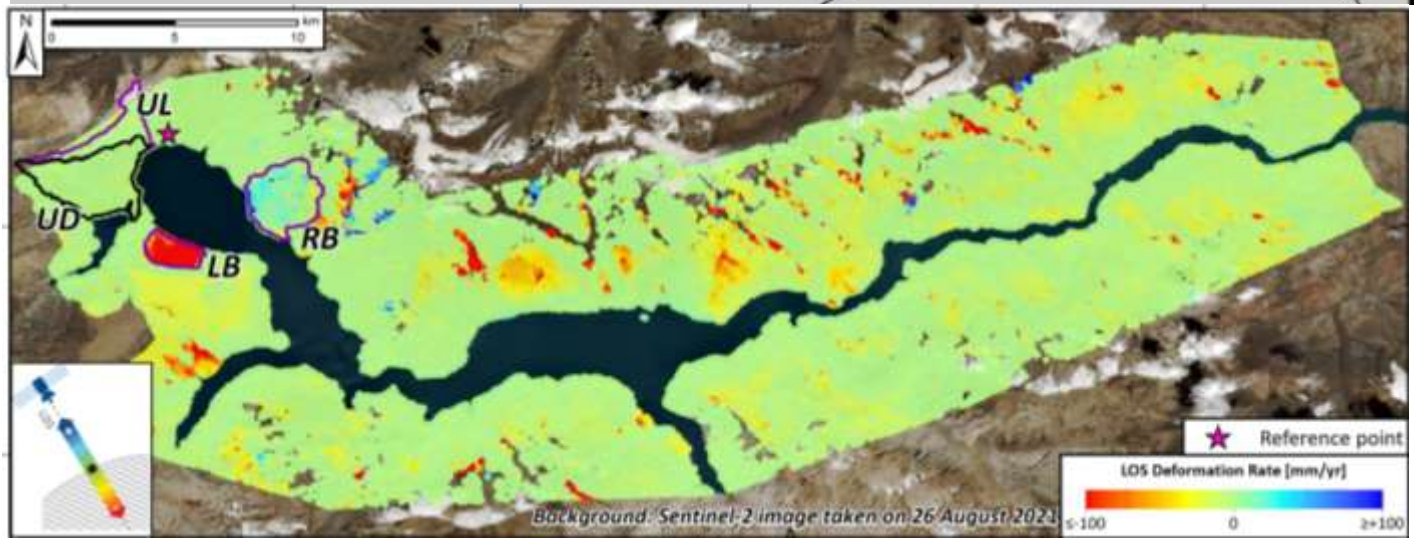
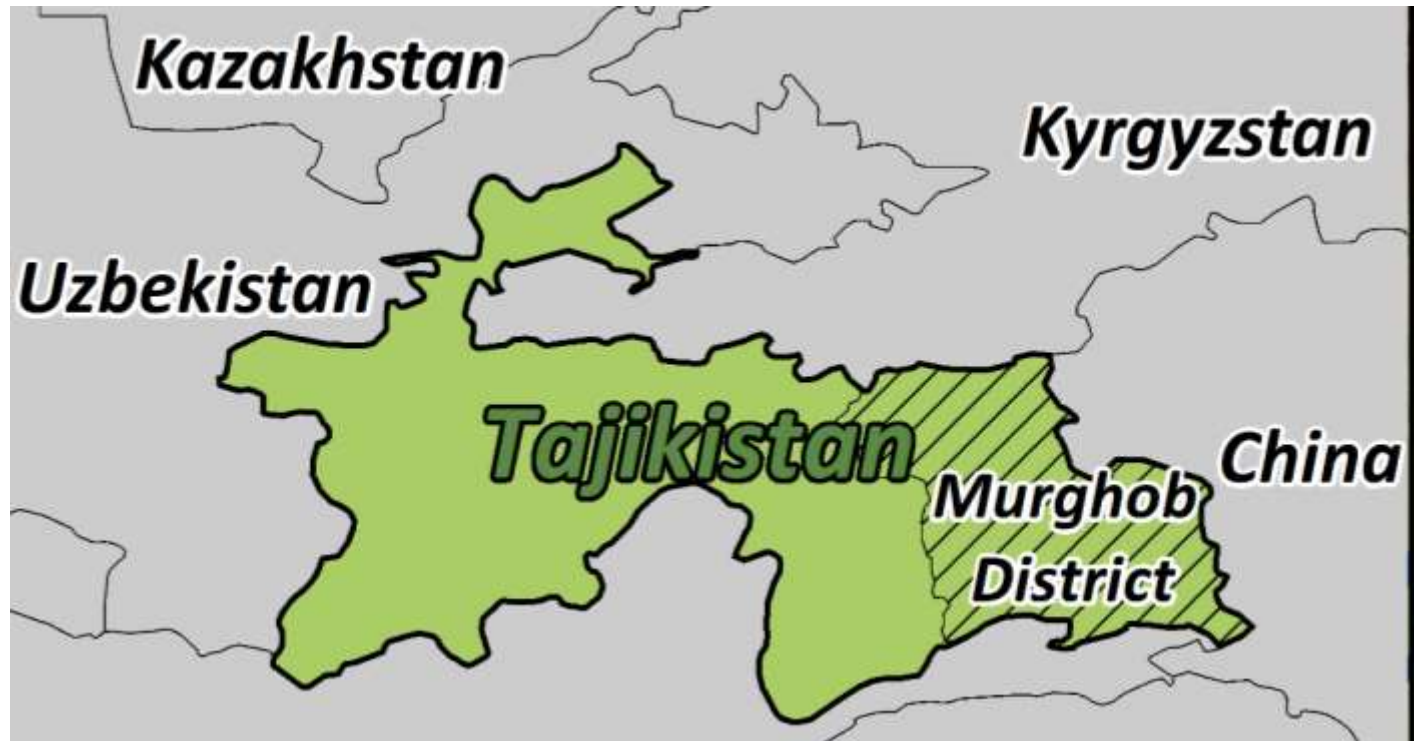
NIR

Red

Green

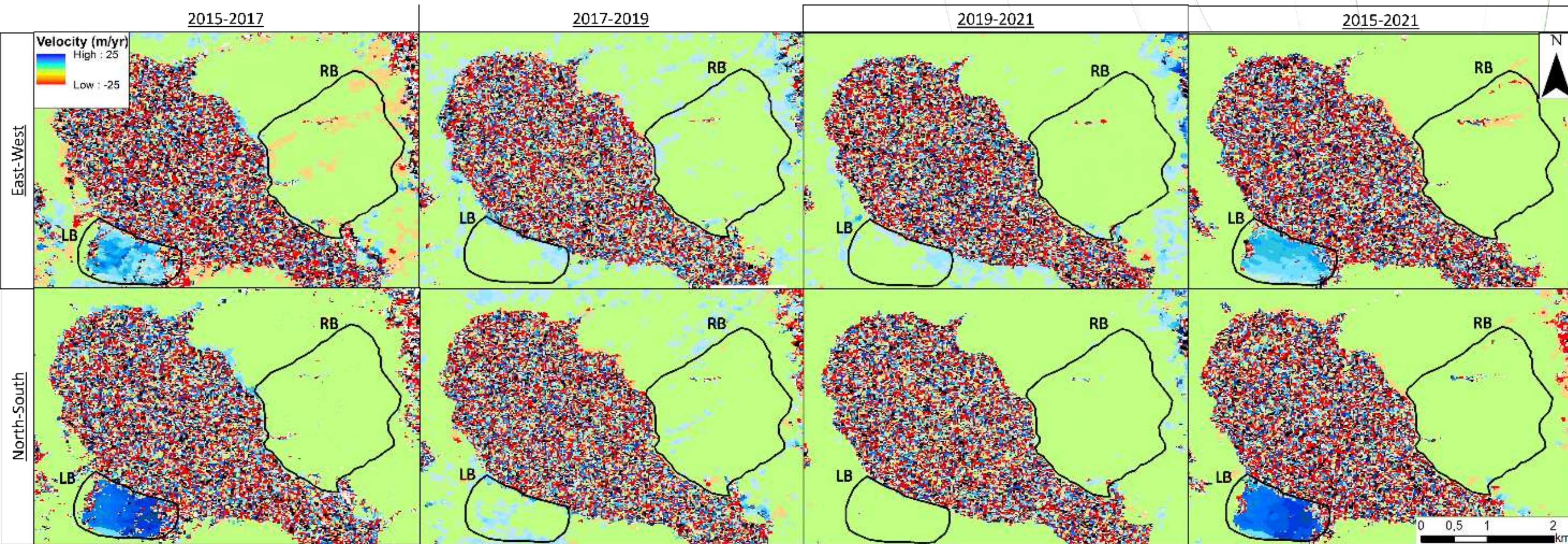
The past: archive elaboration

Lake Sarez landslide (Tajikistan)



The past: archive elaboration

Correlation of pairs of optical images. Four high-resolution (1.5 m) SPOT-6 and -7 optical images were chosen to identify the displacement of the area.

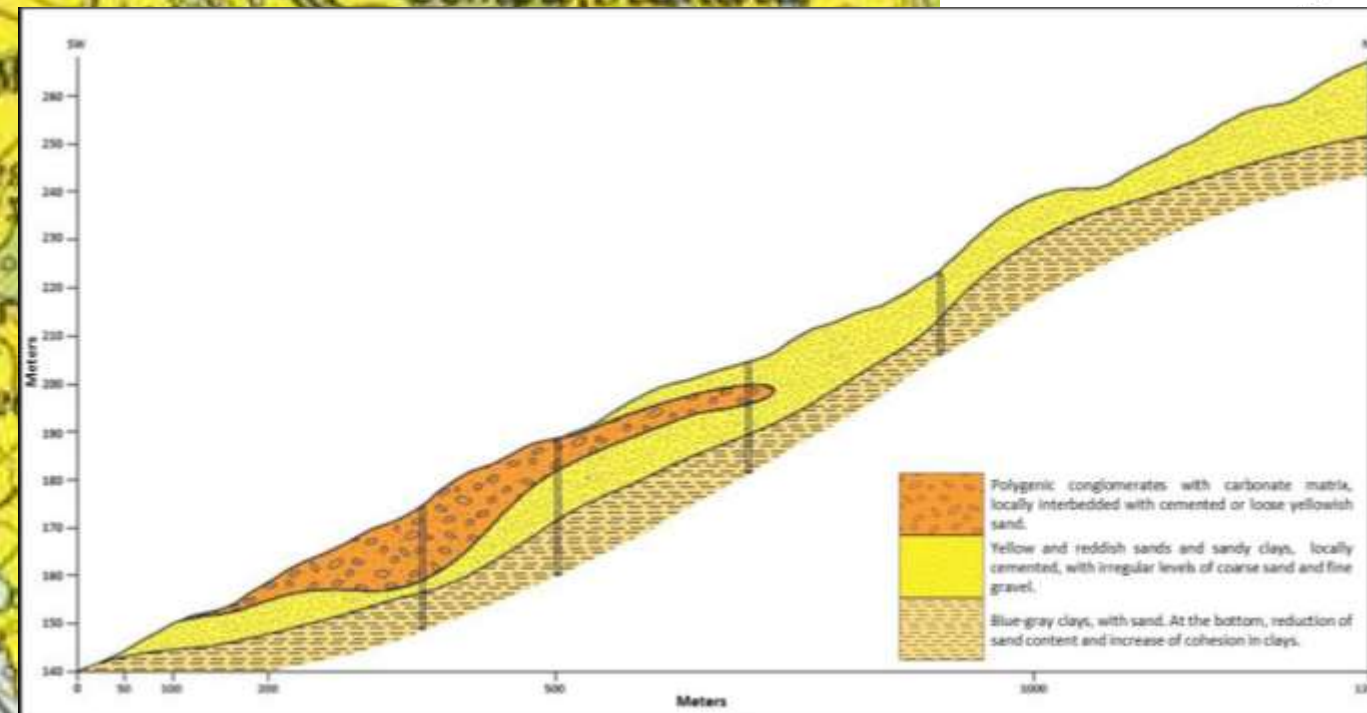
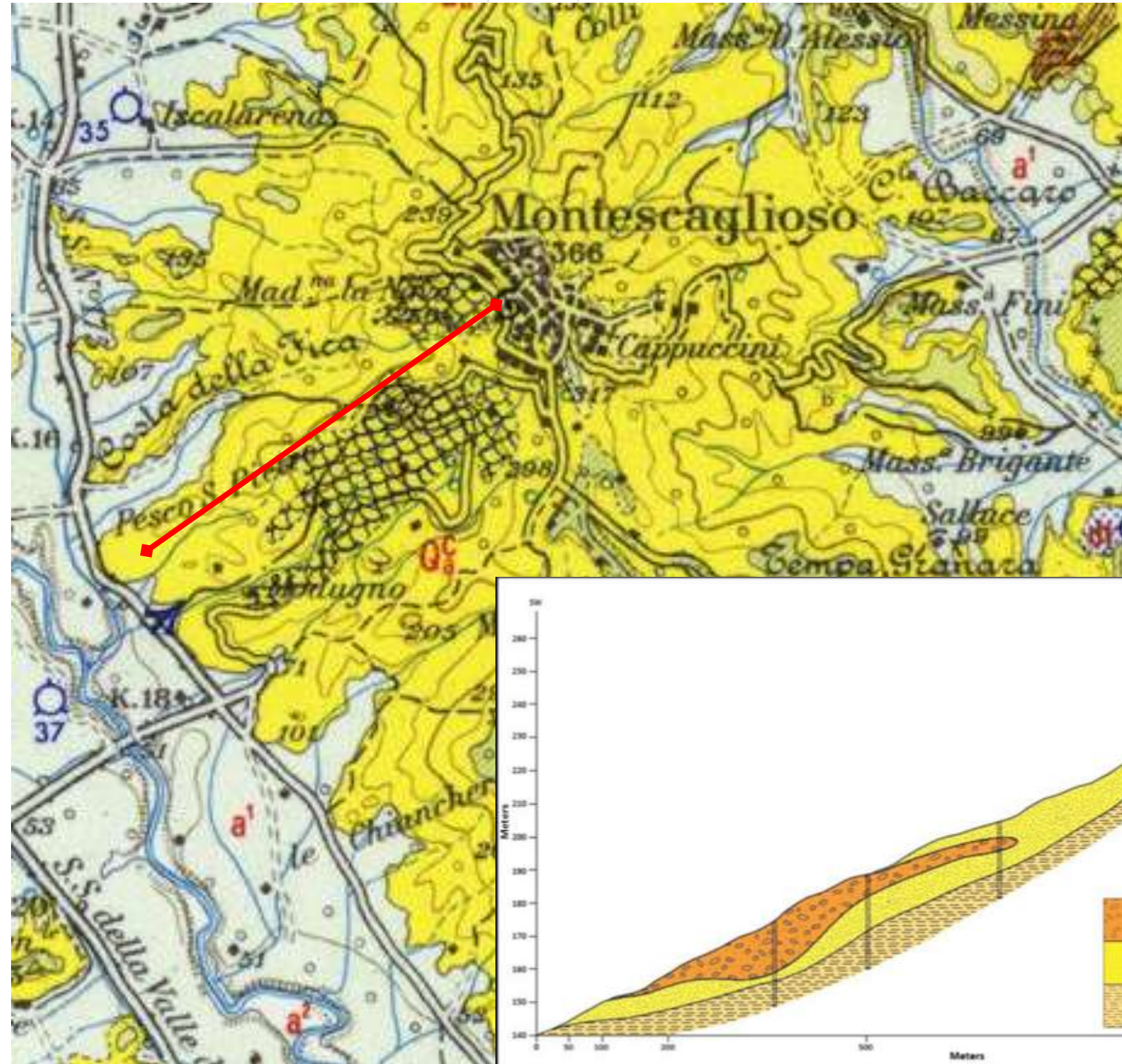
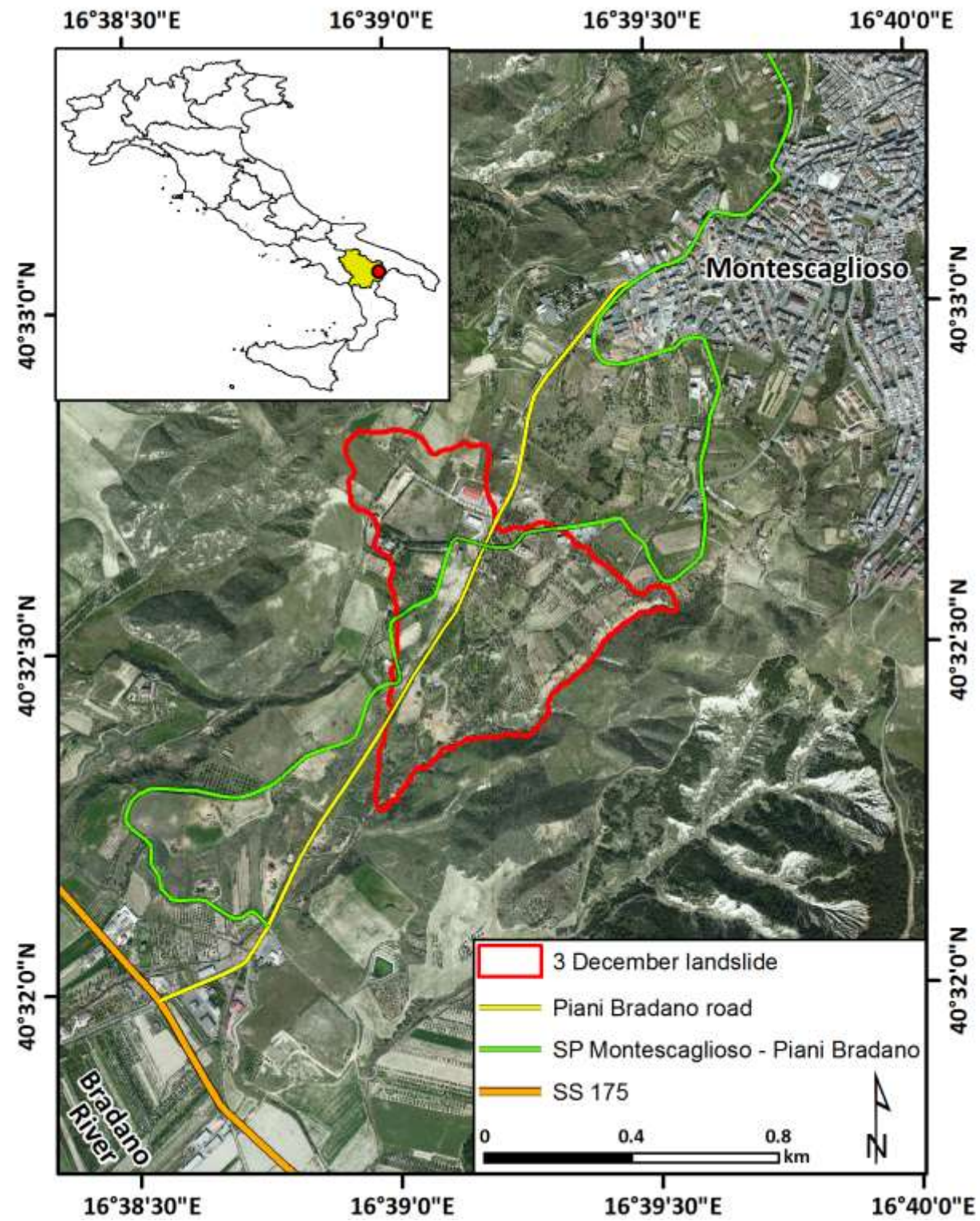


Velocity of 1.5 m/year for the E–W components and of 2.5 m/year for the N-S component

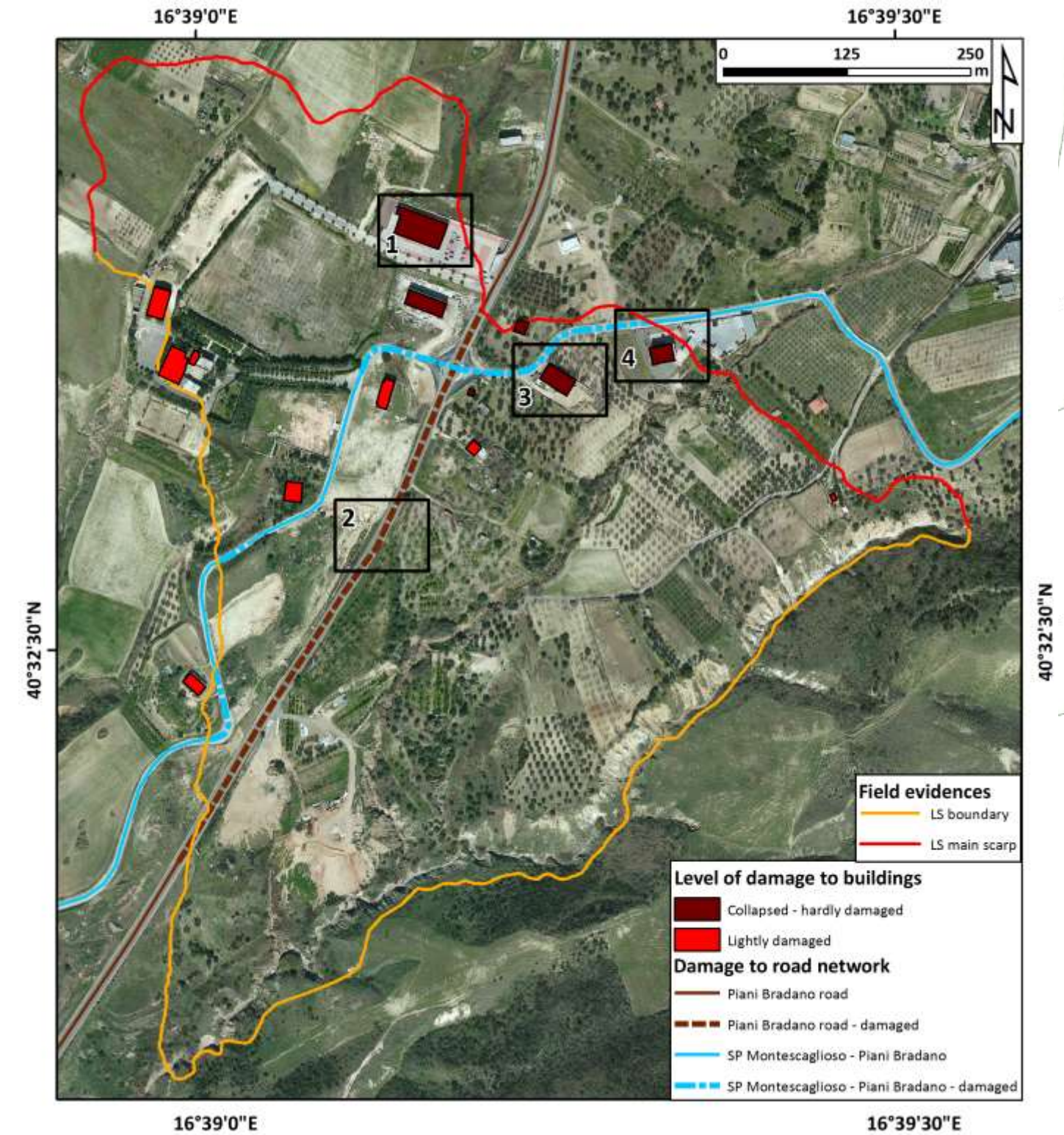
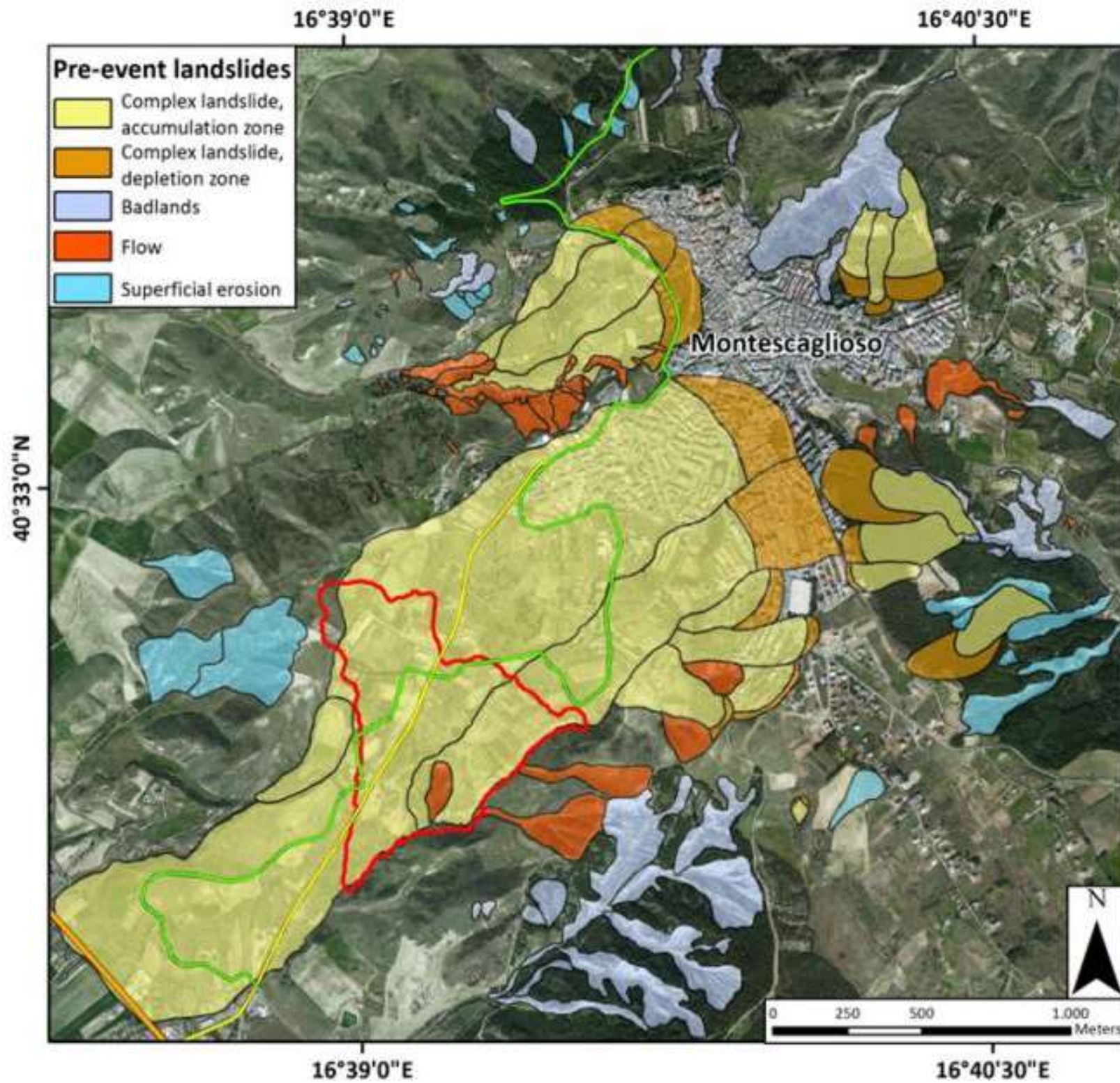
Optical analysis enables the detection and measurement of surface changes produced by **faster displacement**.

Optical analysis enables the detection of the **north-south component of the deformation**, a blind sight direction for SAR satellites

The past: archive elaboration



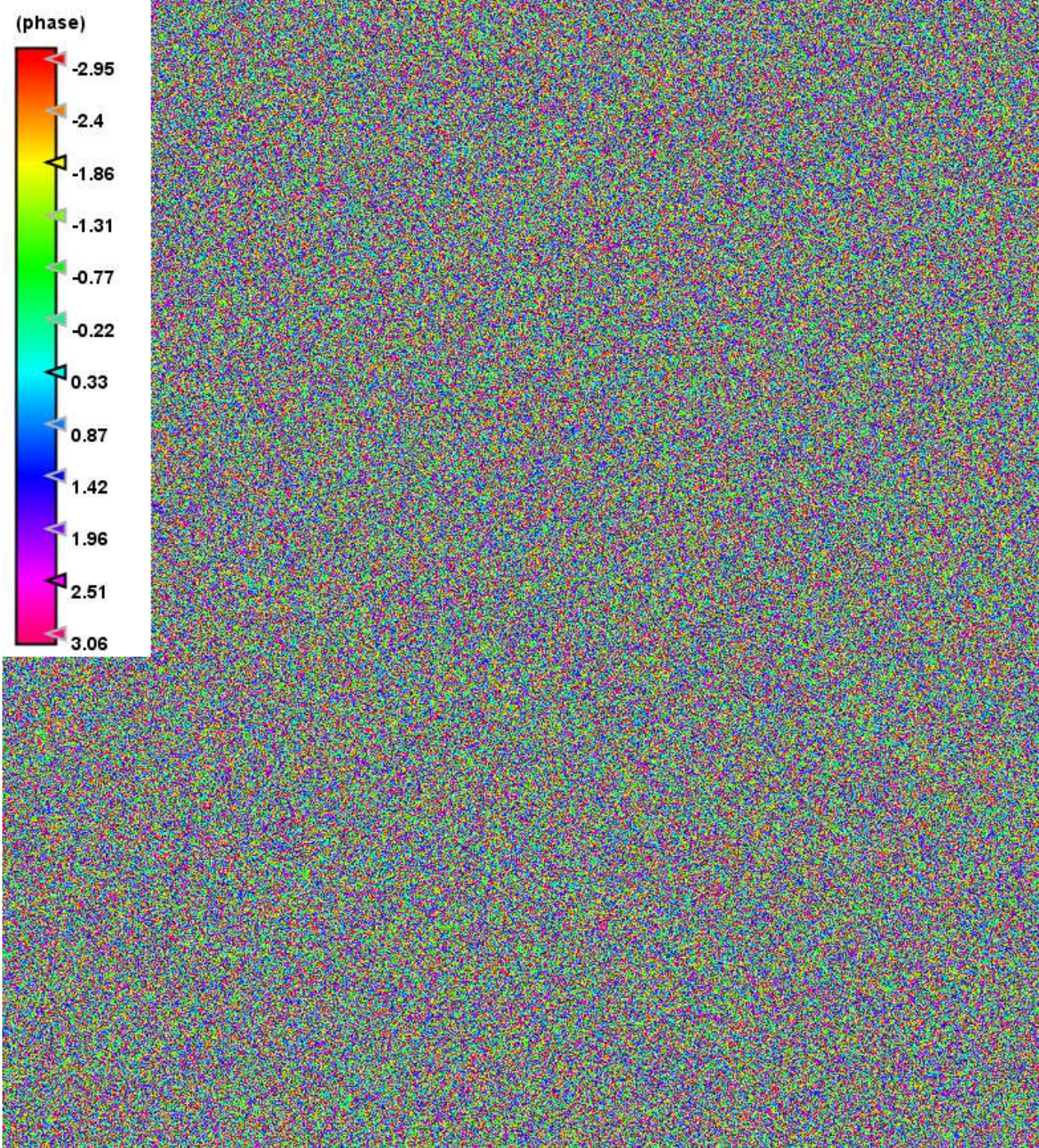
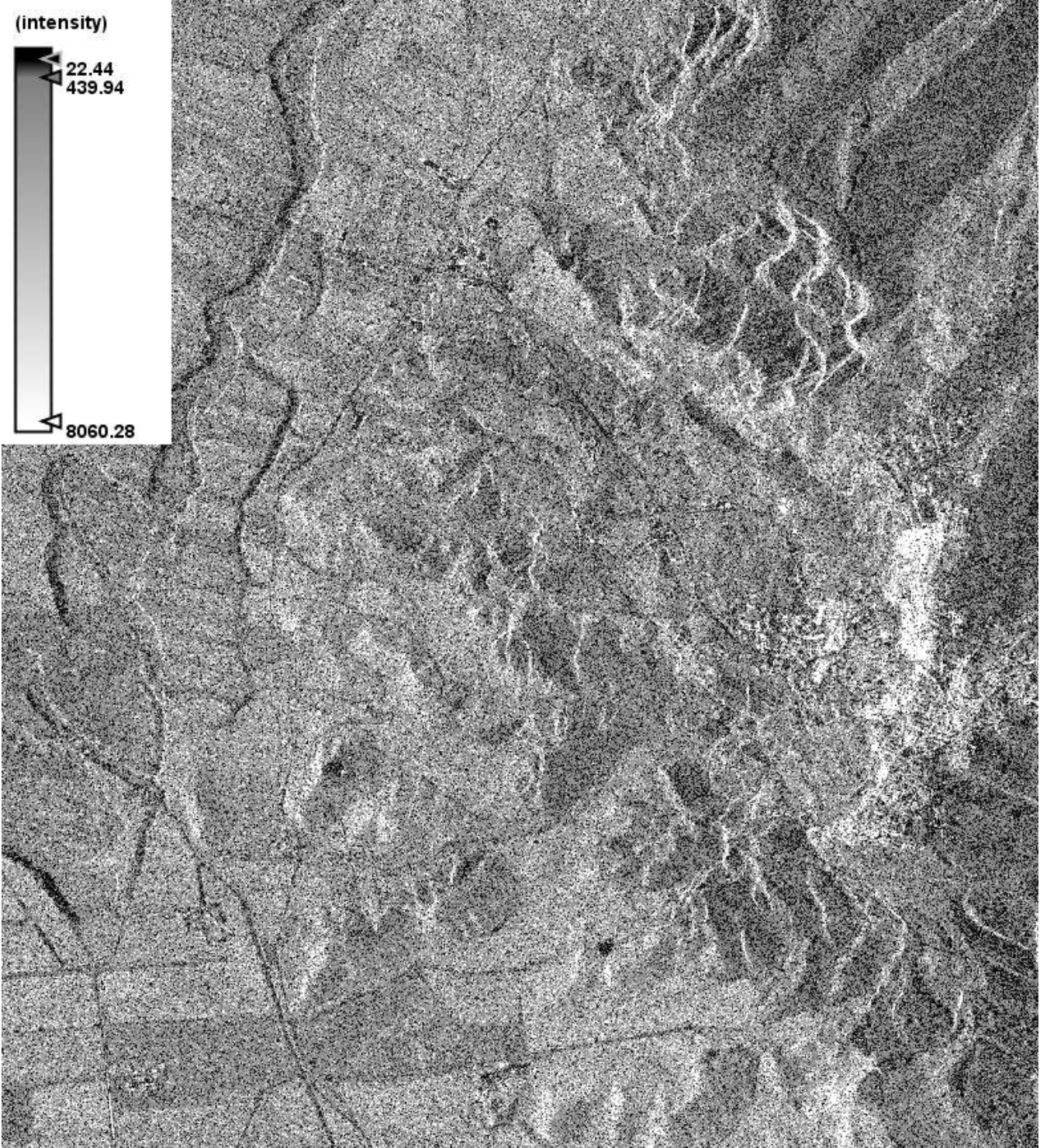
The past: archive elaboration



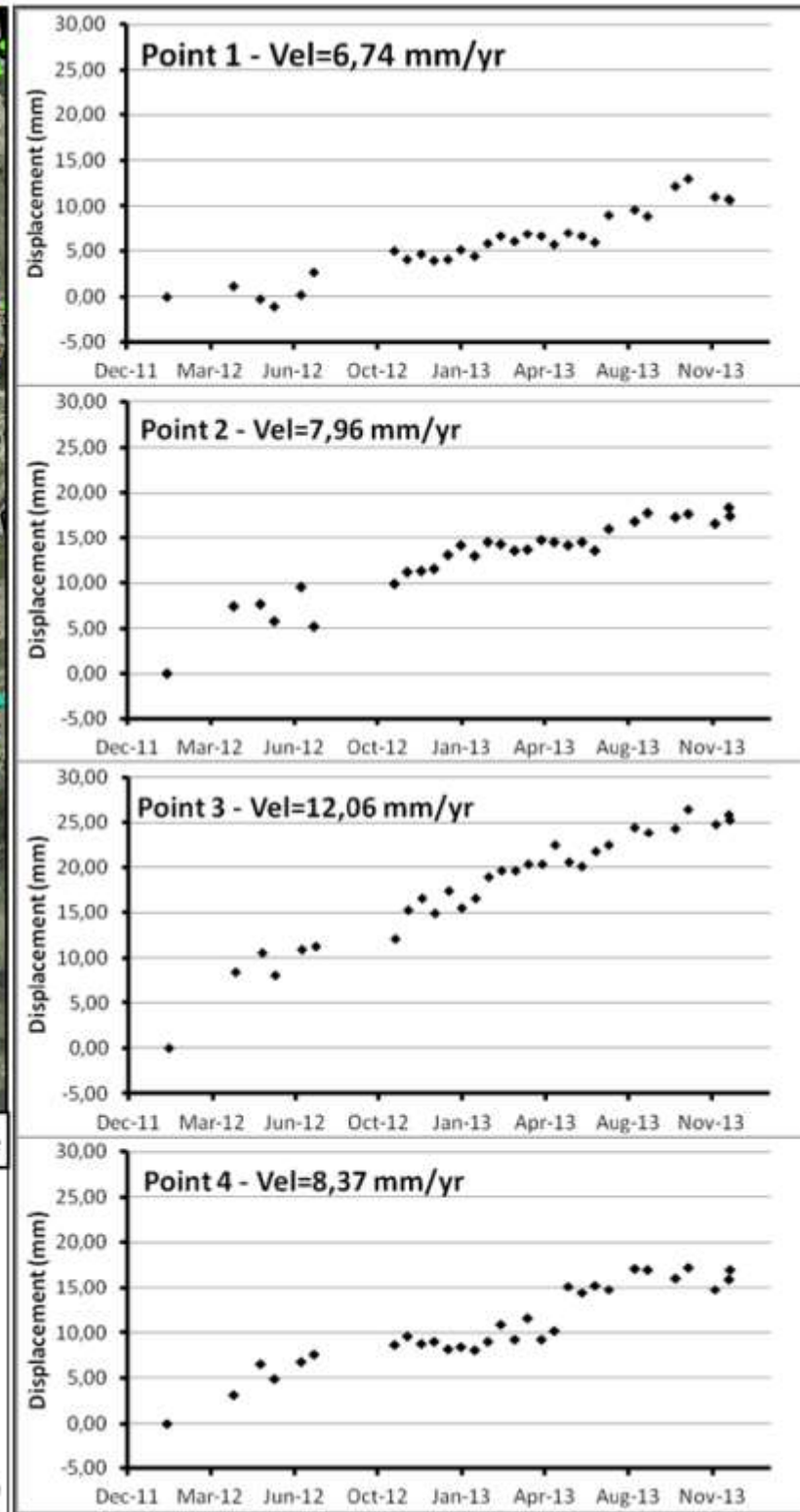
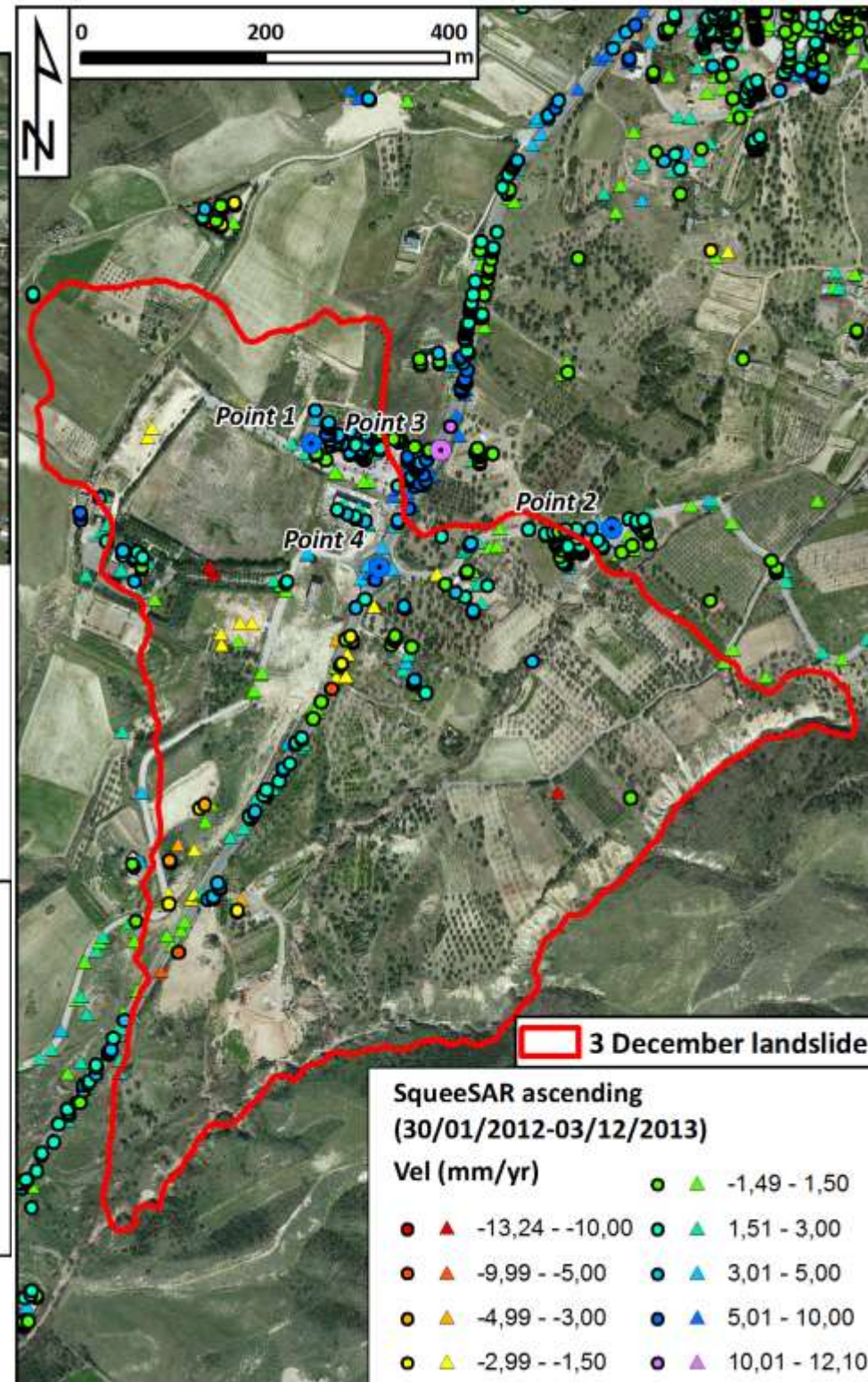
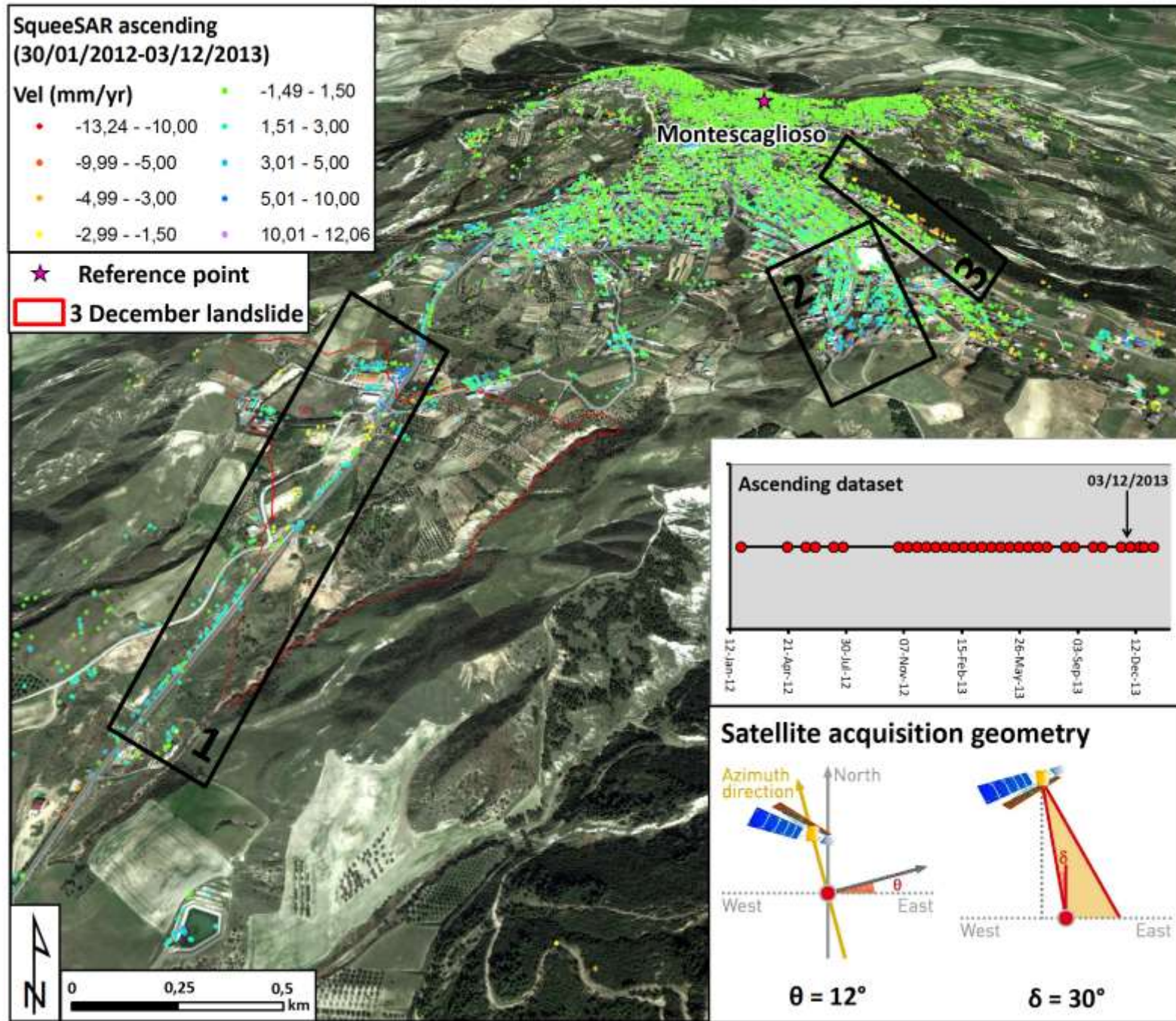
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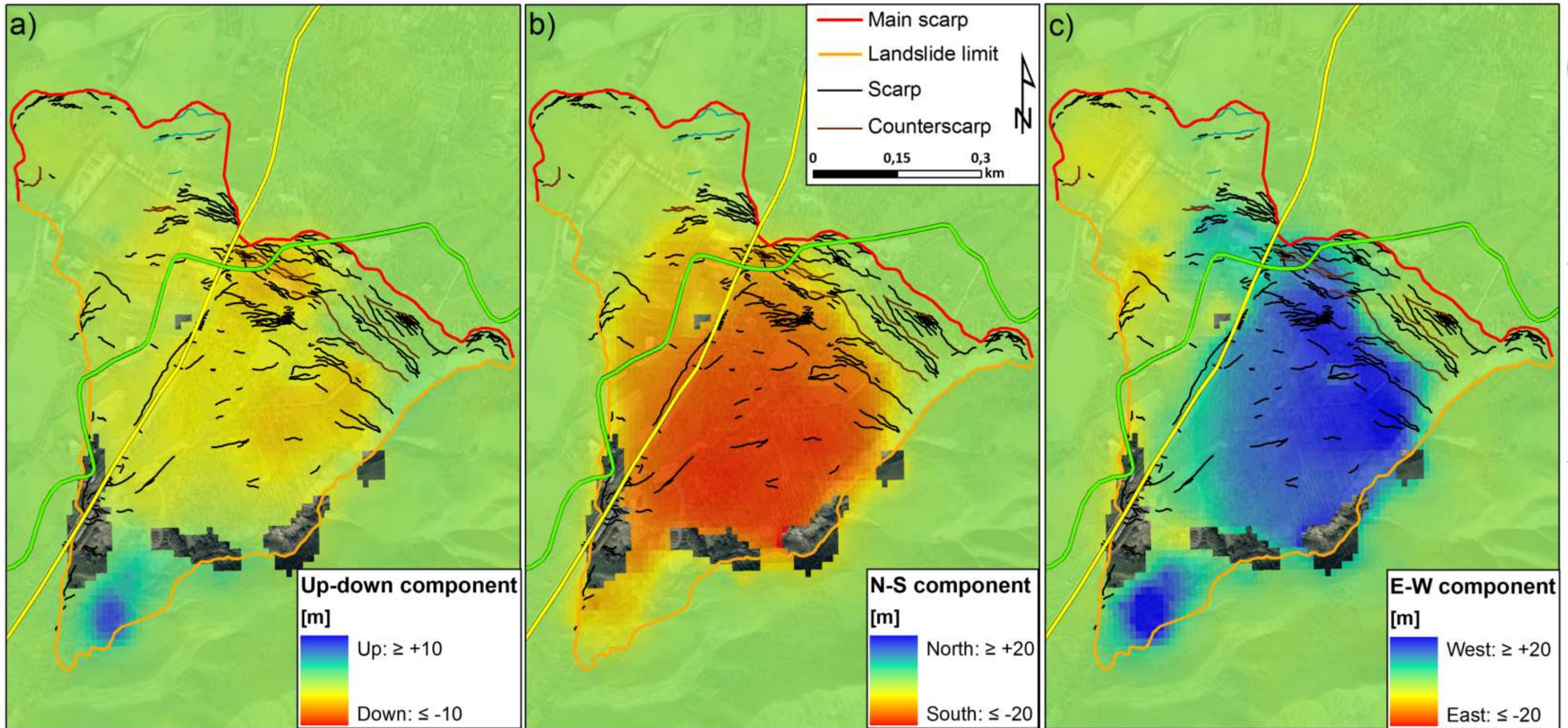
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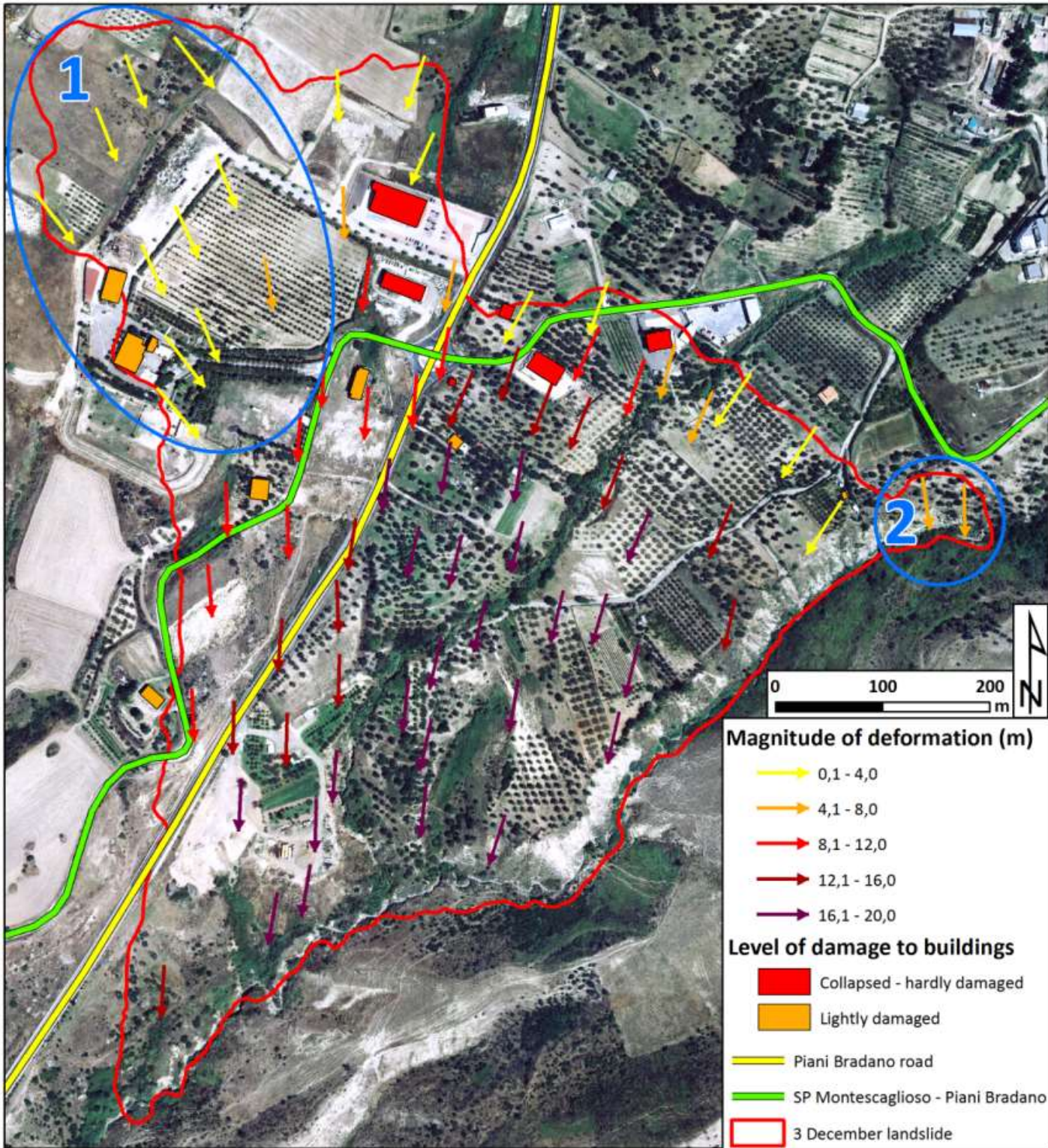
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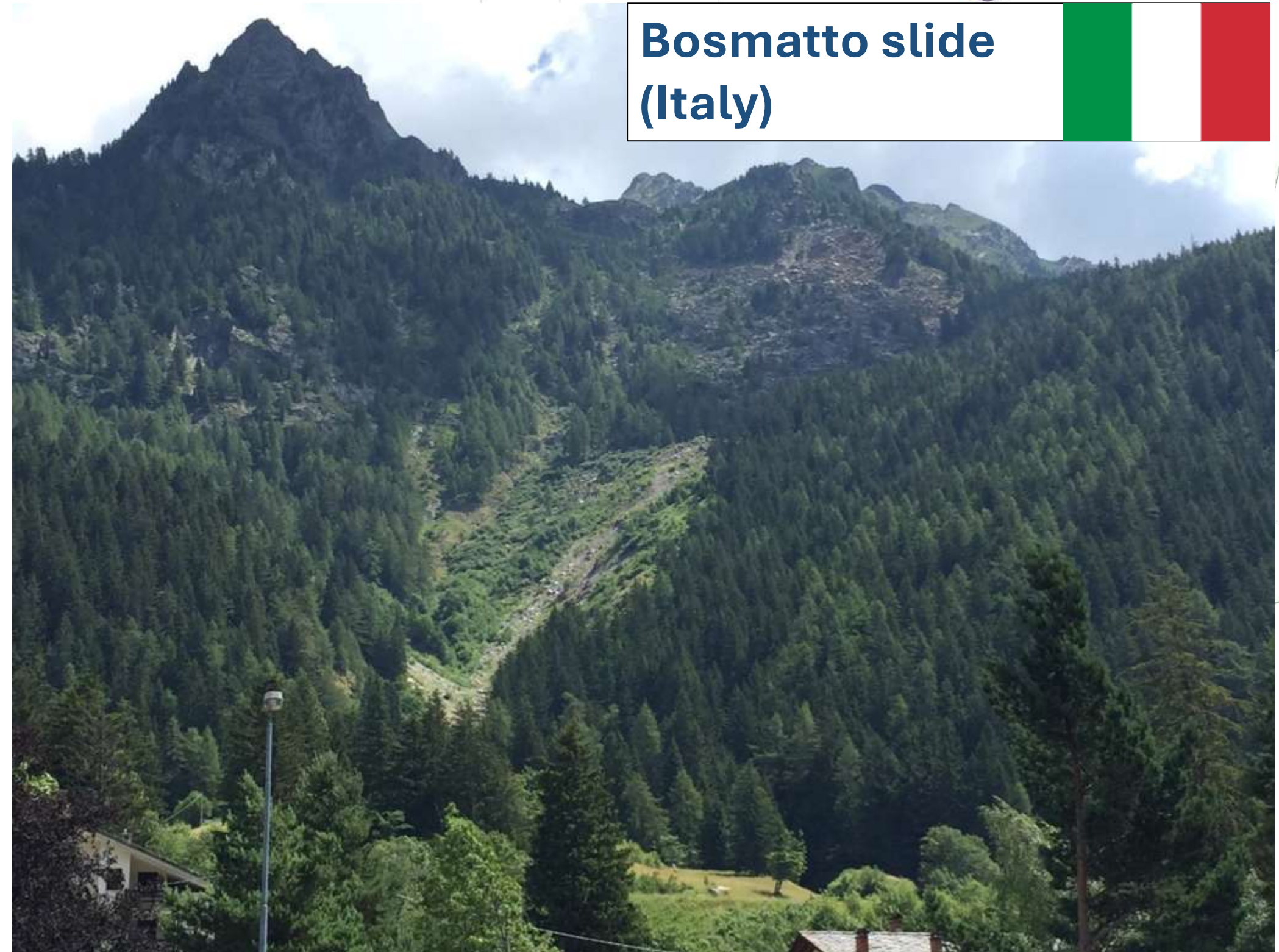
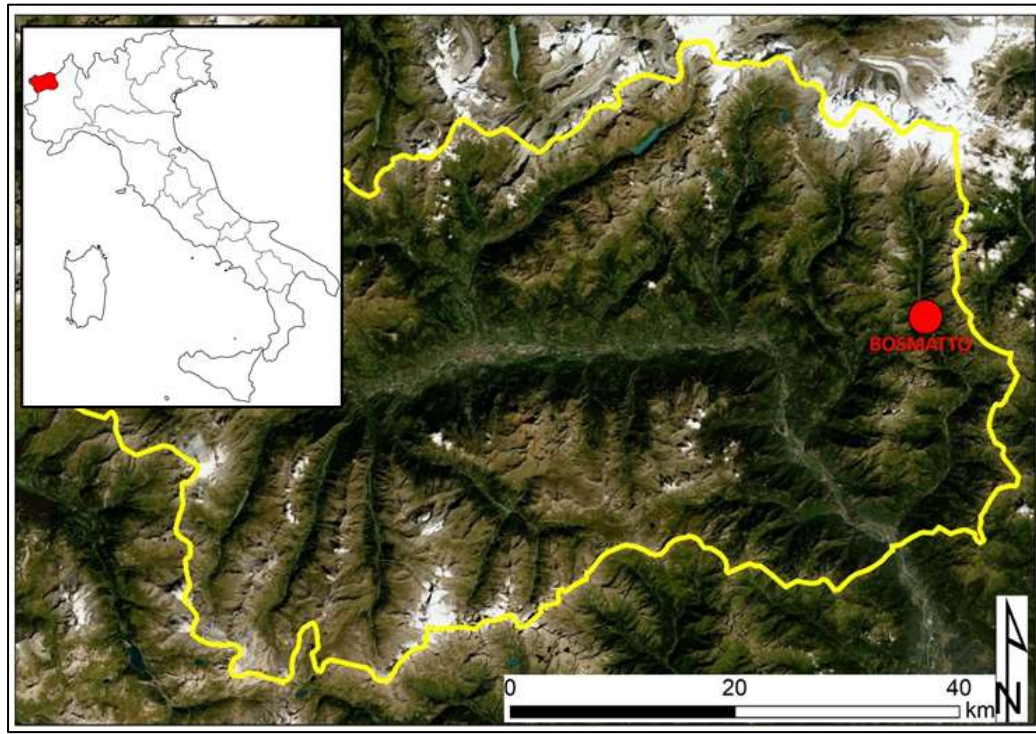
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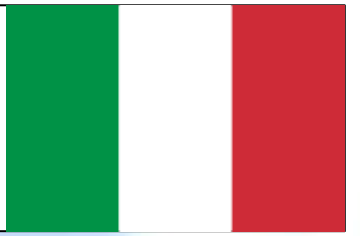
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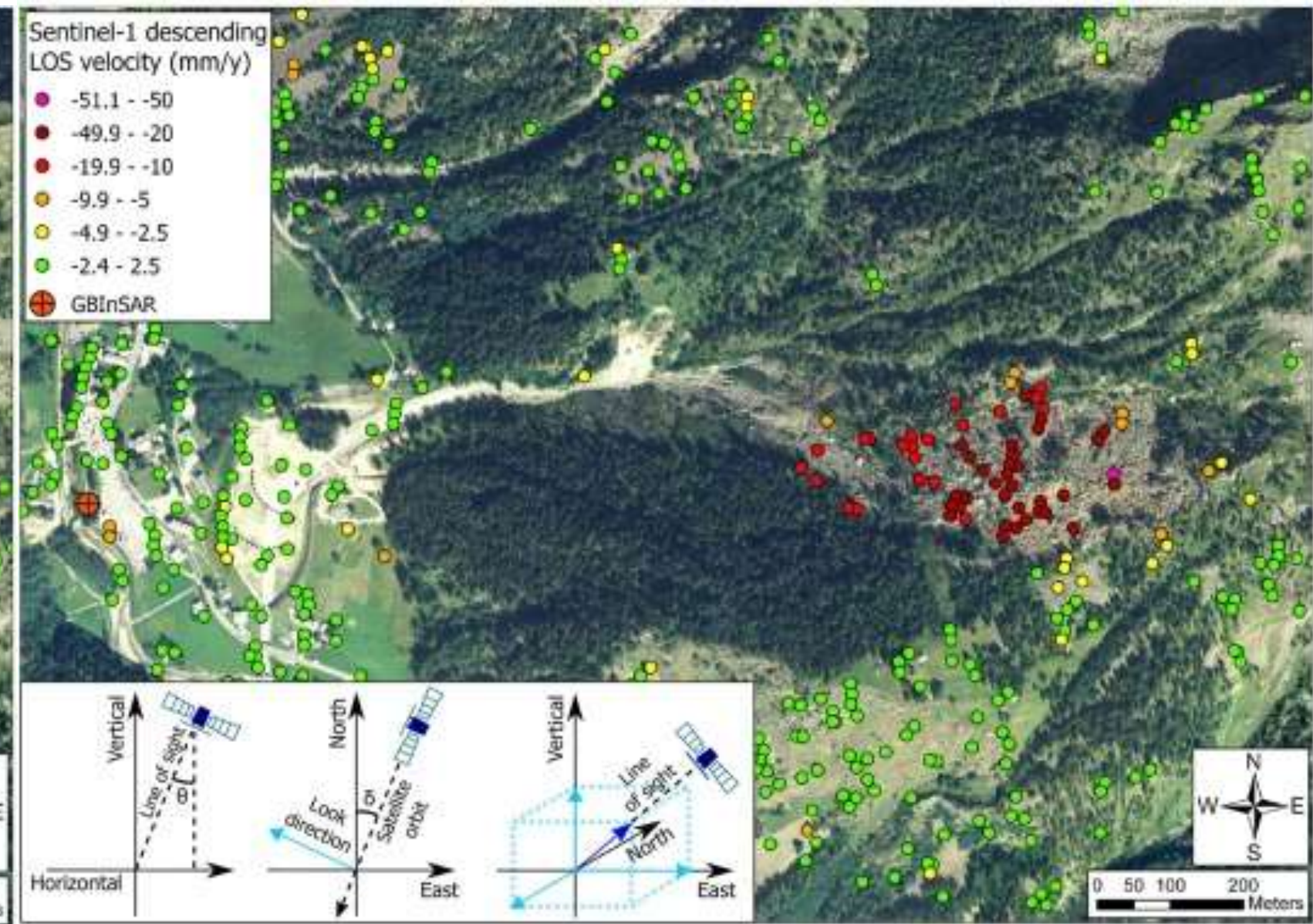
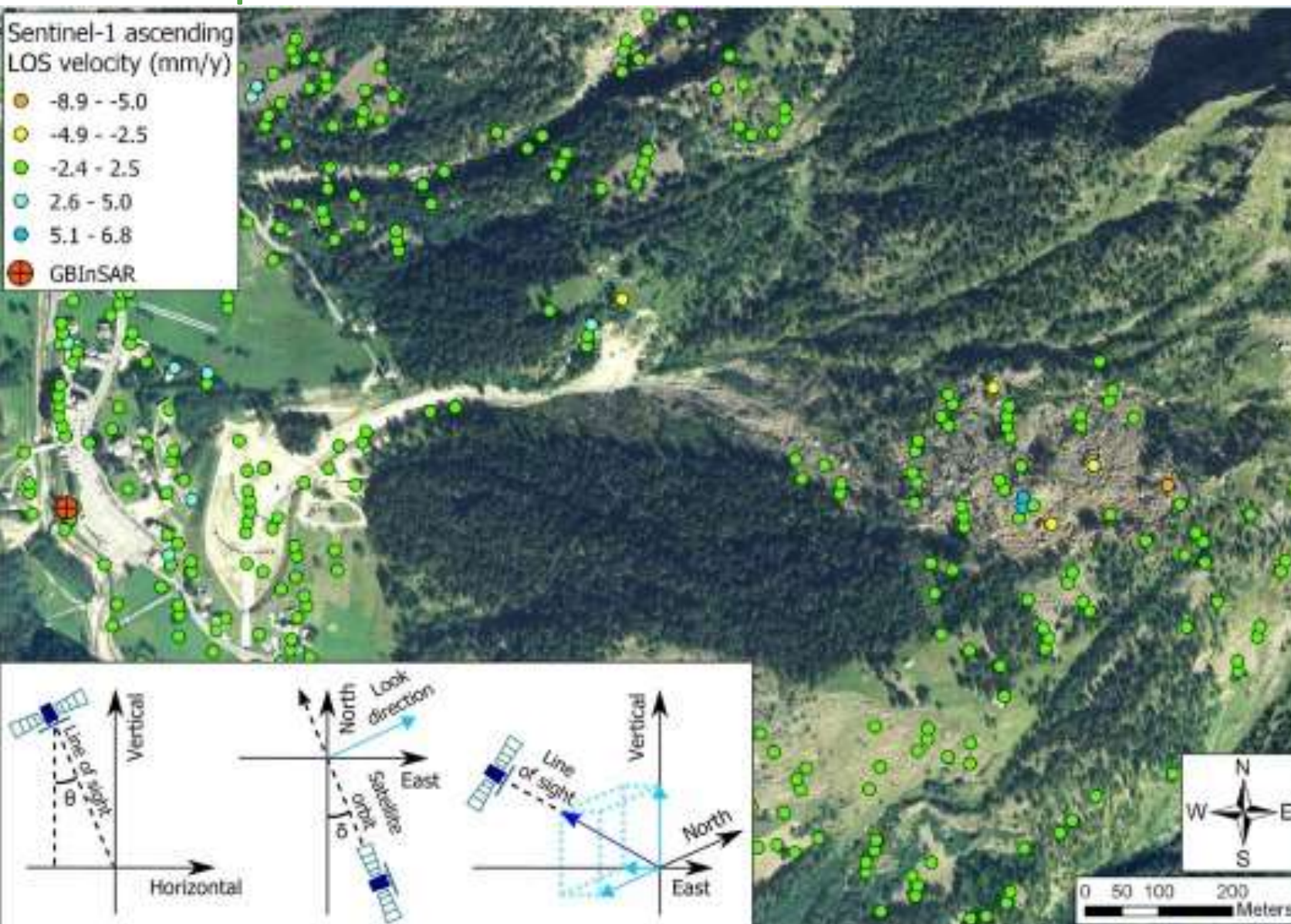
The past: archive elaboration



**Bosmatto slide
(Italy)**



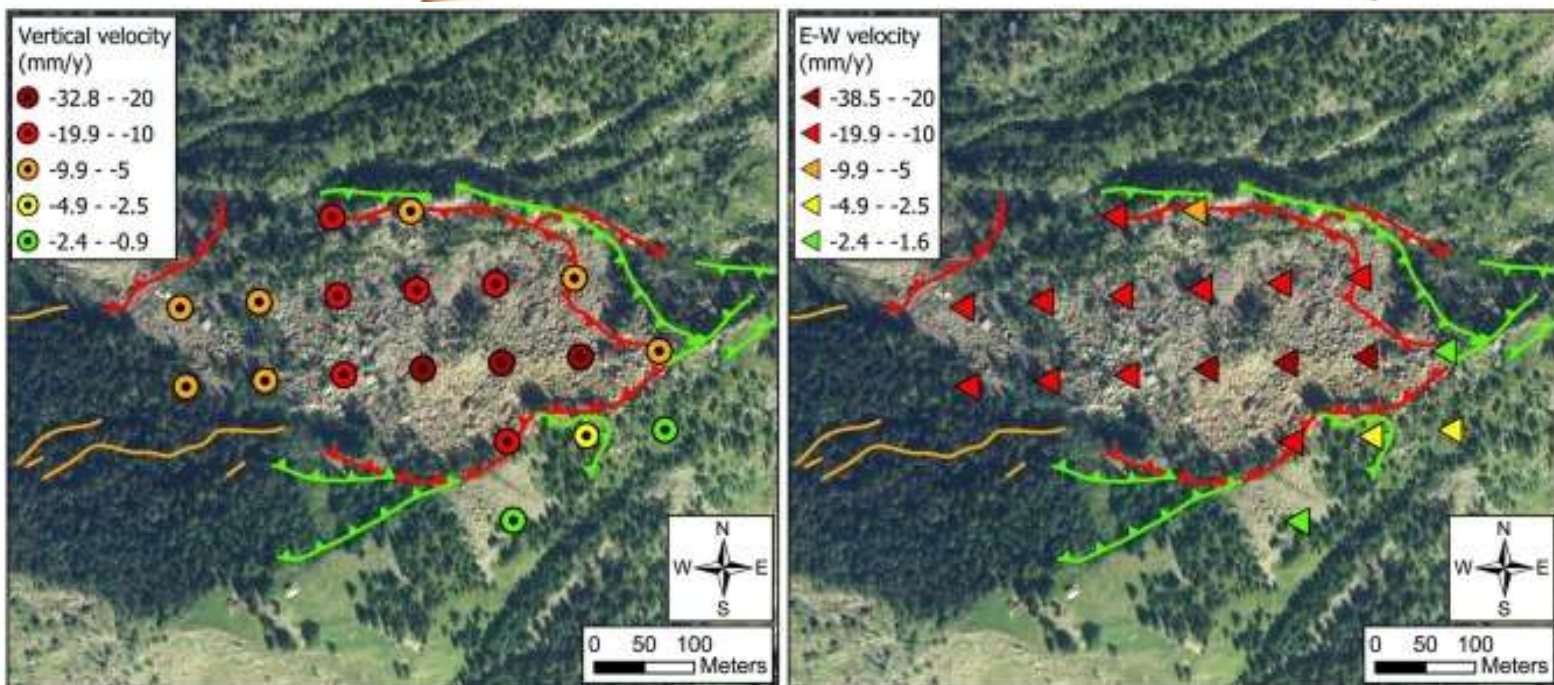
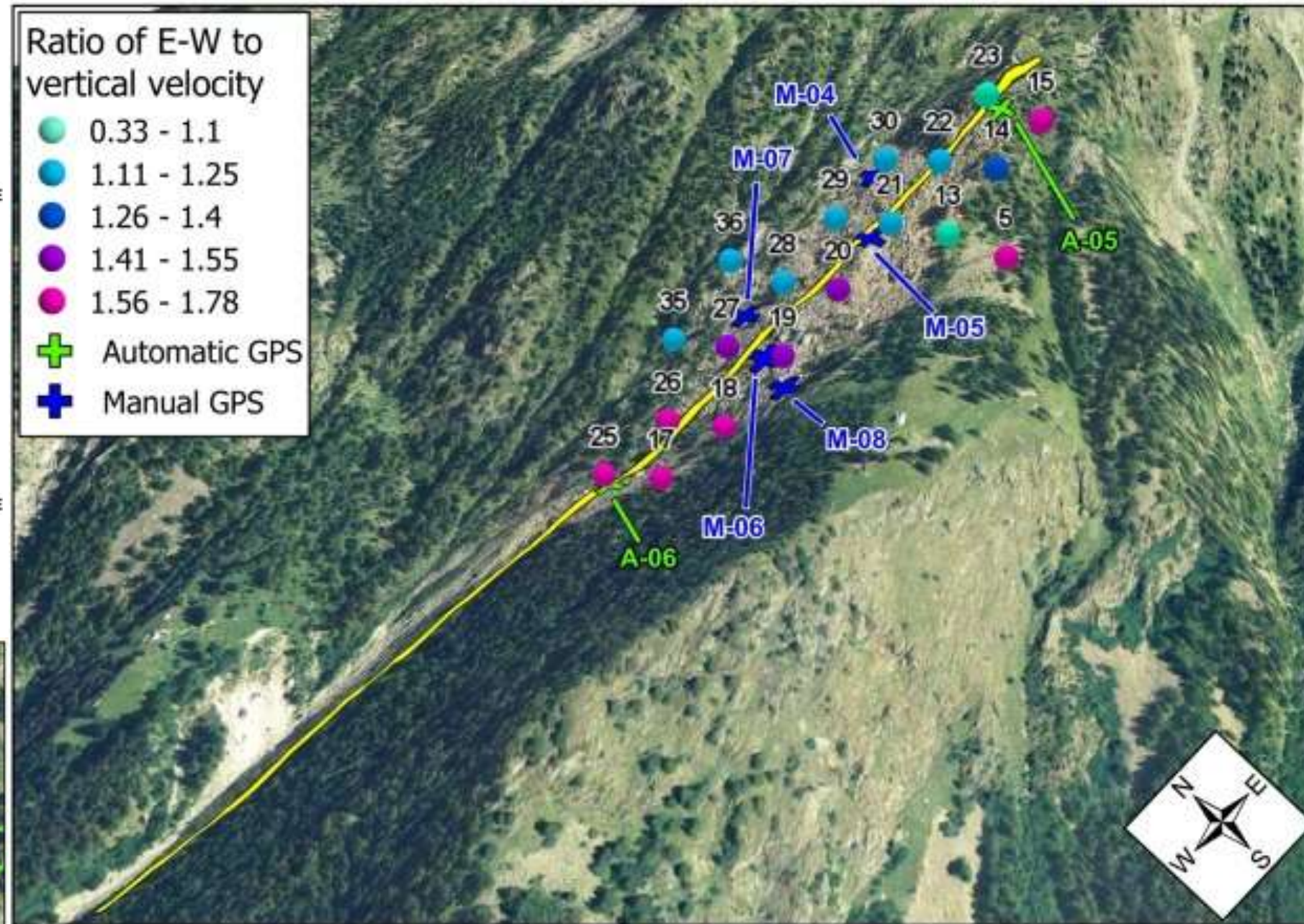
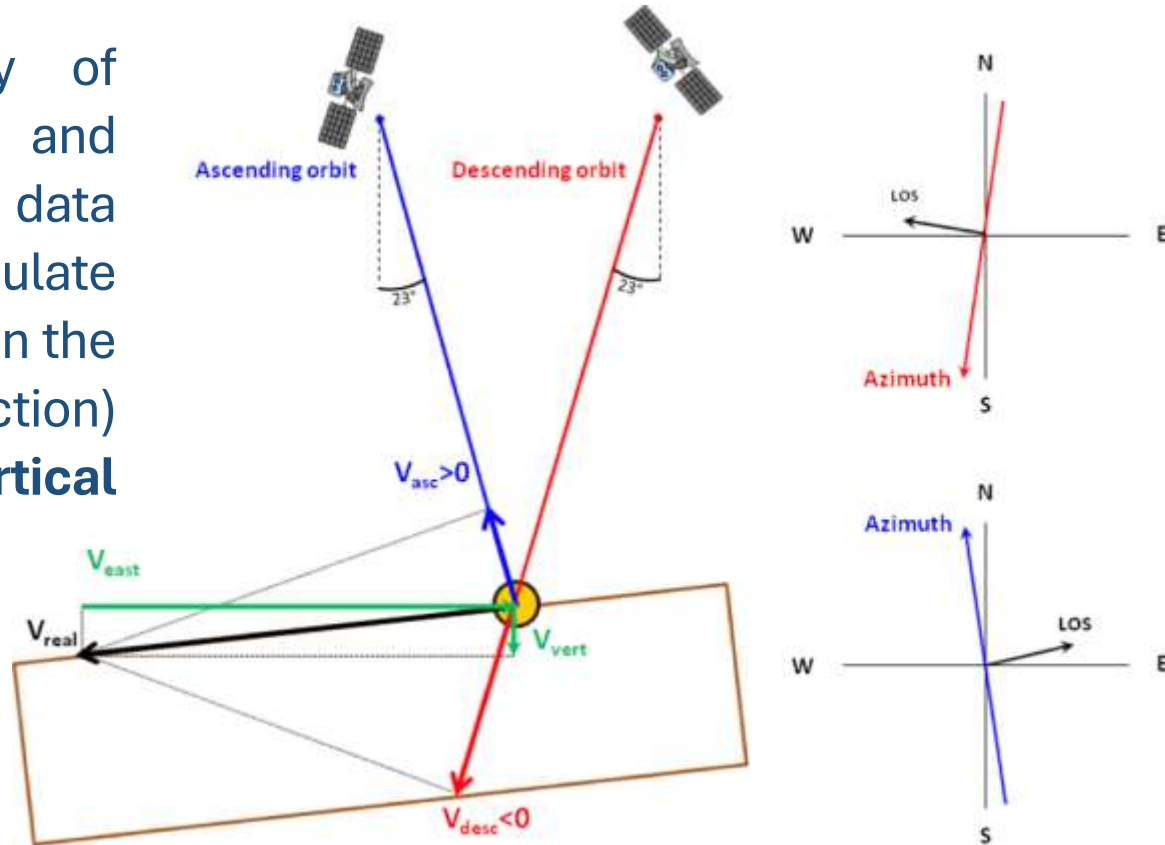
The past: archive elaboration



Satellite data show active movements in the upper part of the landslide
LOS velocity along descending orbits in the order of 40 mm/yr
Displacement time series show a linear trend of movement, without any acceleration, deceleration or season variation

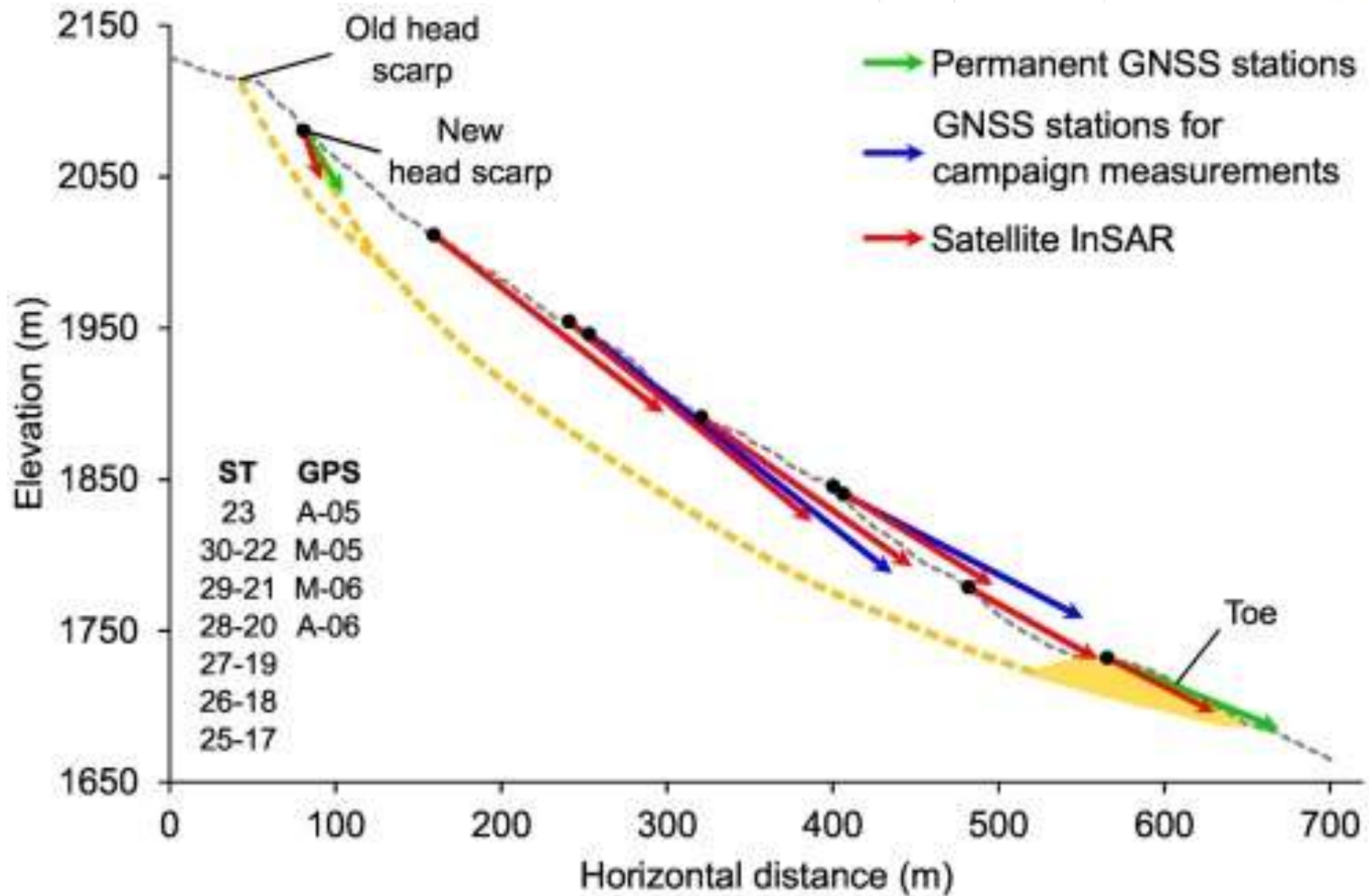
The past: archive elaboration

The availability of ascending and descending data allow to calculate the **horizontal** (in the East-West direction) and the **vertical** direction.



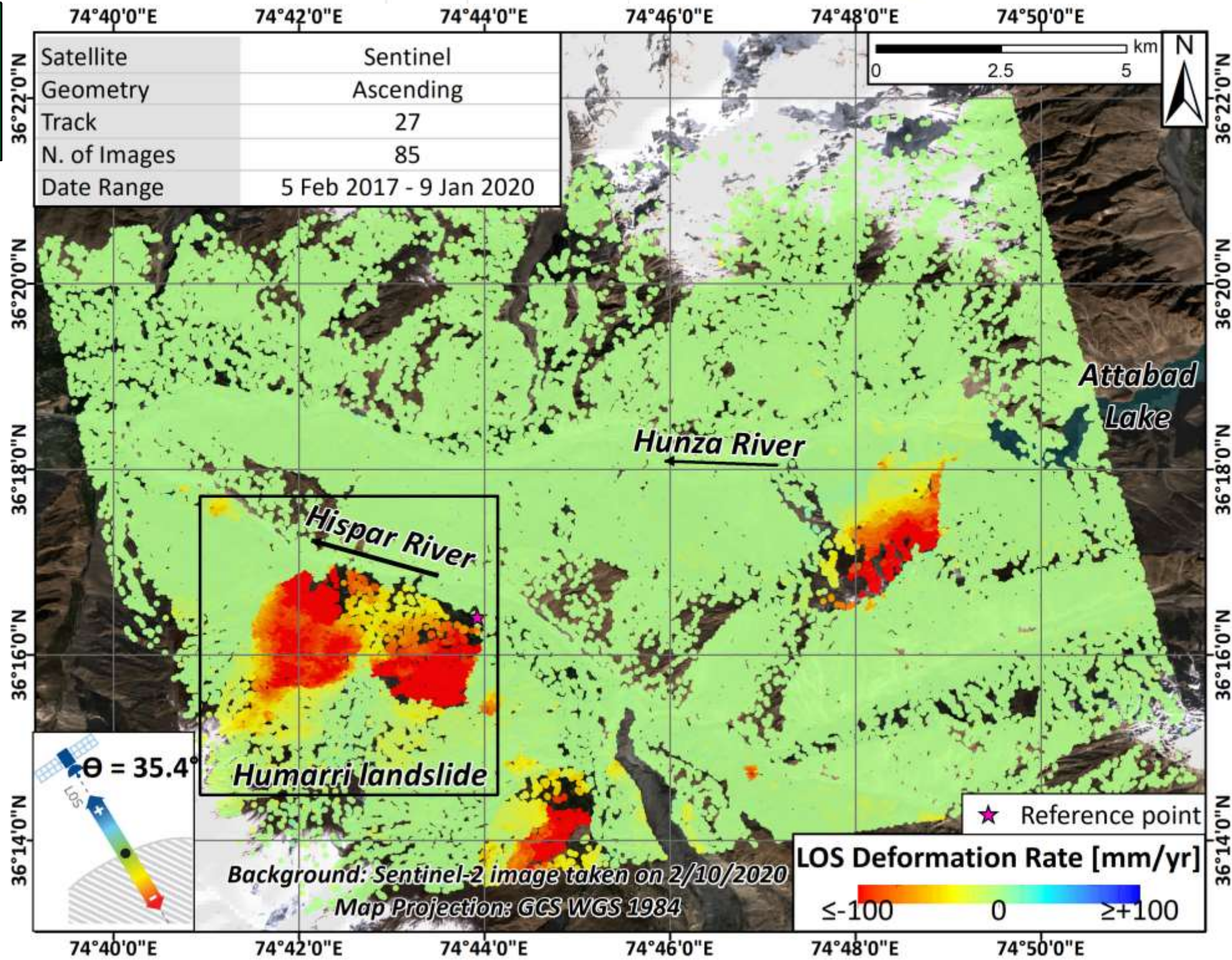
In the upper part of the landslide (crown area) the vertical deformation is dominant, while the horizontal component increases in downslope direction, according to a **roto-translational sliding phenomenon**.

The past: archive elaboration

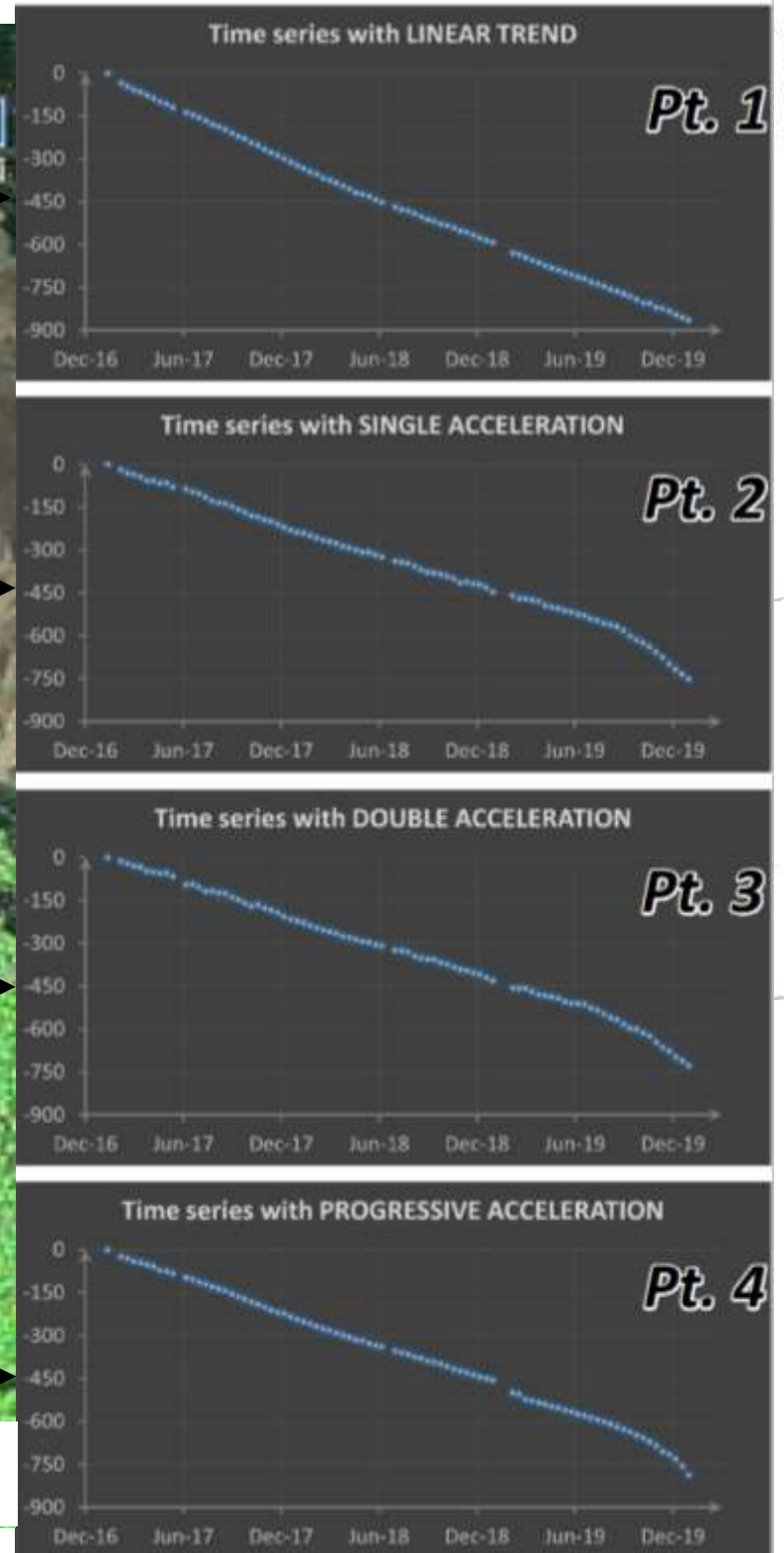
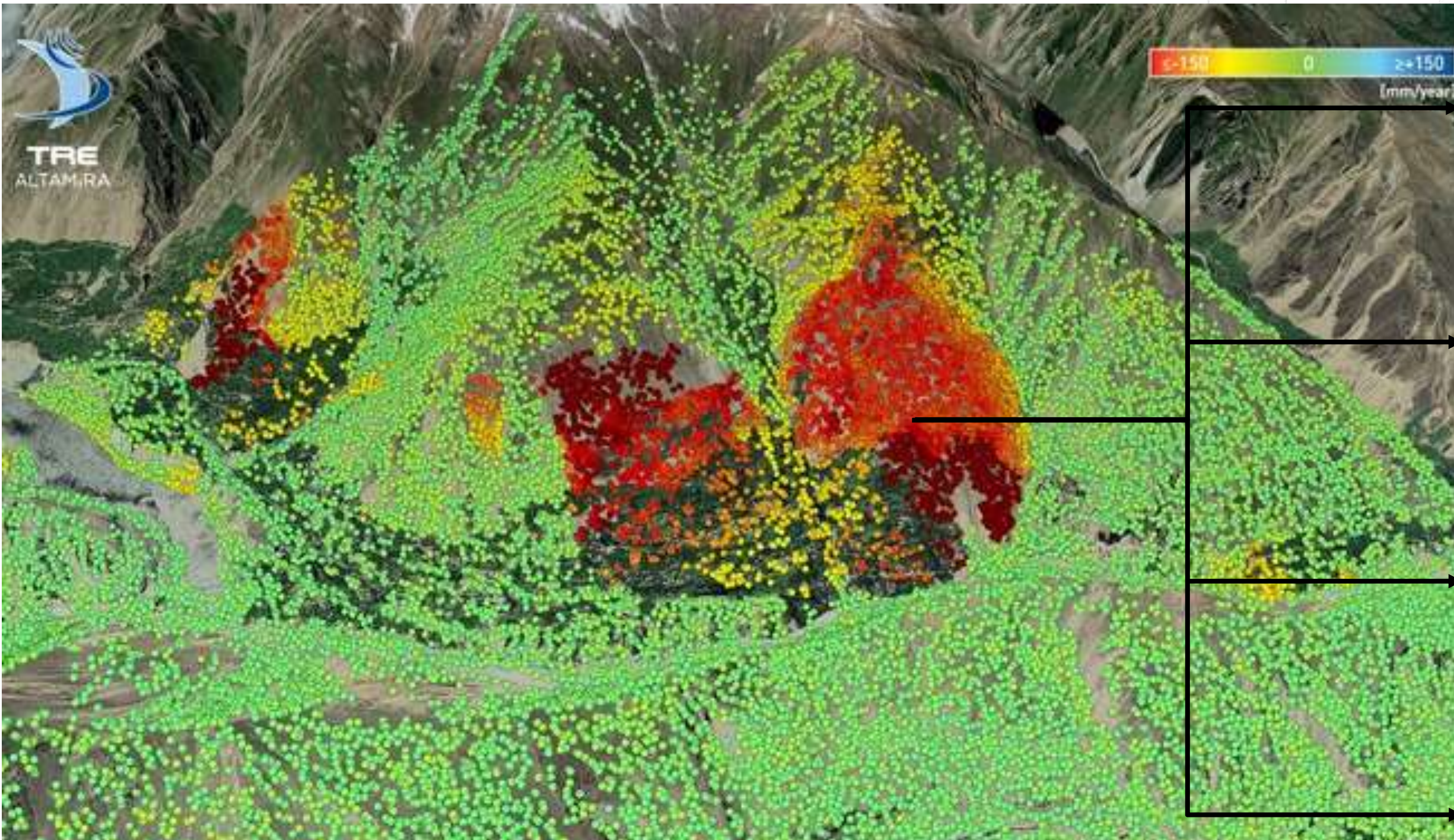


The past: archive elaboration

Humarri landslide (Pakistan)



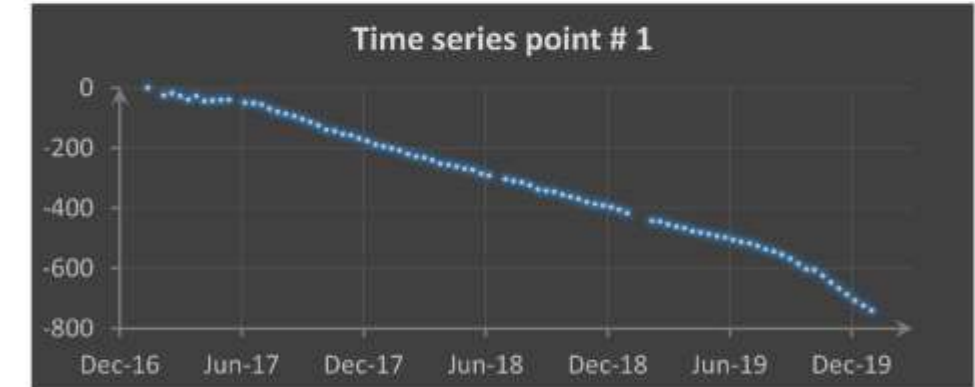
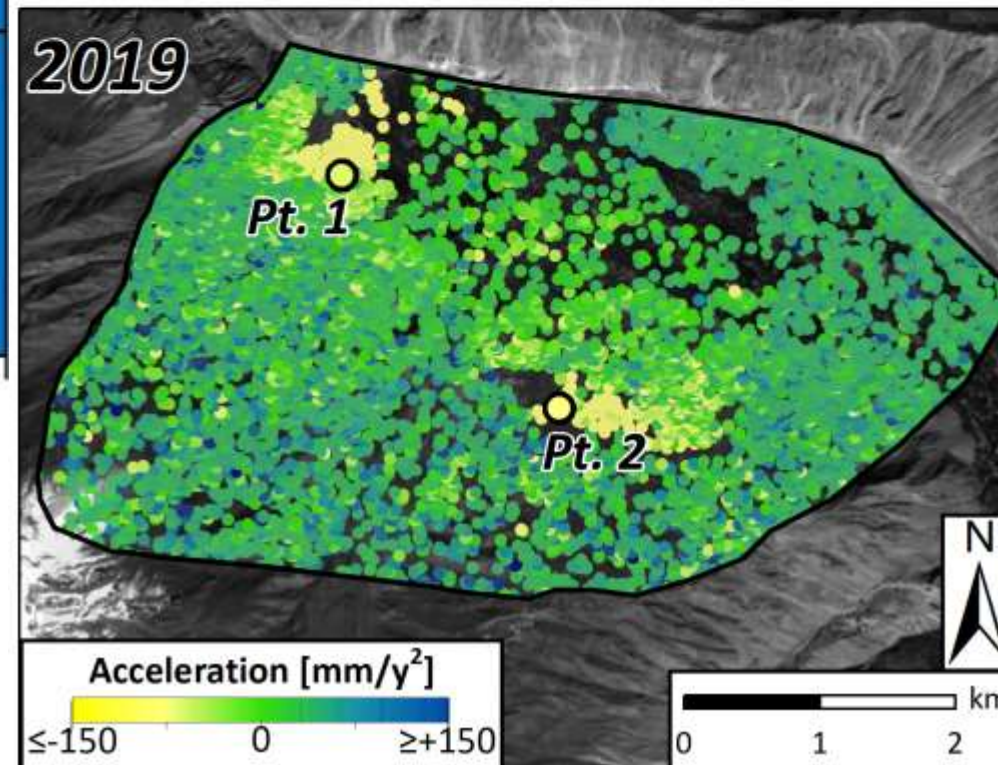
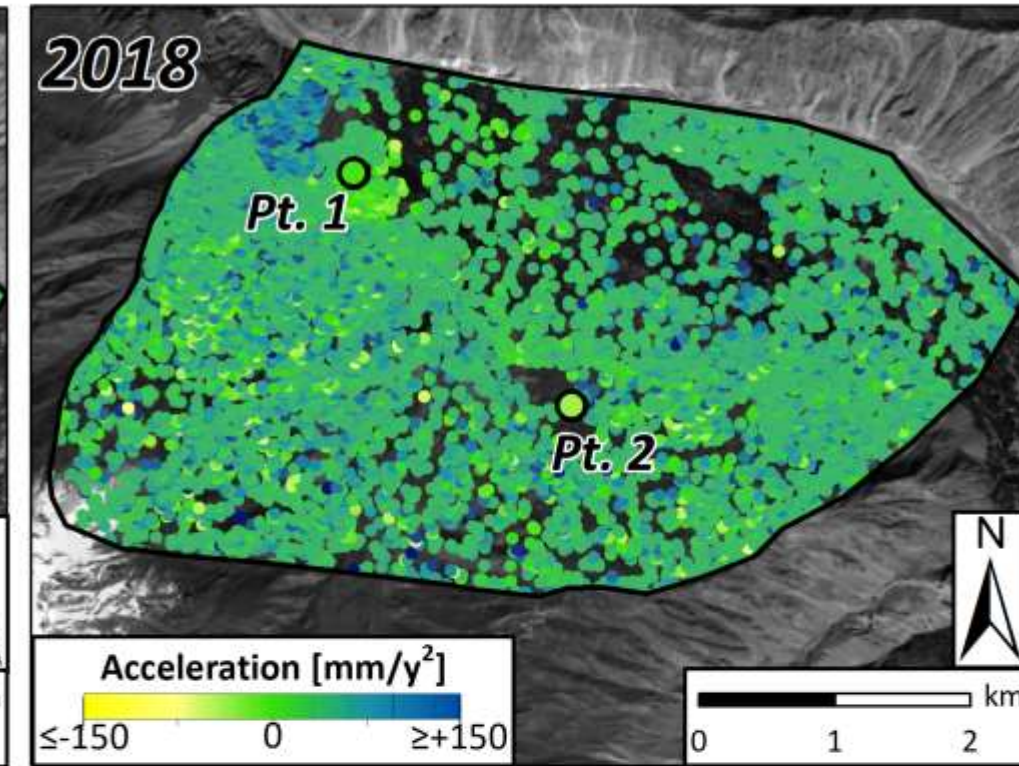
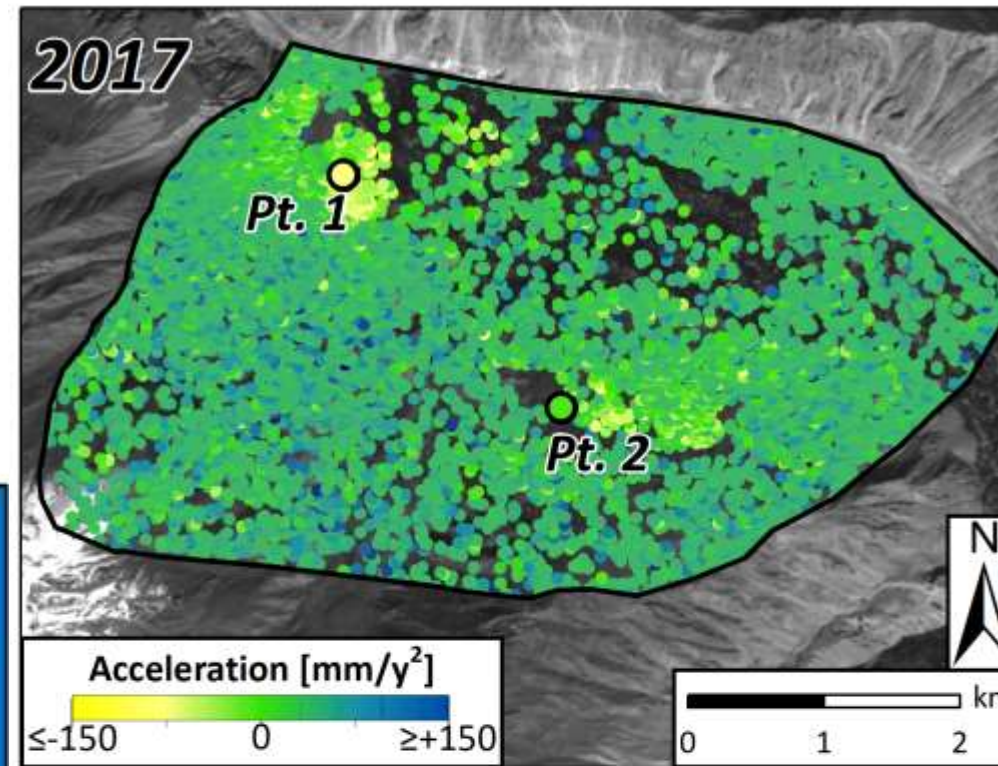
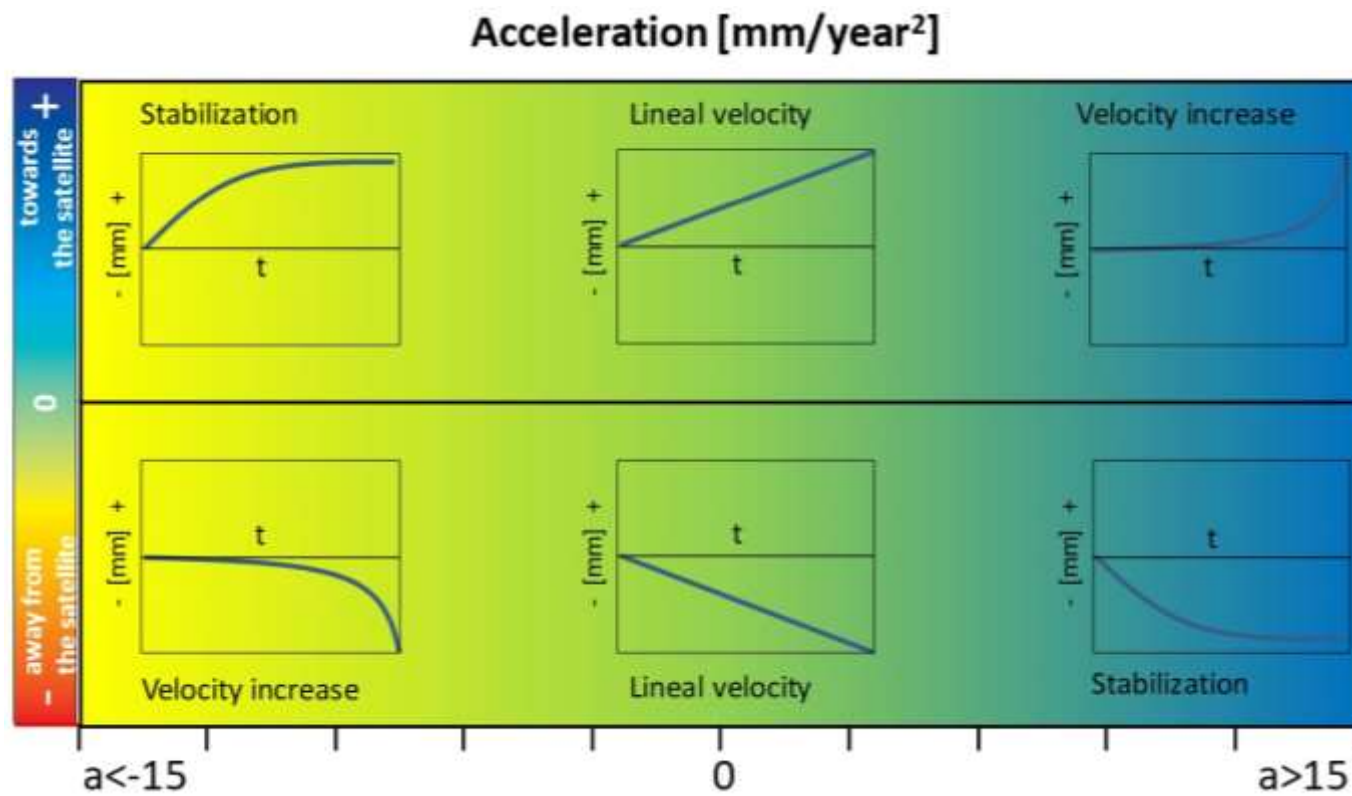
The past: archive elaboration



Analysis of displacement time series to define different **kinematic behaviour**

The past: archive elaboration

Analysis of displacement time series to identify **acceleration** and deceleration in landslide movement



The early detection of accelerating areas is the main purpose of any landslide monitoring system.

They can indicate a **slope instability potentially leading to future landslide failure.**

01

Satellite Interferometry

Radar-interpretation: products, applicability and limitations

02

The past: archive elaboration

Mapping and “one-shot analysis”

03

The present: wide area monitoring system

The Sentinel-1 constellation

04

The future: continental scale

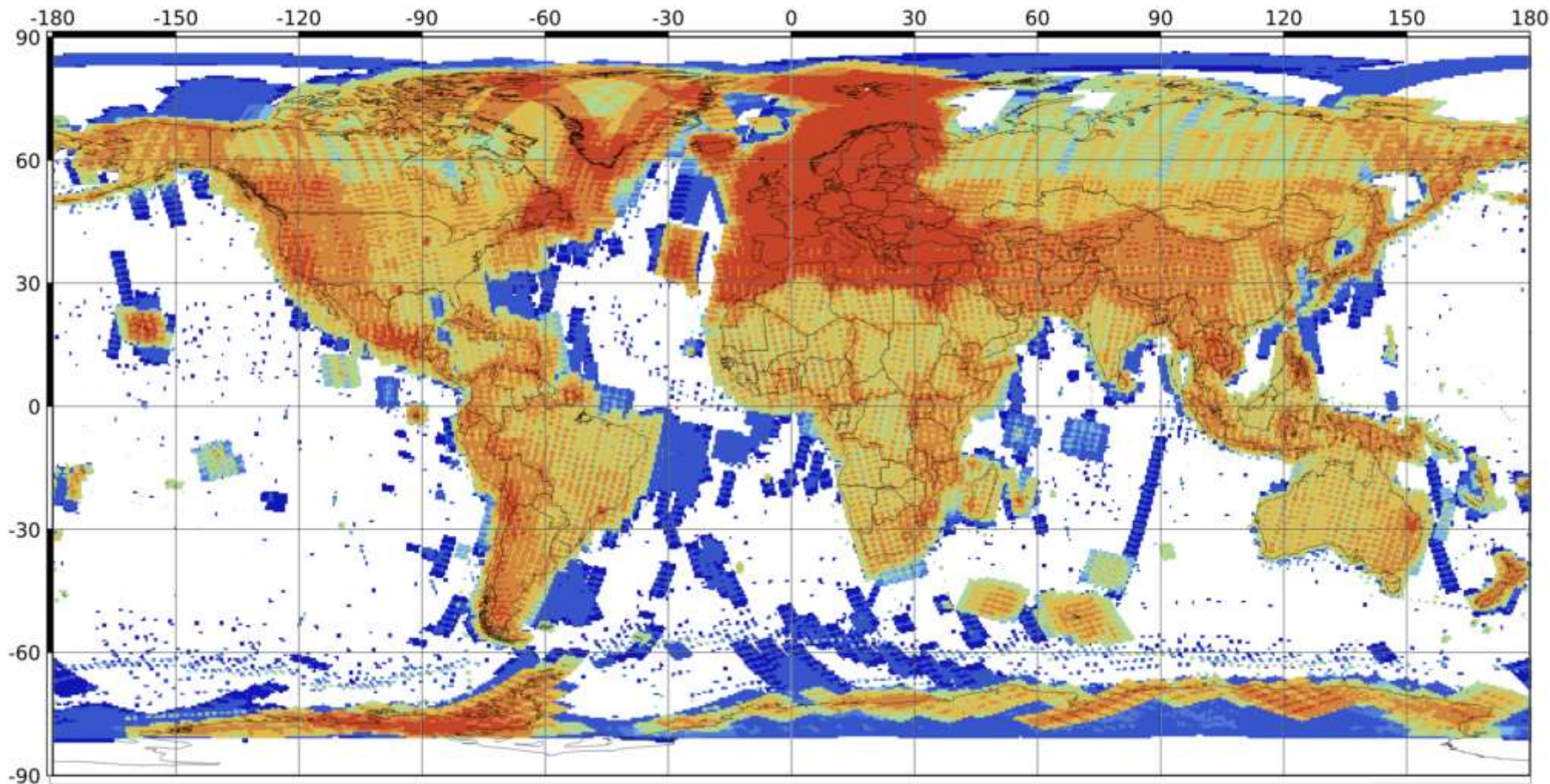
Early warning system based on indicators of instabilities

05

Data availability

Open portal and web application for data access and management

The present: wide area monitoring system



Sentinel-1 Level 1 SLC Data Coverage

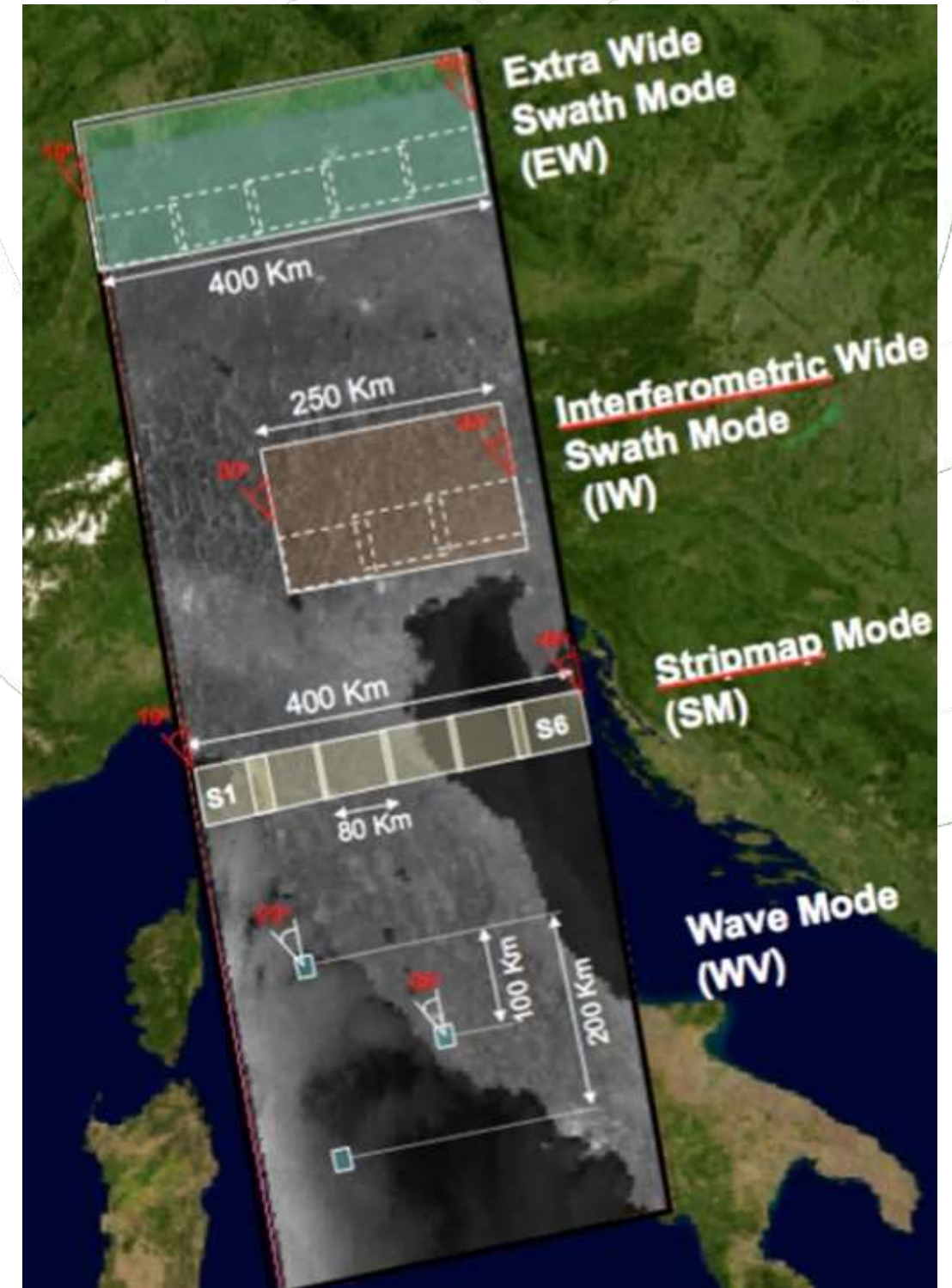
Copernicus Sentinel-1A and Sentinel-1B data,
2014-2021
Current: 30 September 2021

Legend

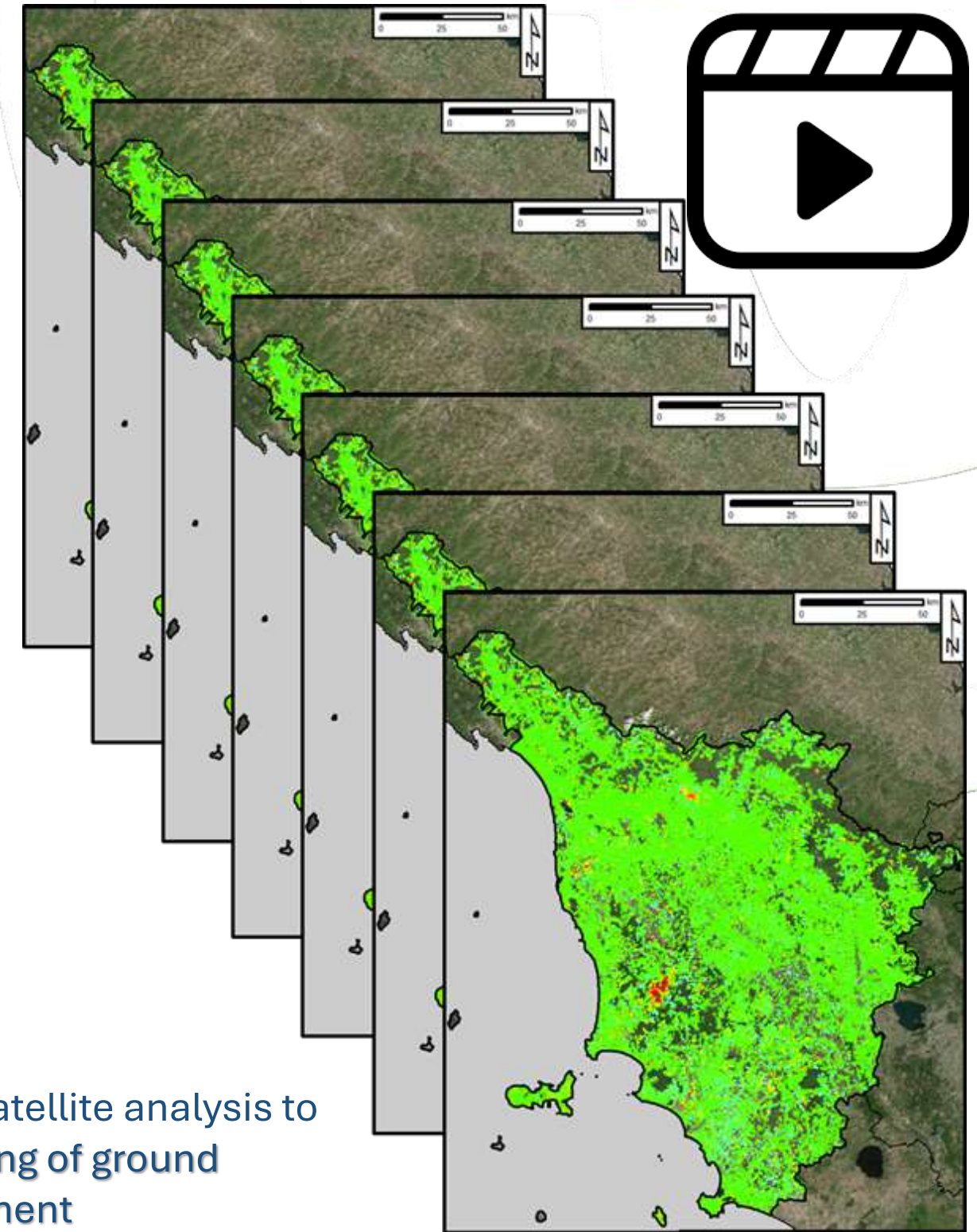
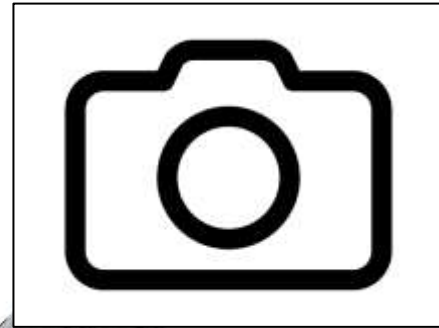
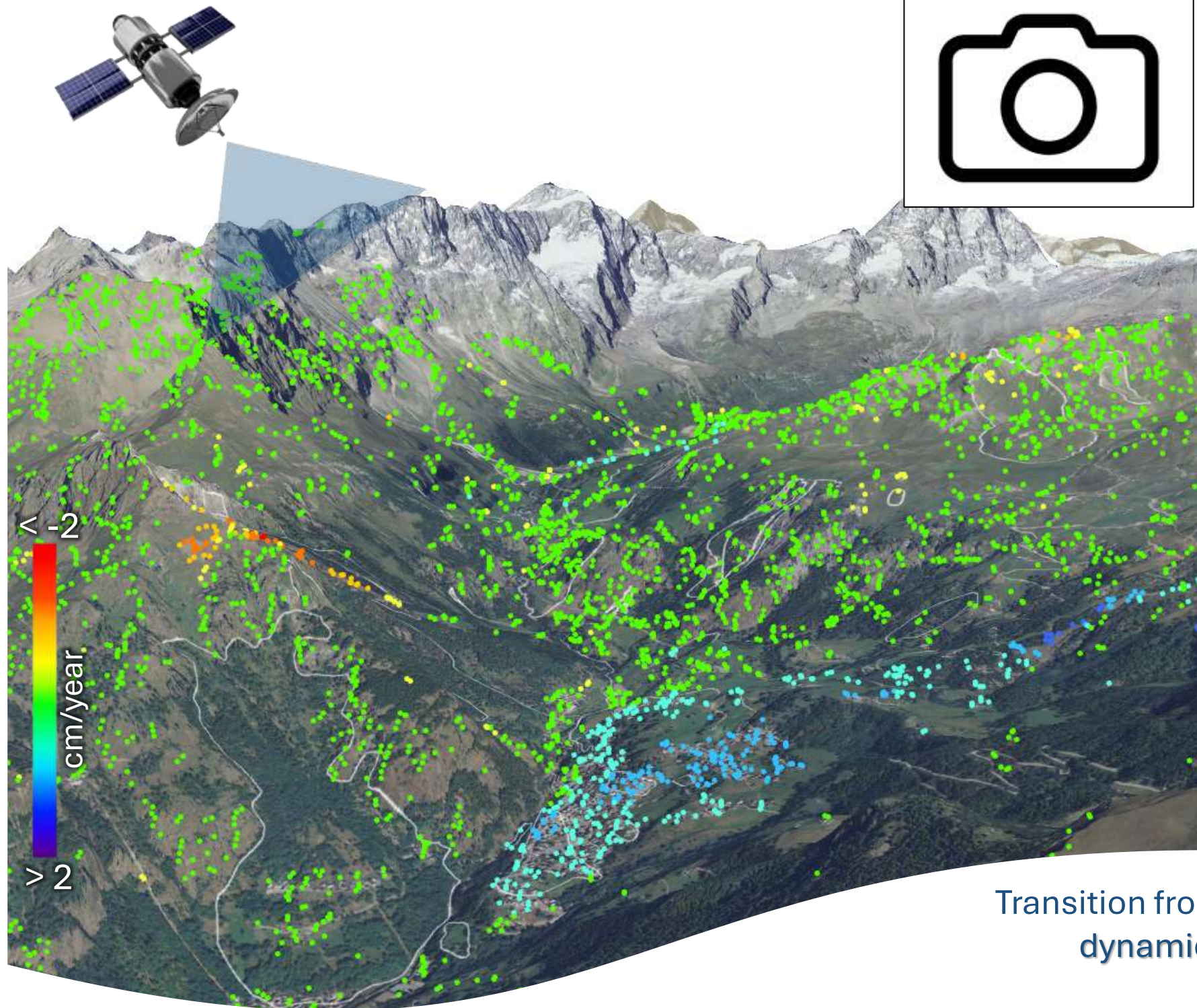
No. Observations

| | |
|-------------|------------|
| Dark Blue | <= 1 |
| Blue | 2 - 25 |
| Light Blue | 26 - 50 |
| Light Green | 51 - 100 |
| Yellow | 101 - 250 |
| Orange | 251 - 500 |
| Red-Orange | 501 - 1000 |
| Red | > 1000 |

Map shows the total of Sentinel-1 SLC product global coverage.
Sentinel-1 data are open access and can be downloaded using the ASF Data Search portal [<https://search.asf.alaska.edu>]



The present: wide area monitoring system



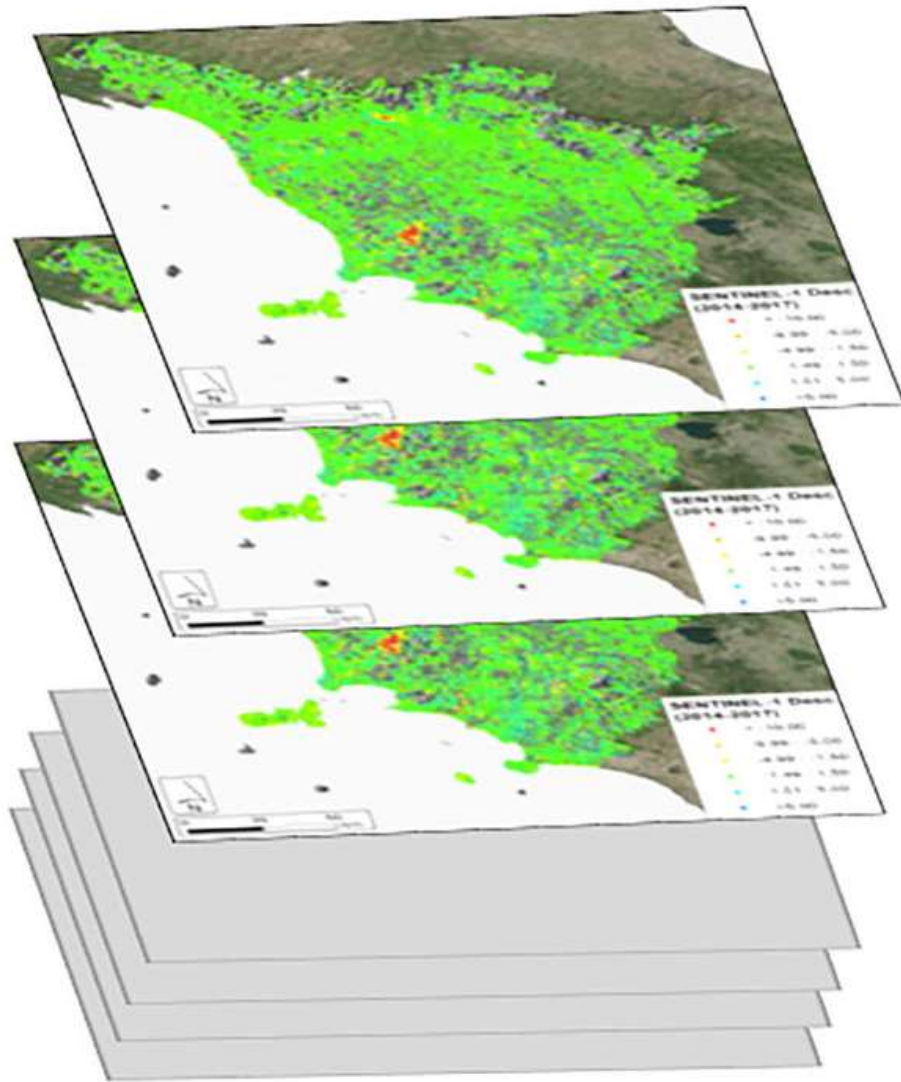
Transition from static satellite analysis to dynamic monitoring of ground displacement

The present: wide area monitoring system



Ottobre 2016

Regione Toscana

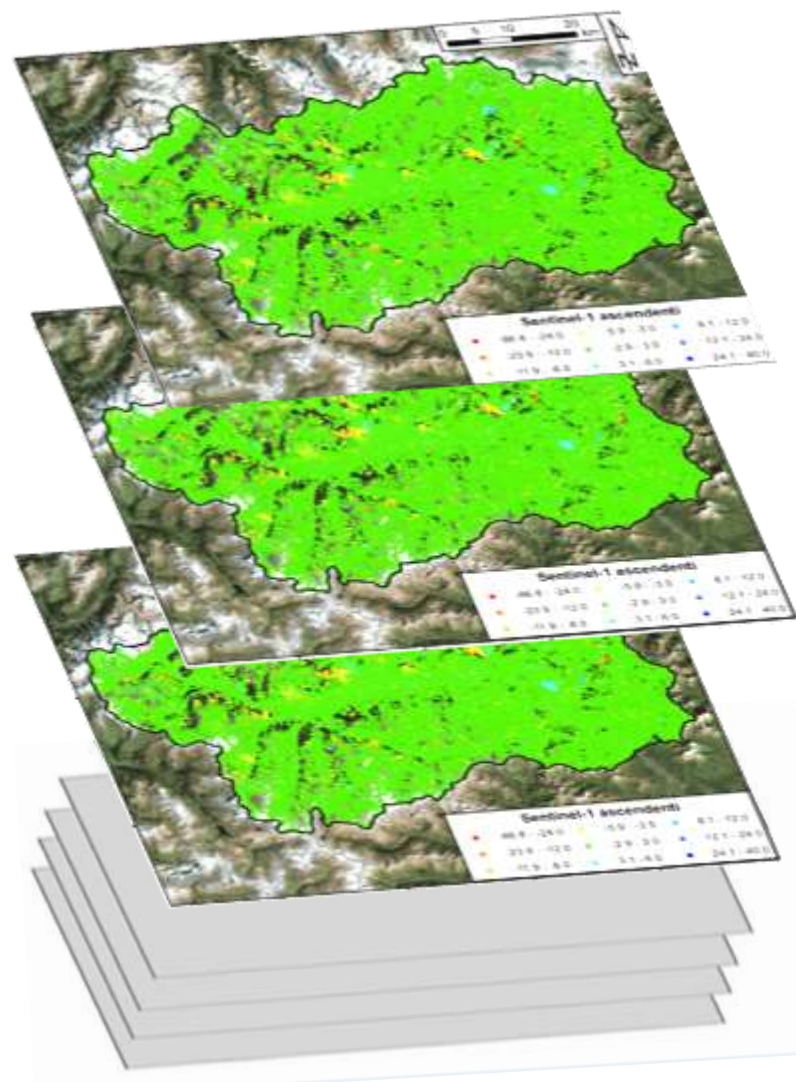


≈ 2.000.000 punti



Gennaio 2018

Regione Valle d'Aosta

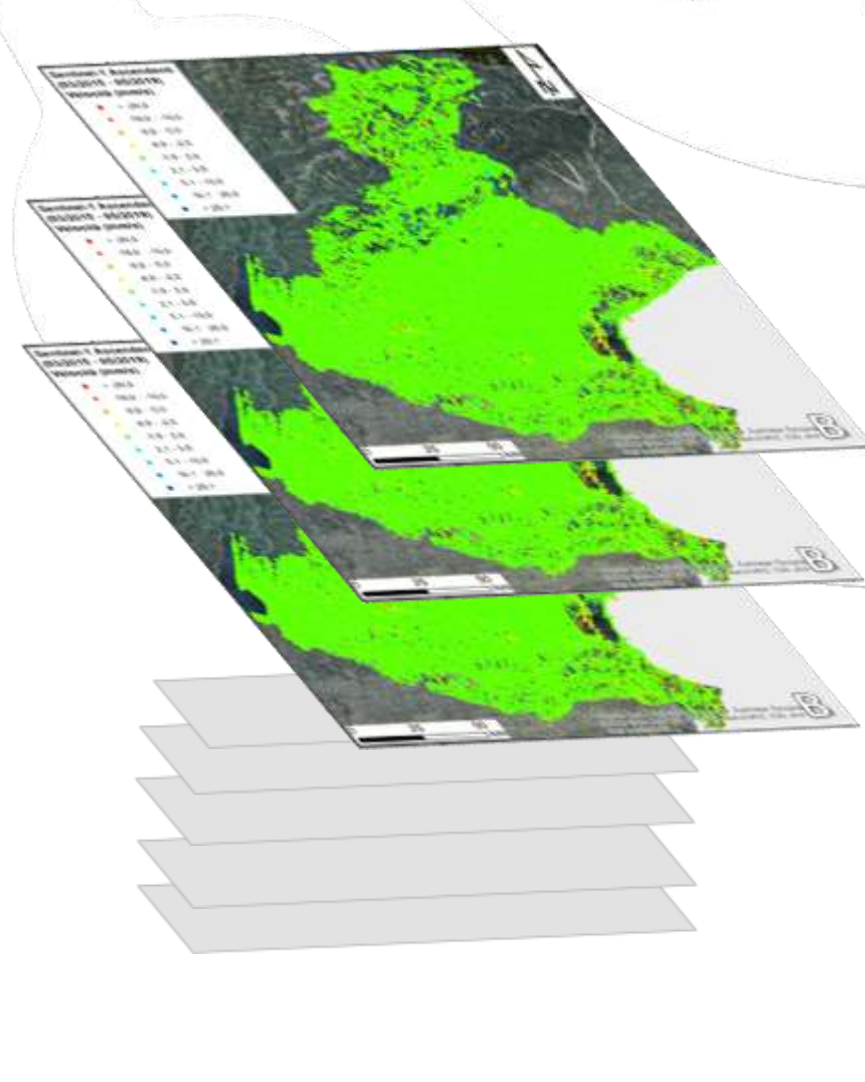


≈ 700.000 punti



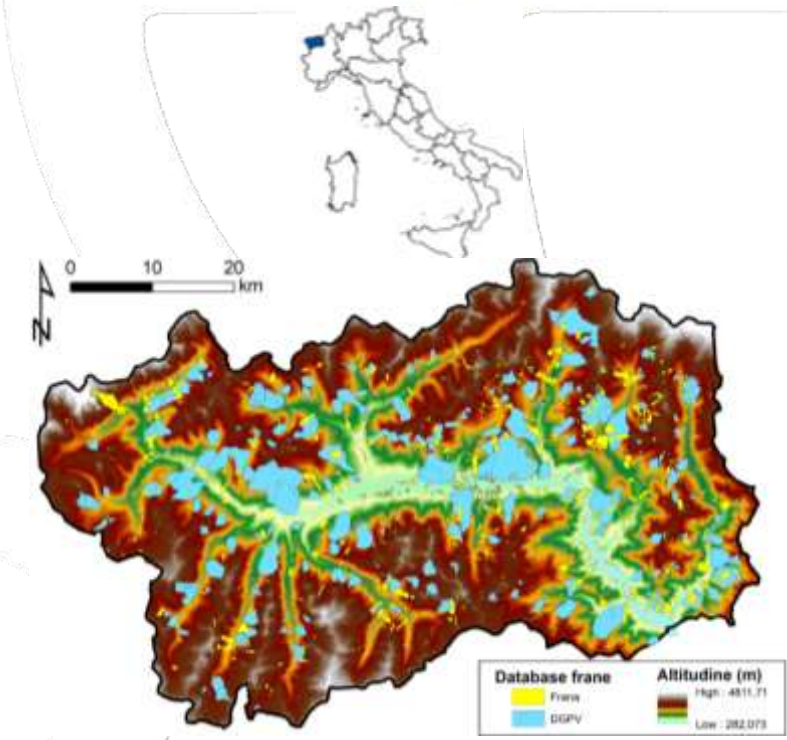
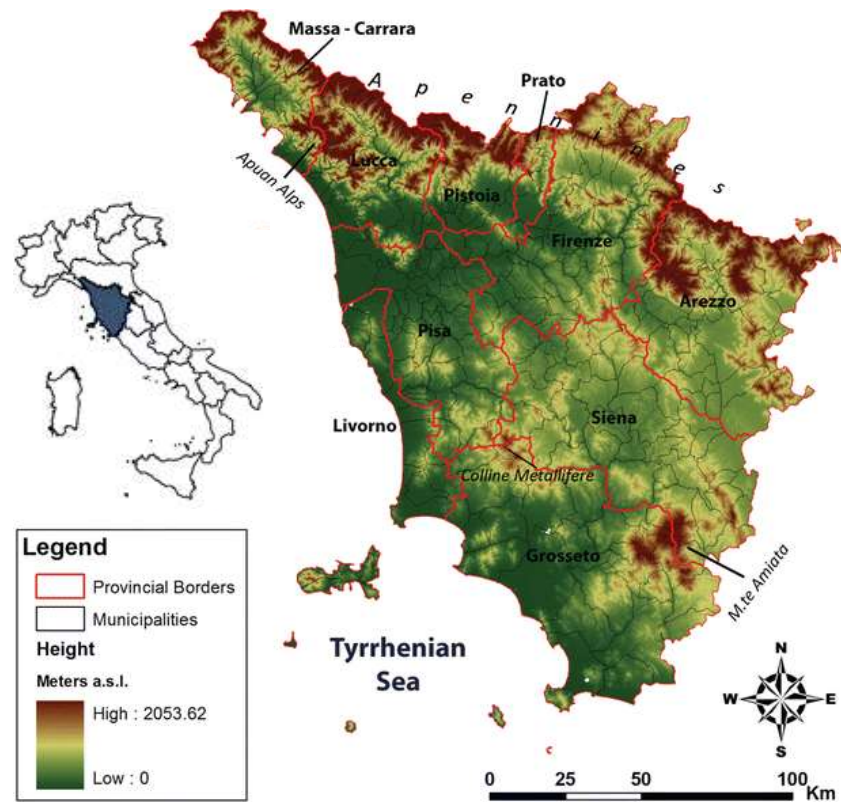
Giugno 2019

Regione Veneto



≈ 3.000.000 punti

The present: wide area monitoring system



Complex landslides, slides

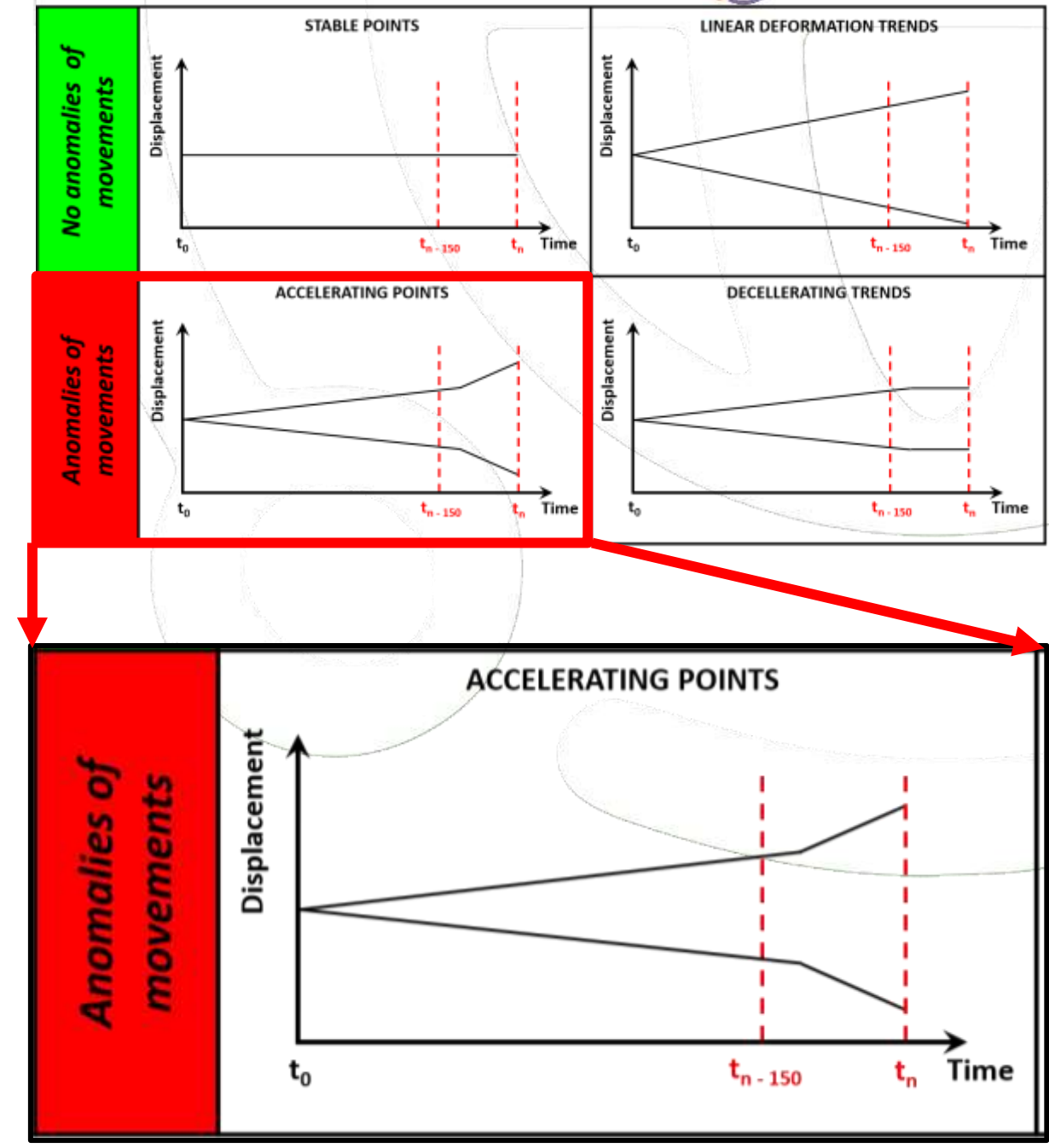
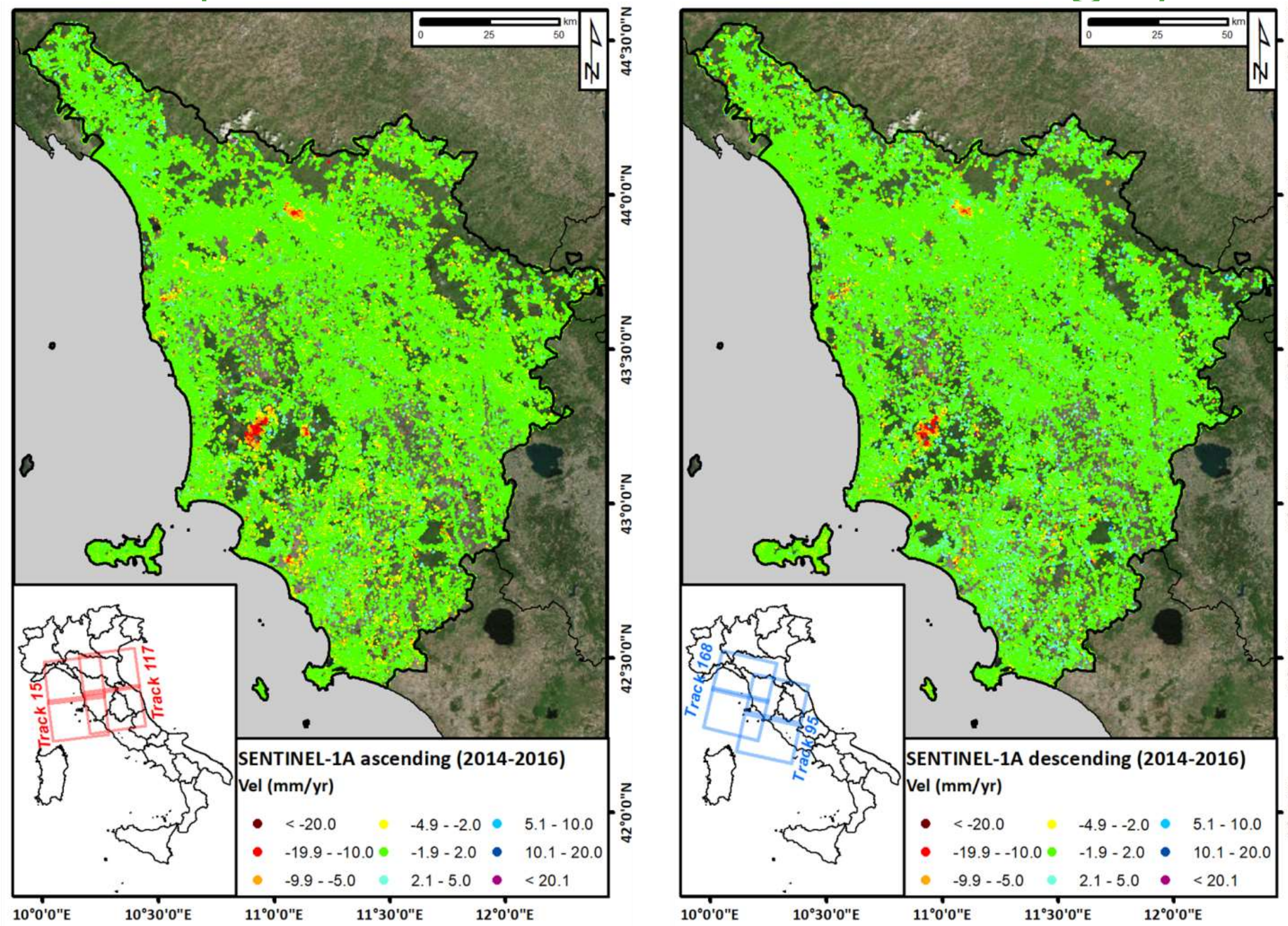


Complex landslides, earth flow



Complex, rockslides, deep-seated LS

The present: wide area monitoring system



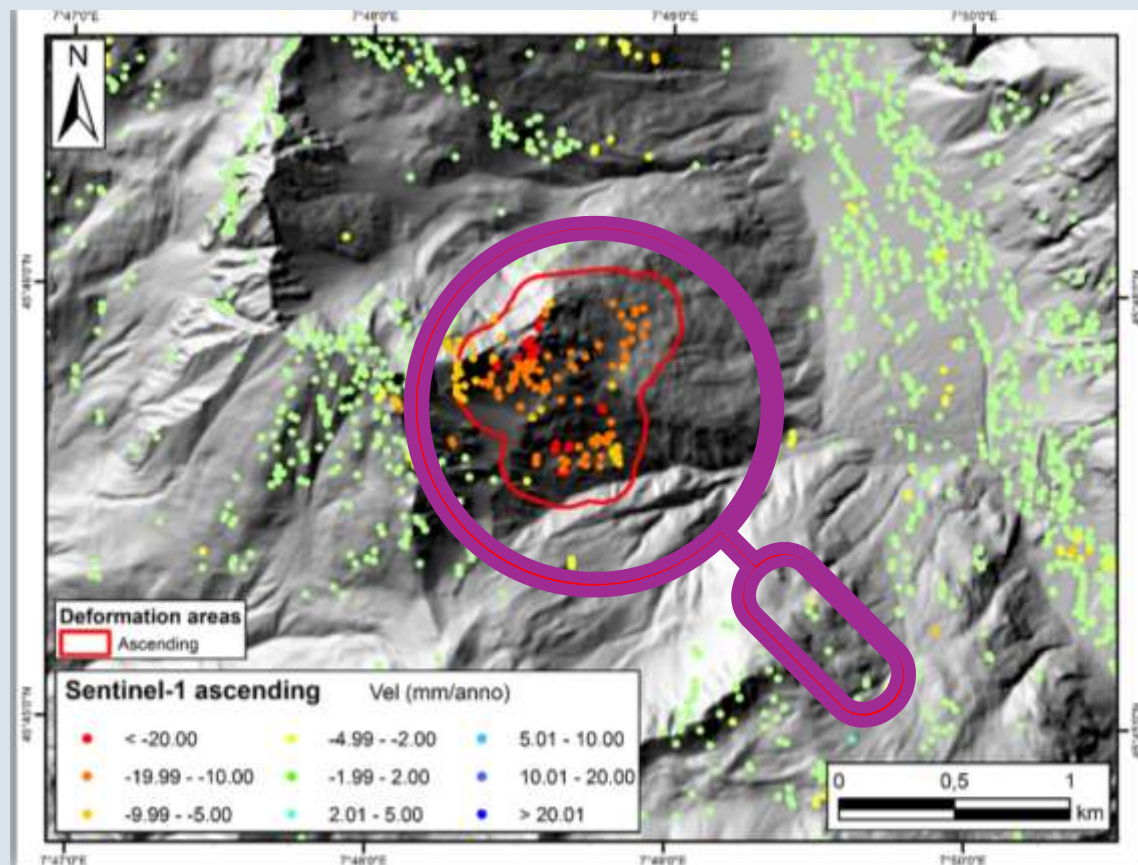
Anomaly of movement:

points where a change in the dynamic of motion is occurring. Information on kinematics of movement

Information on where, when and how fast the ground is moving

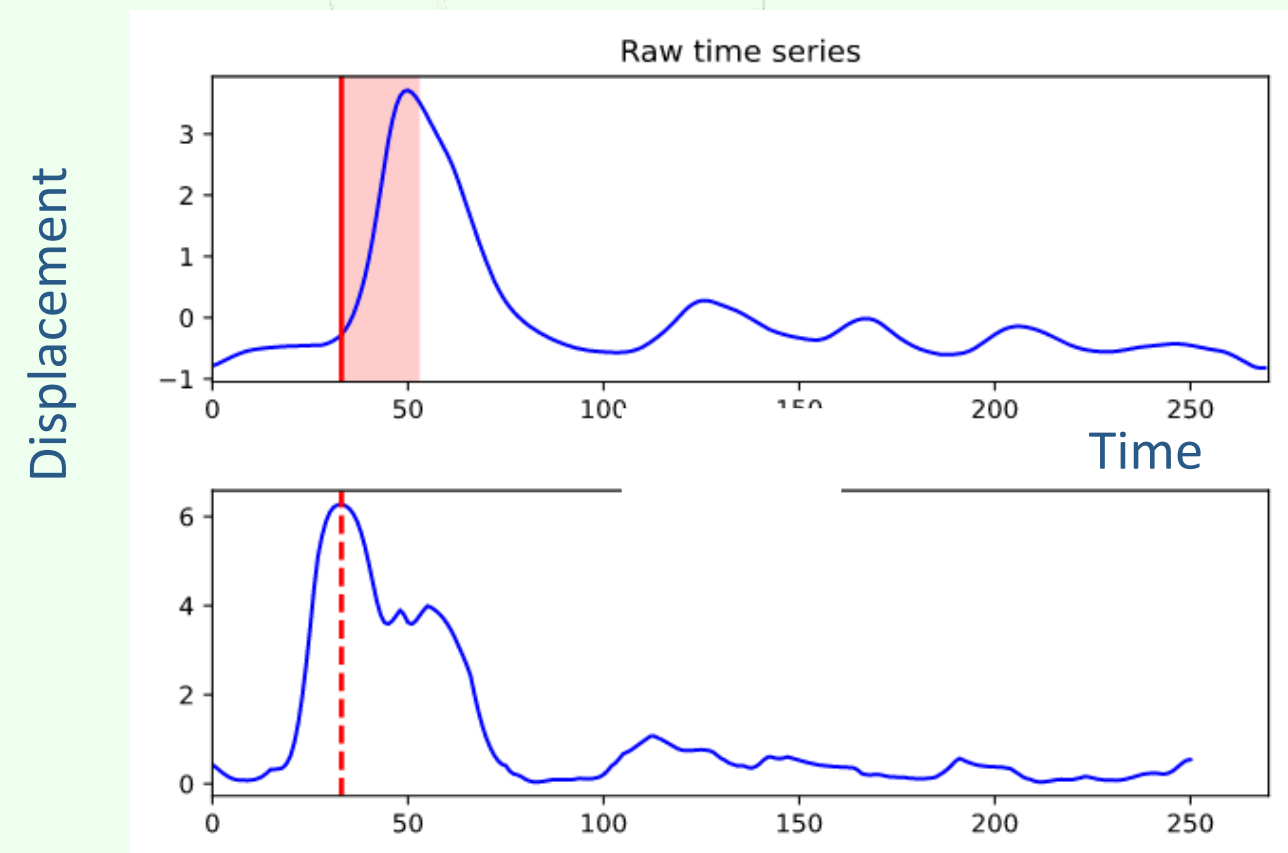
PS Mapping

- Offline activity
- Deformation map analysis
- Single product, annual frequency
 - Deferred time
- Territorial planning and land management



PS Monitoring

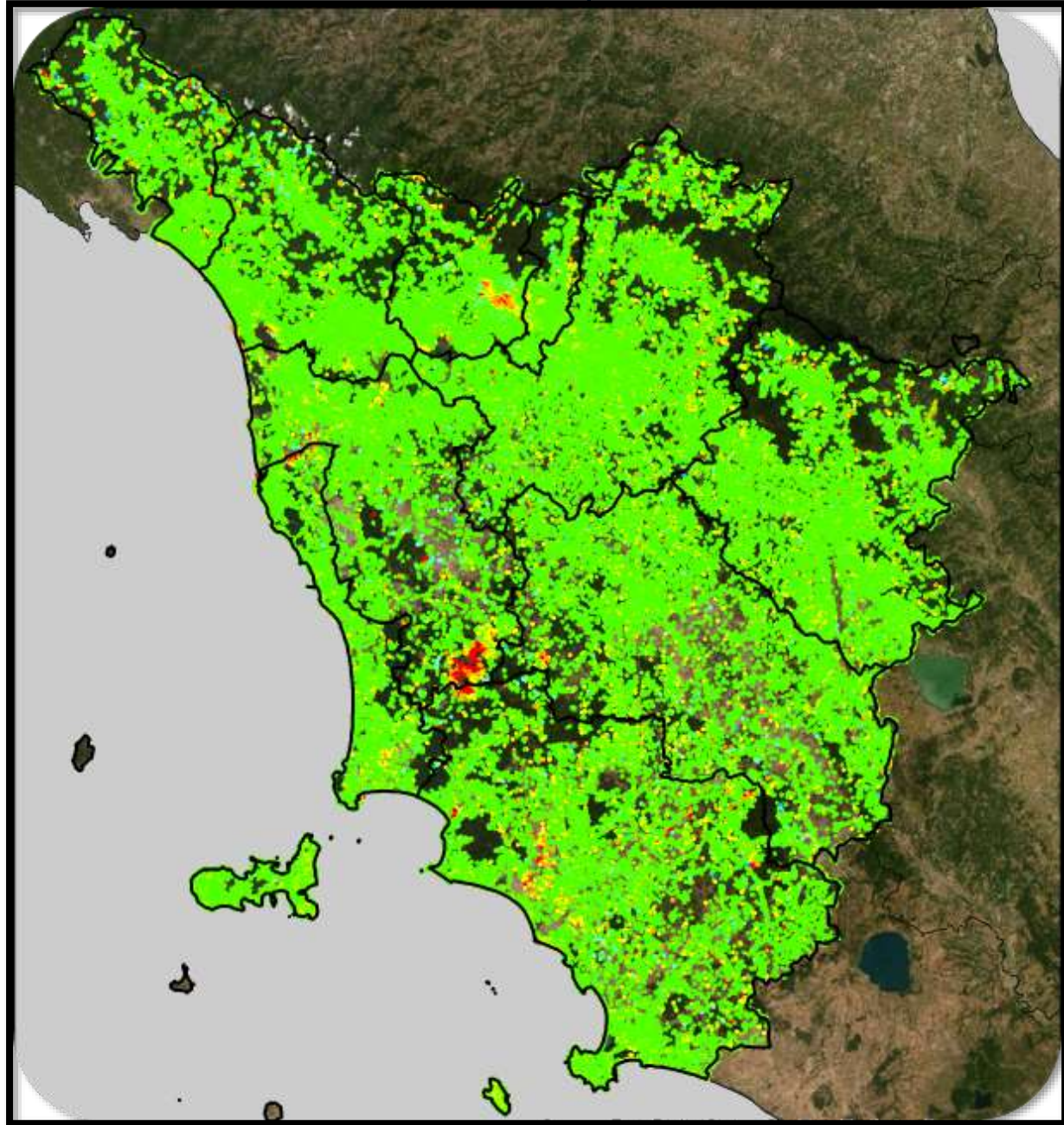
- Online activity
- Time Series analysis
- Continuous service, every Sentinel-1 acq.
 - Near-real time
- Early warning of geohazard risk scenarios



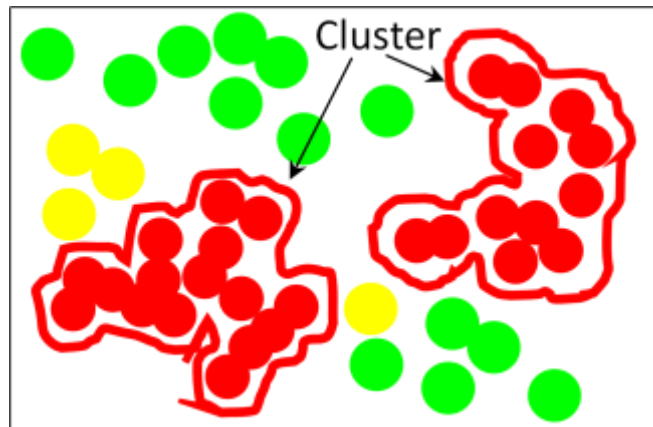
The present: wide area monitoring system

Deformation maps

Millions of points

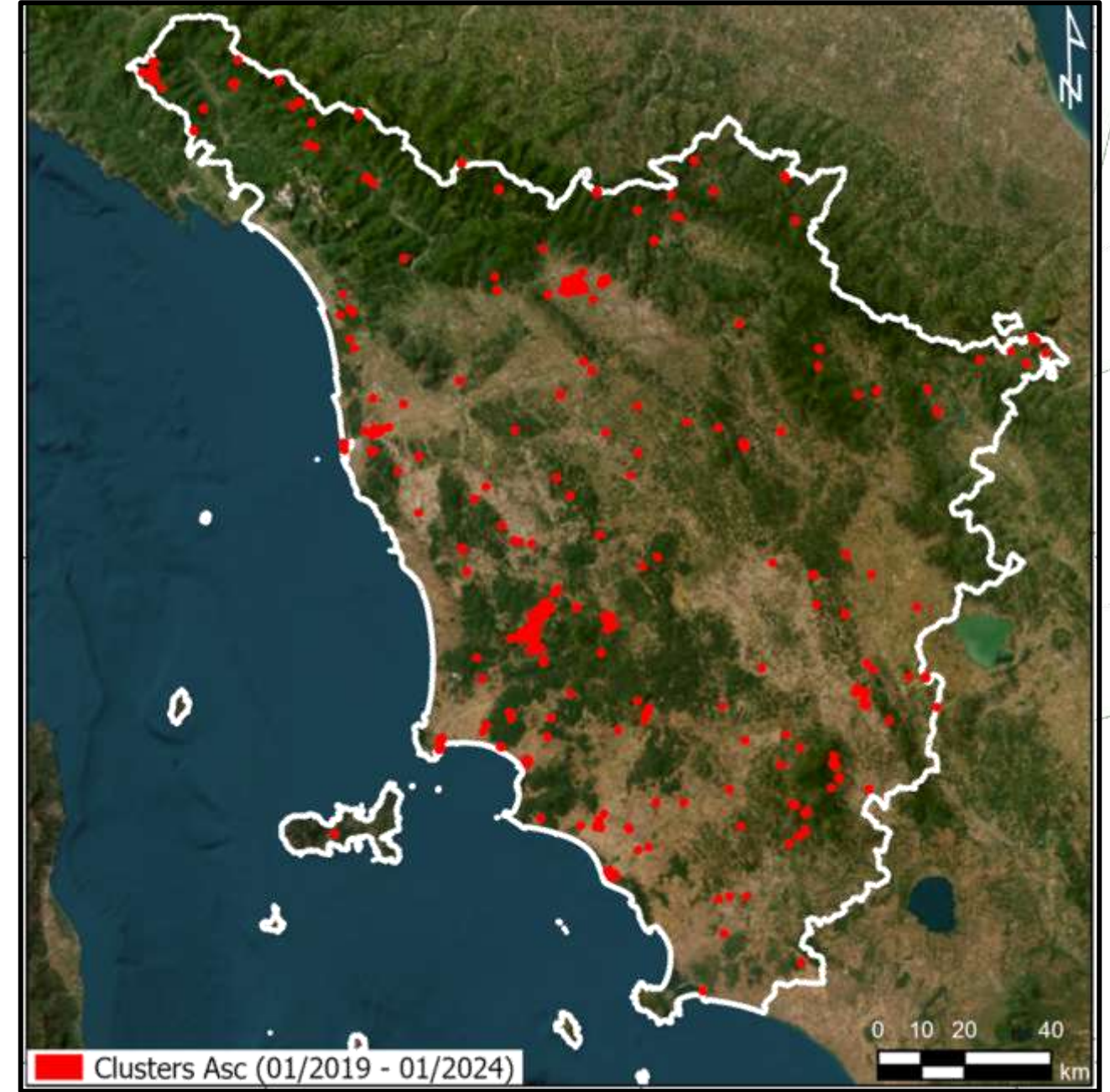


Thresholds and clustering



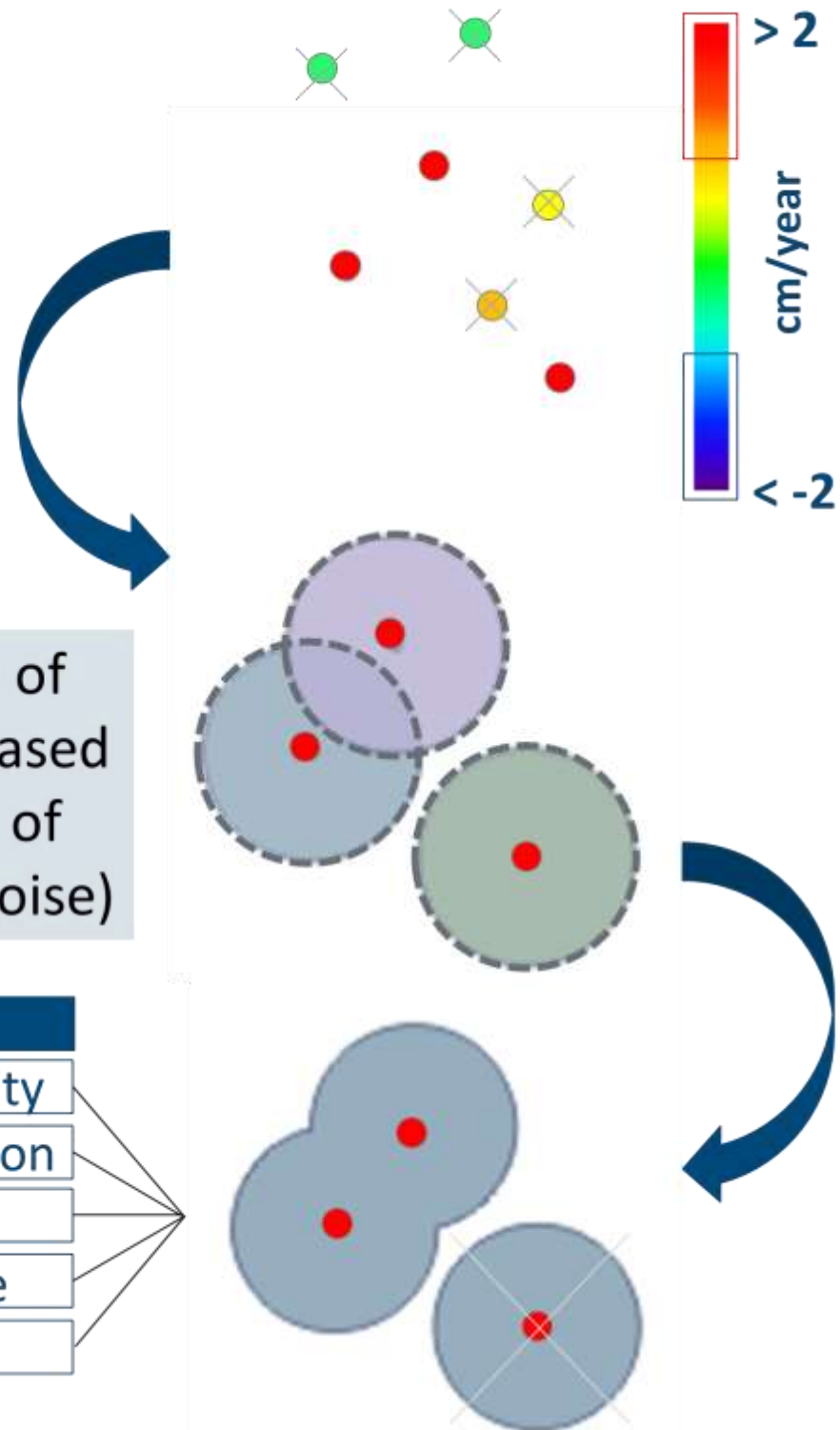
High-moving areas

Few thousands of points



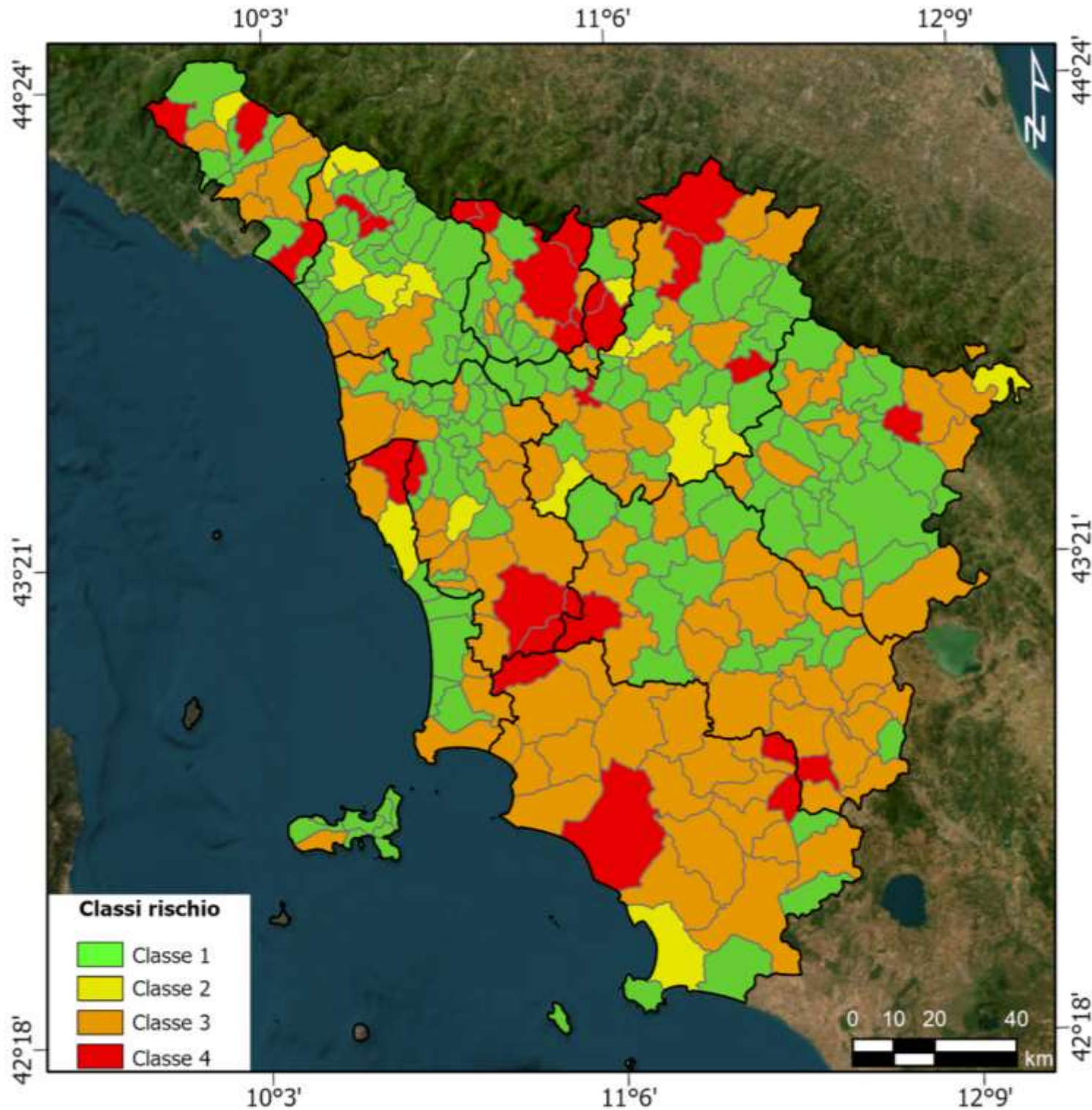
Wide area scanning to spot active deformation zones

The present: wide area monitoring system



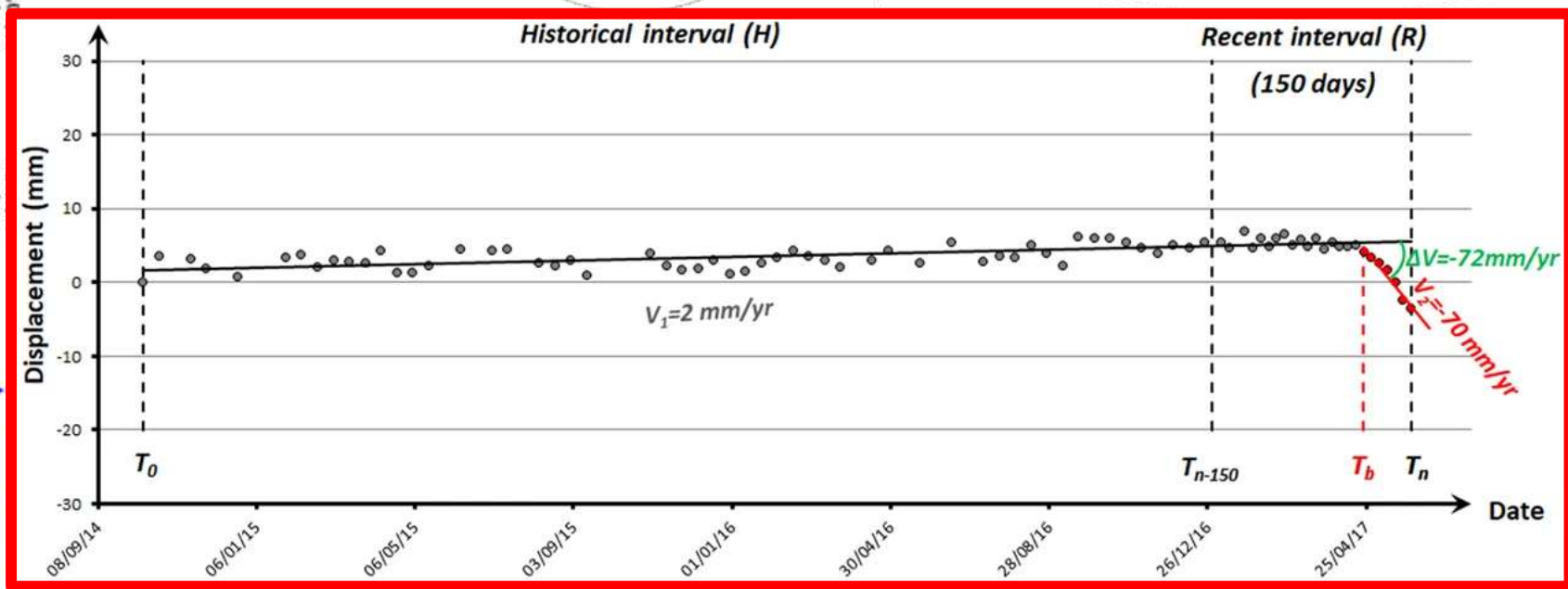
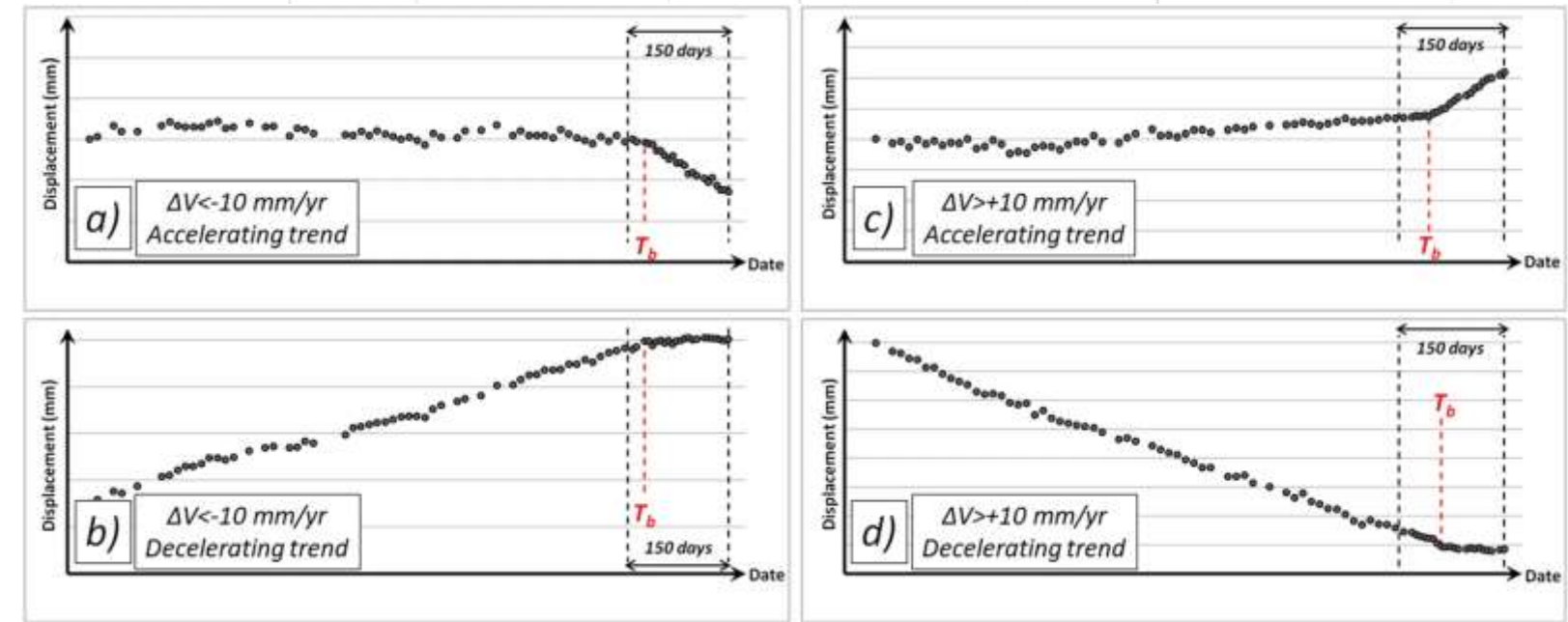
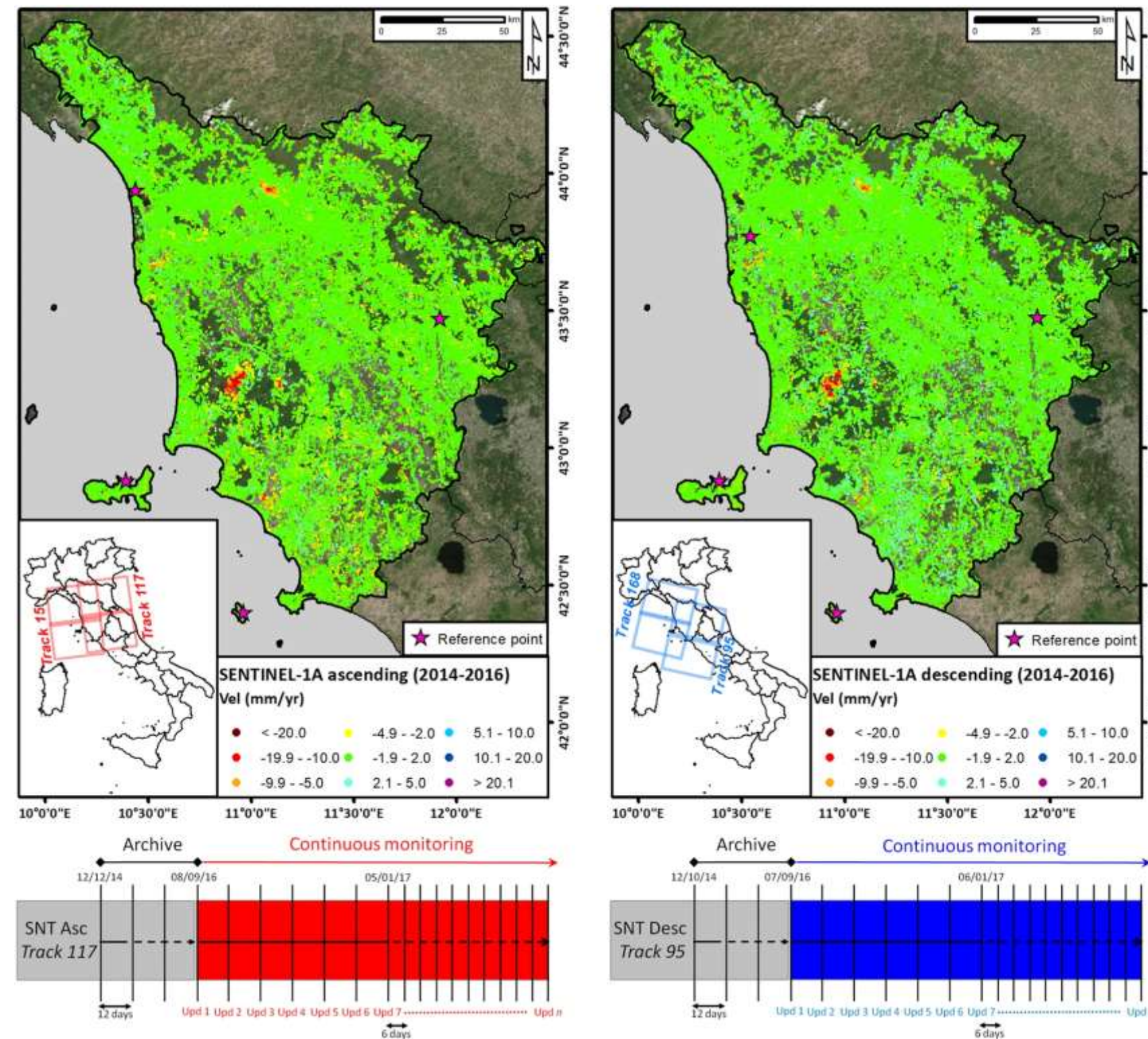
1. PS filtering: setting the displacement rate threshold to retain “outliers” data and to remove stable PS (noise).
2. Buffer size: PS radius of “influence” in accordance with the dataset spatial resolution to retrieve hotspots.
3. Minimum cluster size: PS number threshold to find core samples of high density and exclude noise.
4. Database fields calculation.

The present: wide area monitoring system

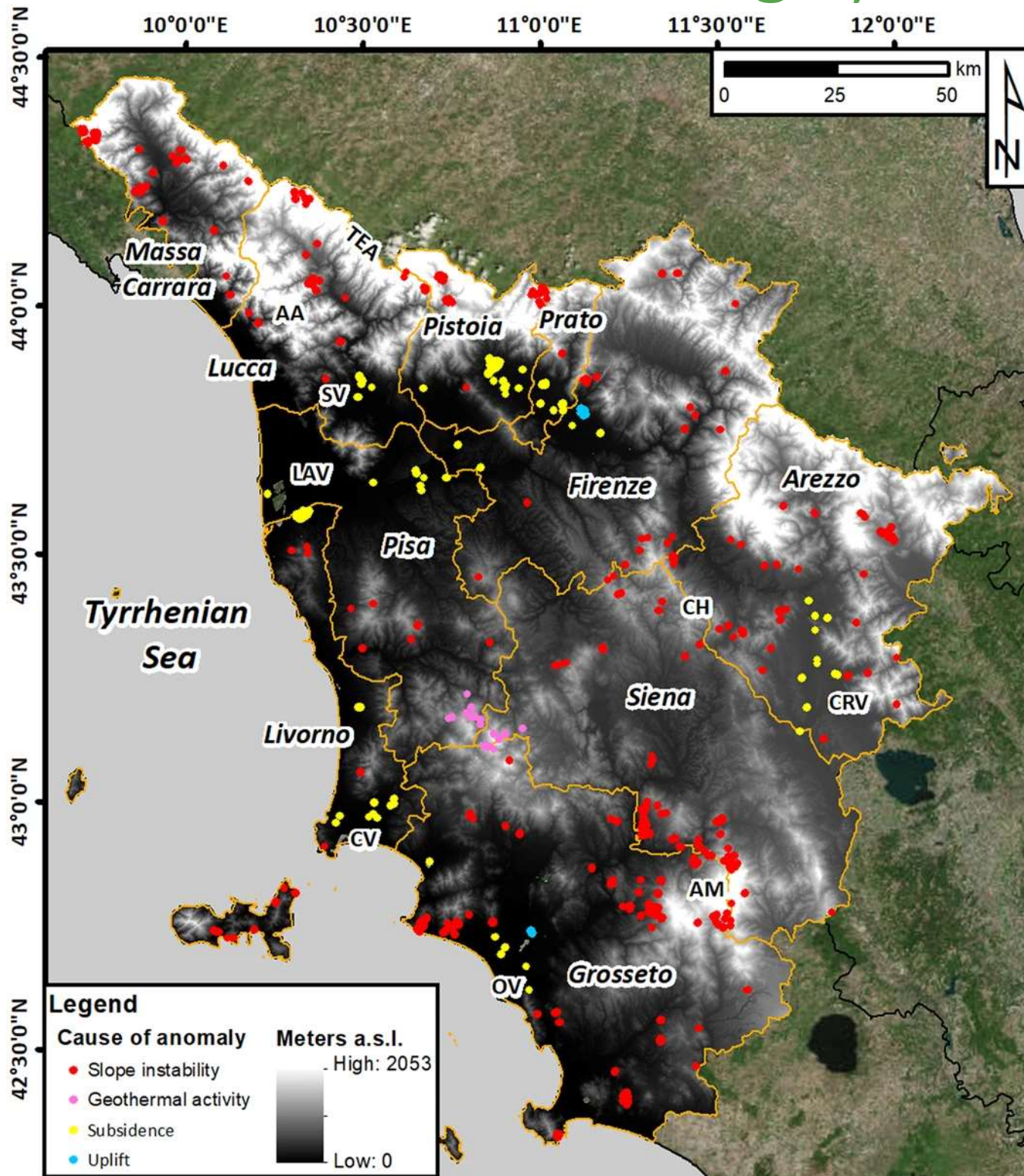


| Level of risk | Description |
|---------------|--|
| 1 | No elements at risk within the active areas |
| 2 | Isolated elements at risk within the active areas |
| 3 | Distributed elements at risk within the active areas |
| 4 | Several elements at risks within the active areas |

The present: wide area monitoring system



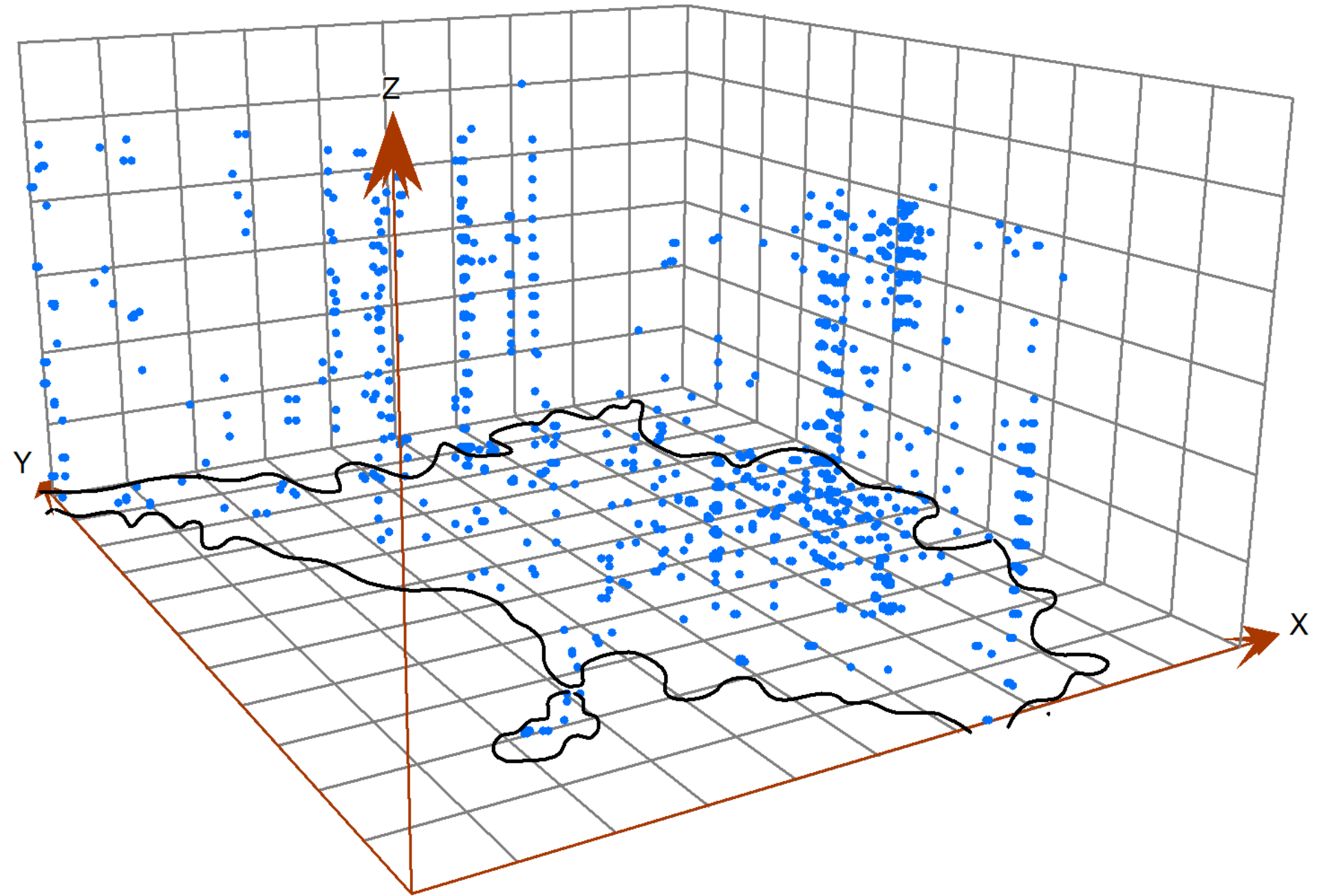
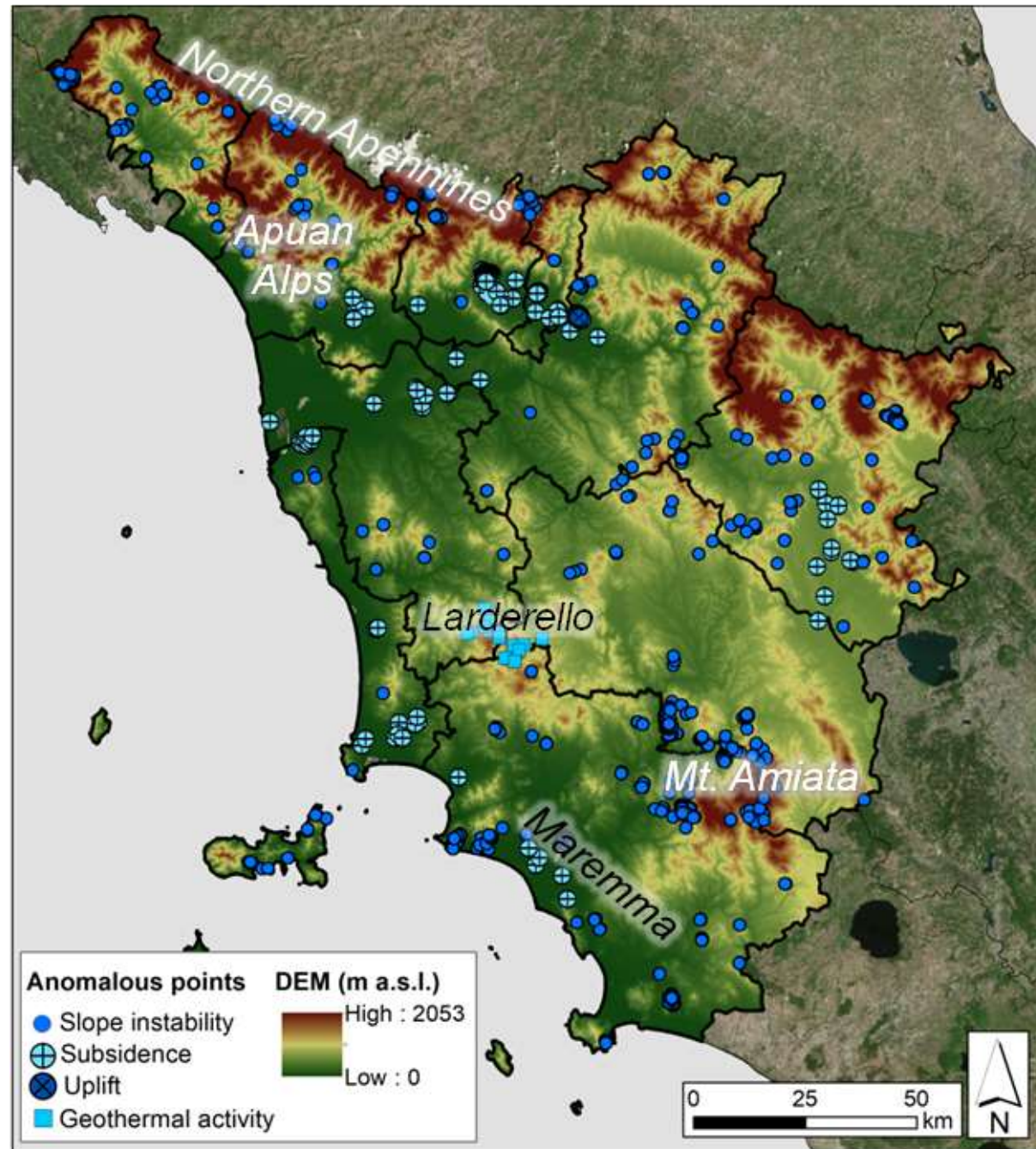
The present: wide area monitoring system



| Update | Last acquisition (track 117) | # of Anomalies | # of ghost anomalies |
|--------------|--------------------------------|----------------|----------------------|
| 2 | 07/11/2016 | 70 | 133 |
| 3 | 19/11/2016 | 90 | 104 |
| 4 | 01/12/2016 | 60 | 72 |
| 5 | 13/12/2016 | 95 | 76 |
| 6 | 25/12/2016 | 121 | 86 |
| 7 | 06/01/2017 | 130 | 55 |
| 8 | 18/01/2017 | 84 | 57 |
| 9 | 30/01/2017 | 94 | 86 |
| 10 | 11/02/2017 | 195 | 154 |
| 11 | 23/02/2017 | 304 | 86 |
| 12 | 07/03/2017 | 341 | 56 |
| 13 | 19/03/2017 | 803 | 109 |
| 14 | 31/03/2017 | 1.233 | 83 |
| 15 | 12/04/2017 | 1.024 | 68 |
| 16 | 24/04/2017 | 907 | 57 |
| 17 | 06/05/2017 | 2.314 | 174 |
| 18 | 18/05/2017 | 2.119 | 497 |
| 19 | 30/05/2017 | 2.034 | 642 |
| Total | 07/11/2016 - 30/05/2017 | 12.018 | 2.597 |

| Province | Area (km ²) | Total anomalies | Anomalies/10 km ² | | | |
|----------------|-------------------------|-----------------|------------------------------|-------------|-------------|---------------------|
| | | | Slope instability | Subsidence | Uplift | Geothermal activity |
| Massa Carrara | 1.159 | 79 | 0.68 | 0 | 0 | 0 |
| Lucca | 177 | 75 | 3.56 | 0.68 | 0 | 0 |
| Pistoia | 966 | 8.001 | 1.12 | 81.71 | 0 | 0 |
| Prato | 365 | 997 | 0.14 | 27.18 | 0 | 0 |
| Firenze | 3.520 | 103 | 0.25 | 0.01 | 0.03 | 0 |
| Pisa | 2.451 | 52 | 0.09 | 0.07 | 0 | 0.05 |
| Livorno | 1.218 | 71 | 0.24 | 0.34 | 0 | 0 |
| Siena | 3.820 | 618 | 1.60 | 0 | 0 | 0.01 |
| Arezzo | 3.235 | 338 | 0.90 | 0.15 | 0 | 0 |
| Grosseto | 4.510 | 1.684 | 2.43 | 0.04 | 1.25 | 0.02 |
| Tuscany | 21.412 | 12.018 | 1.12 | 4.21 | 0.27 | 0.01 |

The present: wide area monitoring system

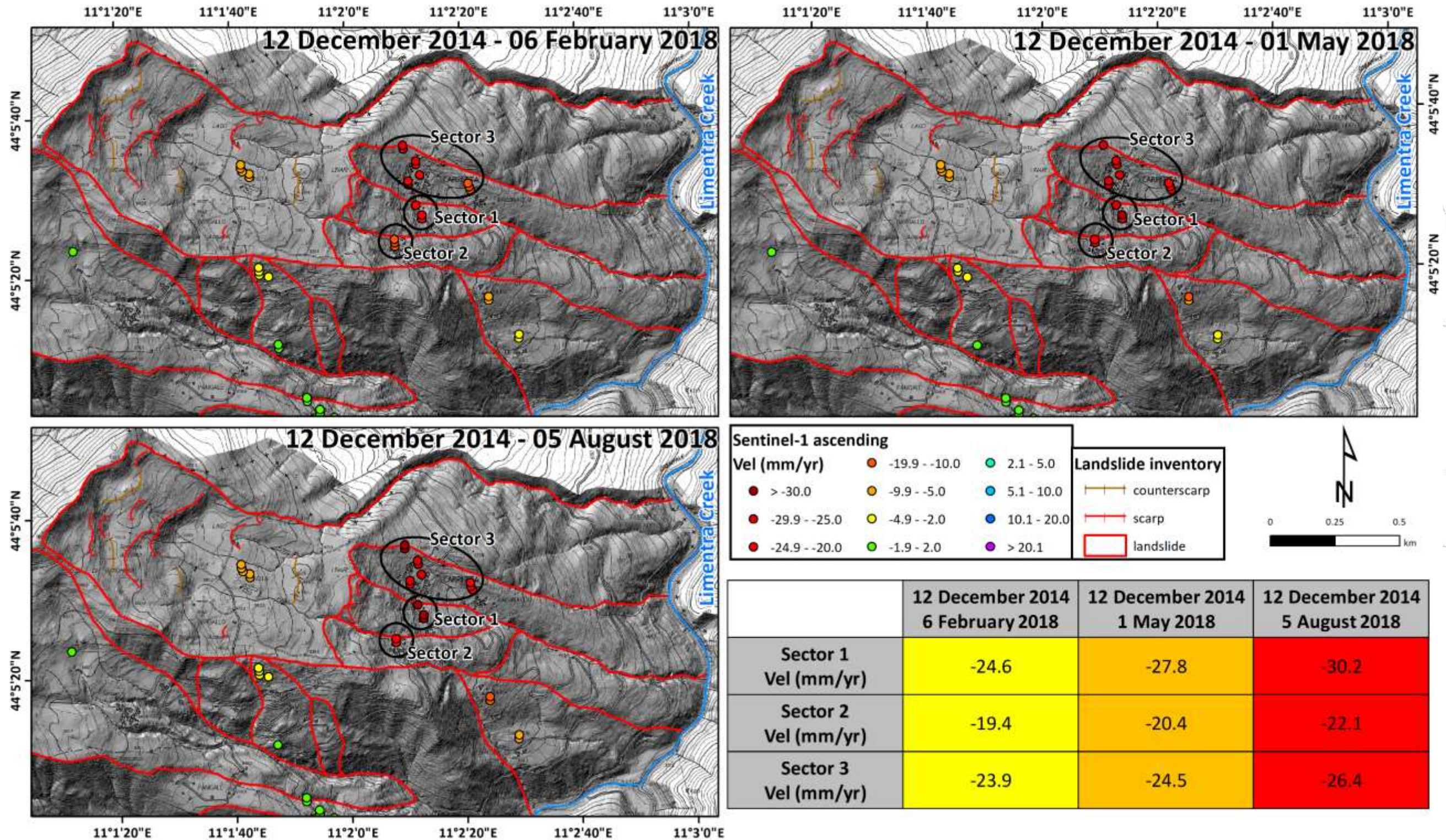


Spatial consistency: only a group of neighbour points (*i.e.*, a cluster) sharing similar trends are considered representative of a change in the kinematics of a given phenomenon

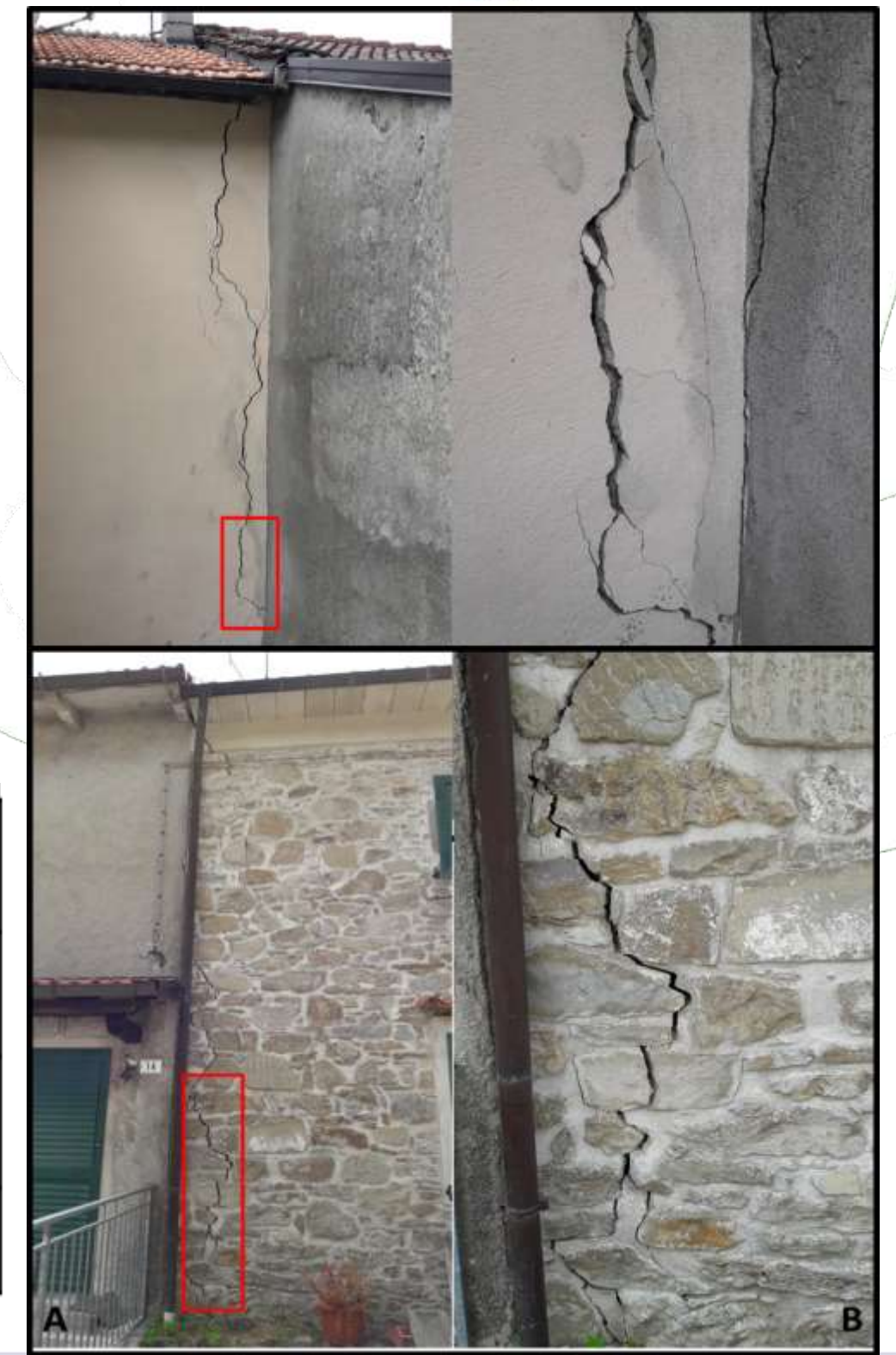
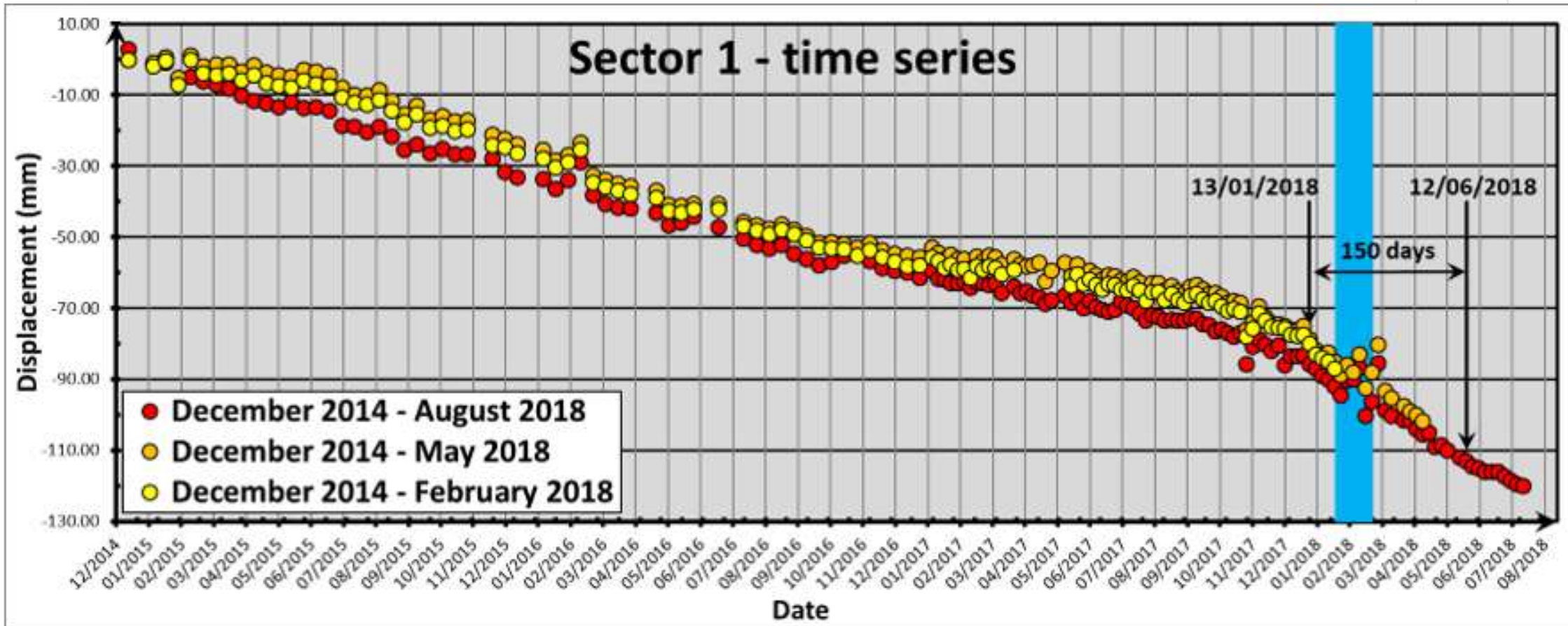
Temporal persistency: a cluster of points labelled as “anomalous” in at least two consecutive updates can generate a “change” to be further considered.

Ghost anomalies: anomalies identified only in one single update

The present: wide area monitoring system



The present: wide area monitoring system



| | Start of acceleration | Latency period | Appearance of anomaly | Disappearance of appearance | Persistency | Life length (days) |
|-----------------|-----------------------|----------------|-----------------------|-----------------------------|-------------|--------------------|
| Sector 1 | 13/01/2018 | 4 acquisitions | 06/02/2018 | 12/06/2018 | 126 | 150 |
| Sector 2 | 12/02/2018 | 5 acquisitions | 14/03/2018 | 06/07/2018 | 114 | 144 |
| Sector 3 | 14/03/2018 | 3 acquisitions | 01/04/208 | 05/08/2018 | 126 | 144 |

The present: wide area monitoring system

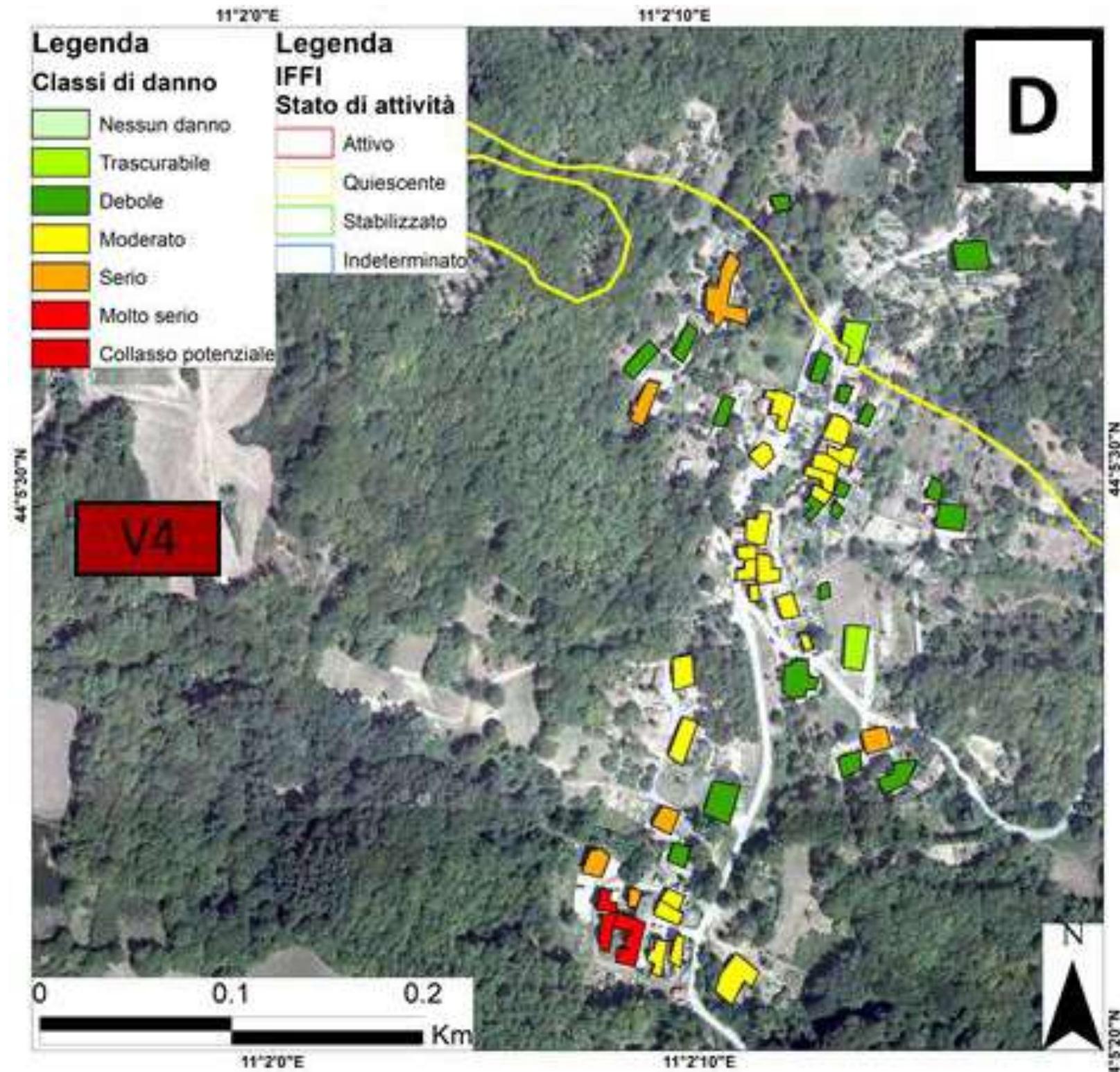


The municipality, committed by the Region authorities, started a plan of geological investigations:

- Survey of the **damage level** to building and infrastructures
- **5 boreholes**
 - - 3 inclinometer
 - - 2 piezometers
- **4 seismic and electric lines**
- Installation of **corner reflectors**
- **Topographic** survey



The present: wide area monitoring system

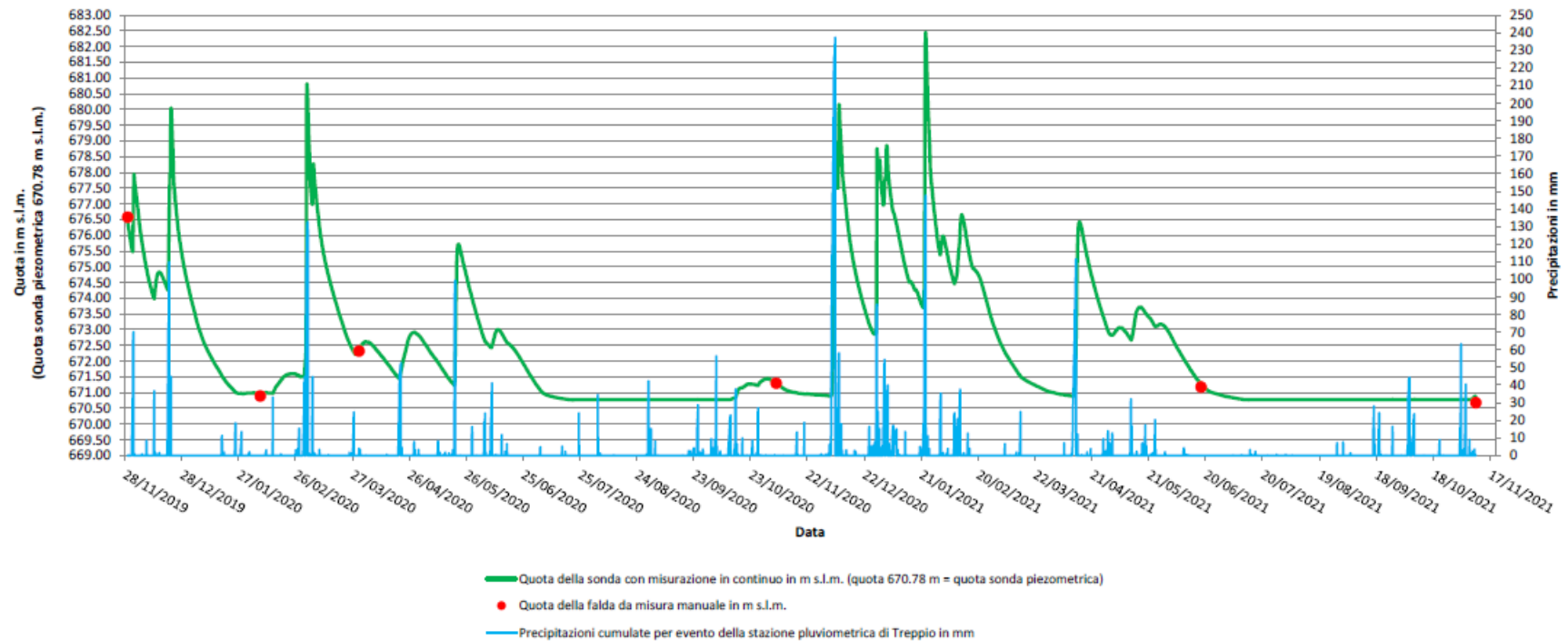
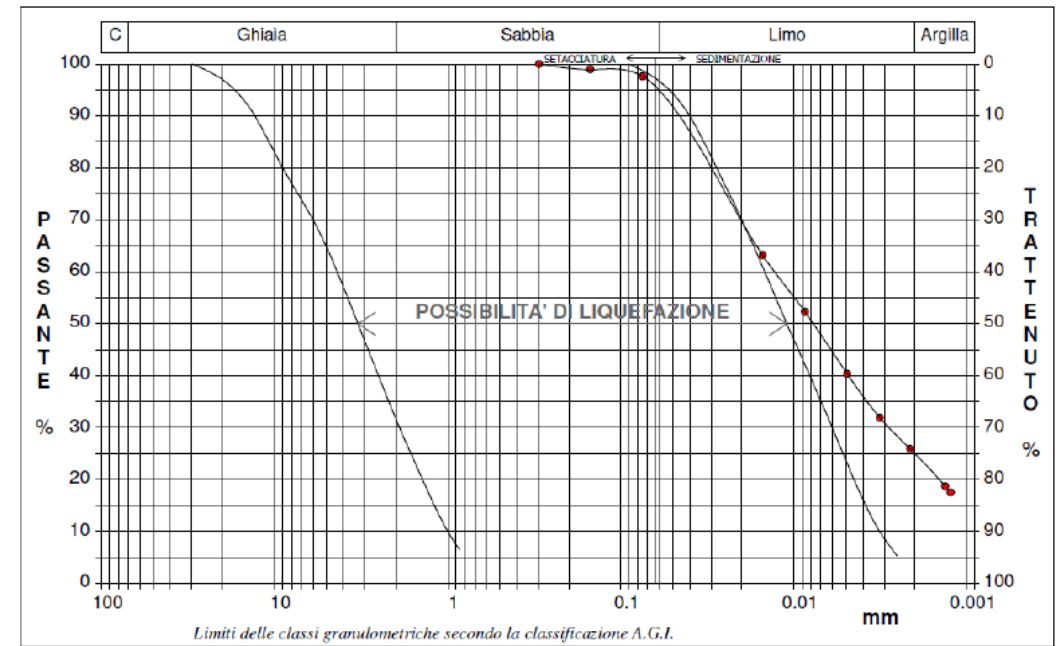


The present: wide area monitoring system

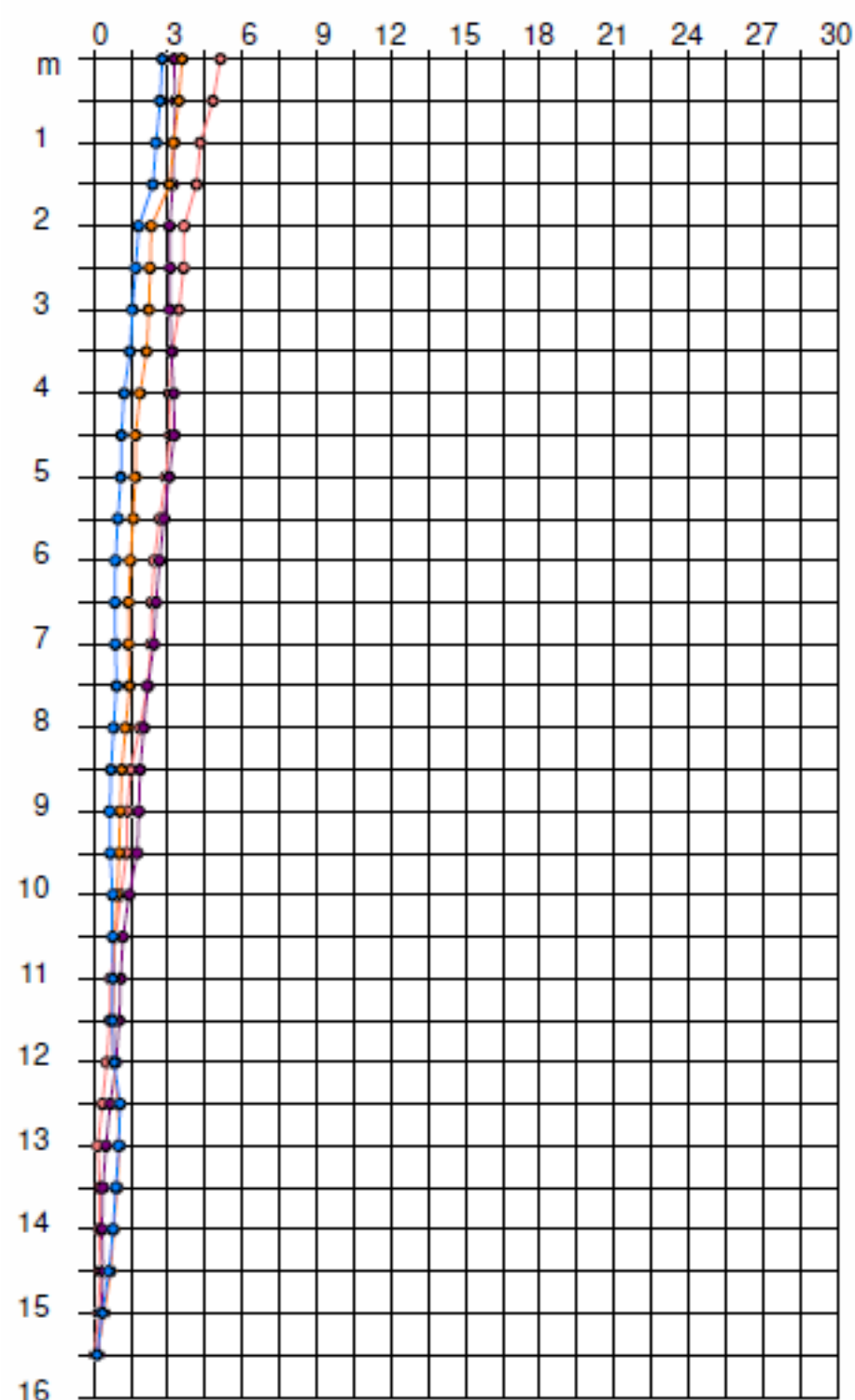
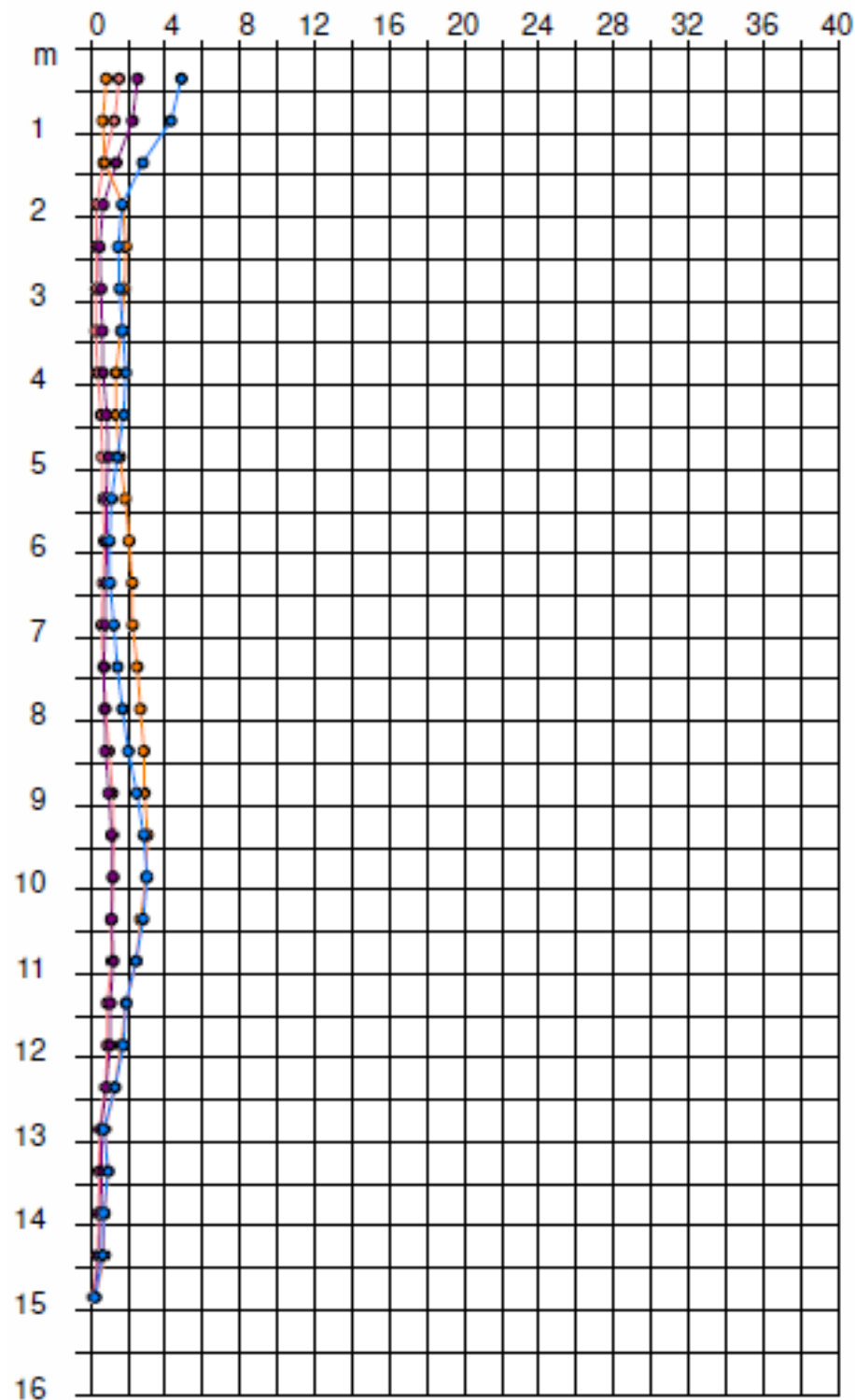
| Profondità dal p.c. (m) | STRATIGRAFIA | | PERCENTUALE DI RECUPERO 50 % | SPT | | | VANE TEST Kg/cm ² | POCKET PENETR. Kg/cm ² | NOTE |
|-------------------------|--|--|------------------------------|-----|----|----|------------------------------|-----------------------------------|----------|
| | Descrizione litologica | | | N1 | N2 | N3 | | | |
| 0.00 | Terreni di riporto | | | | | | | | |
| 1.00 | Limi argillosi con rari inclusi di dimensioni mm | | | | | | | | |
| 2.00 | Limi sabbiosi e sabbie limose con inclusi clasti arenacei di dimensioni da mm a cm a spigoli vivi | | | 2 | 3 | 5 | | | SPT 2m |
| 3.00 | Limi argillosi con inclusi abbondanti clasti arenacei e siltitici di dimensioni da mm a cm | | | | | | | | |
| 3.50 | Campione SIC1 | | | | | | | | |
| 5.50 | Sabbie limose e limi sabbiosi con inclusi clasti arenacei e siltitici molto degradati. Presenza di acqua a circa 4 m | | | 5 | 5 | 6 | | | SPT4.55m |
| 6.00 | Livelli di arenarie e, in subordine, di siltiti, con grado di alterazione più o meno marcato | | | | | | | | |



| | | | | | |
|----------------------------|--------|----------------------------------|---------------------------|-----|------------|
| Ghiaia | 0,0 % | Passante setaccio 10 (2 mm) | 100,0 % | D10 | 0,00079 mm |
| Sabbia | 7,2 % | Passante setaccio 40 (0.42 mm) | 100,0 % | D30 | 0,00280 mm |
| Limo | 67,9 % | Passante setaccio 200 (0.075 mm) | 97,6 % | D50 | 0,00776 mm |
| Argilla | 24,9 % | | | D60 | 0,01286 mm |
| | | | | D90 | 0,05265 mm |
| Coefficiente di uniformità | | 16,25 | Coefficiente di curvatura | | 0,77 |



The present: wide area monitoring system

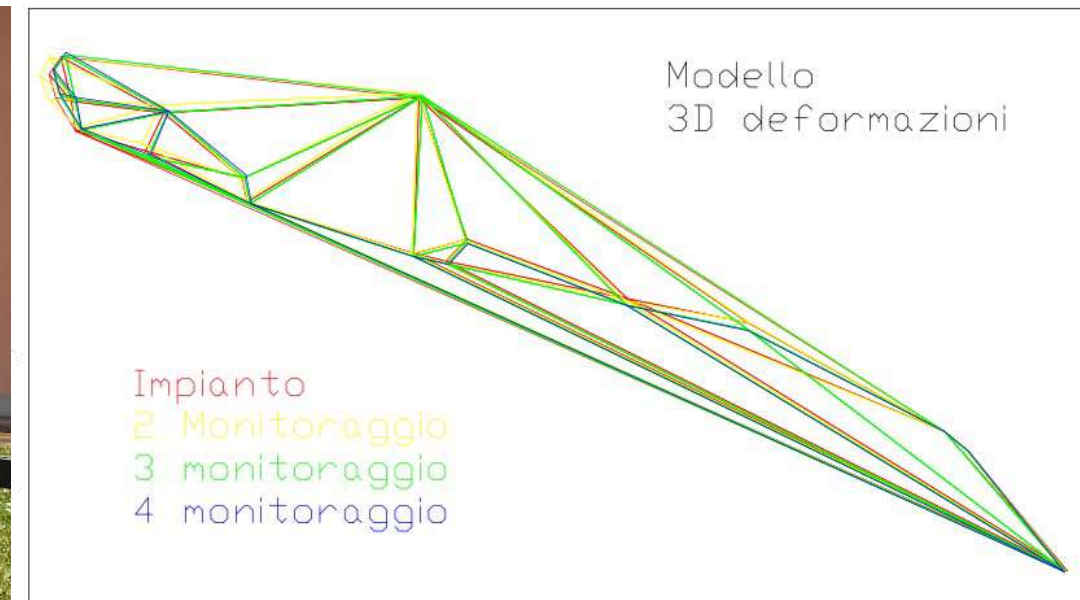


Monitoring of sliding surface with inclinometers

- Measure 0 09/10/2019
- Measure 1 13/05/2020
- Measure 2 28/09/2020
- Measure 3 10/05/2021
- Measure 4 04/11/2021

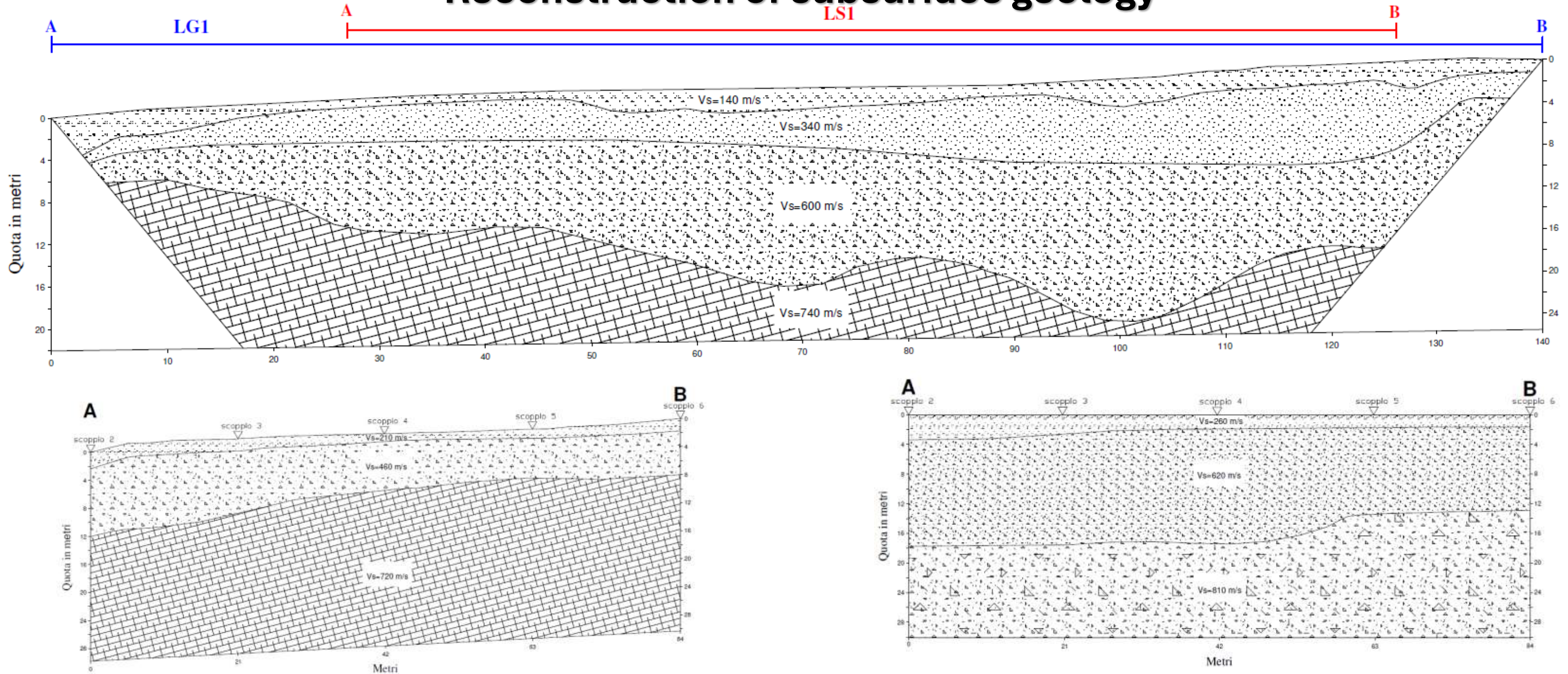
The present: wide area monitoring system

In situ monitoring plan



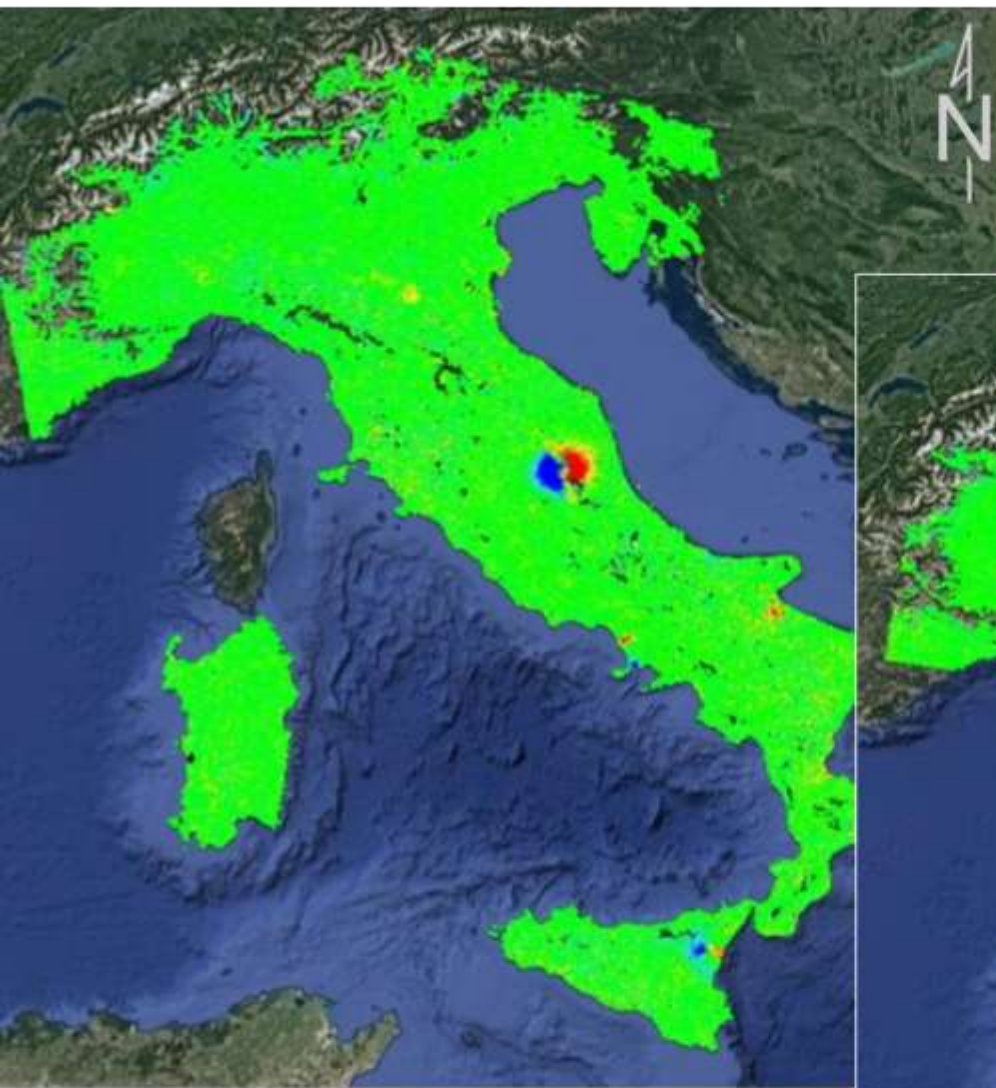
The present: wide area monitoring system

Reconstruction of subsurface geology



The present: wide area monitoring system

Ascending orbit



Descending orbit



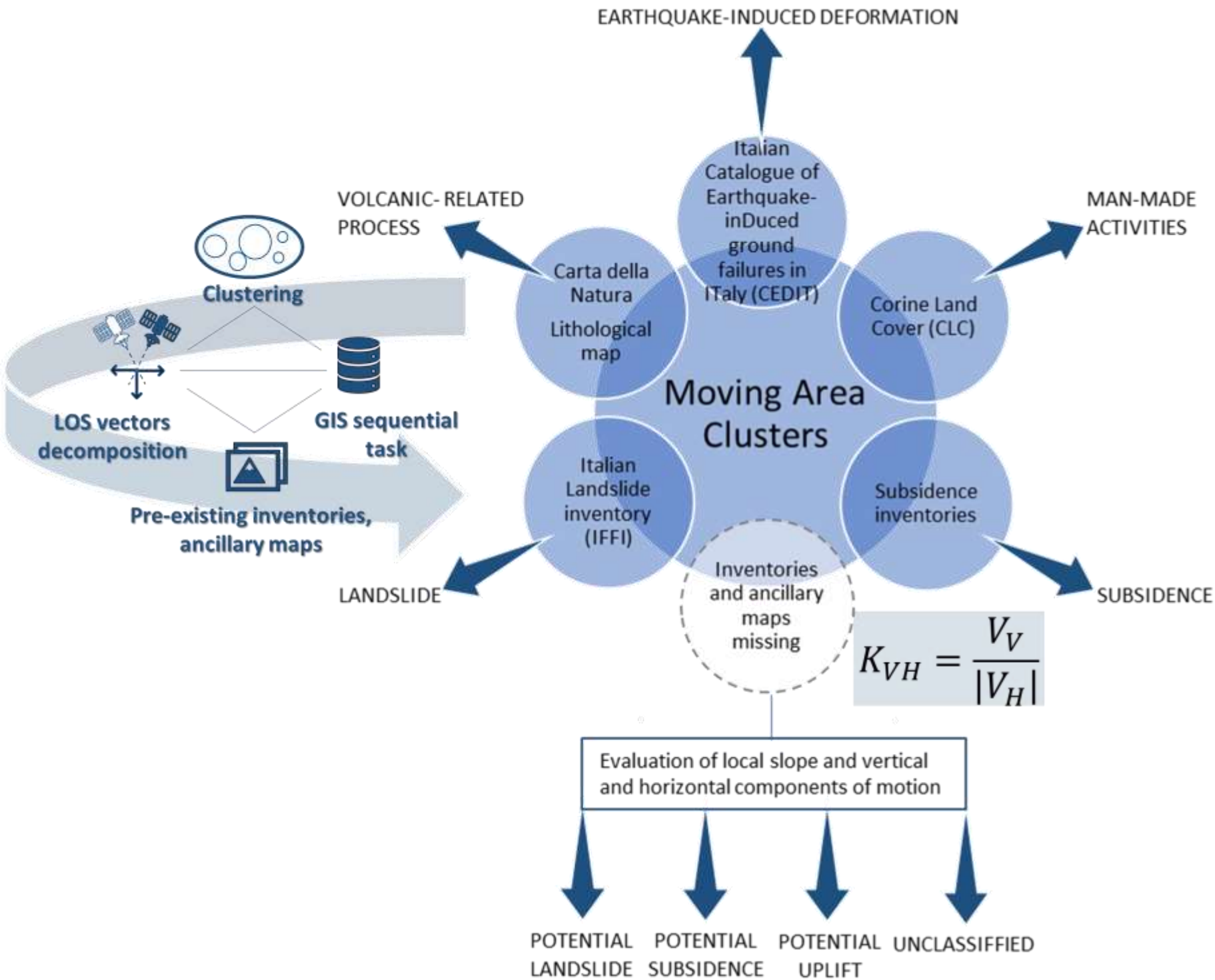
Sentinel-1
(2015-2018)



| Satellite (Orbit) | T interval (No. images) | PS count | Vel.min-Vel.max | Vel SD |
|-------------------------|---|-----------|-----------------|--------|
| Sentinel-1 (Ascending) | 23 Mar 2015 – 26 Dec 2018 (3,294) | 8,066,243 | -10.1 – 6.8 | 0.3 |
| Sentinel-1 (Descending) | 26 Mar 2015 – 29 Dec 2018 (2,868) | 7,181,599 | -11.0 – 10.9 | 0.3 |

- Sentinel 1A and 1B images acquired in C-band (wavelength 5.5 cm and incidence angle ranging from 33° to 43°)
 - P-SBAS processing
 - Cell resolution ~80x80m
 - Coherence threshold -> 0.9

The present: wide area monitoring system

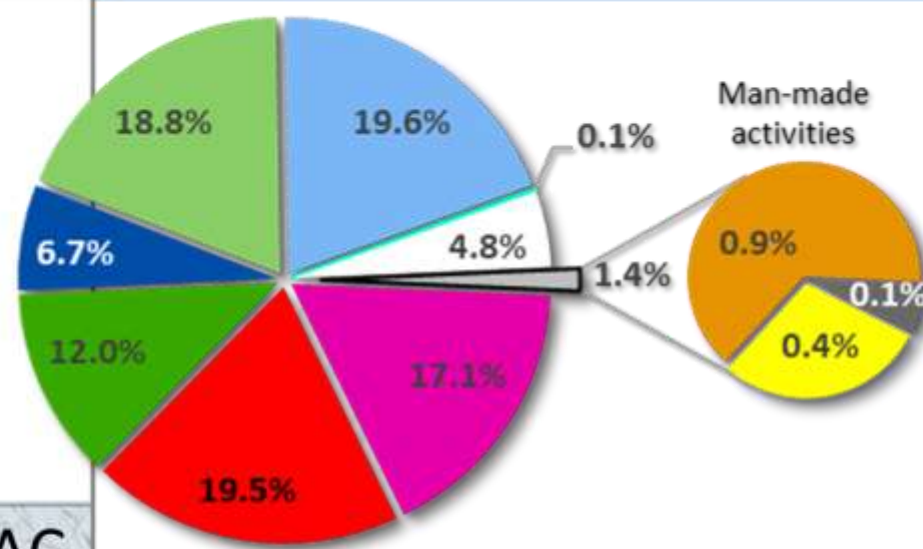
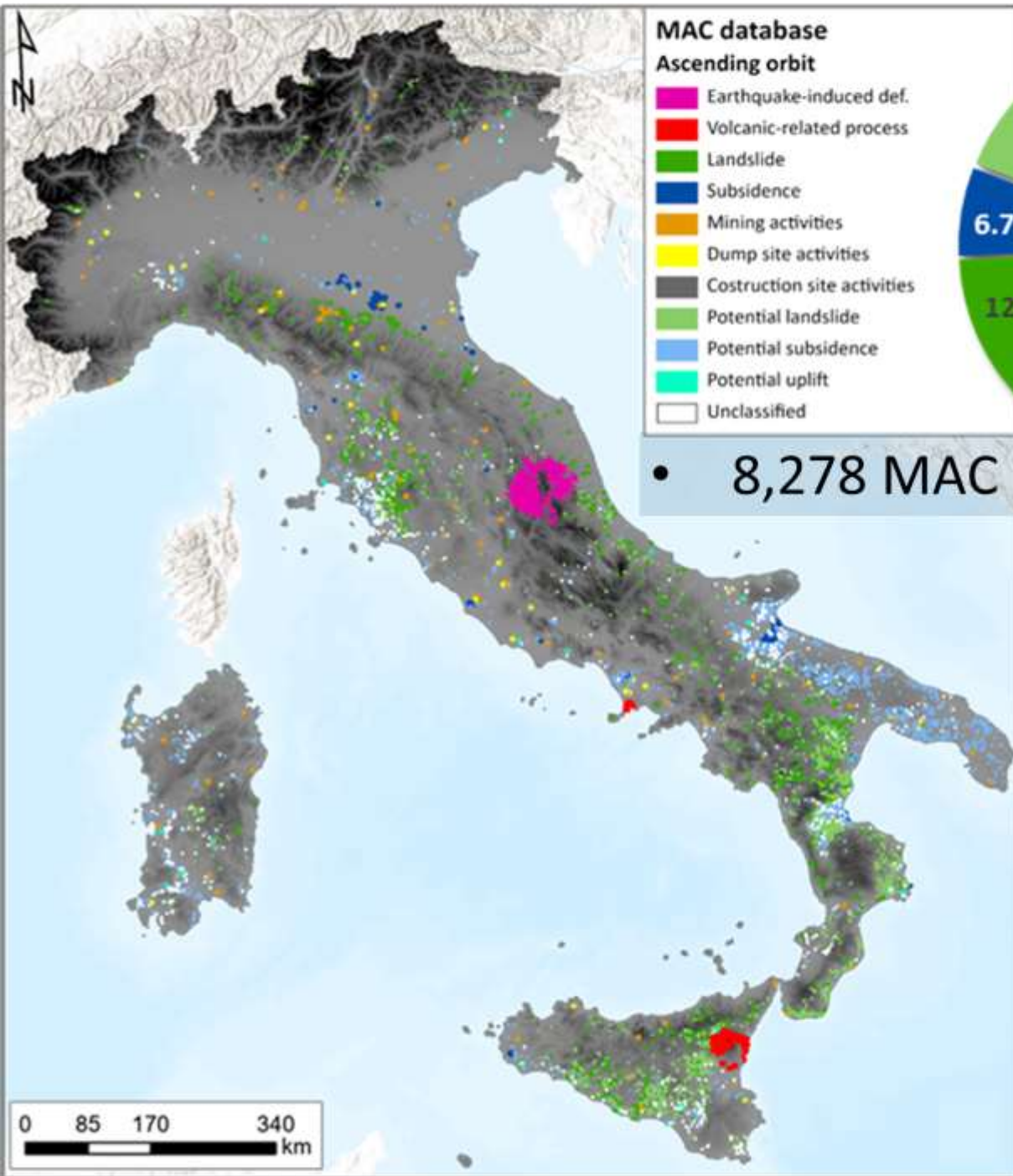


- Combined use of: inventories, DEM-derived maps, ancillary data and VLOS displacement vectors decomposition

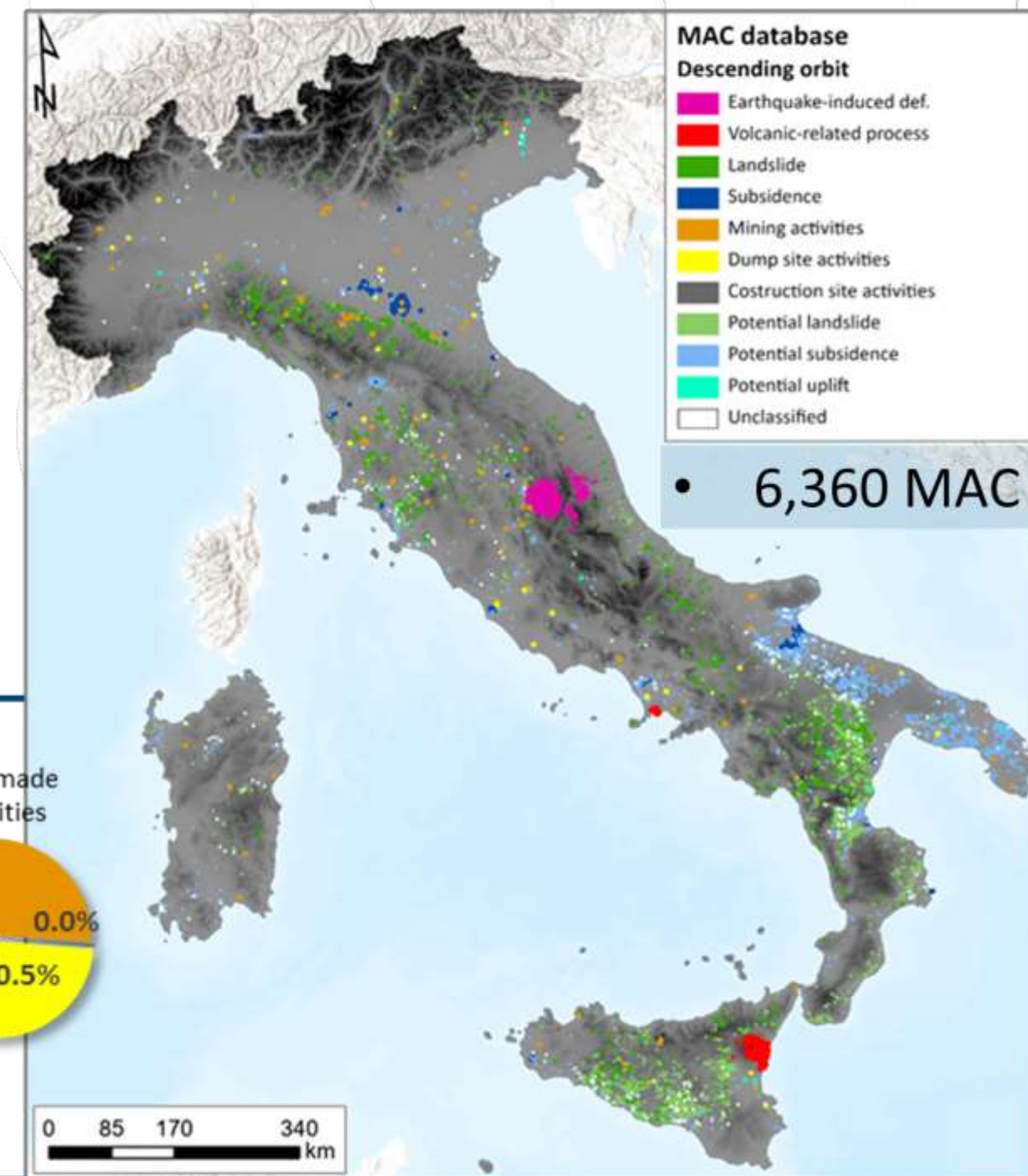
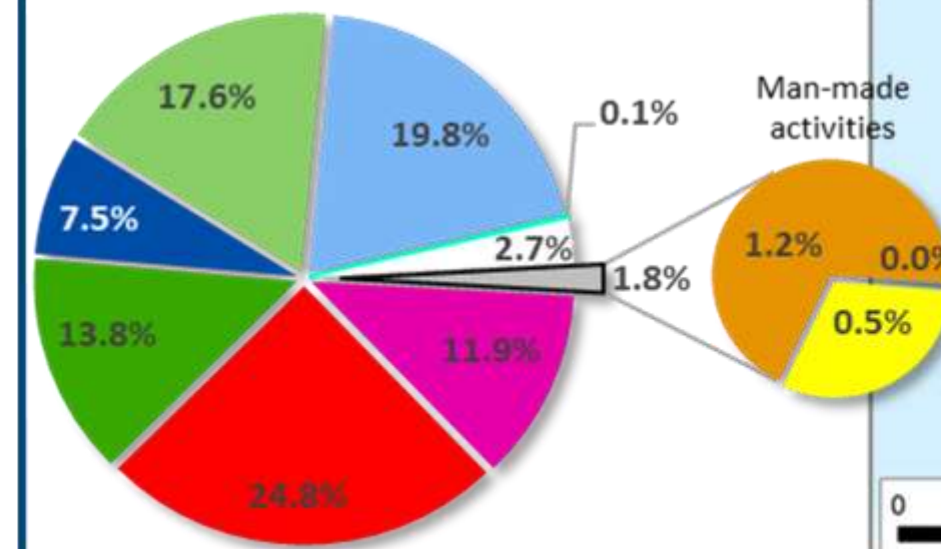
- Classification in:
 - Earthquake-induced deformation
 - Volcanic-related process
 - Landslide (potential landslide)
 - Subsidence (potential subsidence)
 - Uplift
 - Mining activities
 - Dump site activities
 - Construction site activities

The present: wide area monitoring system

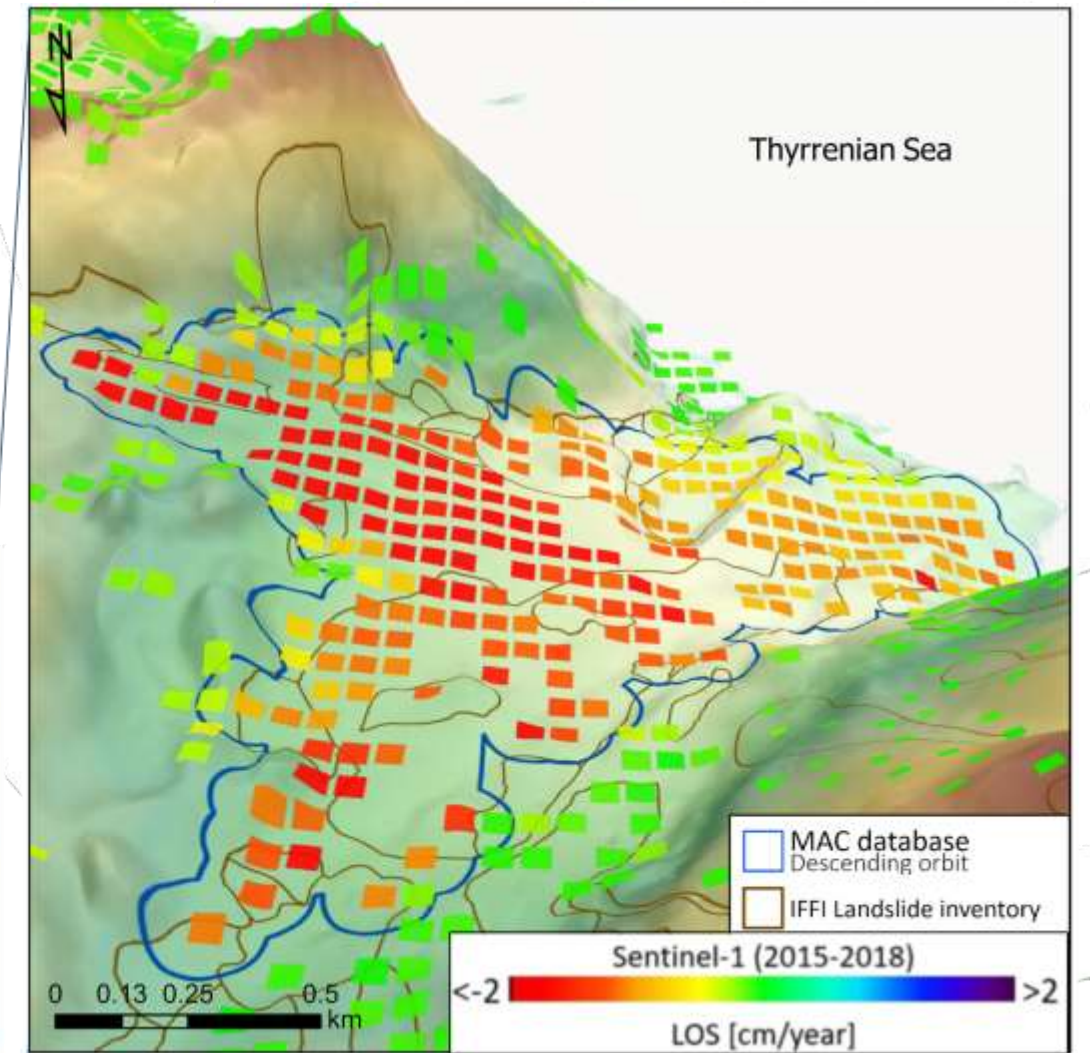
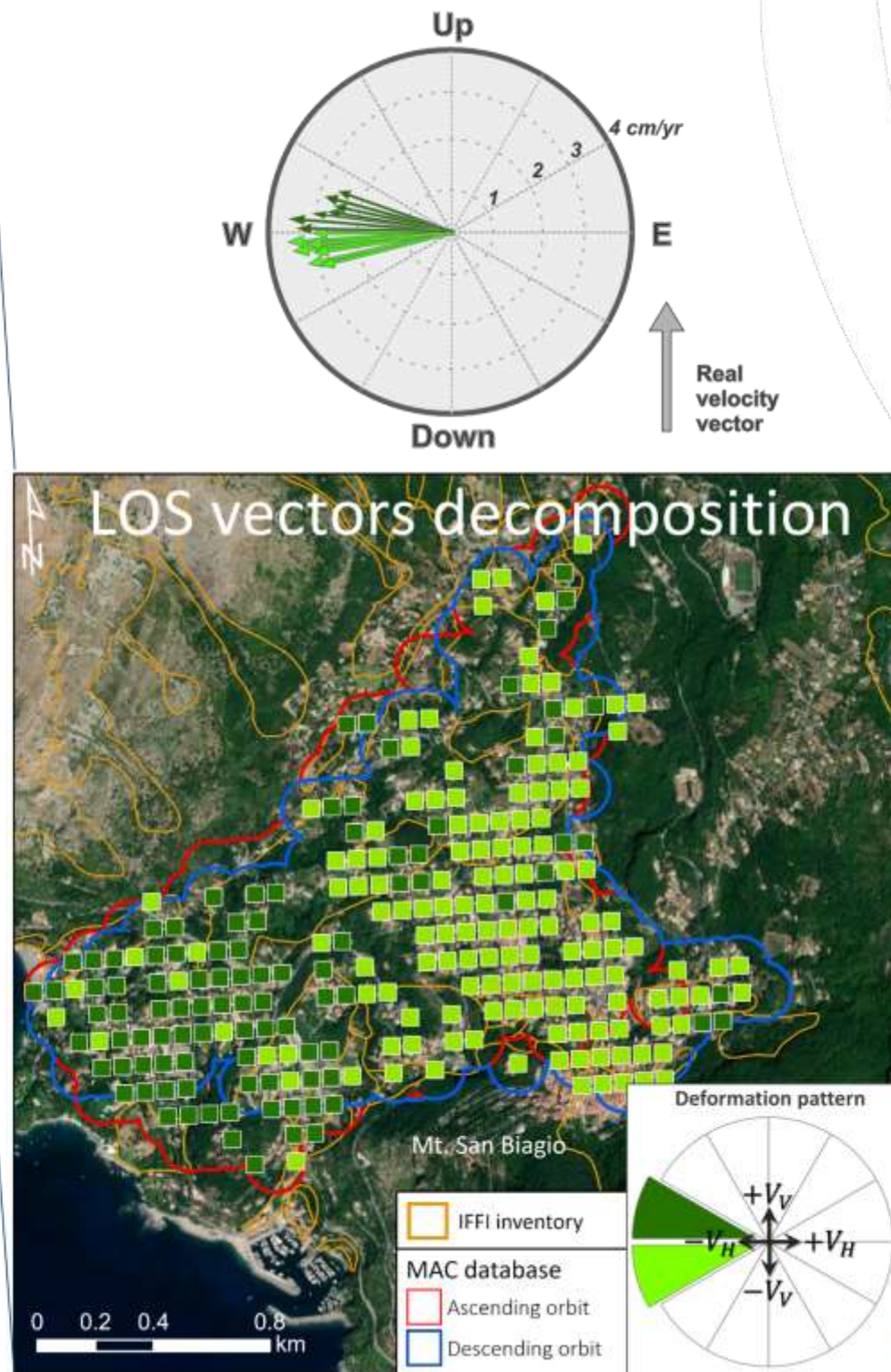
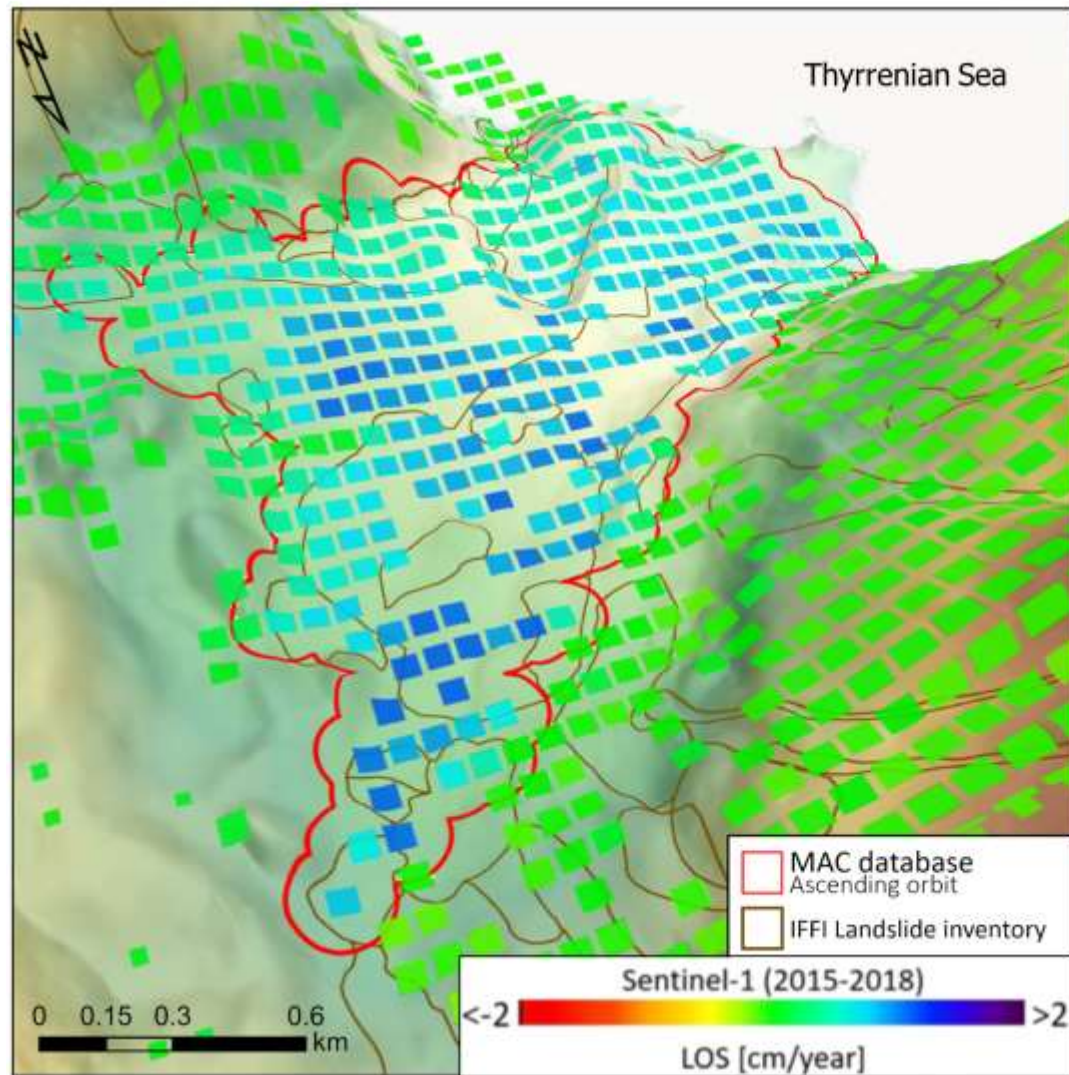
Clustering parameters: $|VEL| \geq 1 \text{ cm/yr}$; Buffer radius = 100 m ; Min. number of PS = 3



MAC area per category
MAC total area

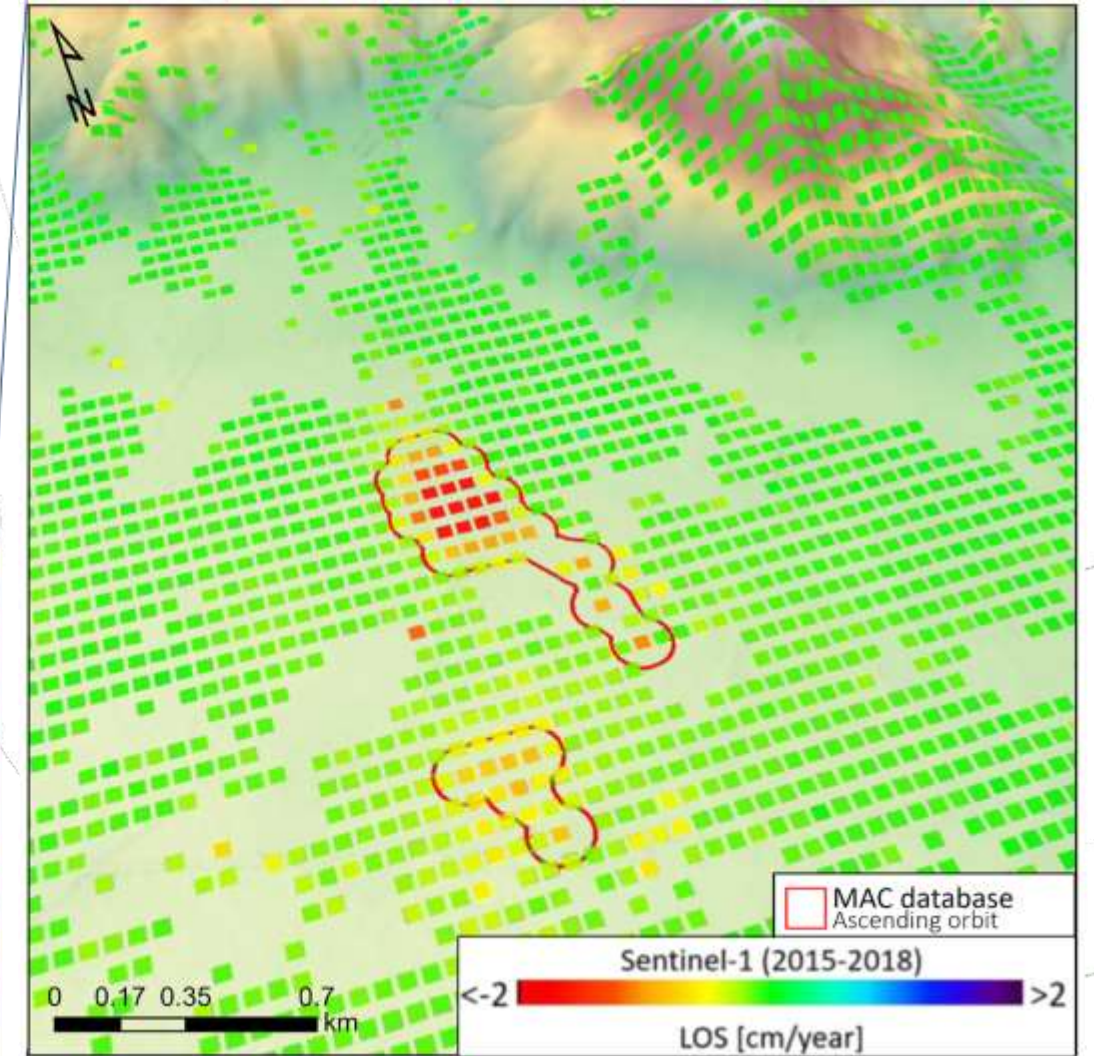
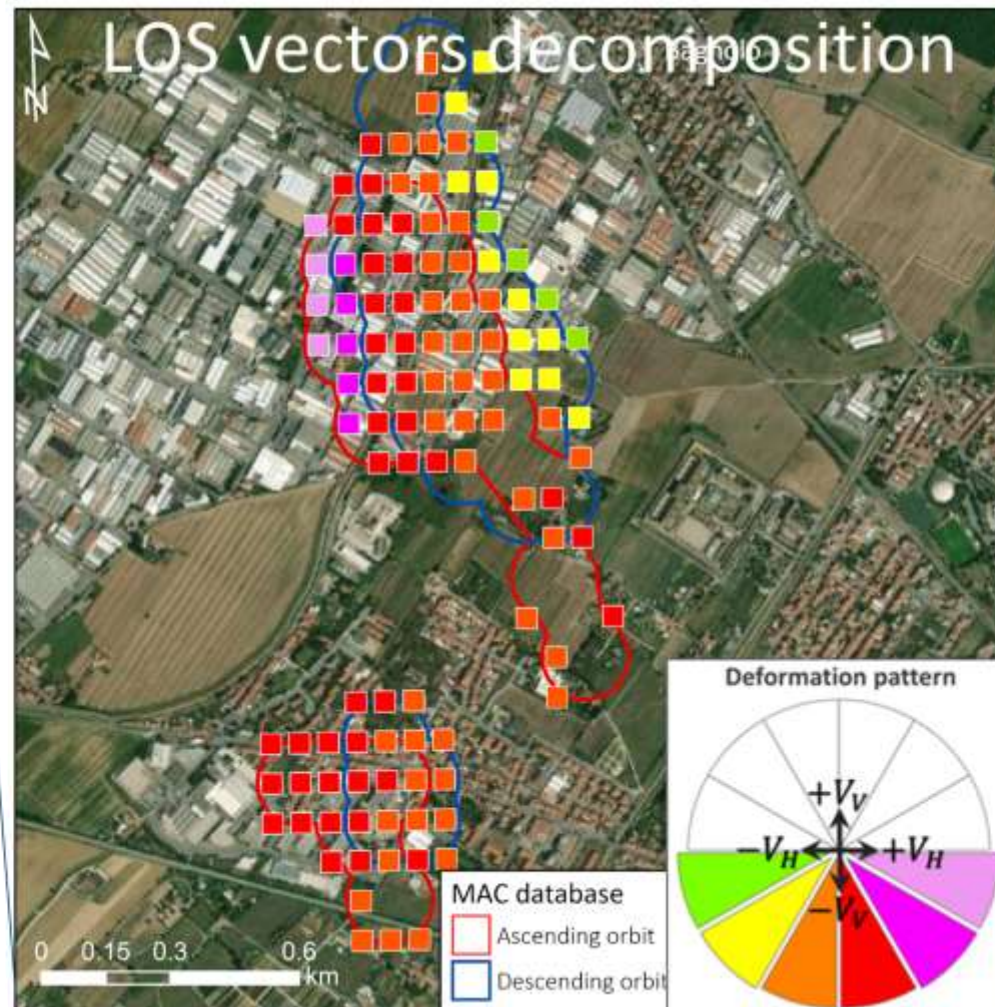
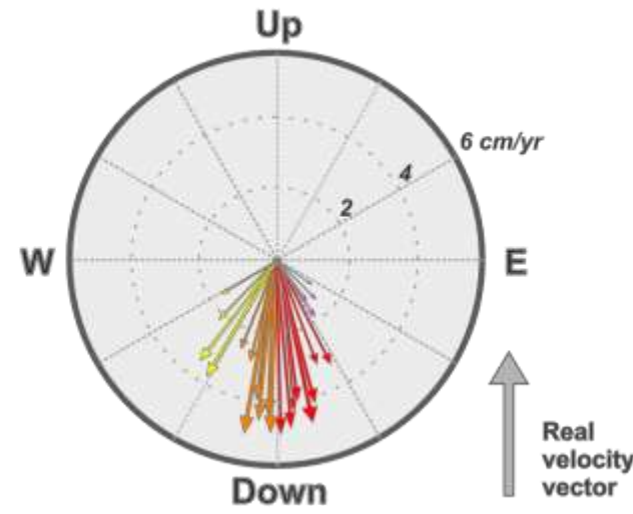
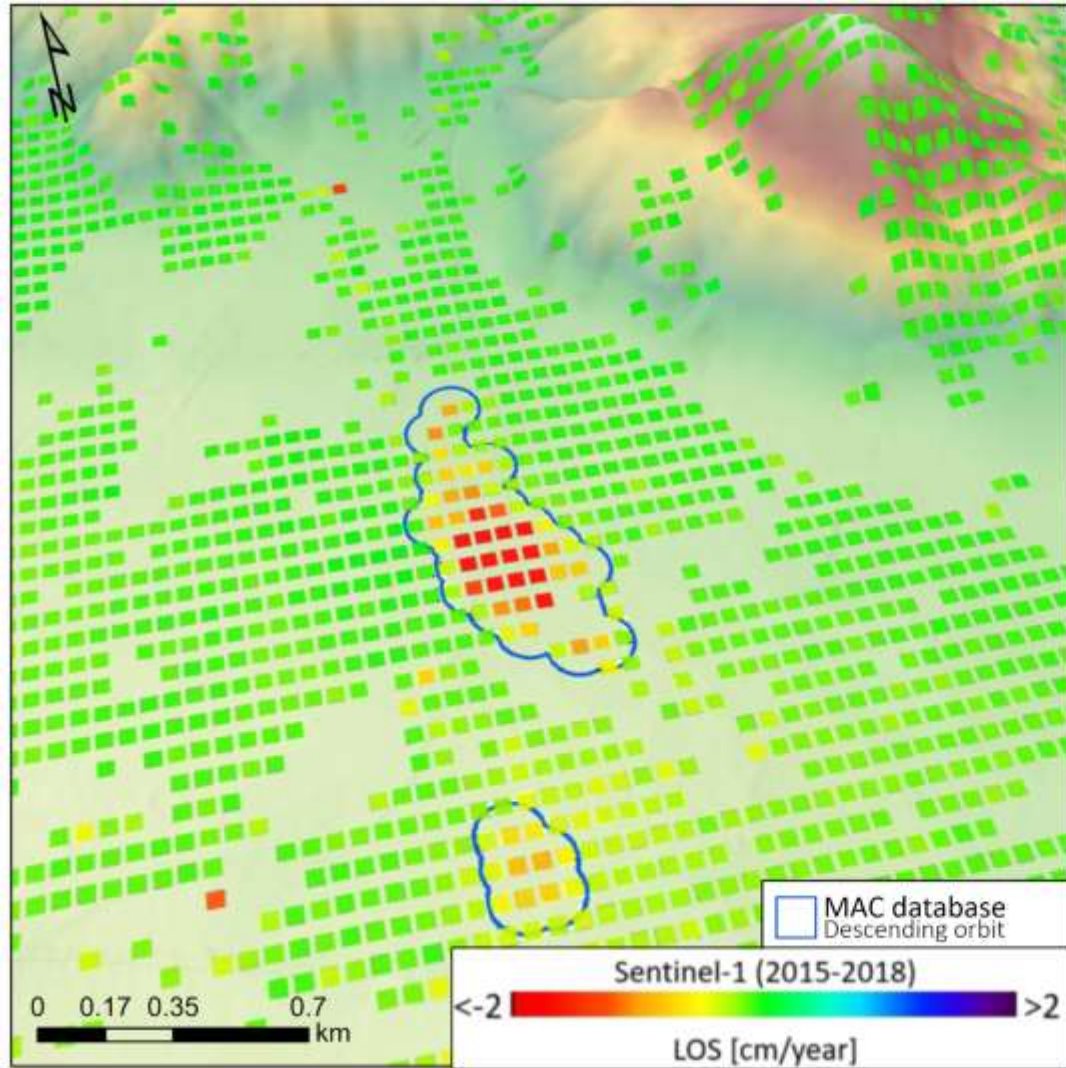


The present: wide area monitoring system



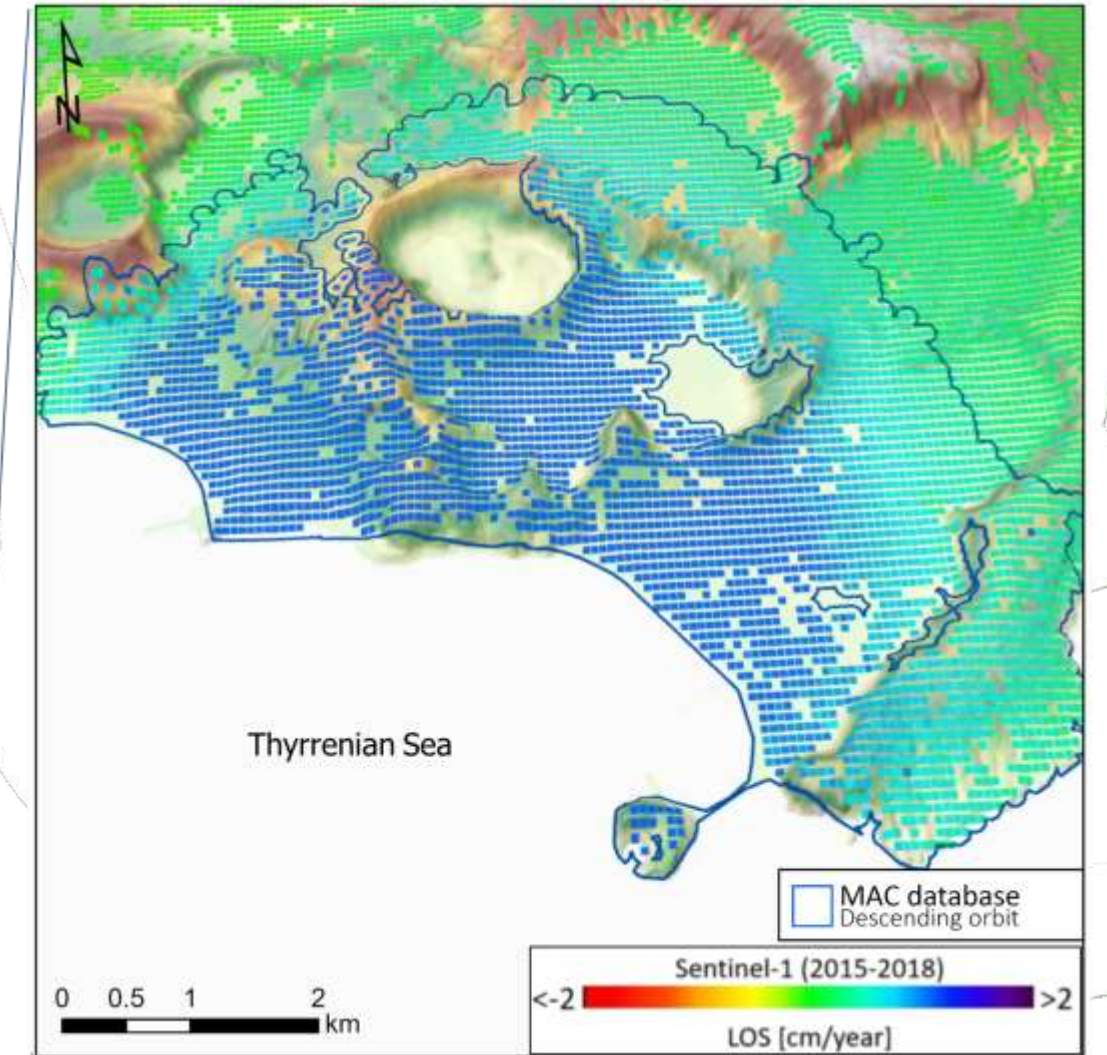
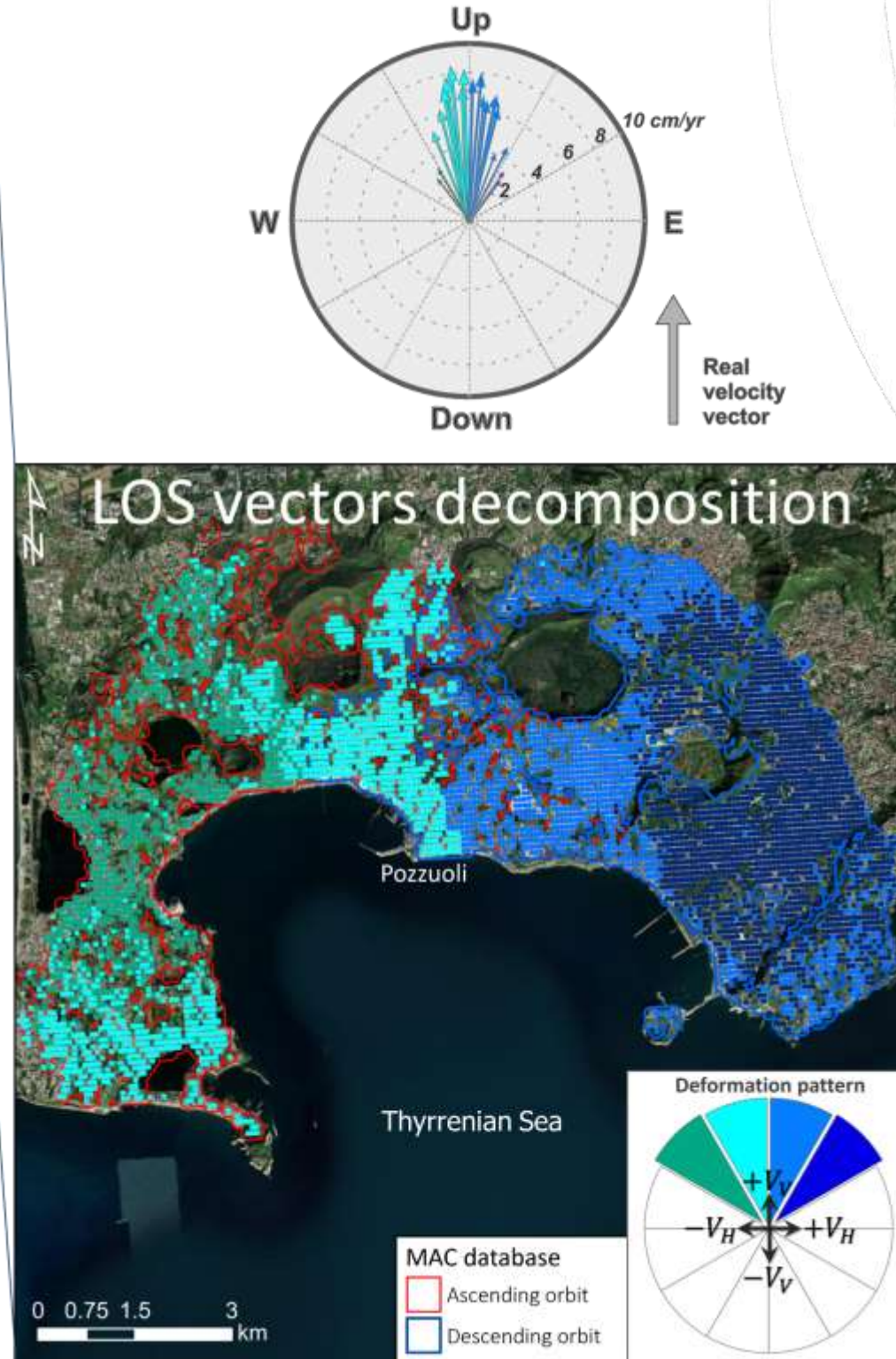
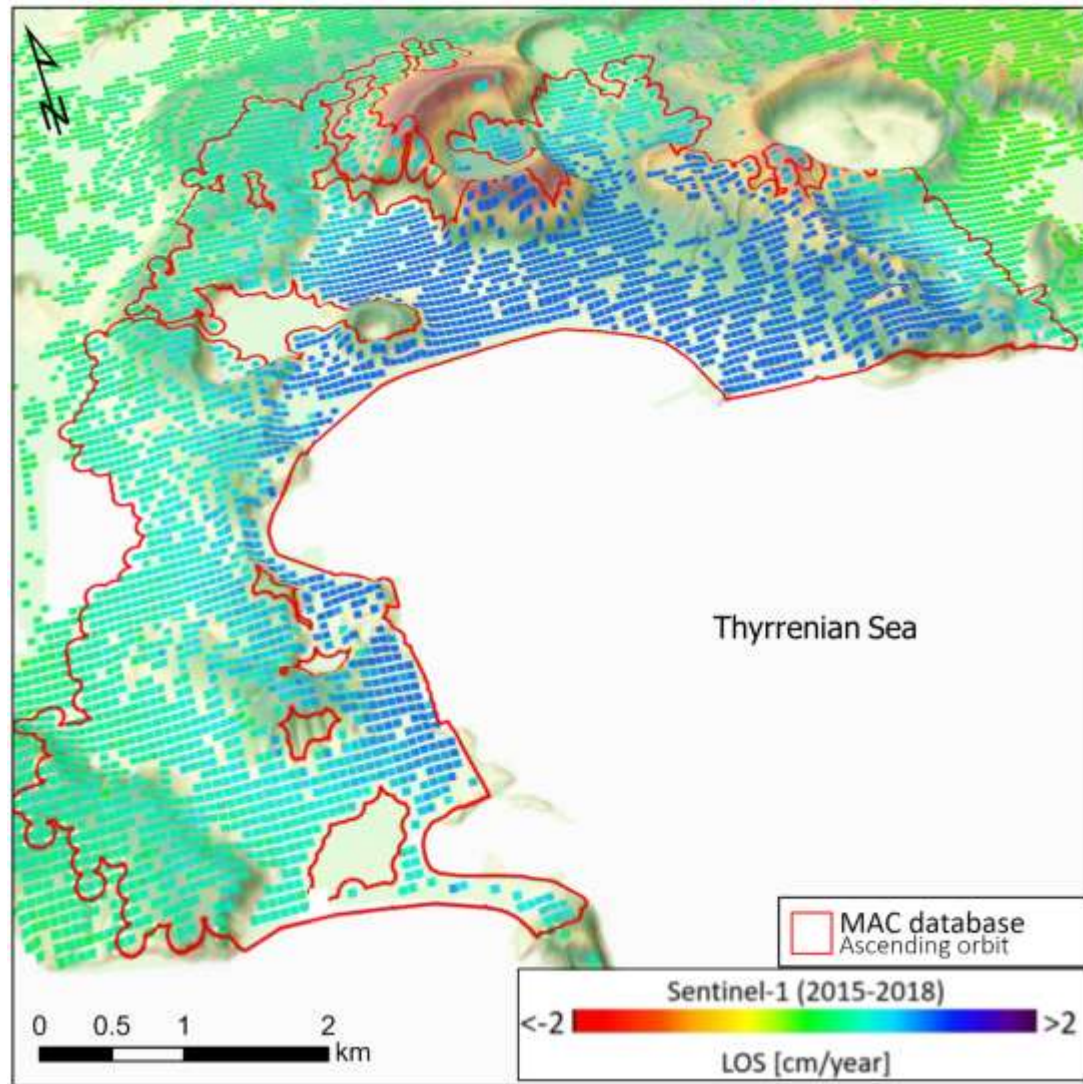
- Composite DSGSD
- Prevalent horizontal mov.
- Retrieved "Real" velocity reaching 3.8 cm/yr

The present: wide area monitoring system



- Resources over-exploitation
- Downward vertical mov.
- Retrieved "Real" velocity reaching 4.8 cm/yr

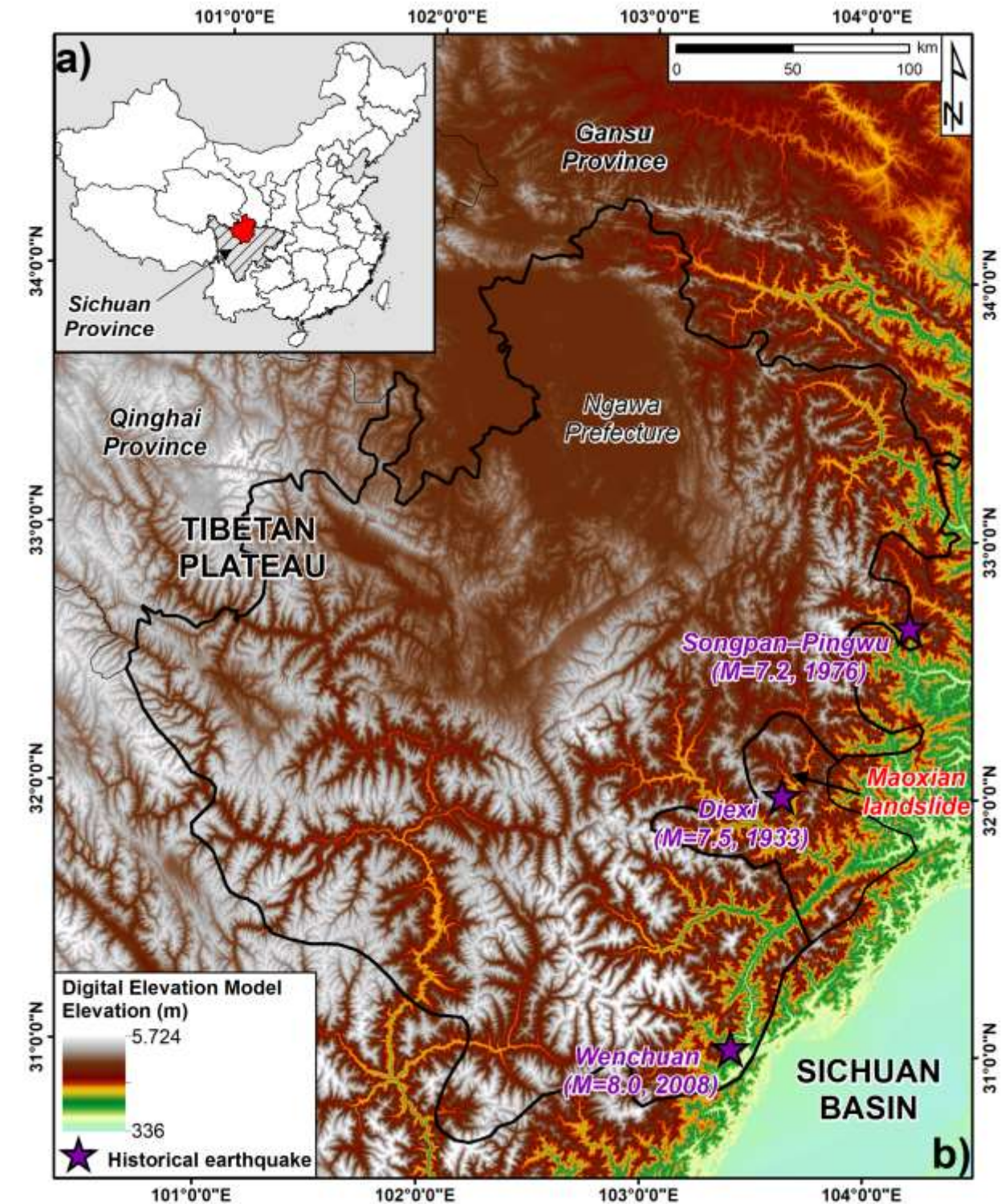
The present: wide area monitoring system



- Bradyseism phenomenon
- Upward vertical movement
- Retrieved “Real” velocity reaching 8.6 cm/yr

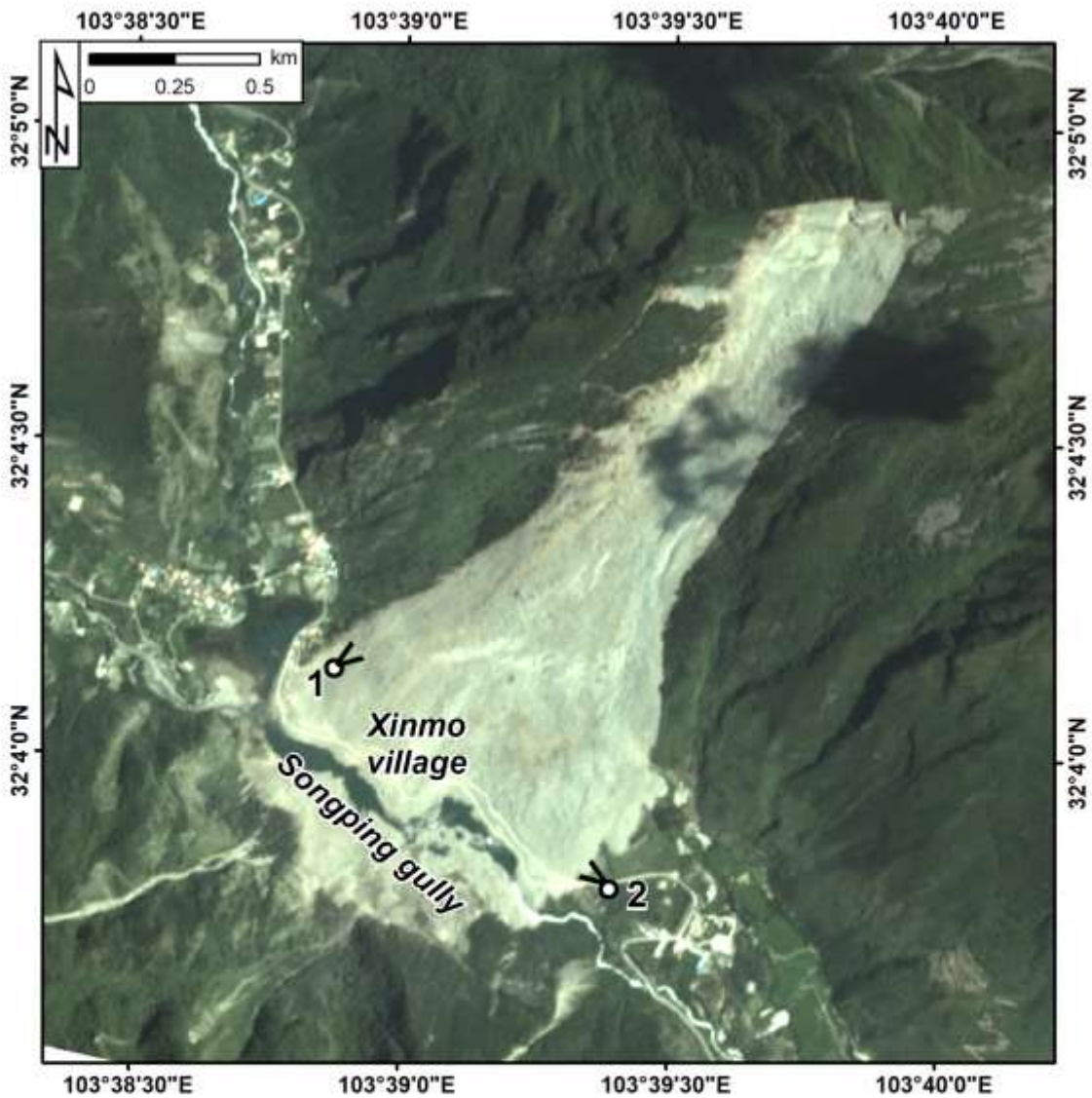
The present: wide area monitoring system

24 June 2017 - 5:45 am

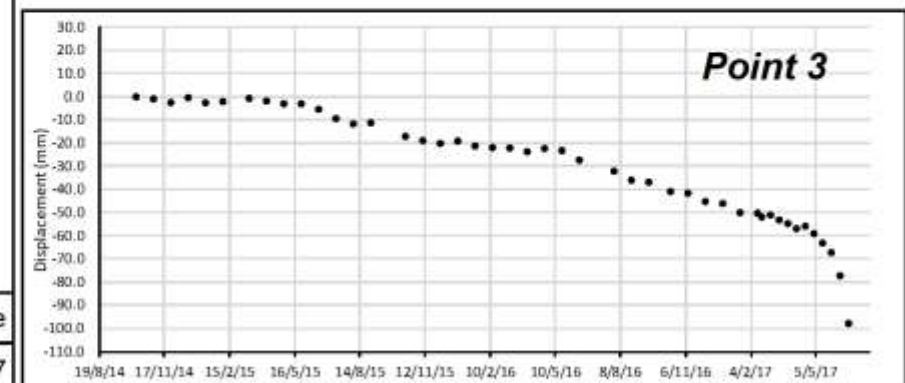
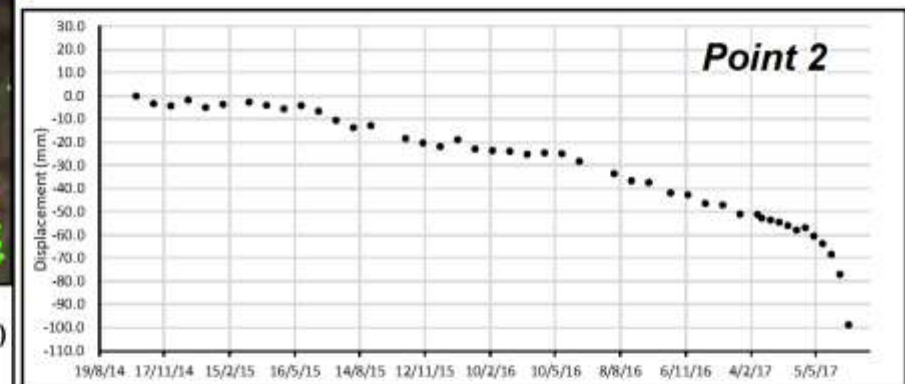
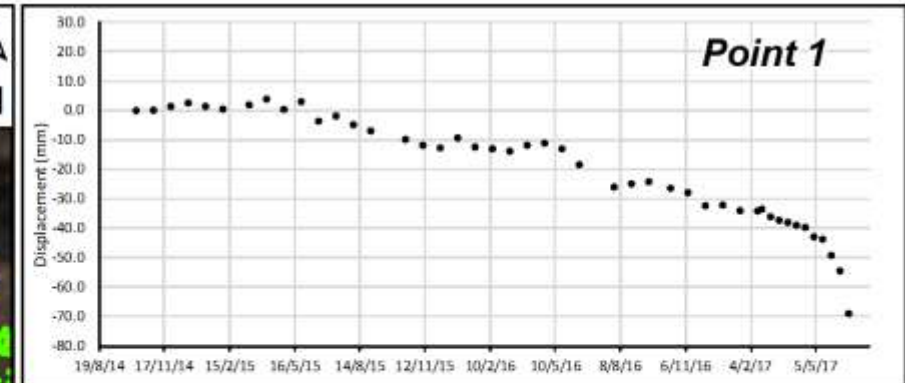
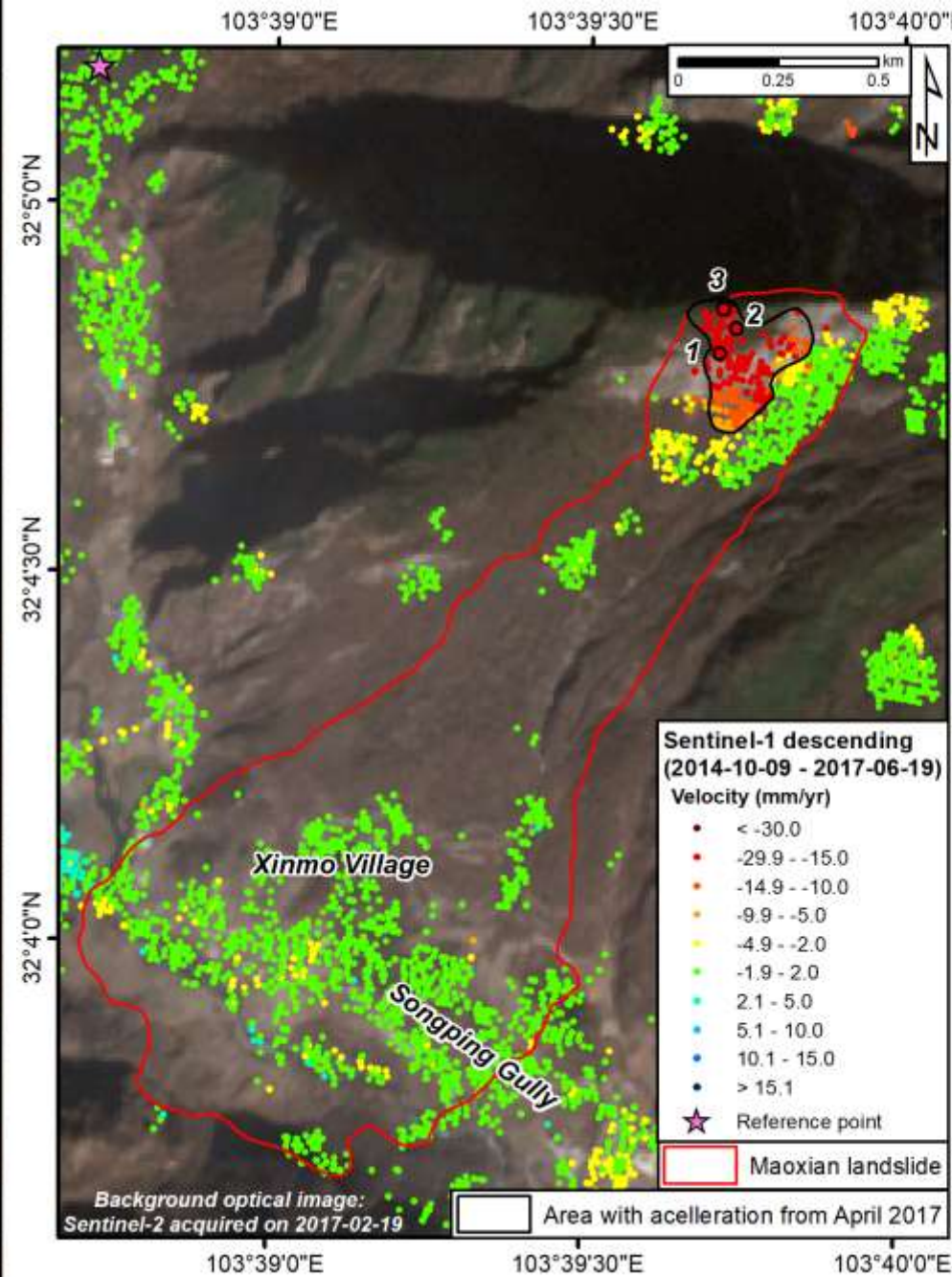
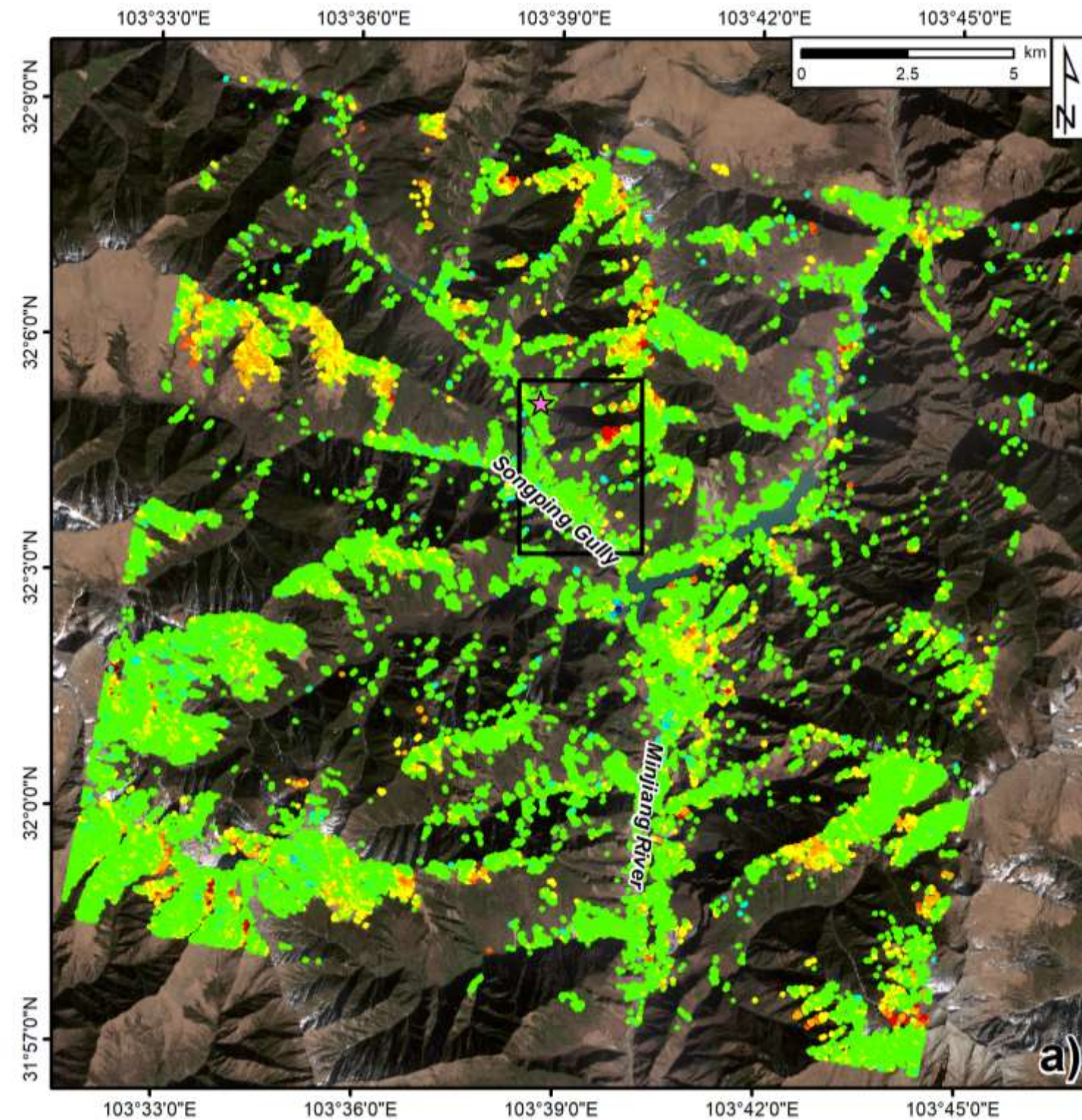


The present: wide area monitoring system

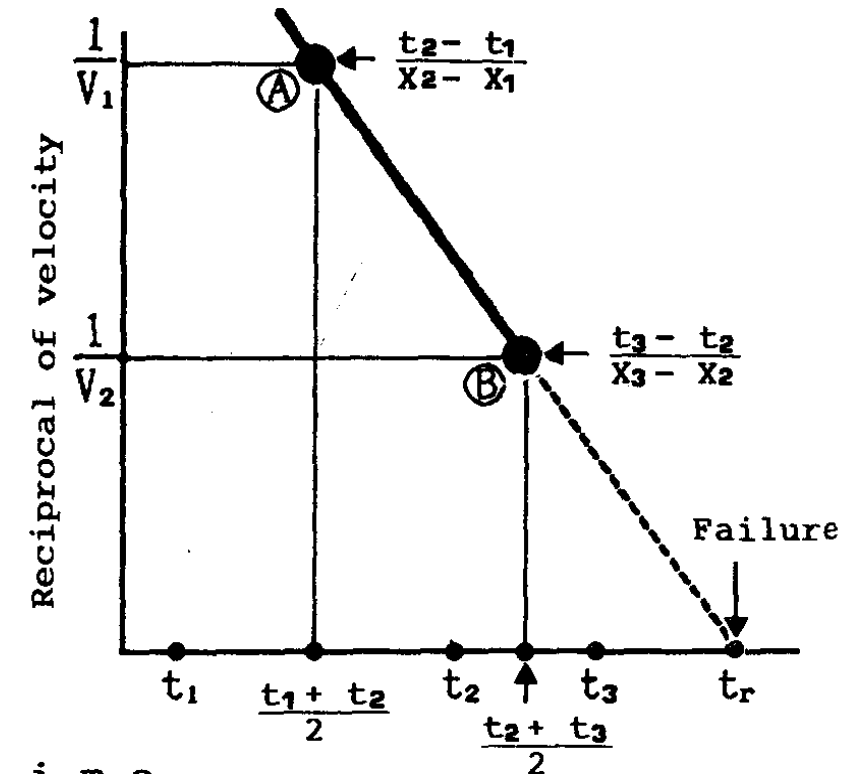
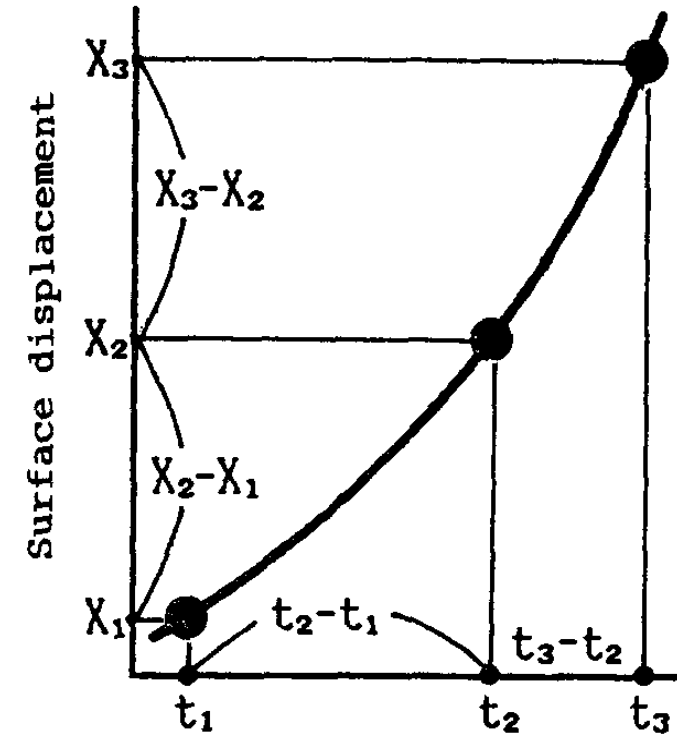
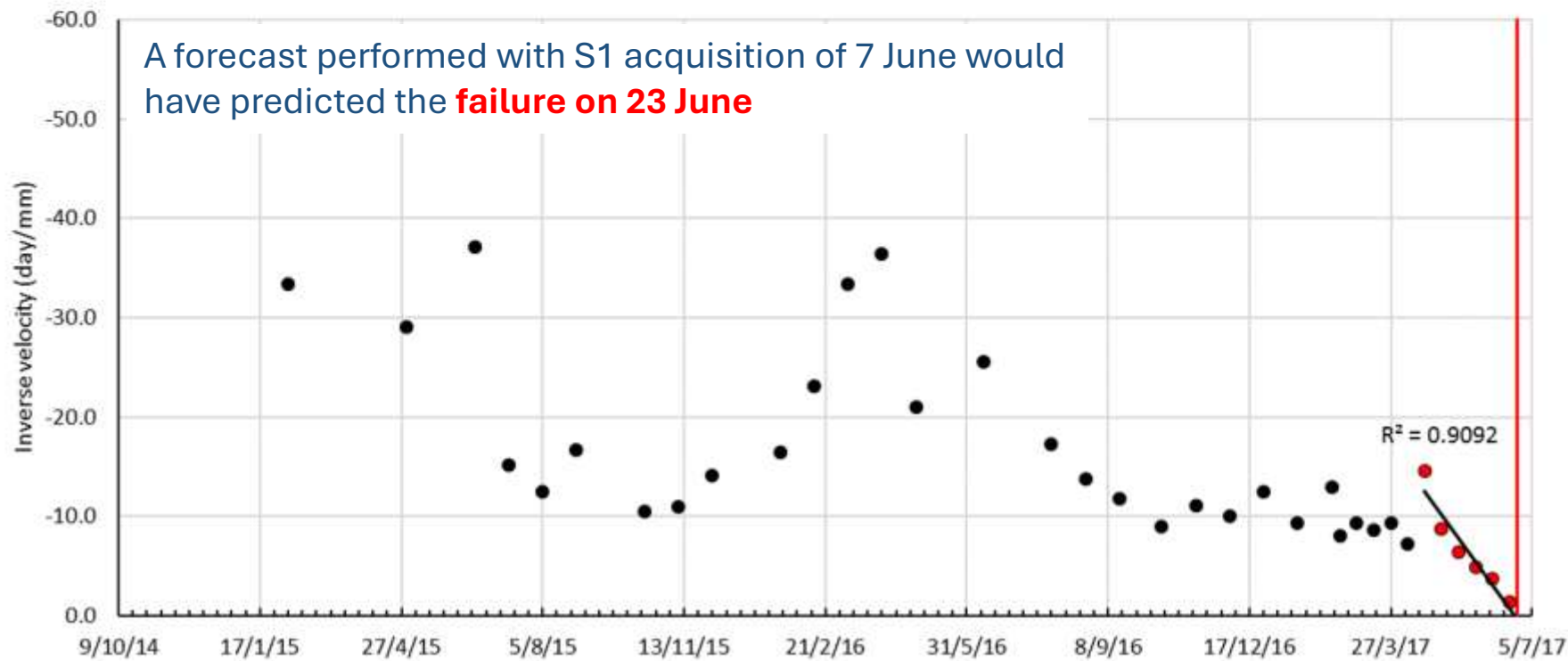
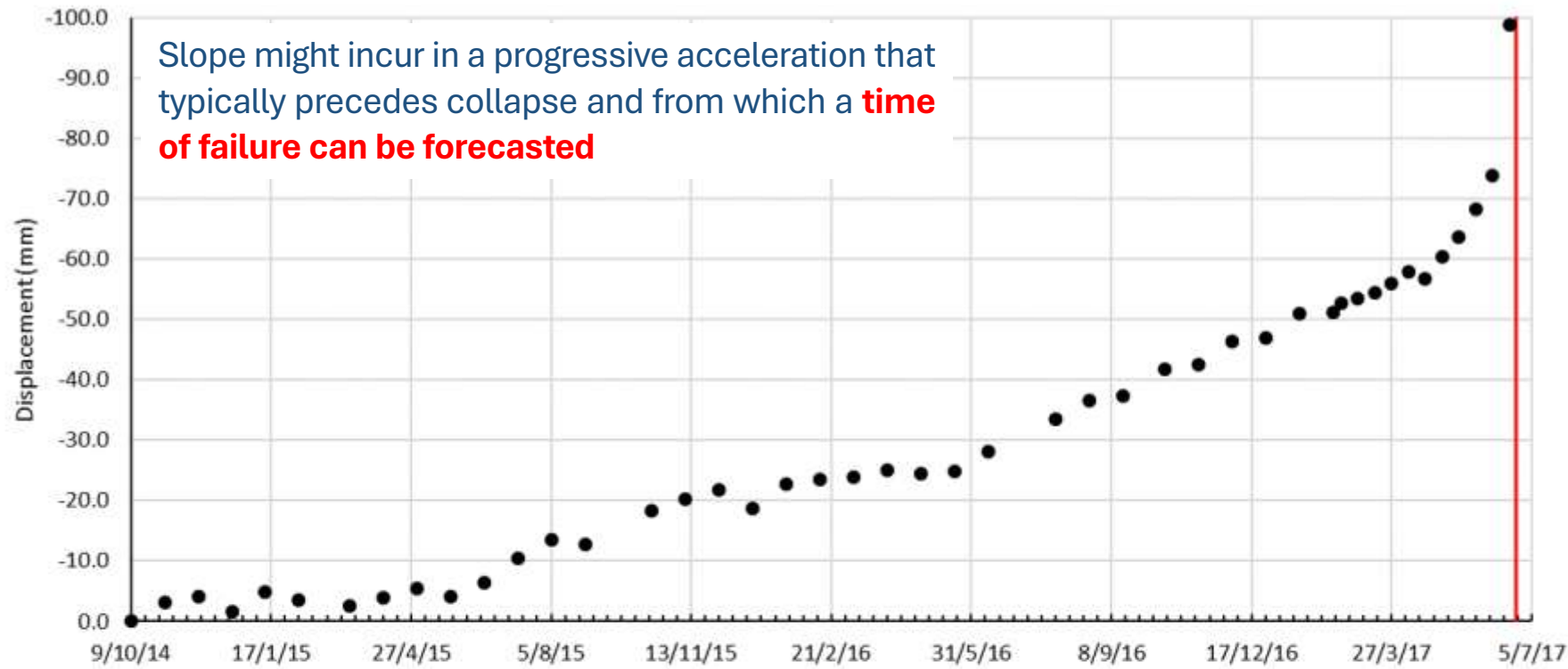
V: 13-18 million m³
A: 1.5 km².
H: 1,100 m
L: 2,600 m



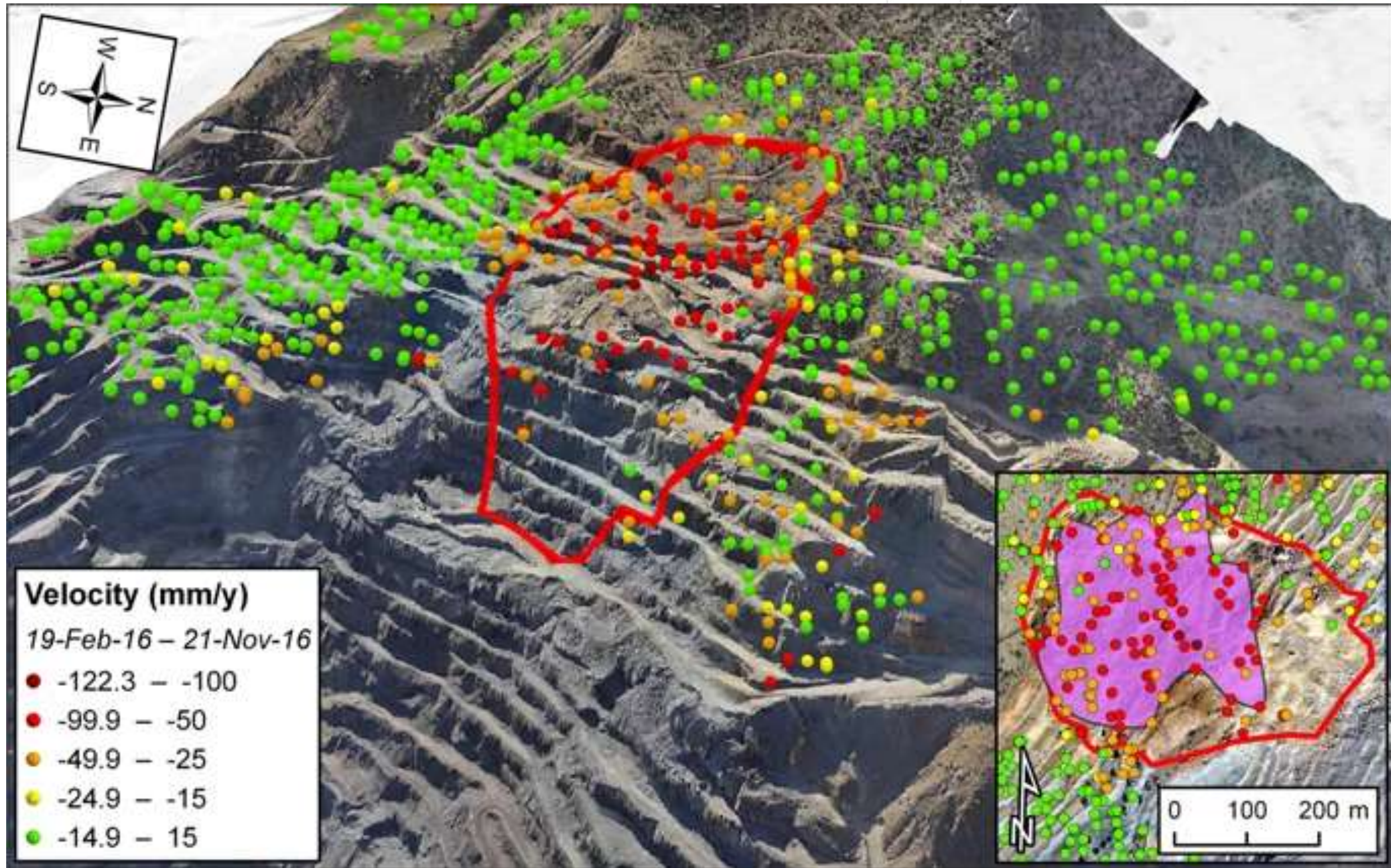
The present: wide area monitoring system



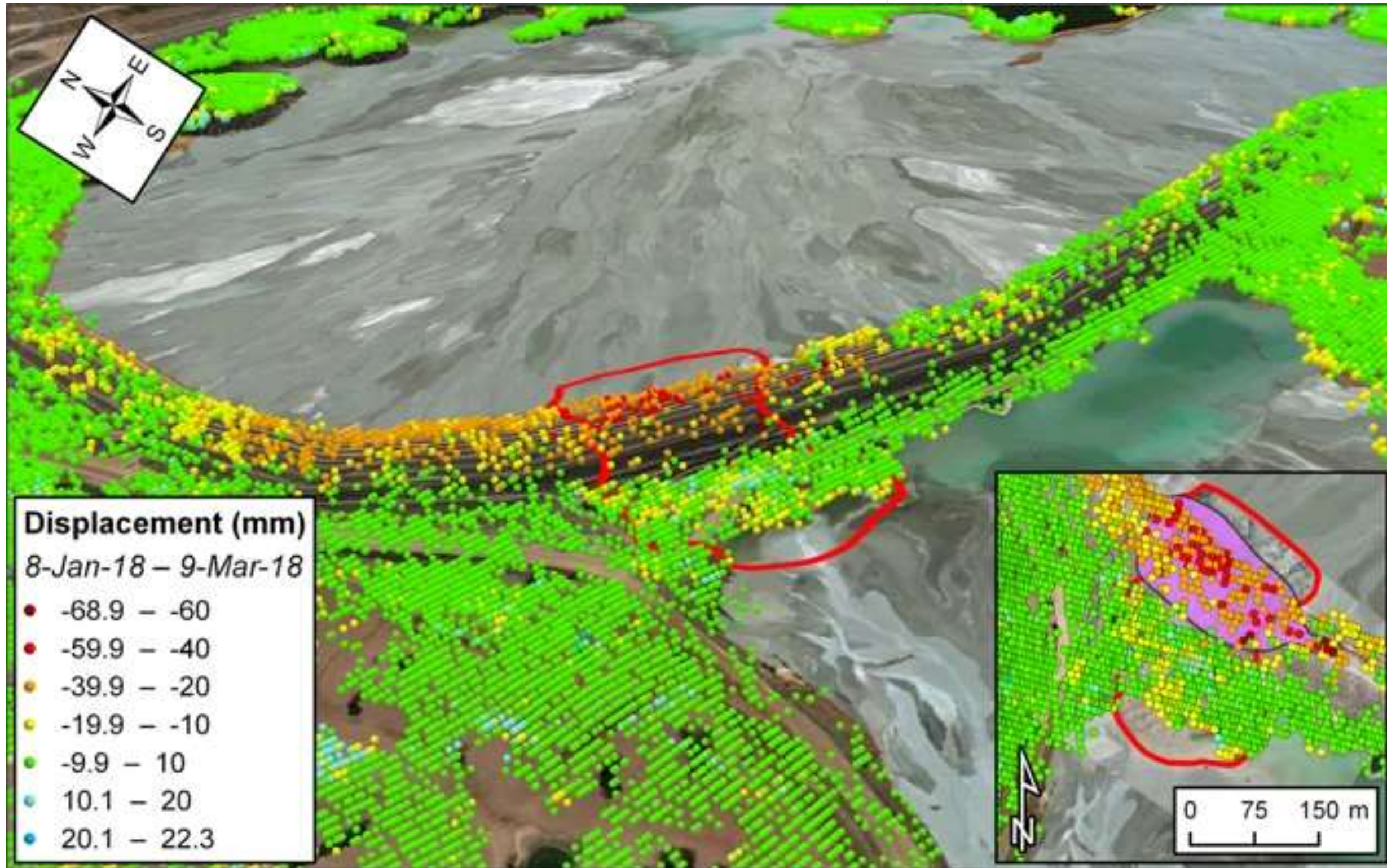
The present: wide area monitoring system



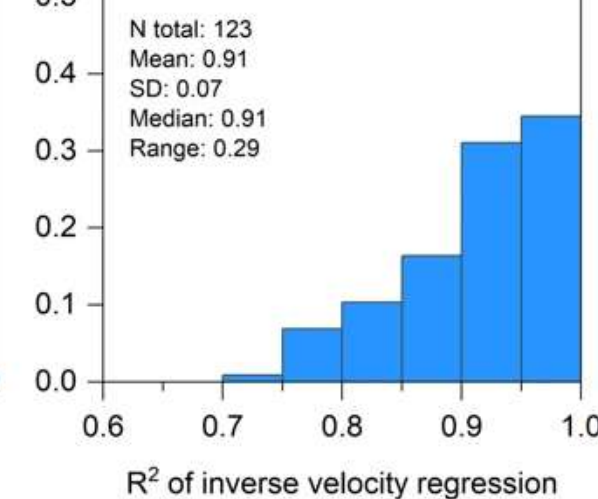
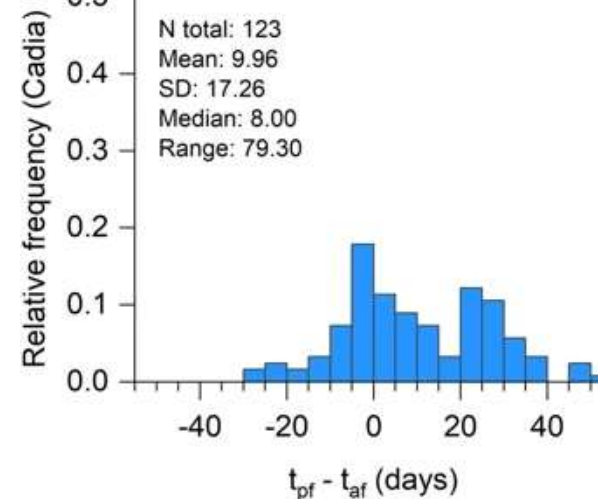
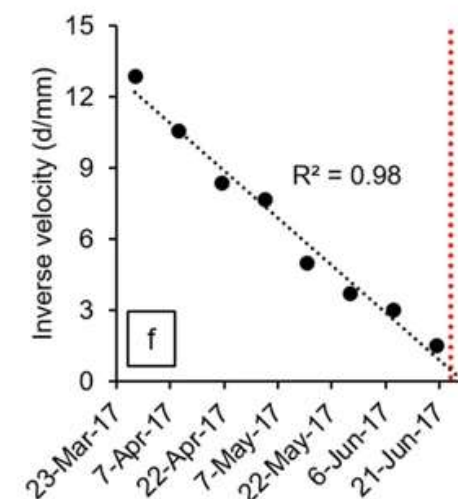
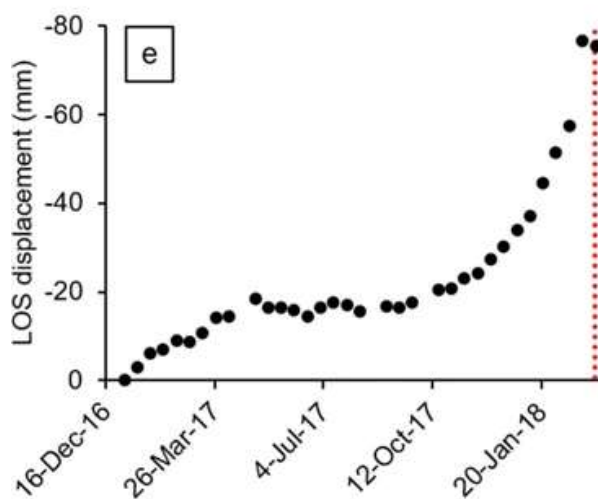
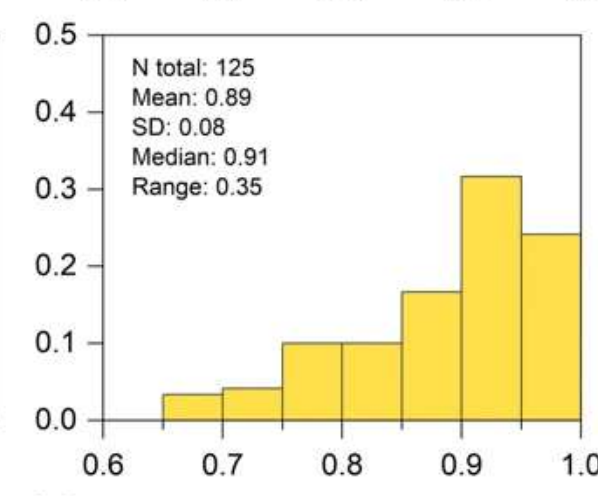
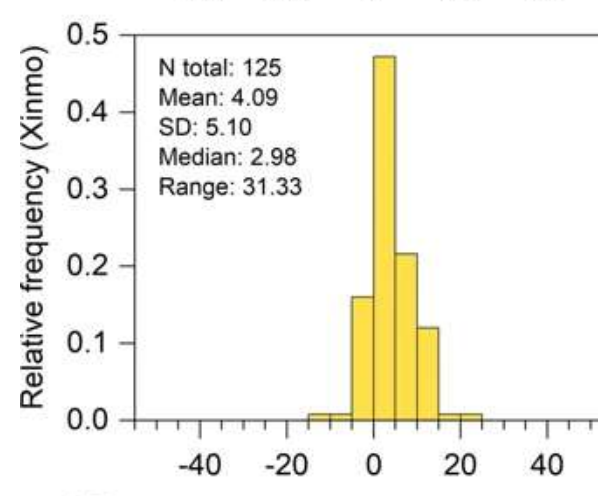
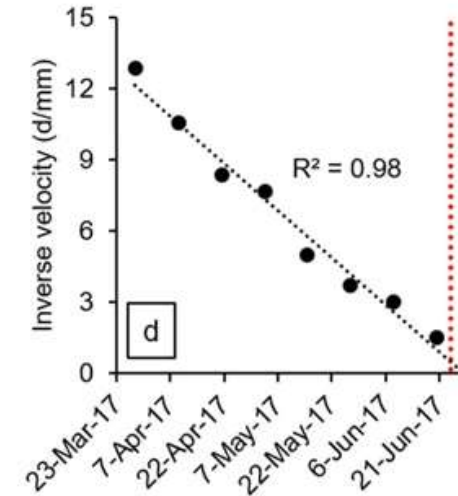
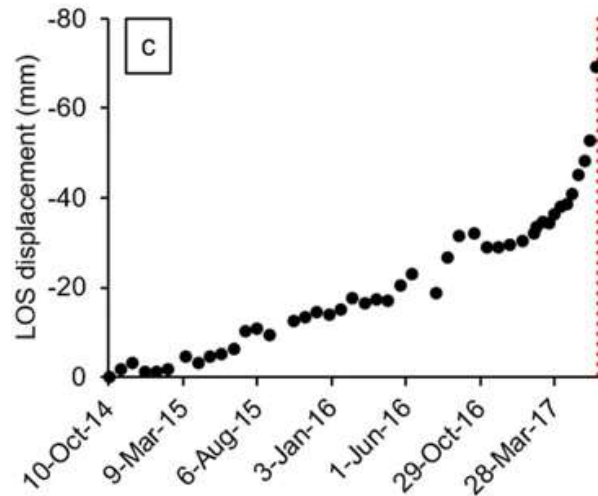
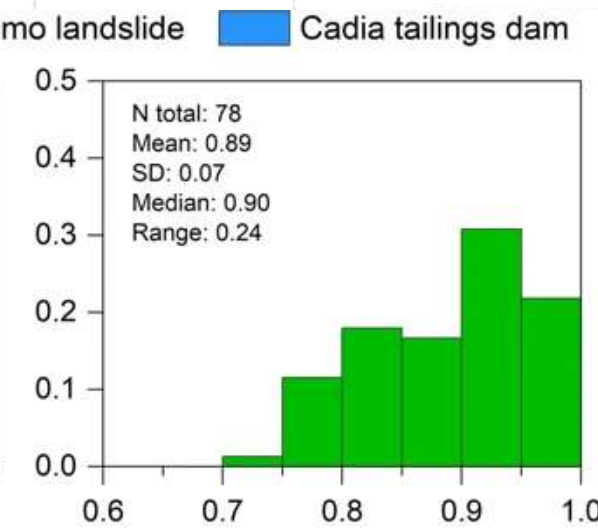
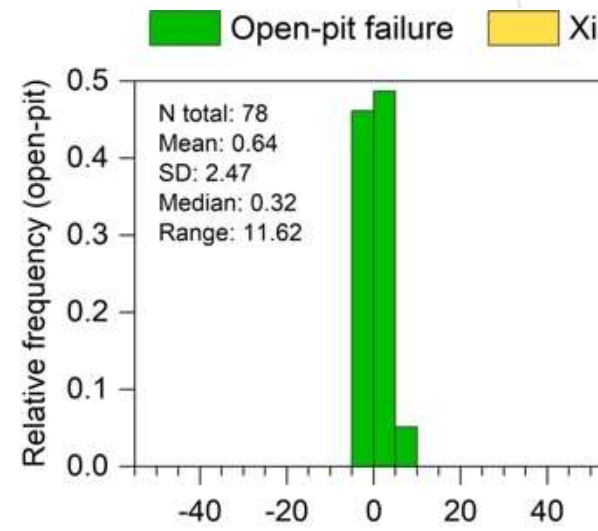
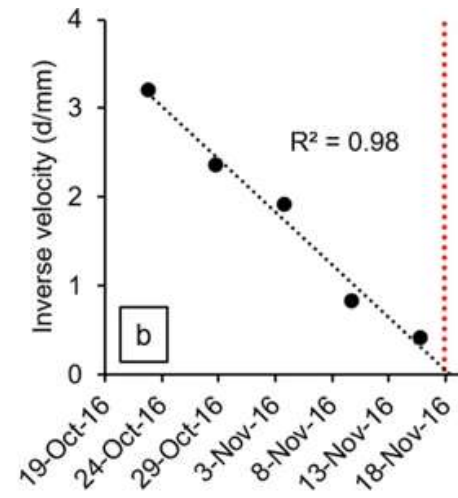
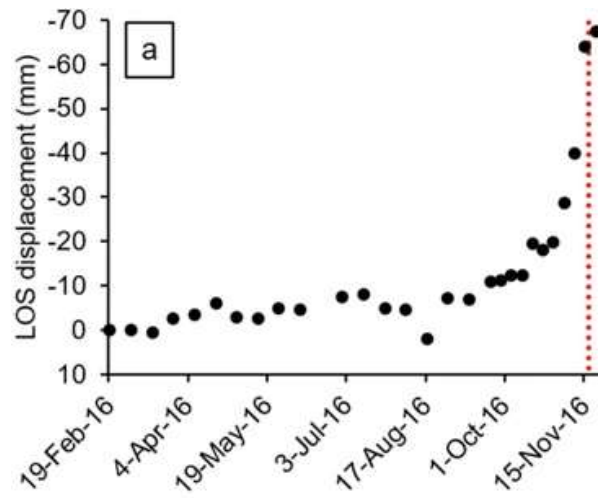
The present: wide area monitoring system



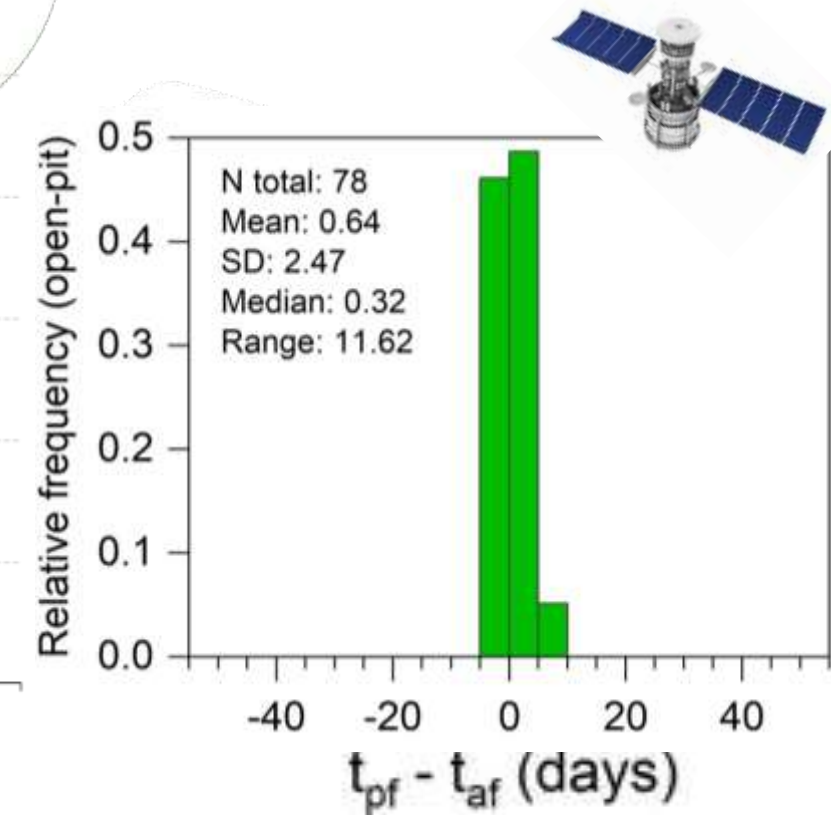
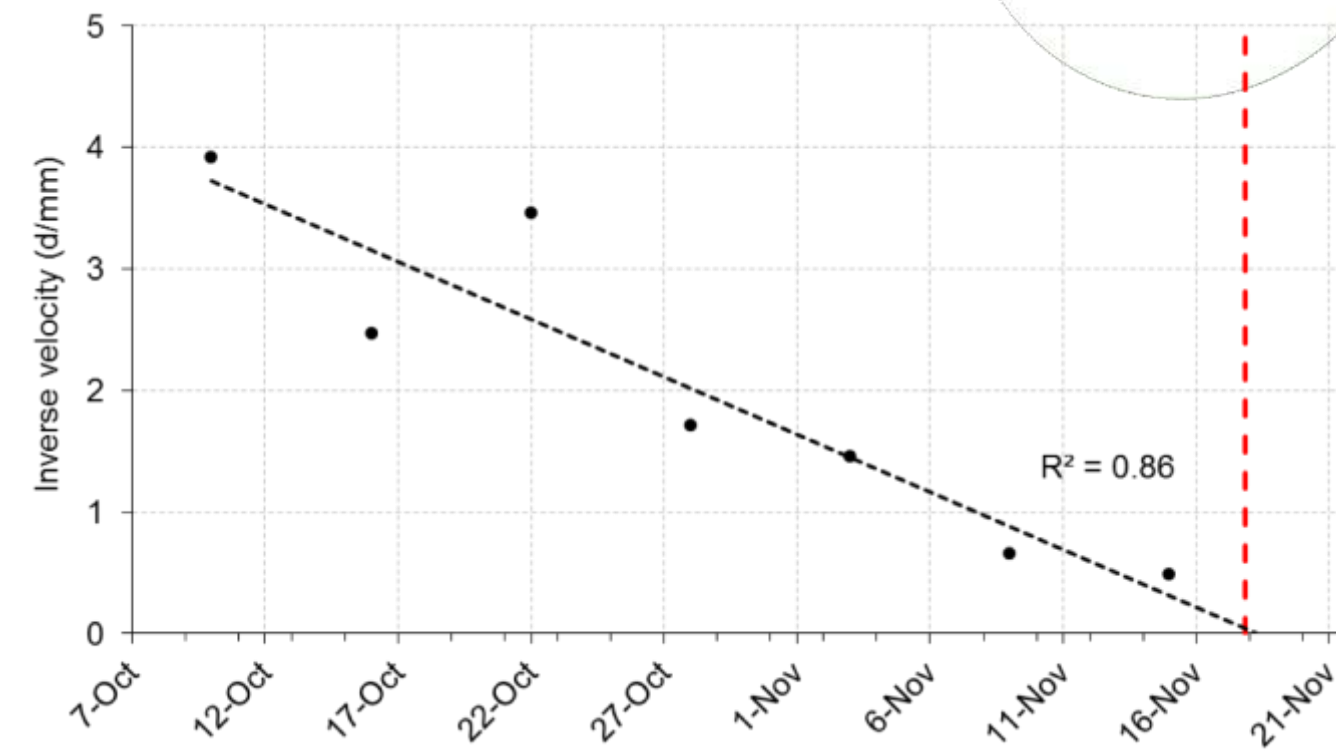
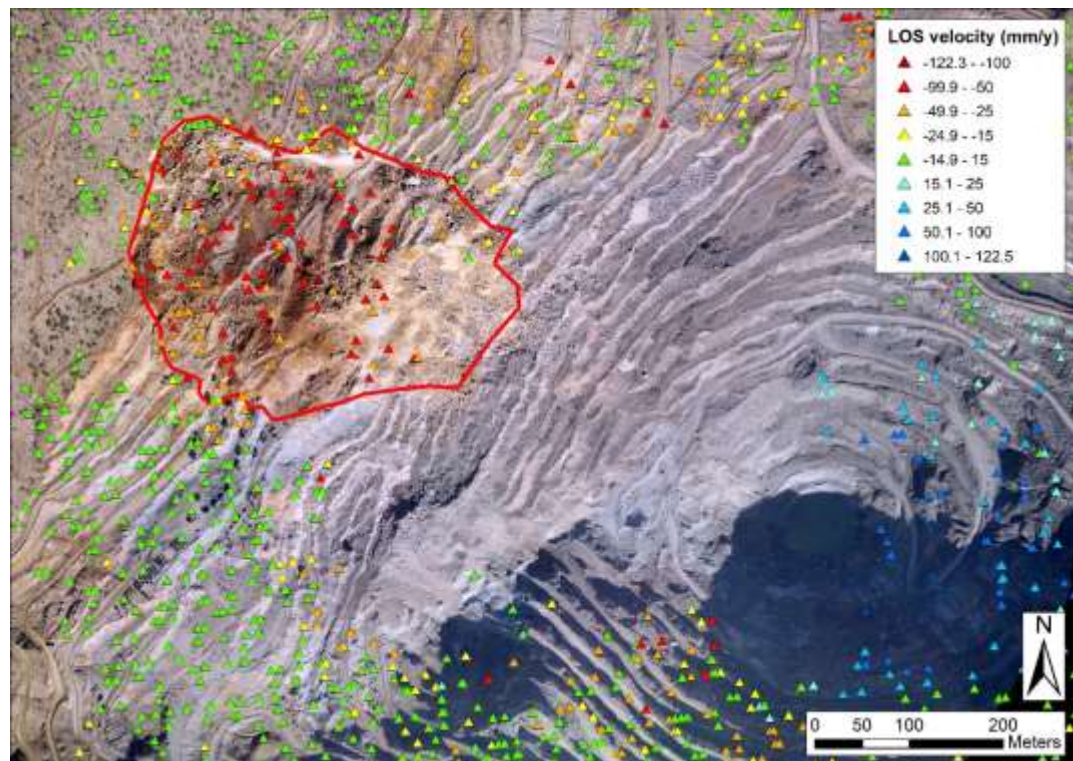
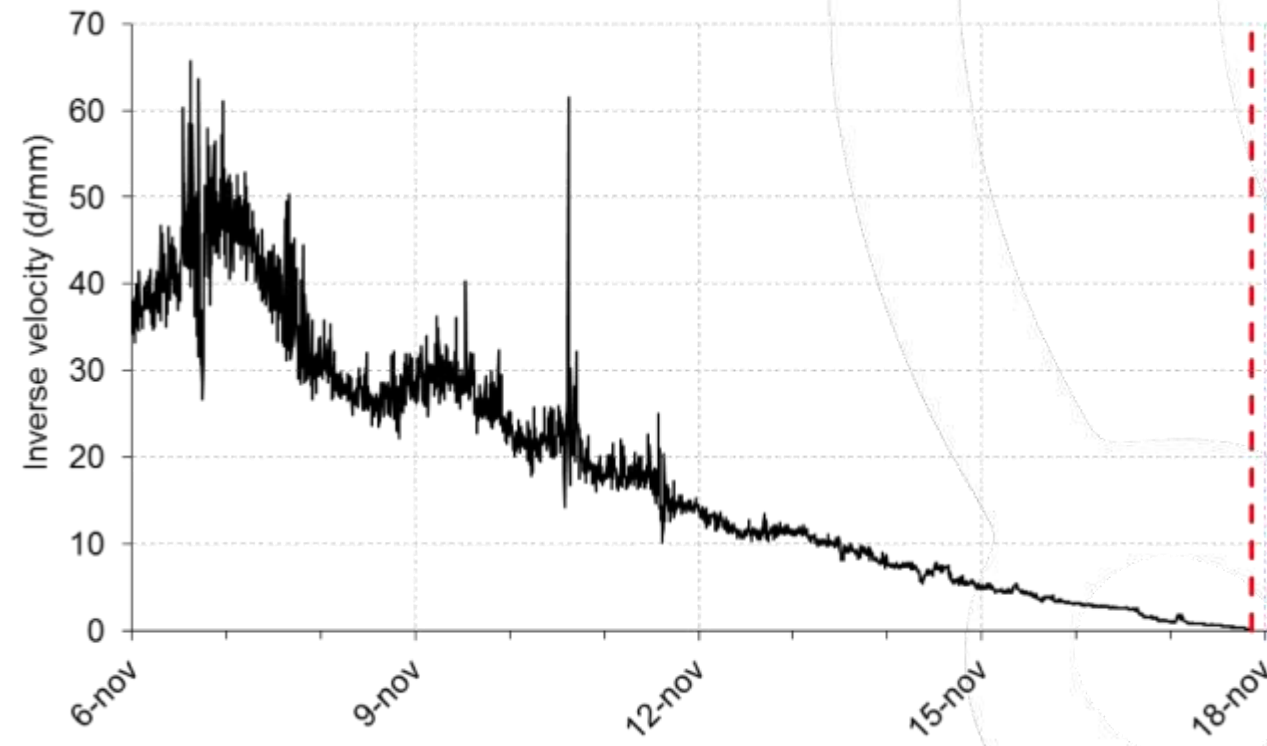
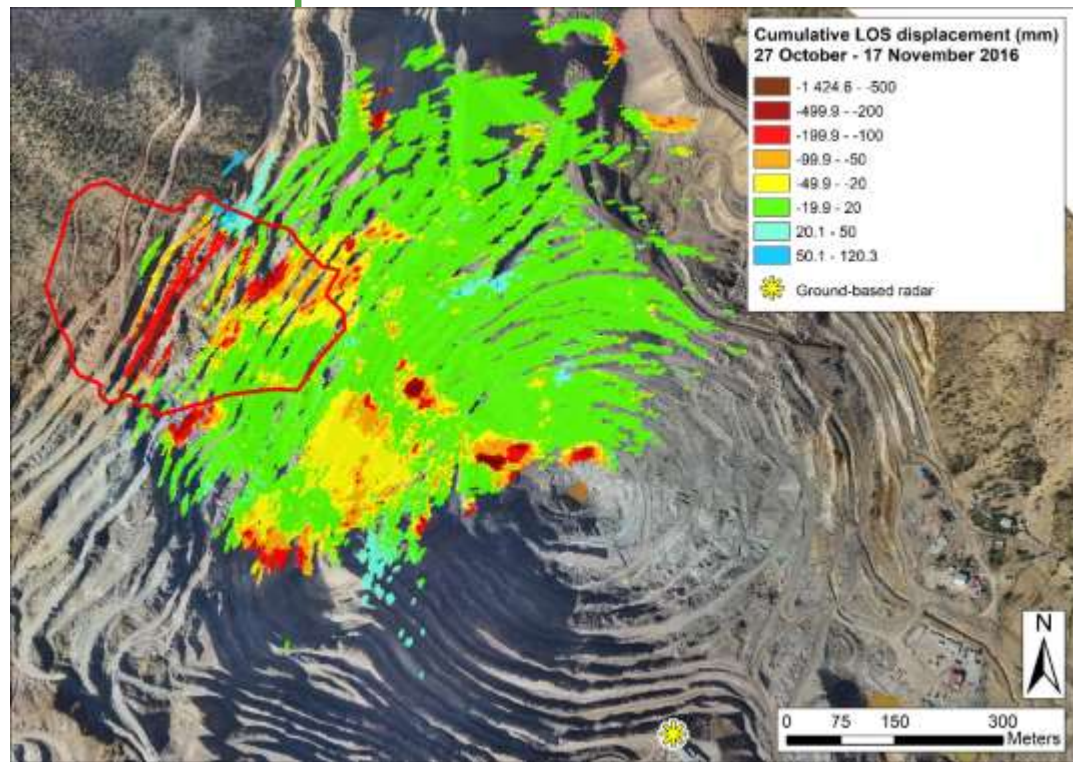
The present: wide area monitoring system



The present: wide area monitoring system



The present: wide area monitoring system



01

Satellite Interferometry

Radar-interpretation: products, applicability and limitations

02

The past: archive elaboration

Mapping and “one-shot analysis”

03

The present: wide area monitoring system

The Sentinel-1 constellation

04

The future: continental scale

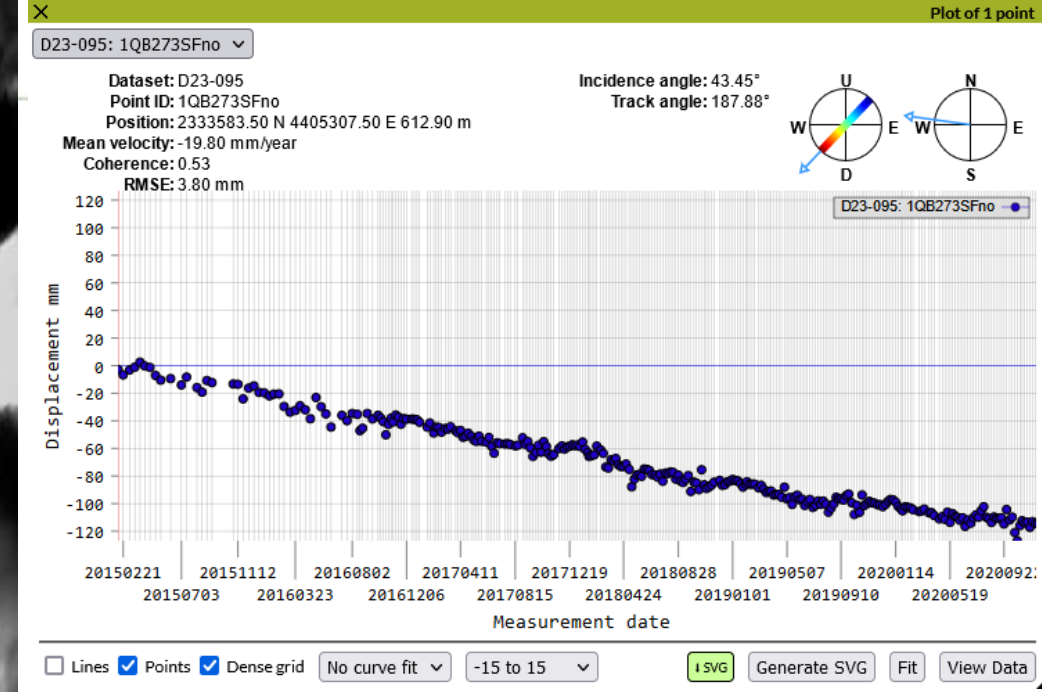
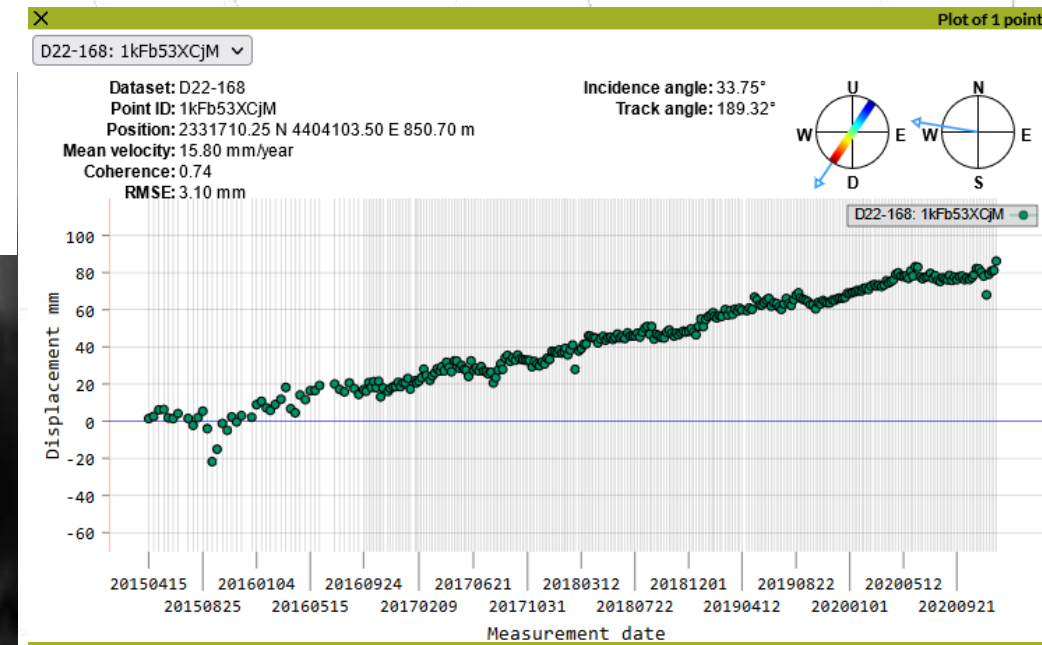
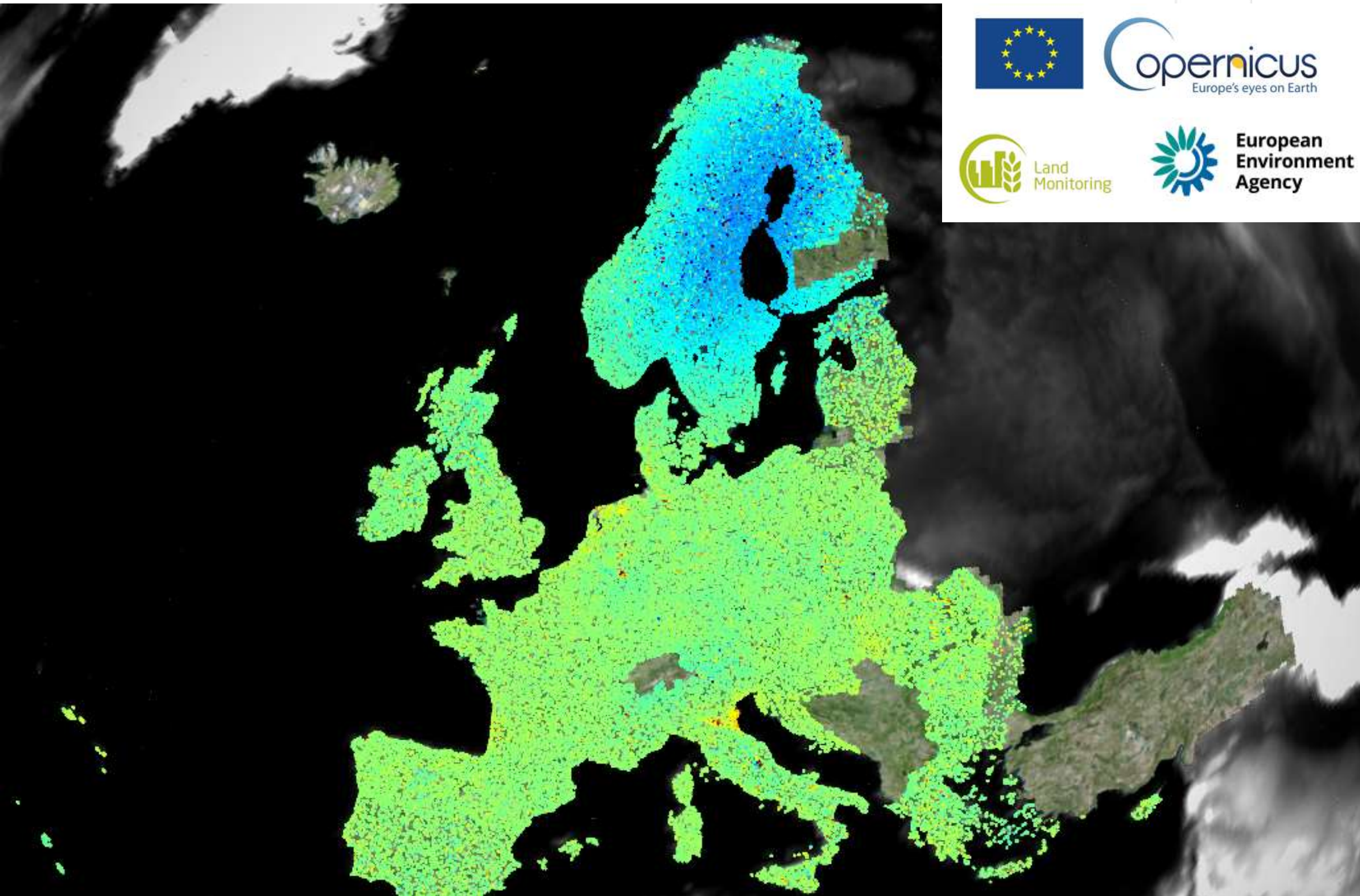
Early warning system based on indicators of instabilities

05

Data availability

Open portal and web application for data access and management

The future: continental scale

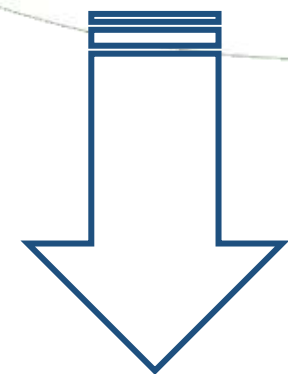


The future: continental scale

- Local to regional Scale

- National scale

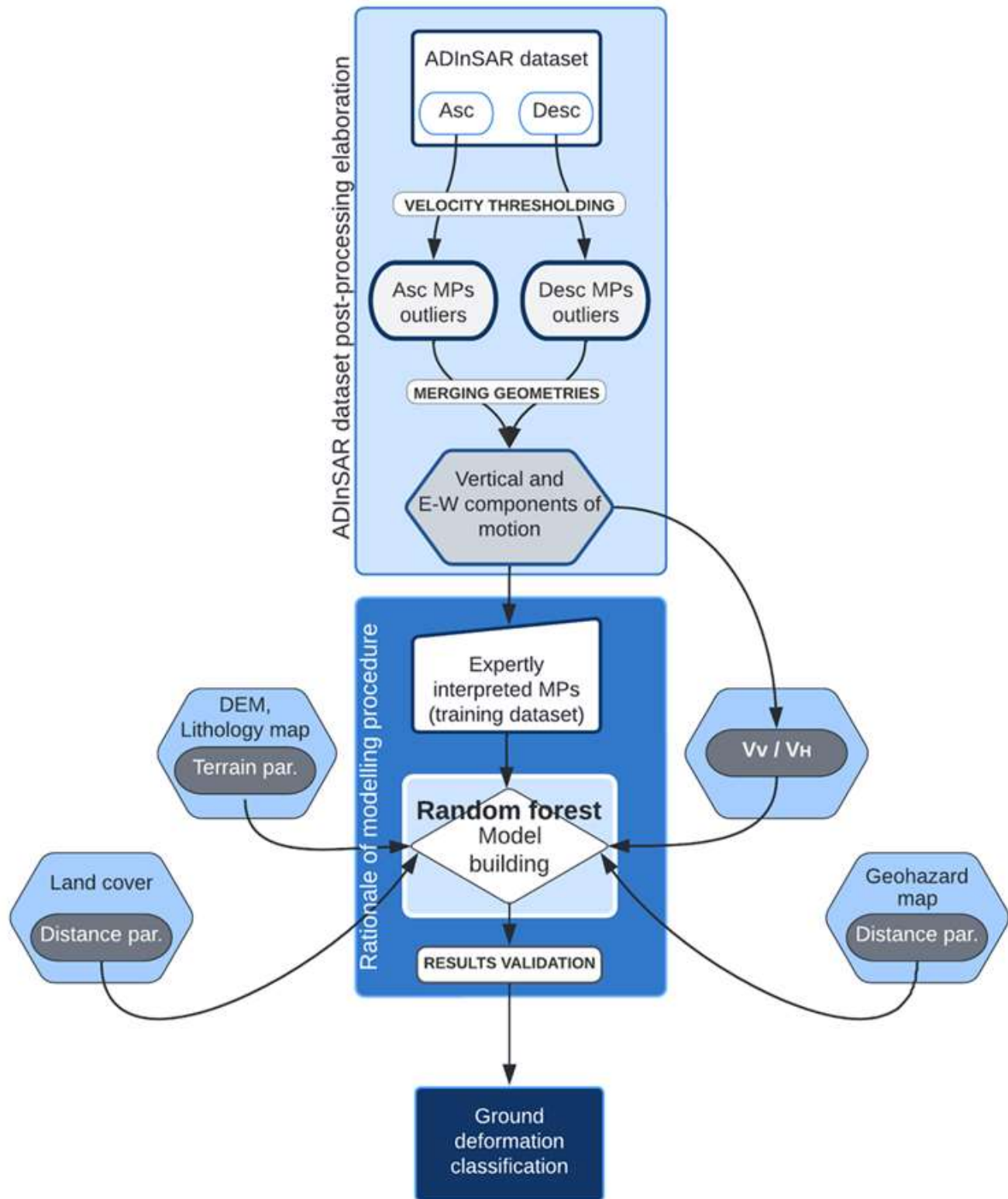
- Continental scale:
European ground
motion Service EGMS



**How can we manage such
amount of data?**



The future: continental scale



1. InSAR dataset post-processing elaboration:

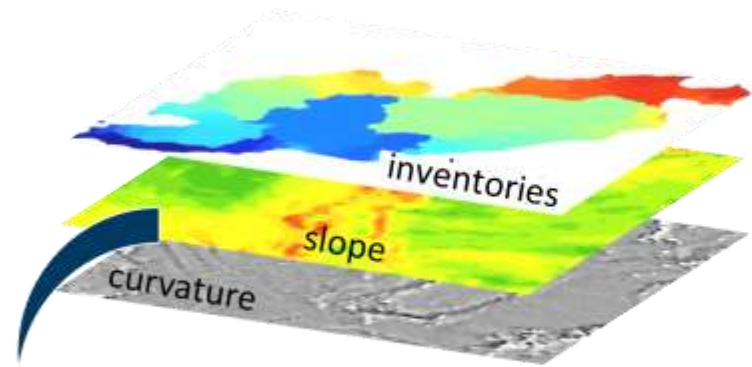
- Velocity thresholding
- Vertical and horizontal components retrieval

2. Rationale of modelling procedure:

- Training dataset of interpreted ground displacements
- Set of common explanatory variables
- Random Forest modelling to predict different classes of radar targets based on the spatial association with a set of predictors

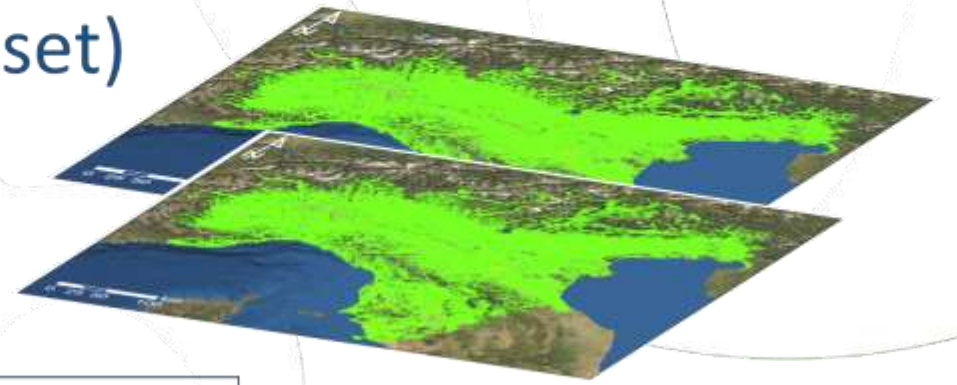
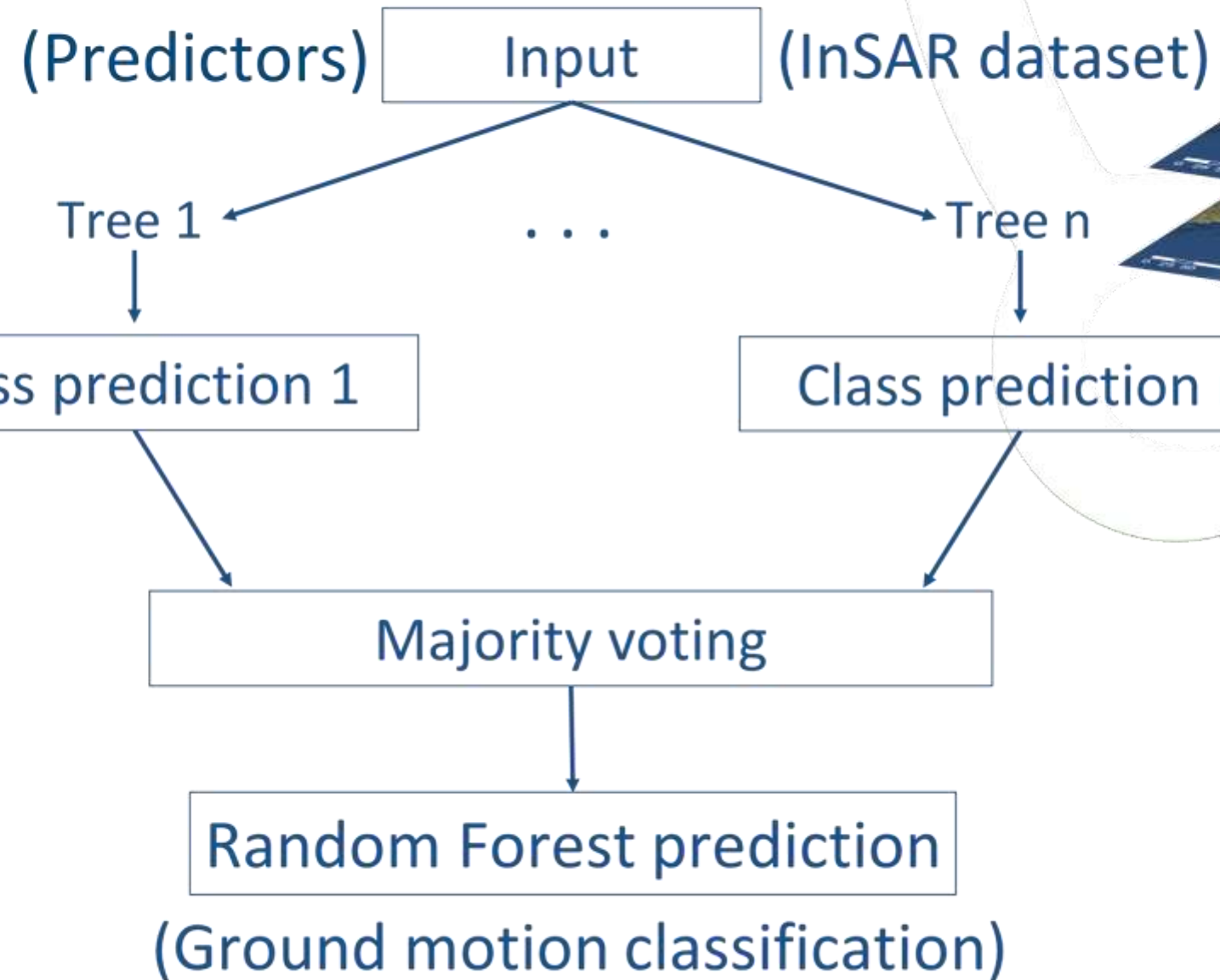
The future: continental scale

Random Forest Process

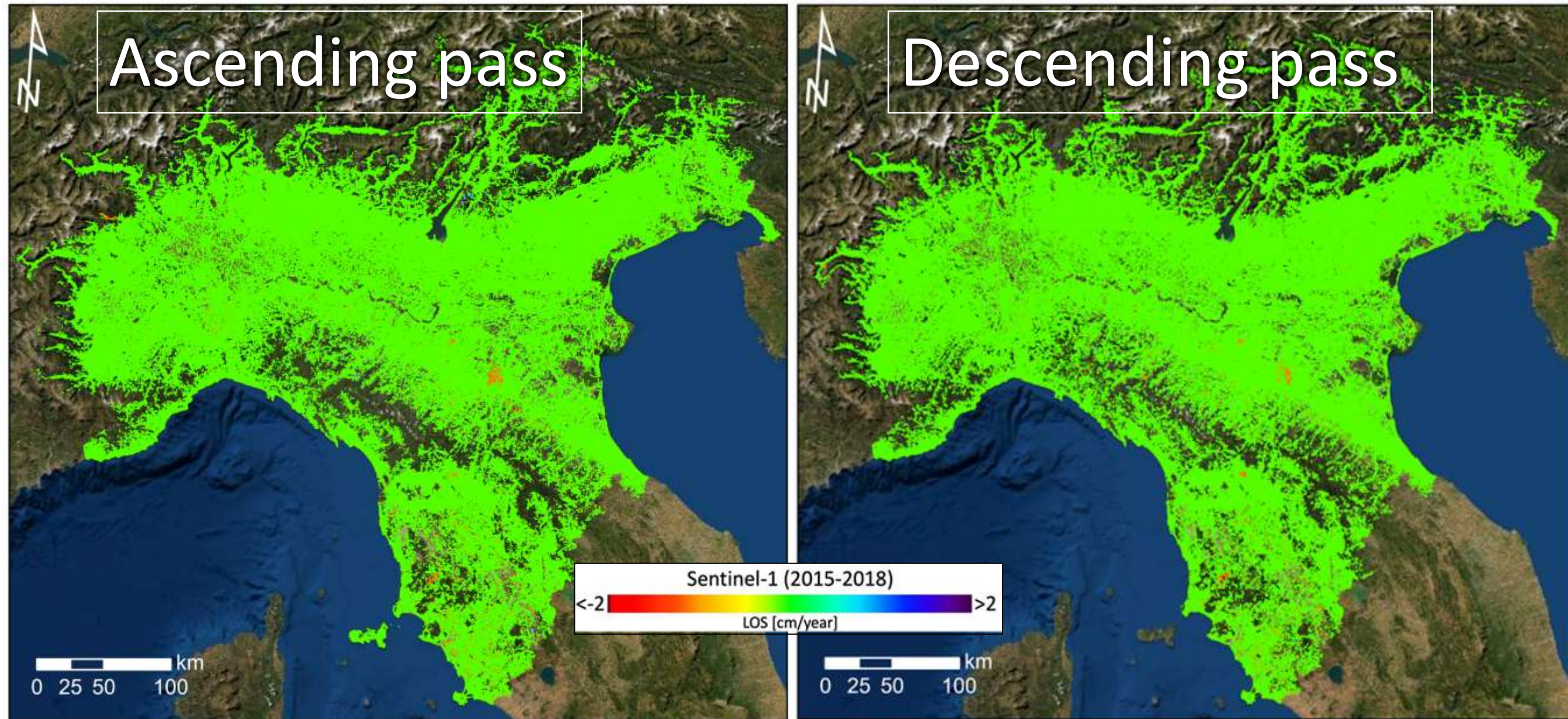


- Elevation
- Aspect
- Slope
- Curvature
- Profile curvature
- Planar curvature
- Topographic Wetness
- Lithology
- Landslide distance
- Mining sites distance
- Kvh

$$K_{VH} = \frac{V_V}{|V_H|}$$



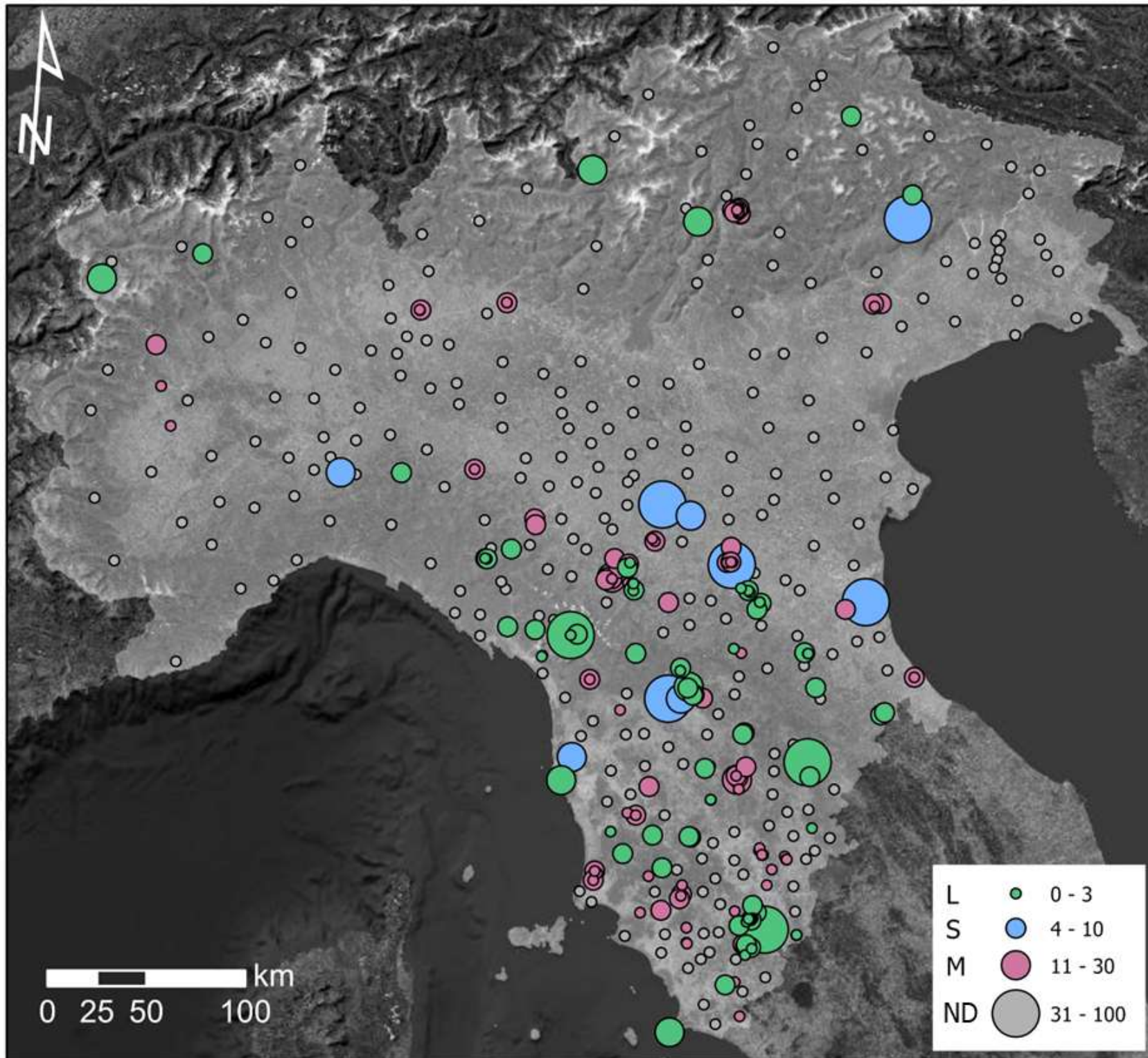
The future: continental scale



| Processing technique | Satellite (orbit) | Covered period | MPs count | MPs density |
|----------------------|-----------------------------------|--------------------------|-----------|--------------------------------------|
| P-SBAS | C-band S-1 ascending & descending | March 2015-December 2018 | 5,343,778 | 18.1 to 19.2 MPs per km ² |

The future: continental scale

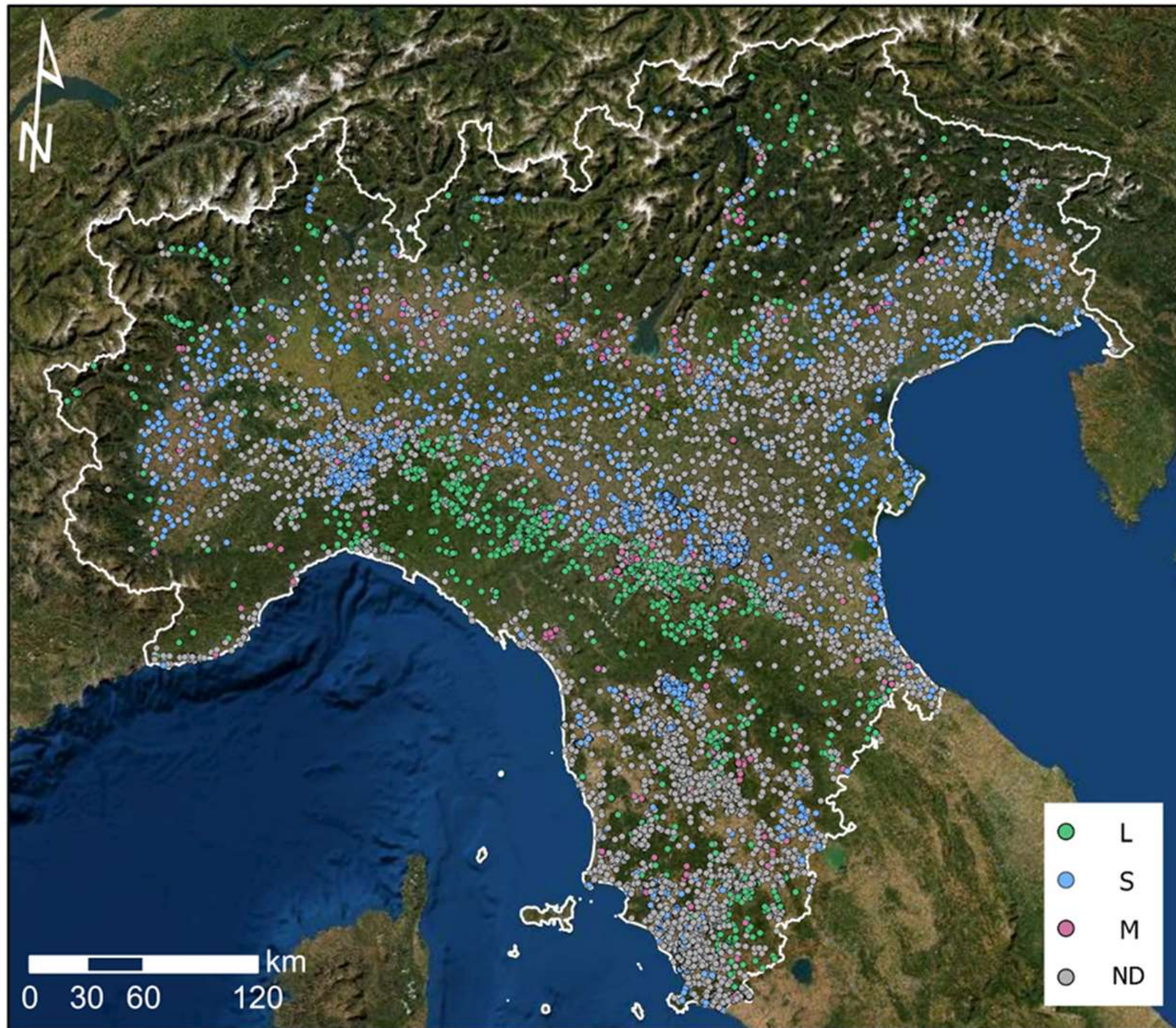
Training dataset



Expert classification of moving MPs into 4 classes:

1. **Landslide**
2. **Subsidence**
3. **Mining-related displacements**
4. **Noise or other phenomena**

After data-levelling, a total of 2,184 MPs constitutes the balanced training dataset

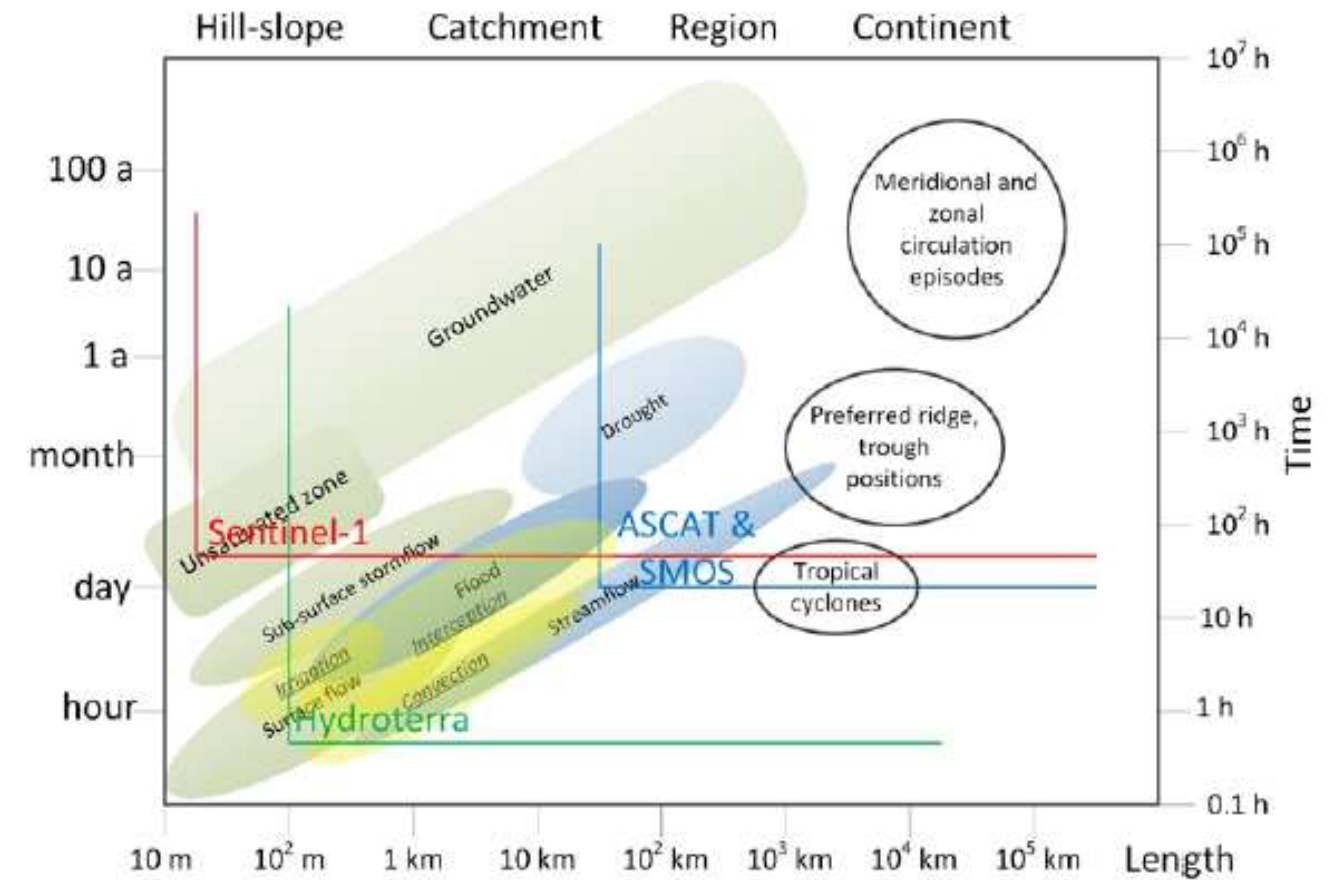
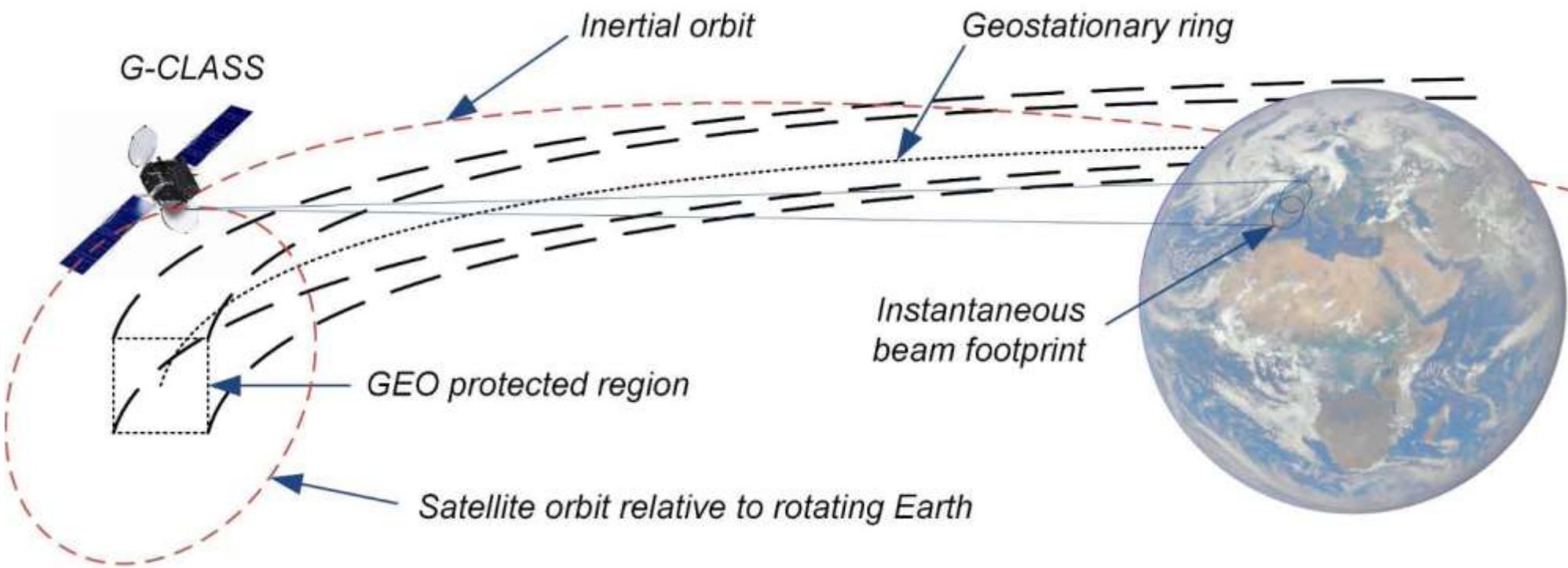


Classification outcomes

Automated classification of 20,212 features:

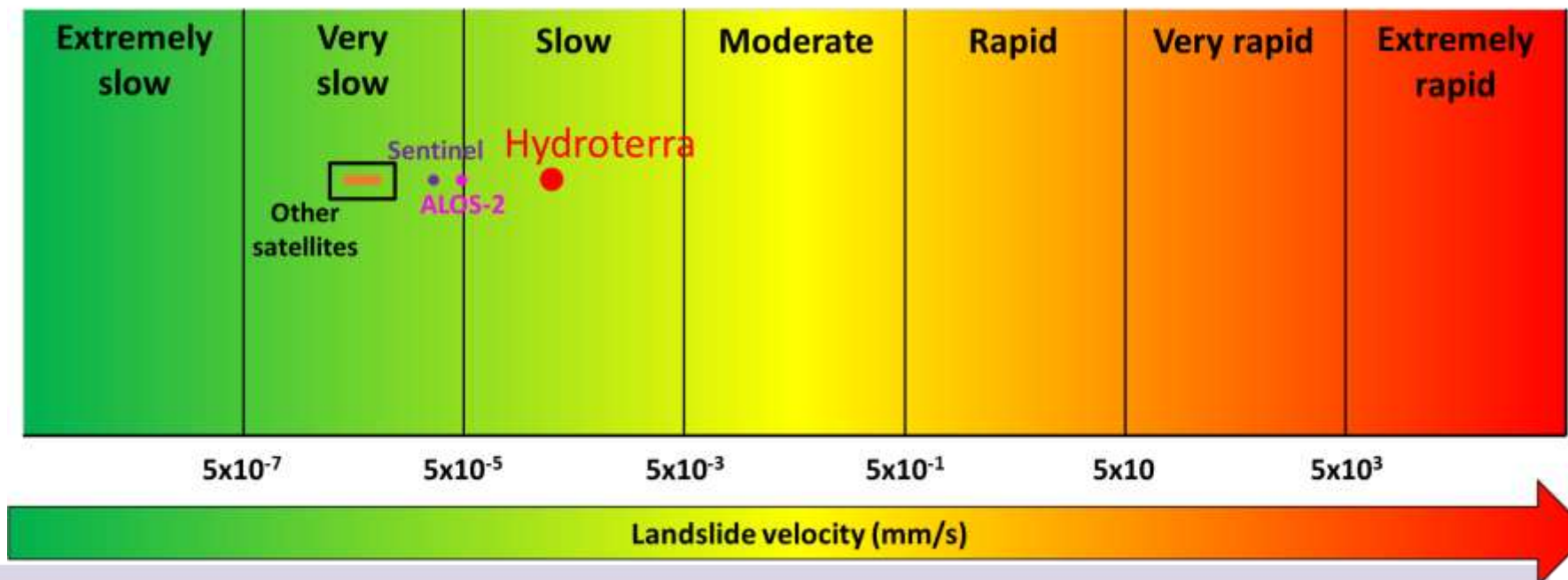
- 2,712 MPs as L
 - 8,255 MPs as S
 - 773 MPs as M
 - 8,472 MPs as ND
-
- Mean slope for L features = 16.1° (standard deviation = $\pm 9.4^\circ$)
 - Mean slope for S features = 0.5° (standard deviation = $\pm 1.3^\circ$)
 - 81% of M features clusters within CLC mining sites boundaries, the remnants in direct proximity (0 to ca. 500 m)
 - ND hold largely dispersed values considering any predictors

The future: continental scale



A mission to observe and understand **rapid processes of the water cycle over land**:

- Hydro-meteorology (intense storms, mitigate weather impacts);
- Surface moisture hydrology (water resource management – agriculture);
- **“Rapid” landslides;**
- Land cryosphere processes.



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Data availability

Open portal and web application for data access and management

Il geoportale nazionale (PCN miniambiente)



Home | INSPIRE | Direttive | Servizi | Progetti | Agenda | Consulta Nazionale

- Panoramica
- Coste
- Geoportale in Comune
- Hermon
- Incendi
- Natura
- Piano Straordinario di Telerilevamento
- Altri progetti

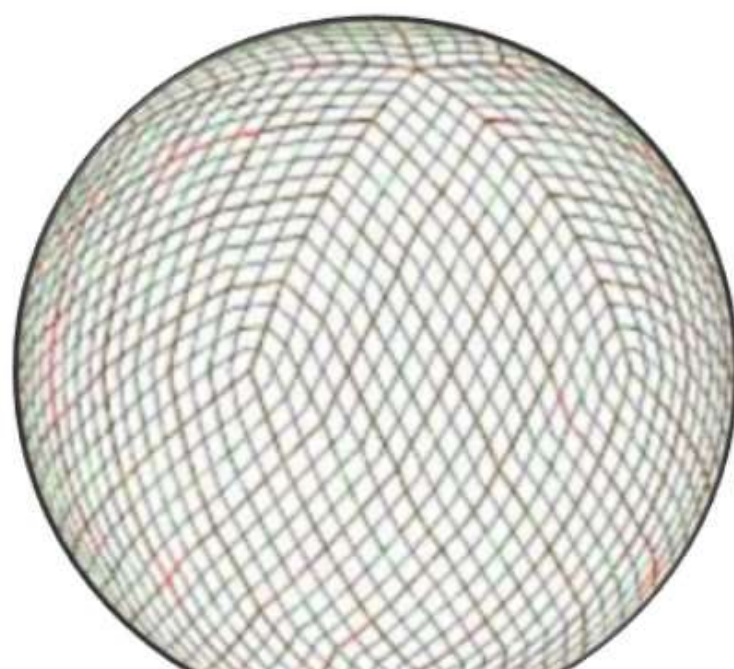
GEOPORTALE NAZIONALE

Punto di accesso nazionale all'informazione ambientale e territoriale

[LEGGI TUTTO](#)

Roma - Ortofoto 2012 - Scala 1:10.000

I dati PS nel geoportale



SERVIZIO DI CONSULTAZIONE - WMS

Cos'è un servizio di consultazione WMS

Un Servizio di Consultazione consente "di eseguire almeno le seguenti operazioni: visualizzazione, navigazione, variazione della scala di visualizzazione (zoom in e zoom out), variazione della porzione di territorio inquadrata (pan), sovrapposizione dei set di dati territoriali consultabili e visualizzazione delle informazioni contenute nelle legende e qualsivoglia contenuto pertinente dei metadati" (Direttiva 2007/2/CE).

Le linee guida INSPIRE per l'implementazione dei Servizi di Consultazione consigliano che tale servizio sia implementato utilizzando lo standard ISO 19128 - Web Map Service (WMS) 1.3.0.

Il WMS (Web Map Service), generato secondo lo standard, eroga una mappa che è la rappresentazione delle informazioni territoriali sotto forma di un file immagine digitale in formato PNG, GIF o JPEG: la mappa quindi, in quanto immagine, non può essere editata o spazialmente analizzata dagli utenti finali.

Tuttavia, l'utilizzo di formati immagine che supportano lo sfondo trasparente consente la sovrapposizione di mappe differenti che possono essere richieste da server differenti.

Catalogo WMS

Servizi

[Distribuzione dati PST](#)

[Catalogo metadati](#)

Visualizzatori

- [Il Nuovo Visualizzatore](#)

- [Il Visualizzatore 3D](#)

I dati PS nel geoportale

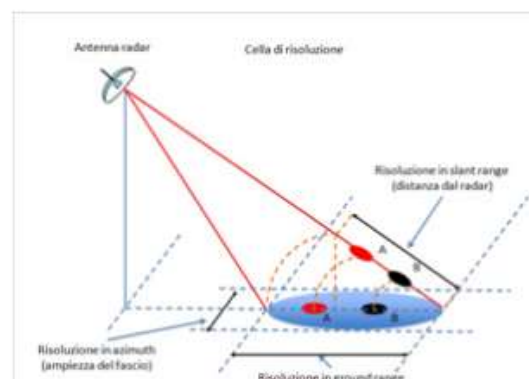


PROGETTO PST - PRODOTTI INTERFEROMETRICI

Cos'è l'interferometria

Il SAR e l'interferometria

Con il termine SAR o radar ad apertura sintetica si definisce un'antenna radar montata su di una piattaforma mobile. Il principio di funzionamento di un sistema SAR è il medesimo di tutti i sistemi radar (RADio Detection And Ranging). Un apparecchio trasmittente (antenna) irraggia lo spazio circostante con un'onda elettromagnetica che incide sugli oggetti che incontra subendo un fenomeno di riflessione. Una parte dell'onda diffusa torna verso l'antenna dove viene misurata. In questo modo il radar è in grado di individuare oggetti (detection) e, misurando il ritardo temporale tra l'istante di trasmissione e quello di ricezione, è possibile misurarne la distanza (slant-range) di tali oggetti dall'antenna (Fig. 1.). Questa misura avviene però solo nella direzione d'illuminazione dell'antenna, cioè non è possibile distinguere due oggetti posti alla stessa distanza dall'antenna.



[Progetti](#)

[Coste](#)

[Geoportale in Comune](#)

[Hermon](#)

[Incendi](#)

[Natura](#)

[Piano Straordinario di Telerilevamento](#)

[Altri Progetti](#)

[Progetti PON](#)

[Genesis-DEC](#)

I dati PS nel geoportale

The screenshot displays a geospatial web application interface. The main map area shows an aerial view of a city with numerous green markers. The interface includes several panels and toolbars:

- STRUMENTI** (Tools): Located in the top-left, it contains a 'Strumenti mappa' section with icons for map navigation and a menu with options: 'Selezione scala', 'Ricerca su attributi', 'Zoom su coordinata', 'Misura', and 'Servizi'.
- GESTIONE SERVIZI** (Service Management): Located in the top-right, it shows a 'Trasparenza' slider set to 0% and a 'Mappa Principale' section with two visible layers: 'Prodotti interferometrici ENVISAT asc' and 'Ortofoto colore 2012'.
- Map Timeline**: At the top of the map, there are year markers for 1988, 1994, 2000, 2006, and 2012.
- Scale Bar**: Located in the bottom-left of the map area, showing a scale from 0 to 100m.
- Search and Navigation**: At the bottom of the map, there is a search bar labeled 'Cerca localita'' and 'Cerca Servizio', along with navigation icons.
- Service List**: A horizontal row of service thumbnails at the bottom of the interface, including: 'Atlante delle aree a rischio di desertificazione', 'Catalogo Frane', 'Progetto Coste', 'Progetto incendi - Cartografia antincendi boschivi nei parchi nazionali', 'Progetto Natura', 'Progetto datafile immagini SAR ERS e ENVISAT', 'Prodotti interferometrici confronto ERS-ENVISAT ascending', 'Prodotti interferometrici confronto ERS-ENVISAT descending', 'Prodotti interferometrici Cosmo Sky Med ascending', 'Prodotti interferometrici Cosmo Sky Med descending', 'Prodotti interferometrici ENVISAT ascending', 'Prodotti interferometrici ENVISAT descending', 'Prodotti interferometrici ERS ascending', and 'Prodotti interferometrici ERS descending'.

www.pcn.minambiente.it/viewer/#

Lon/Lat 11.26528 ; 43.76883 X/Y 682.322,28 ; 4.848.691,56

©2014 Ministero dell'Ambiente - Geoportale Nazionale - [Termini e condizioni d'uso](#)

I dati PS nel portale della Regione Toscana

Condividi

Monitoraggio radar delle deformazioni del terreno

Monitoraggio radar satellitare delle deformazioni del terreno della Regione Toscana. Il sistema informativo e la rappresentazione dei dati

L'applicativo si inserisce nell'ambito dell'accordo "Attività di monitoraggio del rischio idrogeologico nel territorio della regione Toscana" stipulato il 06 dicembre 2017, tra la Regione Toscana, il Dipartimento della Protezione Civile della Presidenza del Consiglio dei Ministri e il Dipartimento di Scienze della Terra dell'Università degli Studi di Firenze. L'obiettivo principale delle attività è quello di **fornire informazioni utili alla formulazione di un quadro sinottico dei fenomeni di deformazione del suolo** sull'intero territorio regionale, **a supporto delle Regioni, dei Comuni e degli Enti Territoriali** coinvolti nelle attività **per la difesa del territorio e di gestione dei rischi**.

A tale scopo è stata generata una banca dati rappresentativa del territorio regionale contenente le **misure dei movimenti del terreno ottenute mediante interferometria SAR** (Synthetic Aperture Radar) satellitare e resa fruibile attraverso il **Geoportale della Difesa del Suolo della Regione Toscana** realizzato del Consorzio LaMMA.

L'infrastruttura geografica sviluppata rappresenta lo strumento utilizzato per organizzare, gestire e divulgare i prodotti del progetto Monitoraggio radar satellitare delle deformazioni del terreno della Regione Toscana.

Per la prima volta **questa tipologia dato è resa accessibile a tutti, sia al funzionario tecnico che al libero professionista**, in modo continuo, con aggiornamento temporale frequente (10 giorni circa), nella sua completezza d'informazione e per un intero territorio regionale.

[Accedi al portale dei dati interferometrici](#)

Documentazione utile:

- Termini di utilizzo
- Linee guida per l'utilizzo dei dati interferometrici del geoportale
- Consulta il manuale d'uso del geoportale

Download dei dati:

Ascending

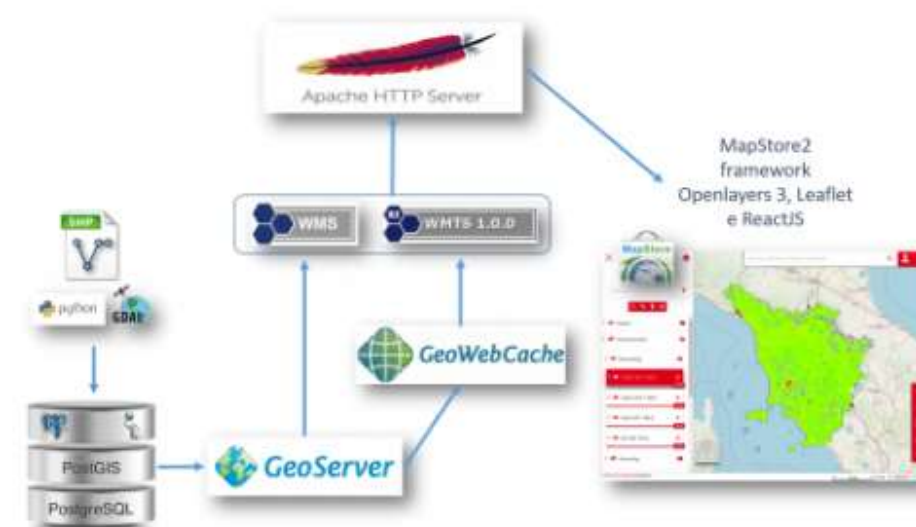
- TOSCANA_ELBA_SNT_T15_A.zip
- TOSCANA_EST_SNT_T117_A.zip
- TOSCANA_GIGLIO_SNT_T117_A.zip

Descending

- TOSCANA_ELBA_SNT_T168_D.zip
- TOSCANA_EST_SNT_T95_D.zip
- TOSCANA_GIGLIO_SNT_T168_D.zip

Mappe sensibilità/visibilità

- Download



I dati PS nel portale della Regione Toscana

Download dei Permanent Scatterers

Documentazione

- [Termini di utilizzo](#)
- [Linee guida per l'utilizzo dei dati interferometrici del geoportale](#)
- [Consulta il manuale d'uso del geoportale](#)

Mappe sensibilità/visibilità

- [Download](#)

Download dei dati:

- **Ascending**
 - [TOSCANA_ELBA_SNT_T15_A.zip](#)
 - [TOSCANA_EST_SNT_T117_A.zip](#)
 - [TOSCANA_GIGLIO_SNT_T117_A.zip](#)
 - [TOSCANA_OVEST_SNT_T15_A.zip](#)

EGMS Explorer

The screenshot displays the EGMS Explorer web application interface. At the top, there is a header with logos for Copernicus, Land Monitoring, and the European Environment Agency, along with the text "European Ground Motion Service" and "Help Info". Below the header is a navigation bar with a search input field labeled "Place/coordinates (lat lon)" and several icons, including a lock icon circled in red. On the left side, there is a sidebar menu with the following items: "Background Layers", "BASIC (Level 2A)", "CALIBRATED (Level 2B)", "DROM", and "ORTHO (Level 3)". The main area shows a map of Europe with ground motion data points represented by small colored dots. A legend window is open on the right side, titled "Legend", with the text "Legend across all datasets. Limits are in mm/year." and a color scale from -20 to 20. The legend also includes a checkered pattern icon, a slider set to 100%, a dot icon, a slider set to 2.5 pixels, a dropdown menu set to "Medium (-20 to 20)", and a dropdown menu set to "InSAR default". At the bottom of the map, there is a scale bar labeled "465 km" and a north arrow. A QR code is visible in the bottom left corner of the map area.

EGMS Explorer

European Ground Motion Service

Help Info

Basic, Calibrated & Ortho

Place/coordinates (lat lon)

Legend

Legend across all datasets. Limits are in mm/year.

-20 20

100%

2.5 pixels

Medium (-20 to 20) Min Max

InSAR default

Click on map to reveal location Live

Credits

465 km

1 --> Data drop-down menu

2 --> Toolbar

3 --> Color bar adjustment

4 --> Coordinates

EGMS Explorer - LoS velocity

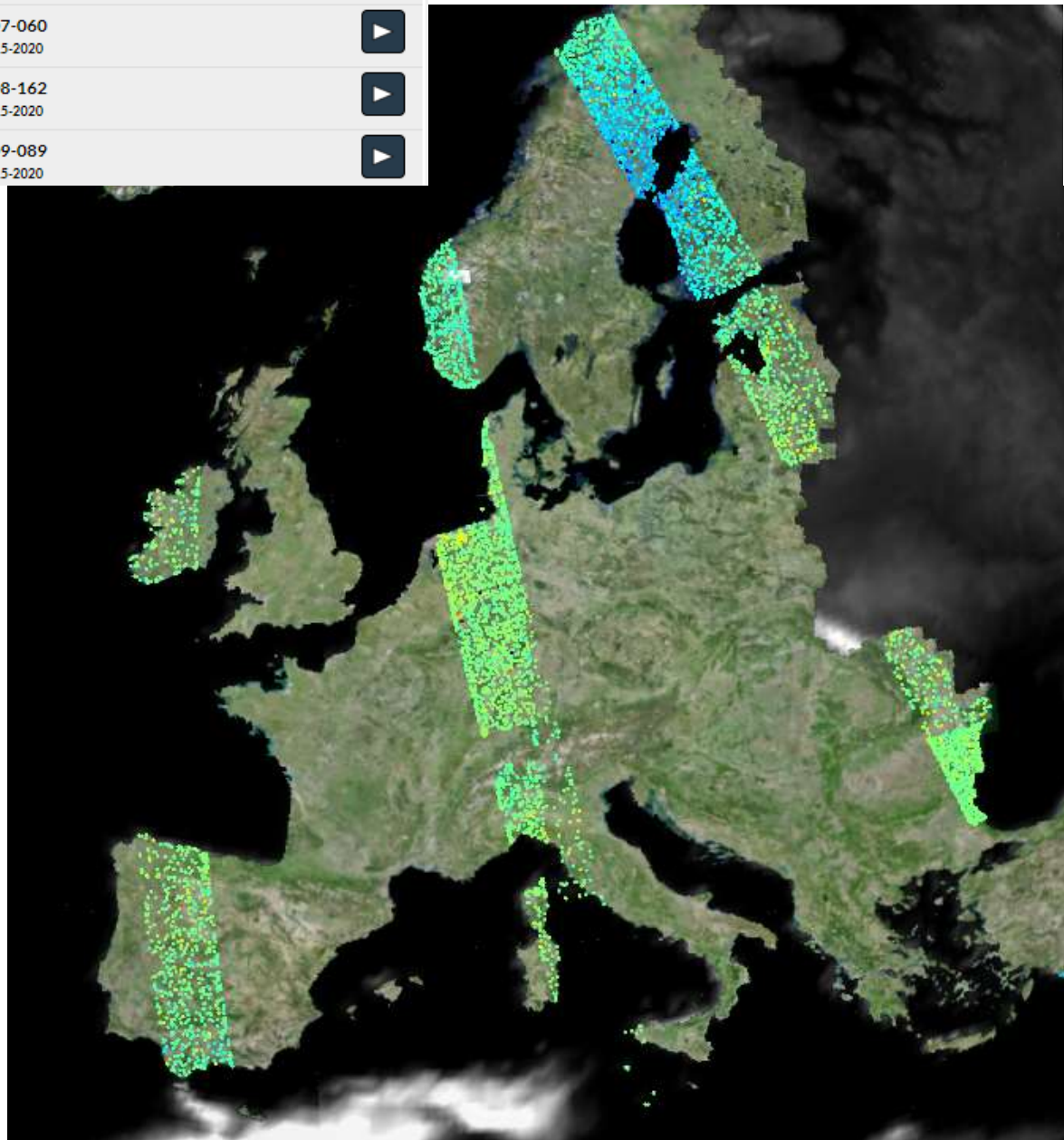
Background Layers

- BASIC (Level 2A)
- CALIBRATED (Level 2B)**
- DROM
- ORTHO (Level 3)

▼ CALIBRATED (Level 2B)

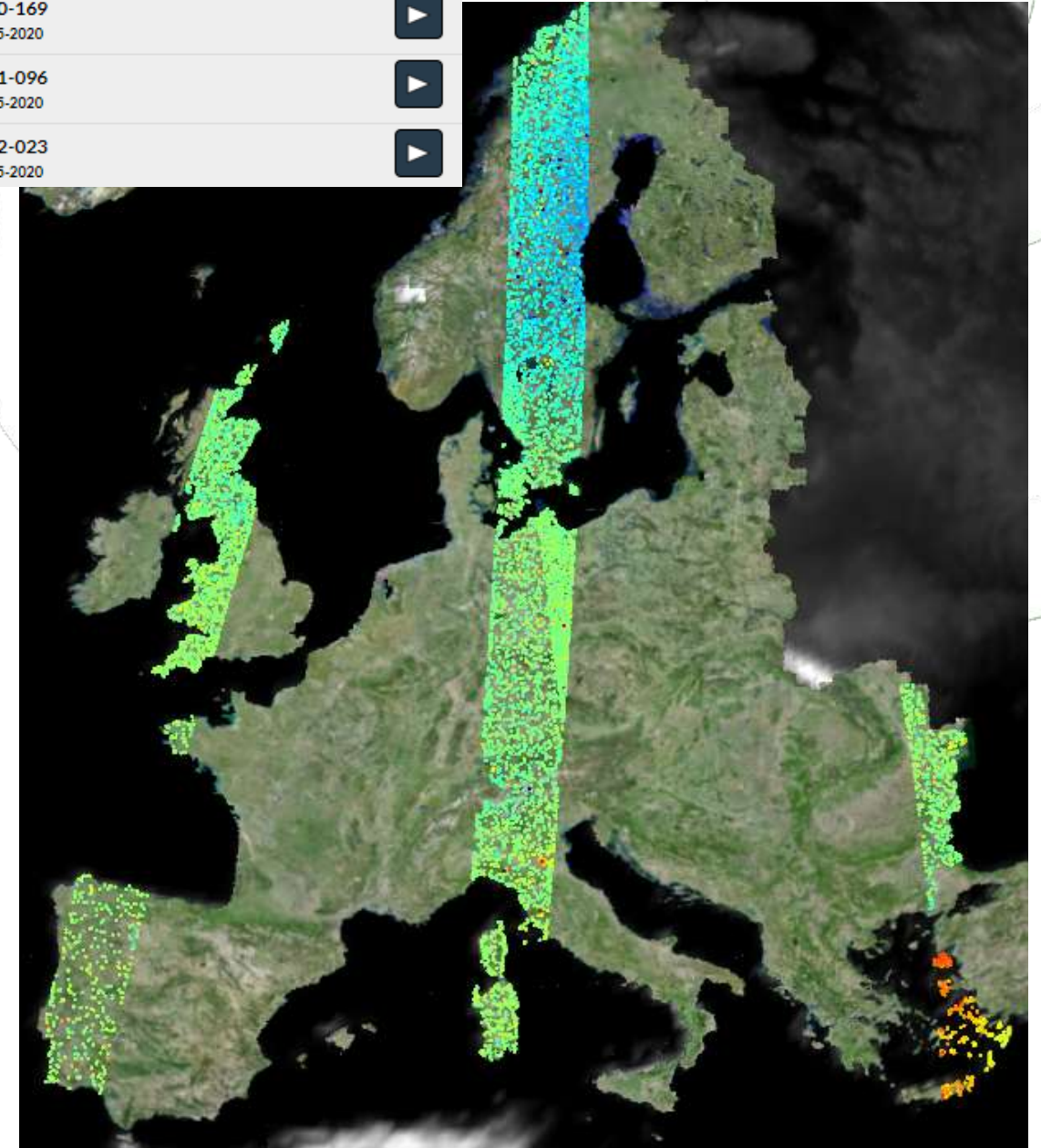
▼ Ascending

| | |
|------------------------|---|
| ✕ A02-075 2015-2020 | ▶ |
| ✕ A03-002 2015-2020 | ▶ |
| ✕ A04-104 2015-2020 | ▶ |
| ✕ A07-060 2015-2020 | ▶ |
| ✕ A08-162 2015-2020 | ▶ |
| ✕ A09-089 2015-2020 | ▶ |



▼ Descending

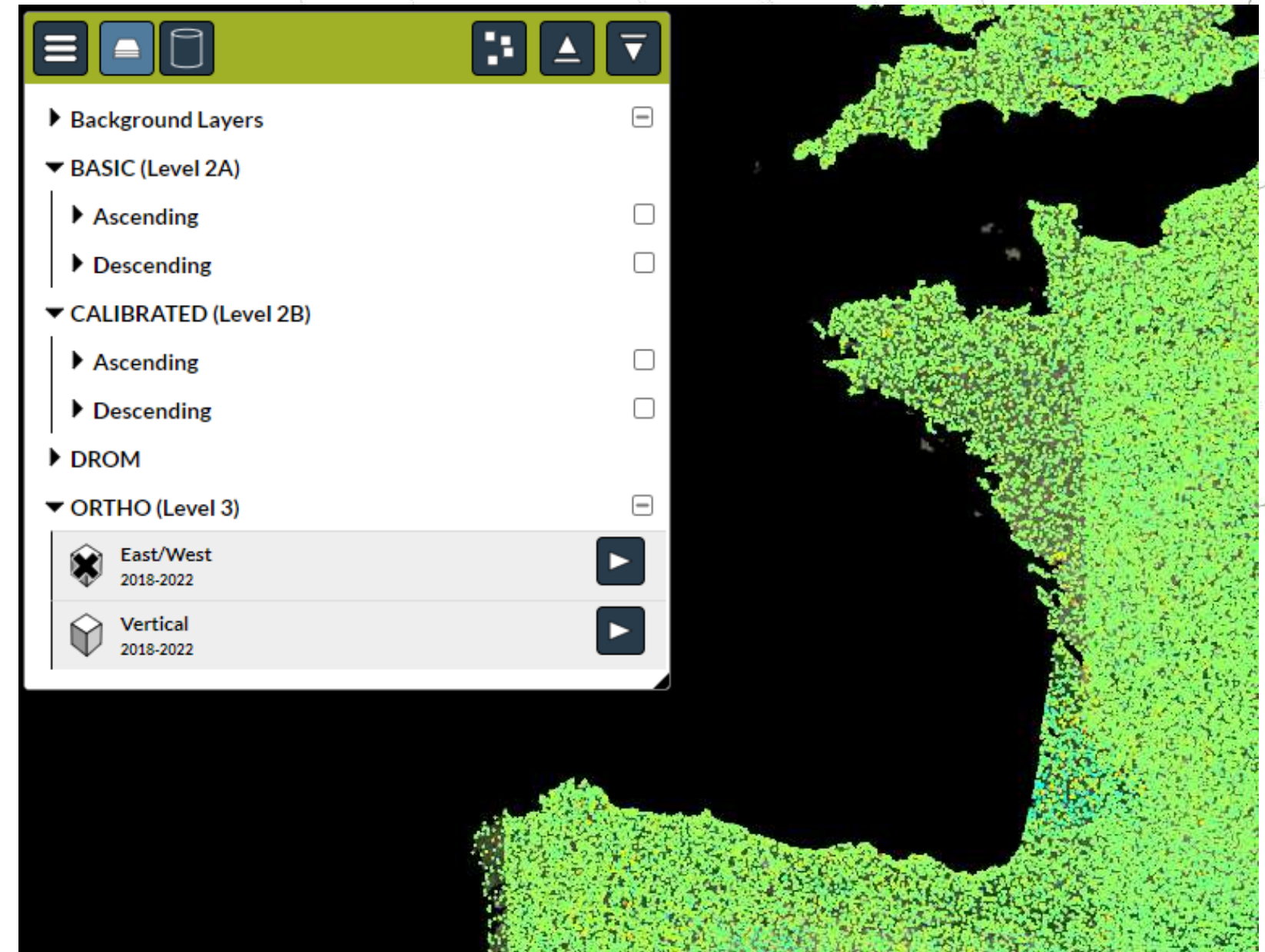
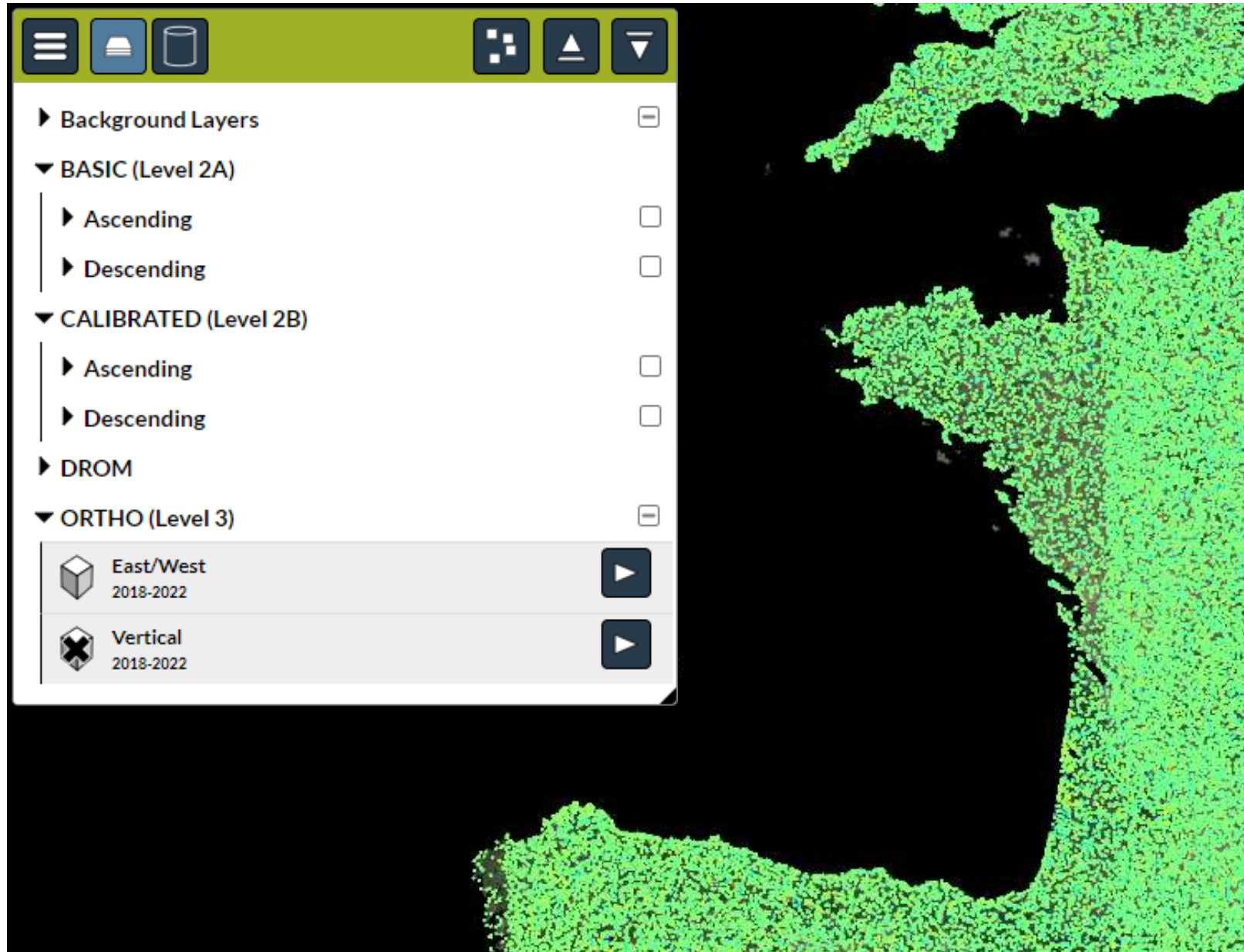
| | |
|------------------------|---|
| ✕ D04-082 2015-2020 | ▶ |
| ✕ D05-009 2015-2020 | ▶ |
| ✕ D06-111 2015-2020 | ▶ |
| ✕ D10-169 2015-2020 | ▶ |
| ✕ D11-096 2015-2020 | ▶ |
| ✕ D12-023 2015-2020 | ▶ |



Numbering of the tracks increases from W to E

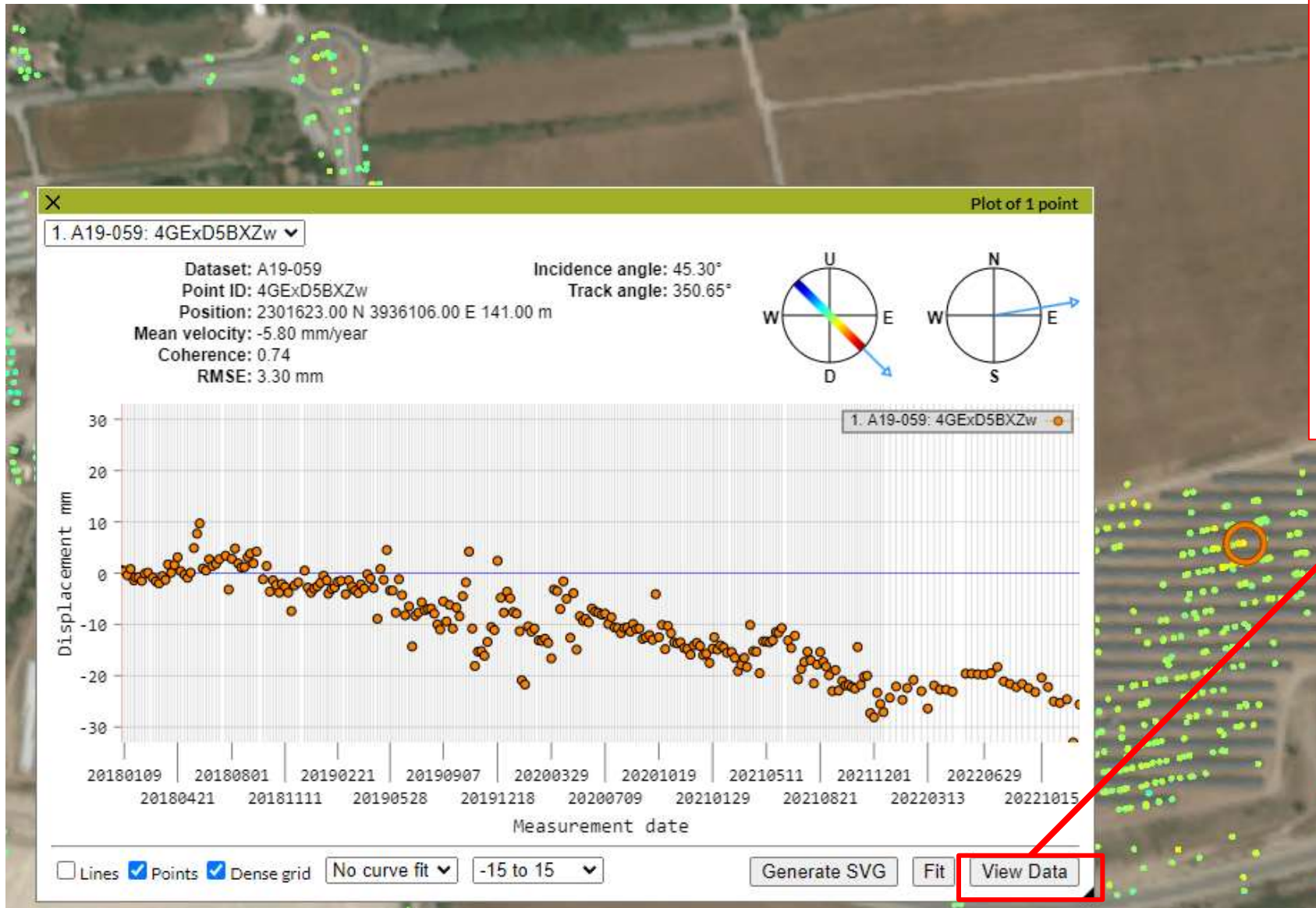
It does not follow the original SNT-1 track numbering

EGMS Explorer - velocity components



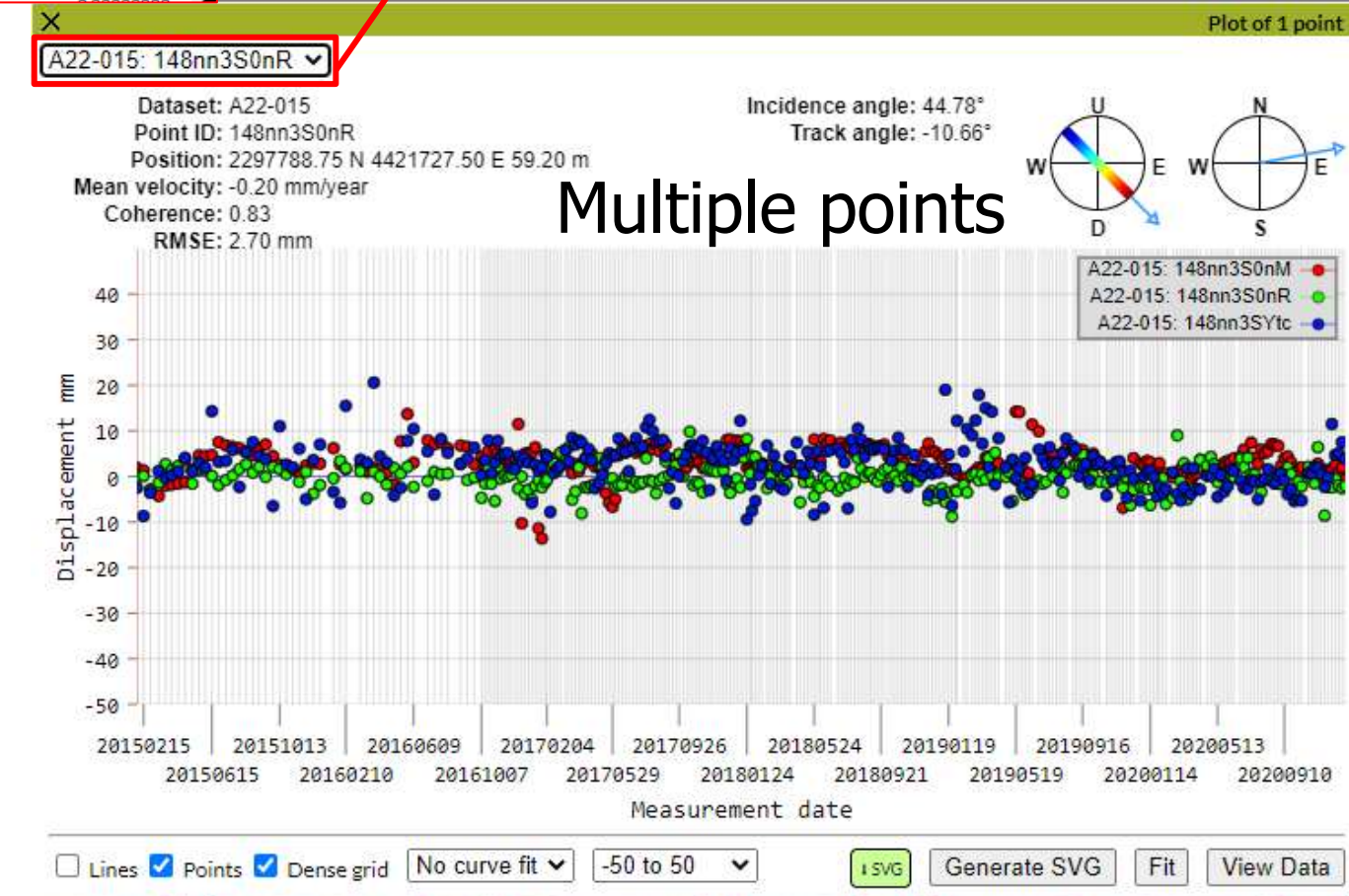
Unique map for each layer

EGMS Explorer - info per point



| Data | |
|----------------------|--------------|
| amplitude_dispersion | 0.36000001 |
| incidence_angle | 44.79000092 |
| track_angle | -10.65999985 |
| los_east | -0.69199997 |
| los_north | -0.13000000 |
| los_up | 0.70999998 |
| mean_velocity | -0.50000000 |
| mean_velocity_std | 0.10000000 |
| acceleration | -0.11000000 |
| acceleration_std | 0.07000000 |
| seasonality | 0.50000000 |
| seasonality_std | 0.10000000 |
| DATA | |
| 20150203 | 2.70000005 |
| 20150215 | 4.59999990 |
| 20150227 | -2.20000005 |
| 20150311 | -0.50000000 |
| 20150323 | -2.29999995 |
| 20150404 | 1.29999995 |
| 20150416 | -0.50000000 |
| 20150428 | -3.00000000 |
| 20150510 | -1.60000002 |
| 20150522 | 0.30000001 |

Click here to switch between points



EGMS Explorer - download data

After login to EU Login



ORTHO-EAST

- EGMS_L3_E46N19_100km_E_2018_2022_1.zip
Level: L3 Type: ORTHO-EAST
Size: 26.89 MB (28197875 bytes)

ORTHO-UP

- EGMS_L3_E46N19_100km_U_2018_2022_1.zip
Level: L3 Type: ORTHO-UP
Size: 26.30 MB (27579904 bytes)

Bacoli

Product Archive

Click the button to enter geographical search mode. Once in this mode, click in the map to draw a polygon representing your area of interest. Double-click to close the polygon and perform the product archive search. Once a search completes, an overview of results will appear here.

You are logged in as ndelsolm.

Archive search returned 2 results

Release: 2015-2021 2018-2022

Level: BASIC (Level 2A) CALIBRATED (Level 2B) ORTHO (Level 3)

[Download links](#) [Clear results](#) [View results](#)

Legend

Legend across all datasets. Limits are in mm/year.

-20 20

100%

2.5 pixels

Medium (-20 to 20) Min Max

InSAR default

EGMS Explorer - download data

If I wan also the oldest data 2015-2021

EGMS Explorer - download data

After login to EU Login



The screenshot displays the EGMS Explorer web interface. On the left, a sidebar lists data products under 'CALIBRATED' and 'Descending' categories. The main map area shows a satellite image of Bacoli with overlaid InSAR data in various colors (red, yellow, green, blue) and yellow polygonal search areas. On the right, a 'Product Archive' search panel is active, showing search criteria for 'Release' (2018-2022) and 'Level' (CALIBRATED (Level 2B)). A 'View results' button is highlighted with a red box. Below the search panel, a 'Legend' window is open, showing a color scale from -20 to 20 mm/year and other visualization settings like 'Medium (-20 to 20)' and 'InSAR default'.

Product Archive

Click the button to enter geographical search mode. Once in this mode, click in the map to draw a polygon representing your area of interest. Double-click to close the polygon and perform the product archive search. Once a search completes, an overview of results will appear here.

You are logged in as ndelsolm.

Archive search returned 7 results

Release: 2015-2021 2018-2022

Level: BASIC (Level 2A) CALIBRATED (Level 2B) ORTHO (Level 3)

[Download links](#) [Clear results](#) [View results](#)

Legend

Legend across all datasets. Limits are in mm/year.

-20 20

100%

2.5 pixels

Medium (-20 to 20) Min Max

InSAR default

EGMS Explorer - download data

BASIC (Level 2A)

- EGMS_L2a_022_0832_IW1_VV_2018_2022_1.zip
- EGMS_L2a_022_0832_IW1_VV.zip
- EGMS_L2a_022_0833_IW1_VV_2018_2022_1.zip
- EGMS_L2a_022_0833_IW1_VV.zip
- EGMS_L2a_044_0240_IW1_VV_2018_2022_1.zip

EGMS_L2b_022_0832_IW1_VV_2018_2022_1.zip

Name: EGMS_L2b_022_0832_IW1_VV_2018_2022_1.zip
Size: 1.10 GB (1181368755 bytes)
Type: CALIBRATED
Level: L2B
Release: 2018-2022 (1)
Direction: descending
Burst ID: 022-0832-IW1-VV
Burst cycle: 0832
Polarization: VV
Relative orbit: 022
Swath: IW1

https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_022_0832_IW1_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101
https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_022_0833_IW1_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101
https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_044_0240_IW1_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101
https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_117_0238_IW3_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101
https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_117_0239_IW3_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101
https://egms.land.copernicus.eu/insar-api/archive/download/EGMS_L2b_124_0833_IW3_VV_2018_2022_1.zip?id=8587ad883b2644139bc1b5b3e0e11101

EGMS_L2a_117_0239_IW3_VV.zip

EGMS_L2a_124_0833_IW3_VV_2018_2022_1.zip

EGMS_L2a_124_0833_IW3_VV.zip

CALIBRATED (Level 2B)

- EGMS_L2b_022_0832_IW1_VV_2018_2022_1.zip
- EGMS_L2b_022_0832_IW1_VV.zip
- EGMS_L2b_022_0833_IW1_VV_2018_2022_1.zip
- EGMS_L2b_022_0833_IW1_VV.zip
- EGMS_L2b_044_0240_IW1_VV_2018_2022_1.zip

Bacoli

Product Archive

Click the button to enter geographical search mode. Once in this mode, click in the map to draw a polygon representing your area of interest. Double-click to close the polygon and perform the product archive search. Once a search completes, an overview of results will appear here.

You are logged in as ndelsolm.

Archive search returned 28 results

Release: 2015-2021 2018-2022

Level: BASIC (Level 2A) CALIBRATED (Level 2B) ORTHO (Level 3)

[Download links](#) [Clear results](#) [View results](#)

EGMStream webapp



EGMStream

[Read Me](#)

Browse [EGMS explorer](#) to download links

(egms-archive-links.txt) No file selected

Crop data on Area of Interest: ▾

(.kmz, .kml, .shp*) No file selected

Include Time Series: ▾

Select Date Format: ▾

Data Format: ▾

Save also CSV files: Yes No

Output Folder Name:

Email Address:

*for .shp upload .zip folder containing files related to the .shp

Credits
Becattini F., Medici C. & Dei Soldato M.

Acknowledgments
EGMS © European Union, Copernicus Land Monitoring Service 2022, European Environment Agency (EEA) - <https://land.copernicus.eu/oan-eurocean/eurocean-ground-motion-service>



EGMStream webapp

User guide



The screenshot shows the EGMStream web application interface. At the top left is the EGMStream logo. A blue arrow points from the 'User guide' text to a 'Read Me' button in the top right corner of the interface. The main content area contains a form with the following fields and options:

- Browse [EGMS explorer](#) to download links
- Upload the txt file (egms-archive-links.txt) - No file selected
- Crop data on Area of Interest: Yes ▾
- Upload the area file (.kml, .shp*) - No file selected
- Include Time Series: Yes ▾
- Select Date Format: Dddmmyyy ▾
- Data Format: Shapefile (.shp) ▾
- Save also CSV files: Yes No
- Output Folder Name:
- Email Address:
-

Footnote: *for .shp upload .zip folder containing files related to the .shp

Credits: Becattini F., Medici C. & Del Soldato M.

Acknowledgments: EGMS © European Union, Copernicus Land Monitoring Service 2022, European Environment Agency (EEA) - <https://land.copernicus.eu/gan-european/european-ground-motion-service>

Interoperative map



EGMStream App v2.0

SIDE BAR

Mail to egmstream@dst.unifi.it for receiving support and to stay up-to-date on EGMStream future releases

Data download: a free web application


EGMStream webapp

1  **EGMStream**
Browse [EGMS viewer](#) to download links

2 **European Ground Motion Service** Help Info

Place/coordinates (lat lon)

Product Archive

Click the  button to enter geographical search mode. Once in this mode, click in the map to draw a polygon representing your area of interest. Double-click to close the polygon and perform the product archive search. Once a search completes, an overview of results will appear here.

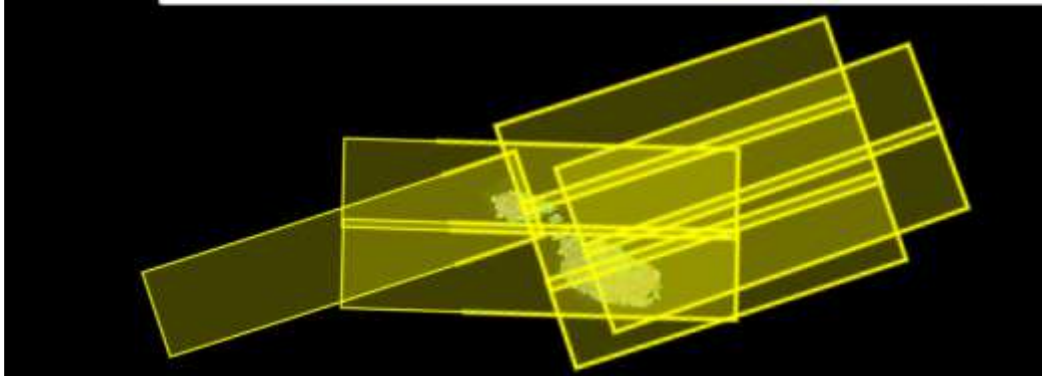
You are logged in as n00c7muu.

Archive search returned 8 results

Releaser: 2013-2021 2018-2022


Level: BASIC (Level 2A) CALIBRATED (Level 2B) ORTHO (Level 3)

[Download links](#) [Clear results](#) [View results](#)



3  **egms-archive-links.txt**

COMING SOON

 **EGMStream** [Read Me](#)

Browse [EGMS explorer](#) to download links

[Upload the txt file](#)
(egms-archive-links.txt) No file selected

Crop data on Area of Interest:

[Upload the area file](#)
(.kmz, .kml, .shp*) No file selected

Include Time Series:

Select Date Format:

Data Format:

Save also CSV files: Yes No

Output Folder Name:

Email Address:

[Convert](#)

EGMStream webapp



1 Upload the txt file (egms-archive-links.txt) No file selected

2 Crop data on Area of Interest: Yes ▾
Upload the area file (.kmz, .kml, .shp*) No file selected

3 Include Time Series: Yes ▾
Select Date Format: Dddmmyyyy ▾

4 Data Format: Shapefile (.shp) ▾

5 Save also CSV files: Yes No

6 Output Folder Name:

7 Email Address:

8

1) Browse folder location where the archive links were previously stored and select the .txt file containing the hyperlinks;

2) Optionally browse the .kml, .kmz or .zip (for .shp) file containing the Area of Interest (Aoi) on which you want to clip out your data;

3) Adjust data storage settings according to the presence or absence of time series, you can choose between the date format Dddmmyyyy or Dyyyymmdd;

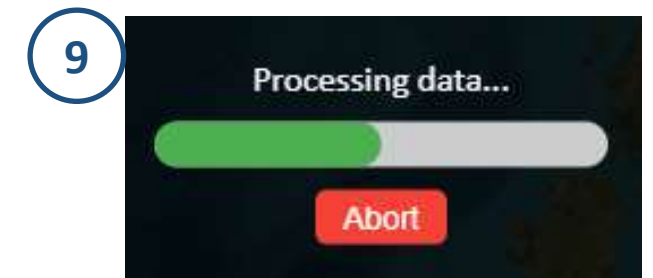
4) Adjust the data storage settings according to the desired data format, you can choose between Shapefile (.shp), Json (.json) or GeoPackage (.gpkg) format;

5) Select whether you also want to receive the original .csv files, in addition to the files converted to .shp/.gpkg;

6) Choose the name of the folder that the EGMStream app will create as a .zip and send by e-mail to the user at the end of data processing, with inside the products selected in step 4 and 5;

7) Enter the e-mail address to which you want to receive the data at the end of processing;

8) Run conversion by triggering the 'Convert' action button;



EGMStream webapp

COMING SOON

EGMStream Read Me

Browse [EGMS explorer](#) to download links

Upload the txt file [egms-archive-links.txt] egms-archive-links (1).txt

Crop data on Area of Interest: Yes No

Upload the area file [kml, kmz, shp*] Aoi Campi Flegrei.kmz

Include Time Series: No Yes

Data Format:

Save also CSV files: Yes No

Output Folder Name:

Email Address:

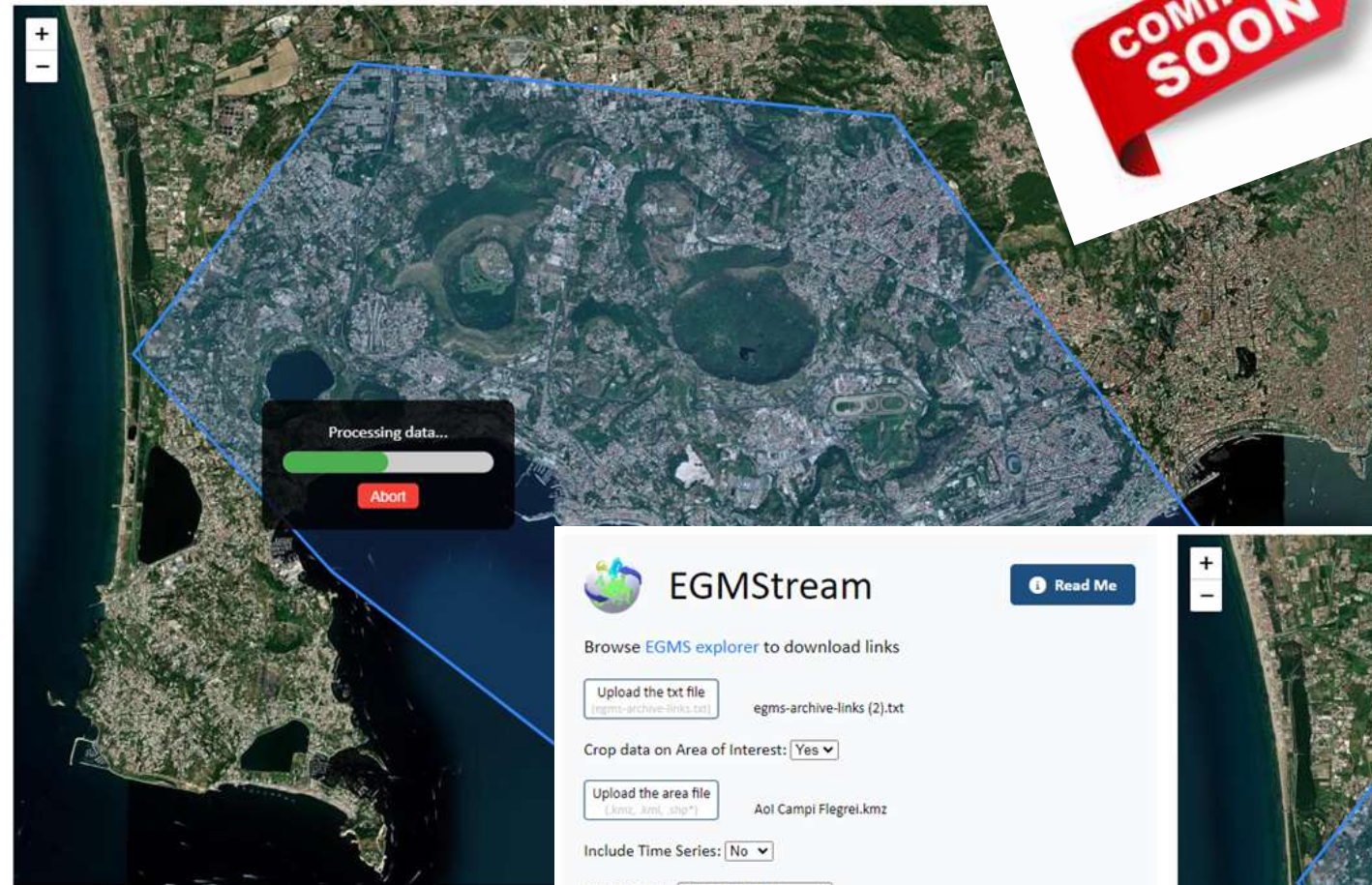
Convert

*for .shp upload .zip folder containing files related to the .shp

Credits
Becattini F., Medici C. & Del Soldato M.

Acknowledgments
EGMS © European Union, Copernicus Land Monitoring Service 2022, European Environment Agency (EEA) - <https://land.copernicus.eu/pan-european/european-ground-motion-service>

EGMStream App v2.0



Mail to egmstream@dst.unifi.it for receiving support and to stay

EGMStream Read Me

Browse [EGMS explorer](#) to download links

Upload the txt file [egms-archive-links.txt] egms-archive-links (2).txt

Crop data on Area of Interest: Yes No

Upload the area file [kml, kmz, shp*] Aoi Campi Flegrei.kmz

Include Time Series: No Yes

Data Format:

Save also CSV files: Yes No

Output Folder Name:

Email Address:

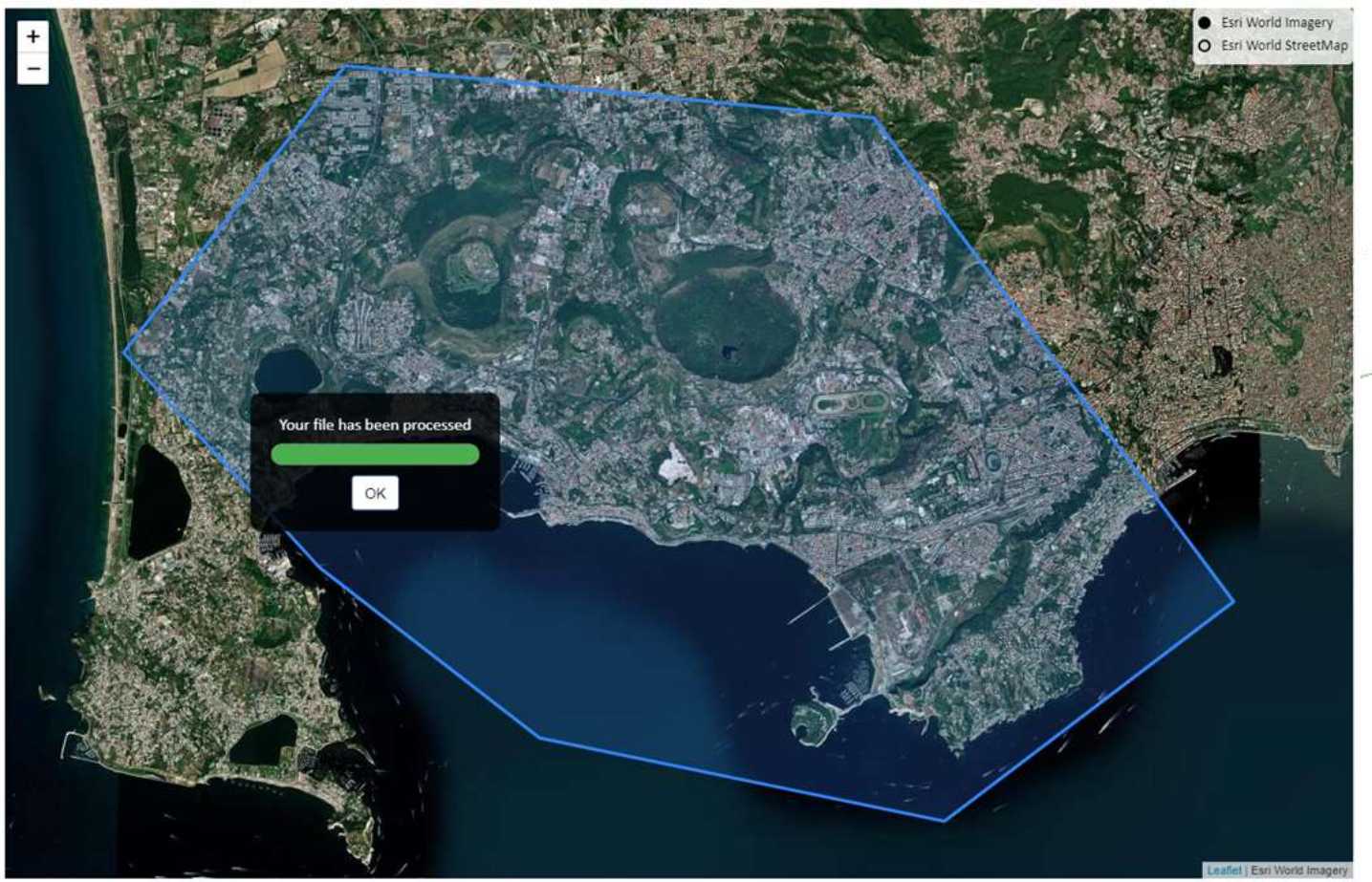
Convert

*for .shp upload .zip folder containing files related to the .shp

Credits
Becattini F., Medici C. & Del Soldato M.

Acknowledgments
EGMS © European Union, Copernicus Land Monitoring Service 2022, European Environment Agency (EEA) - <https://land.copernicus.eu/pan-european/european-ground-motion-service>

EGMStream App v2.0



Mail to egmstream@dst.unifi.it for receiving support and to stay up-to-date on EGMStream future releases



EGMStream webapp - final results

COMING SOON

EGMS data Posta in arrivo x



egmstream@dst.unifi.it

a me

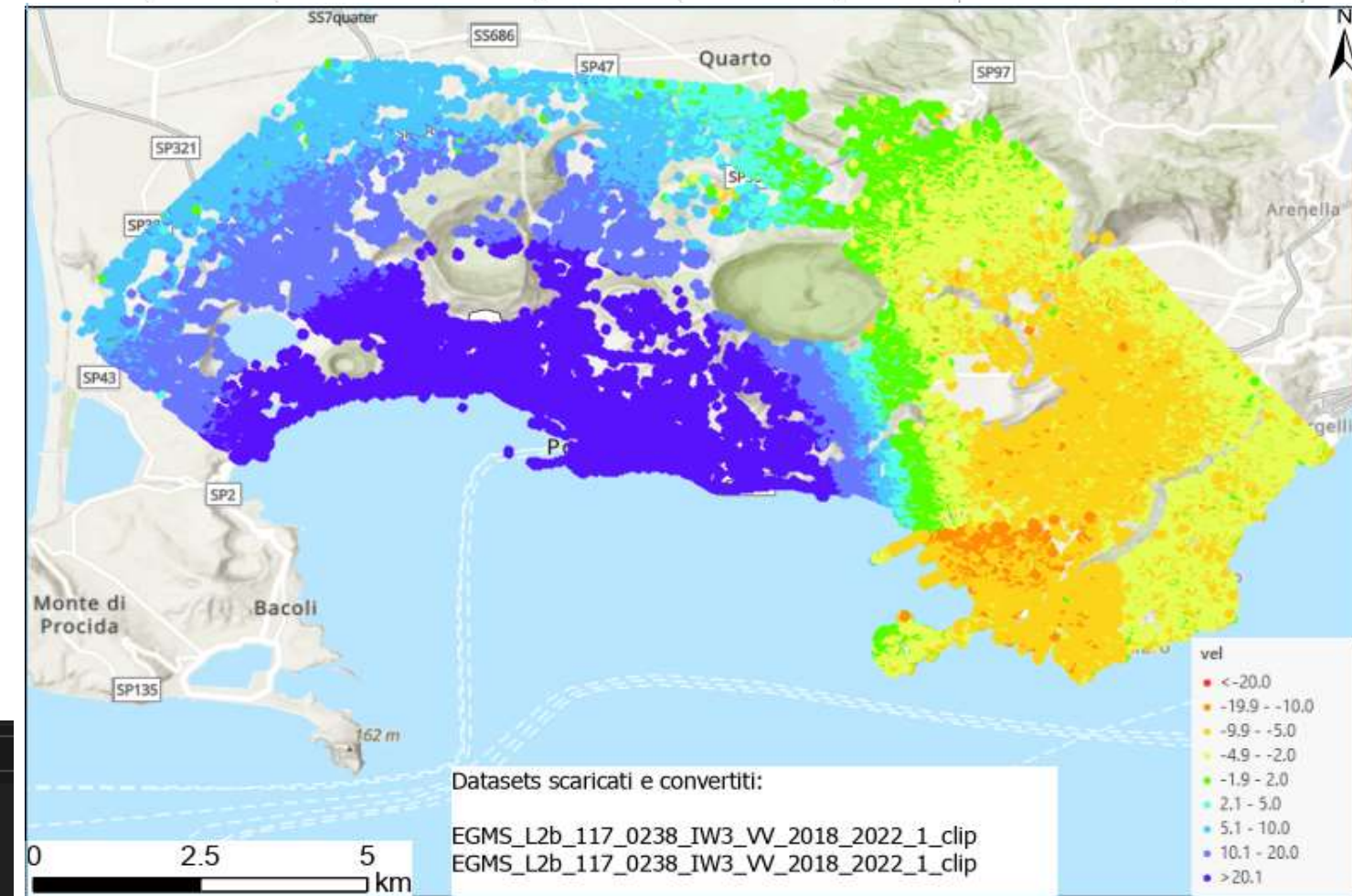
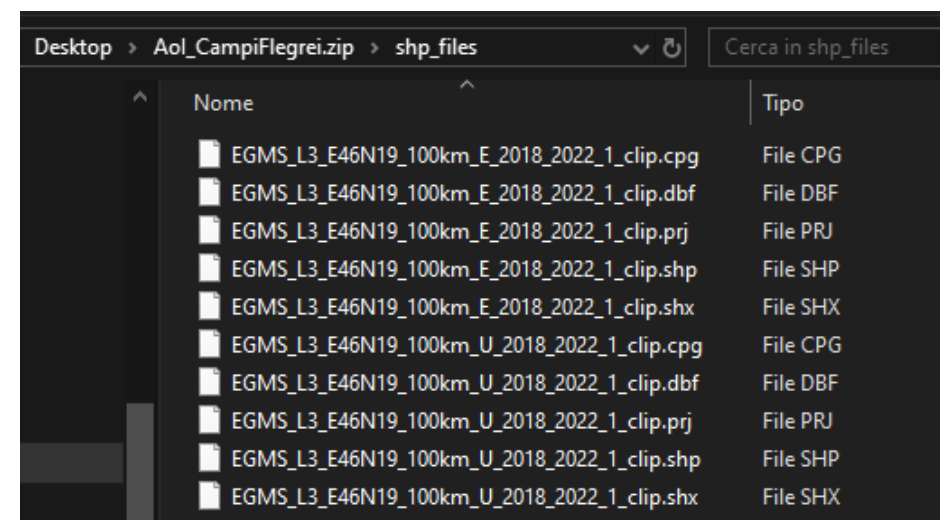
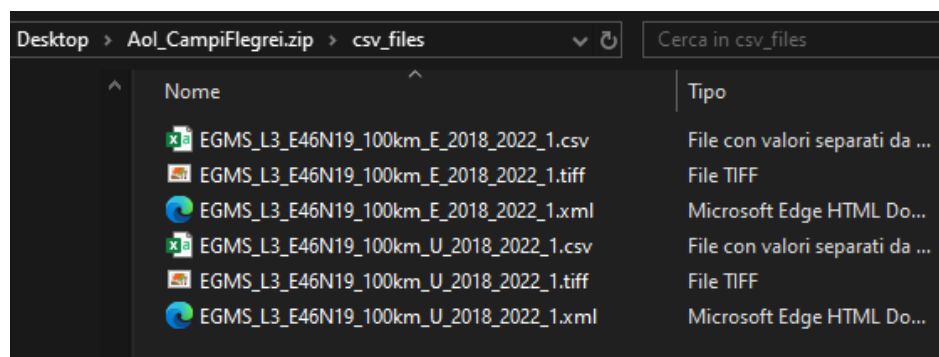
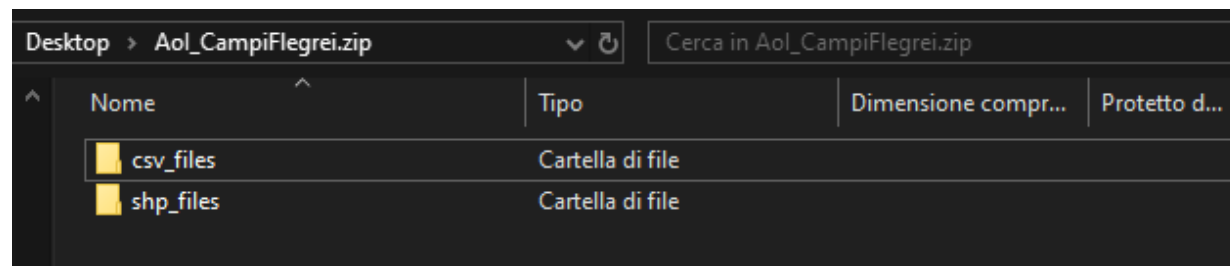
Your files have been processed. You can download it from the following link: http://localhost:5000/download/Campi_Flegrei.zip

Please consider that the data will expire in 3 days.

The EGMStream team thank you for using our service.

Best regards,

EGMStream team





THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”

