Satellite radar interferometry for mapping and monitoring ground instabilities

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Matteo Del Soldato

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Who I am

Federico RASPINI

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- 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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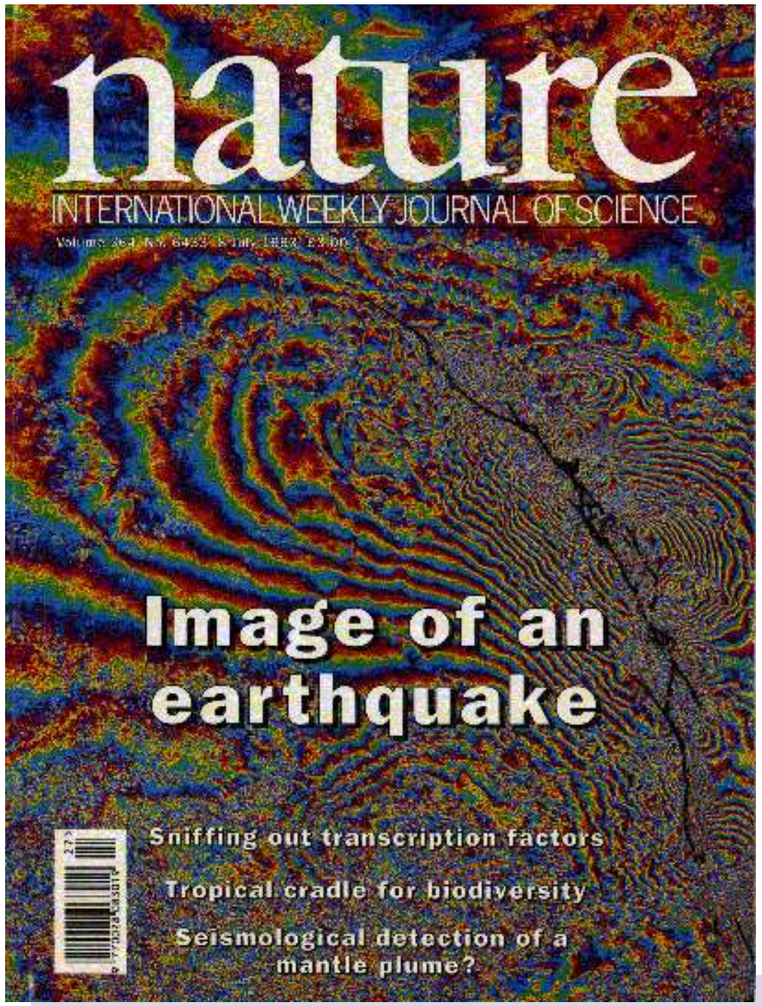
The displacement field of the Landers earthquake mapped by radar interferometry

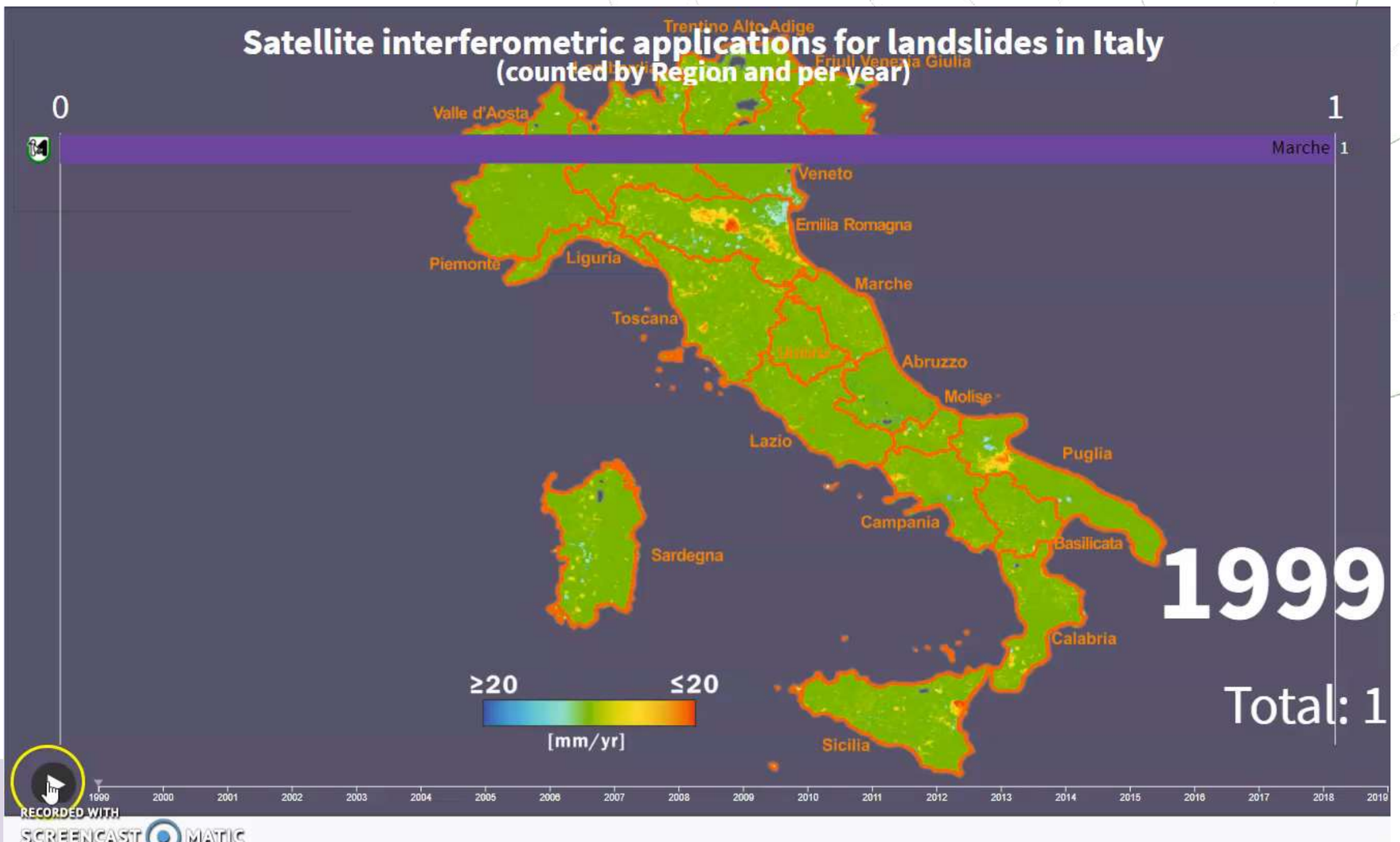
Didier Massonnet, Marc Rossi, Cesar Carmona, Frederic Adragna, Gilles Pletzner & Kurt Feigl



Insar evolution and spreading

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



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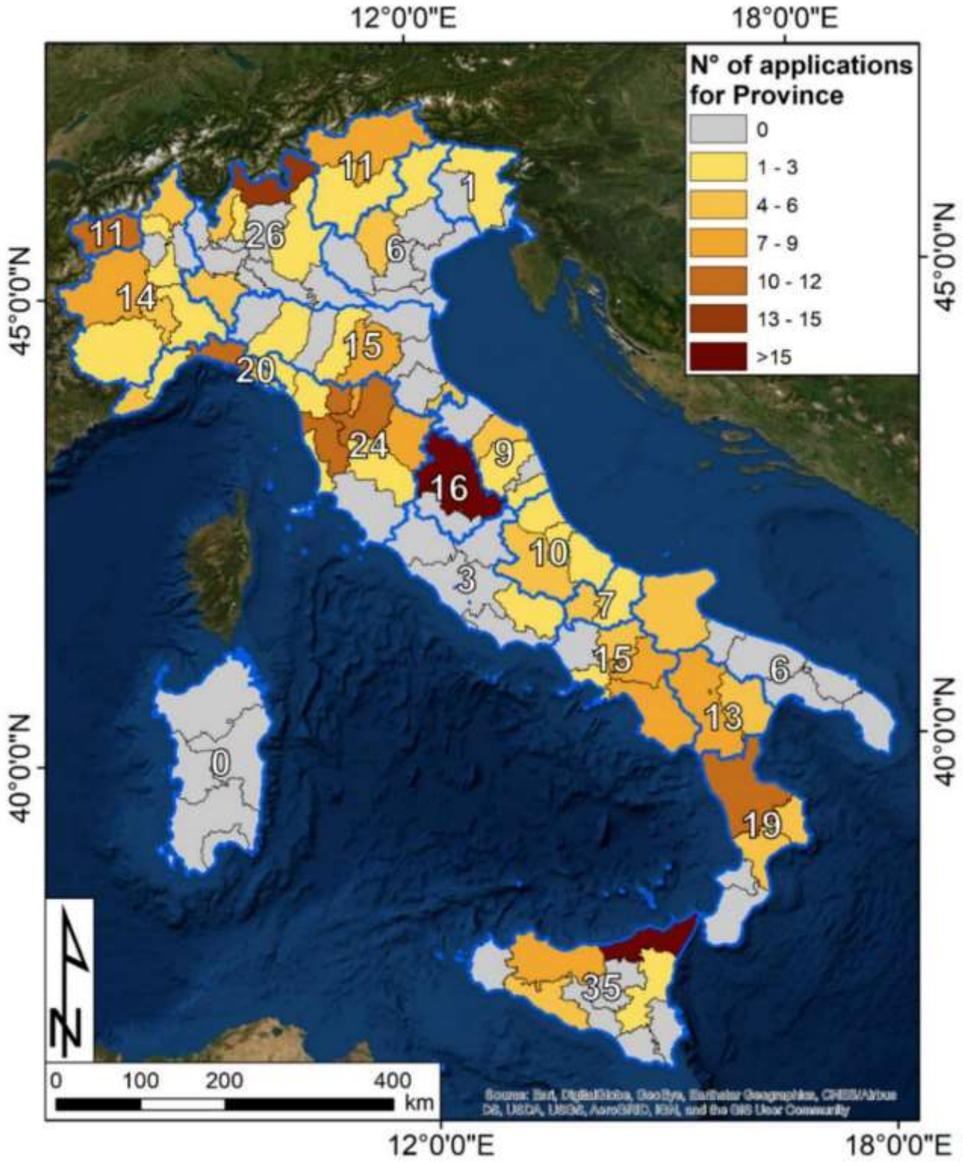

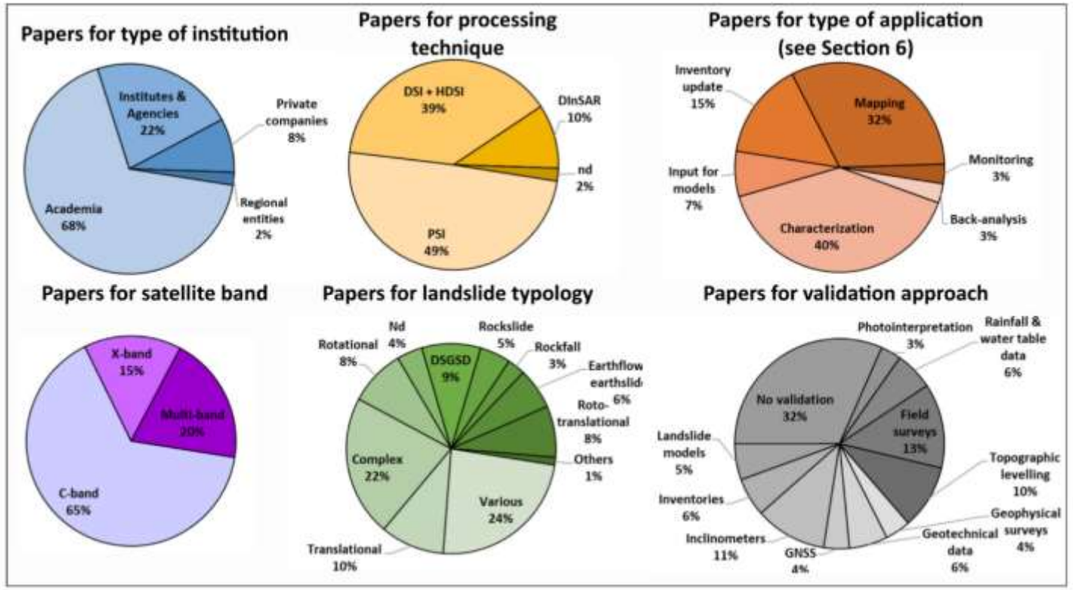

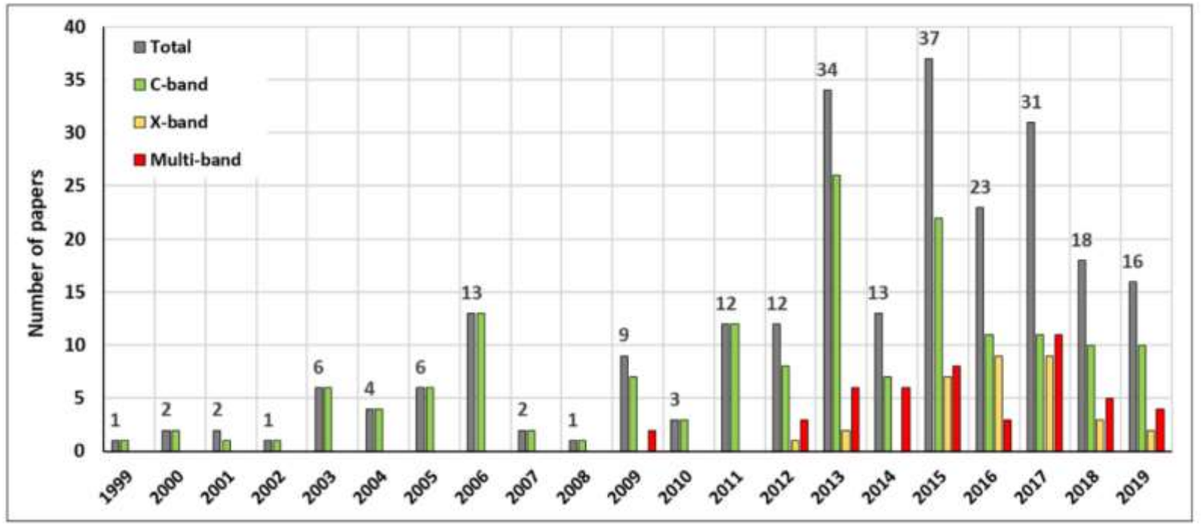

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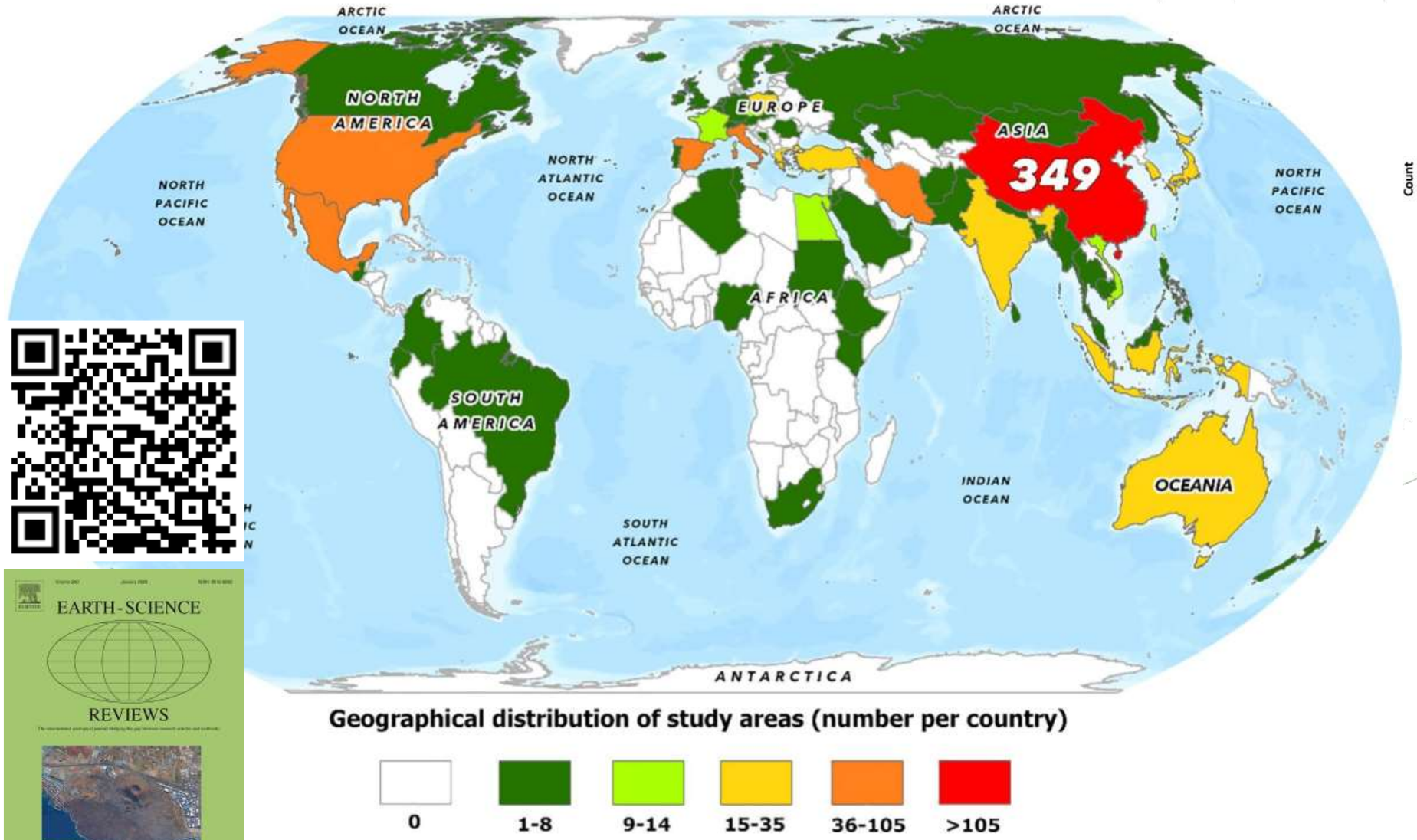

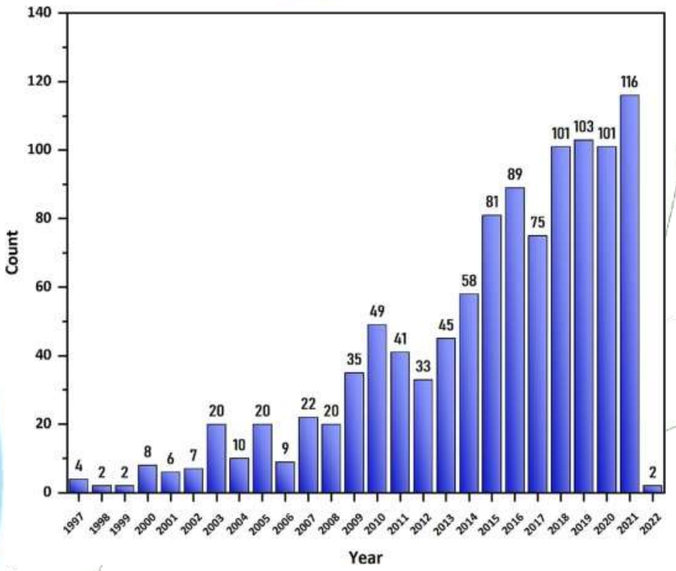

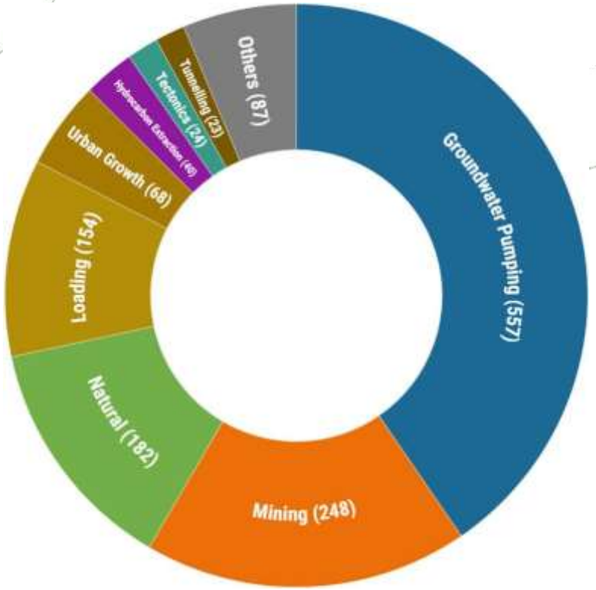

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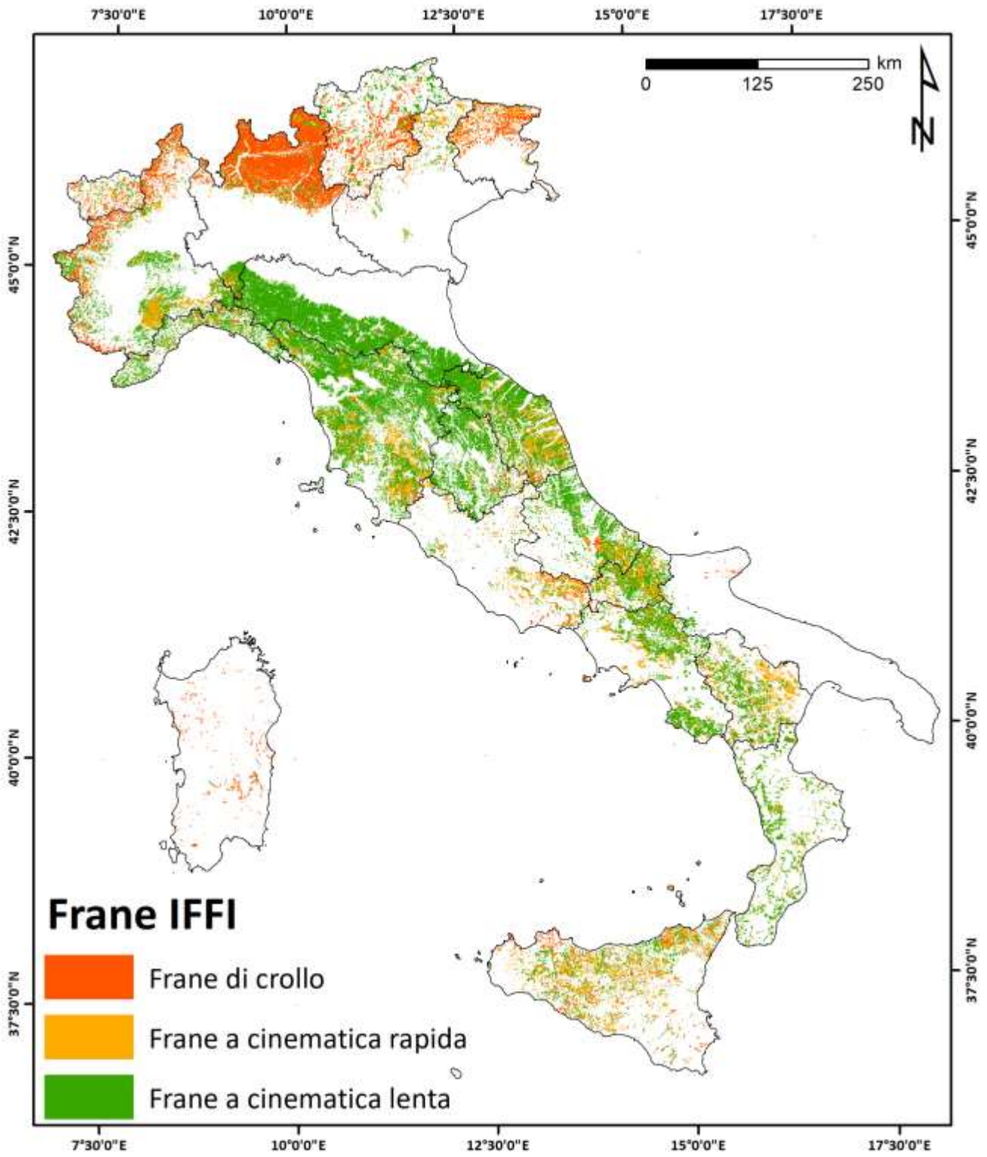


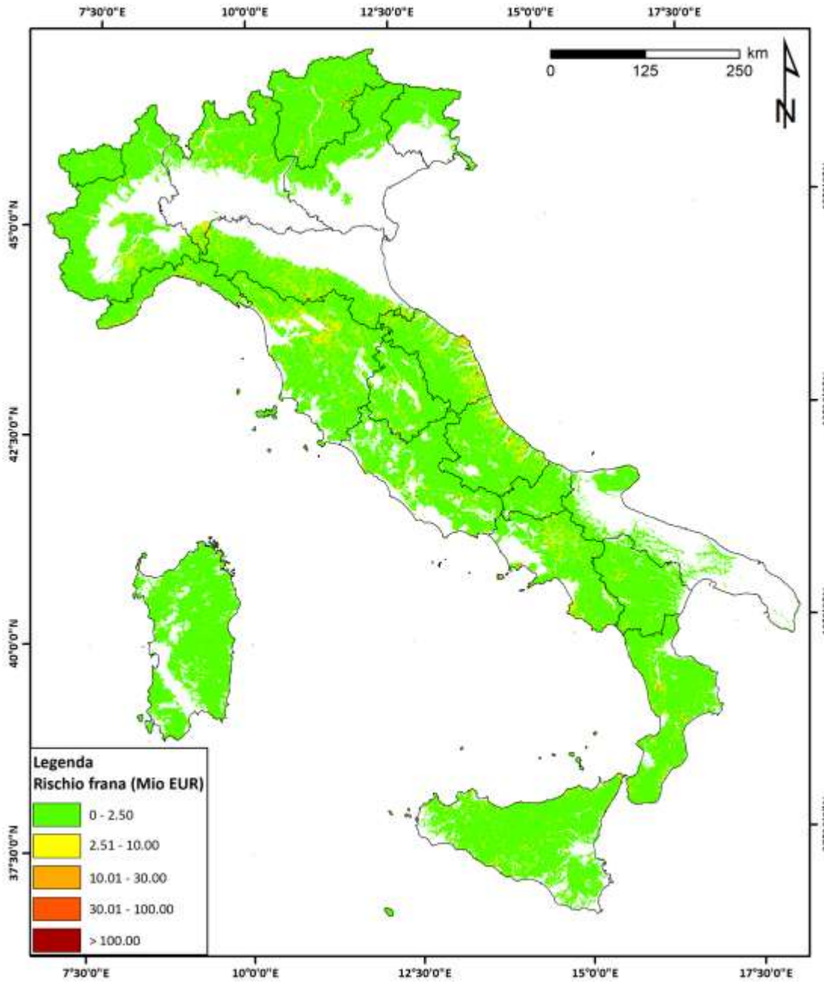
Landslide risk areas
about 2 millions of mapped landslides
about 10.000 areas at very high risk

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

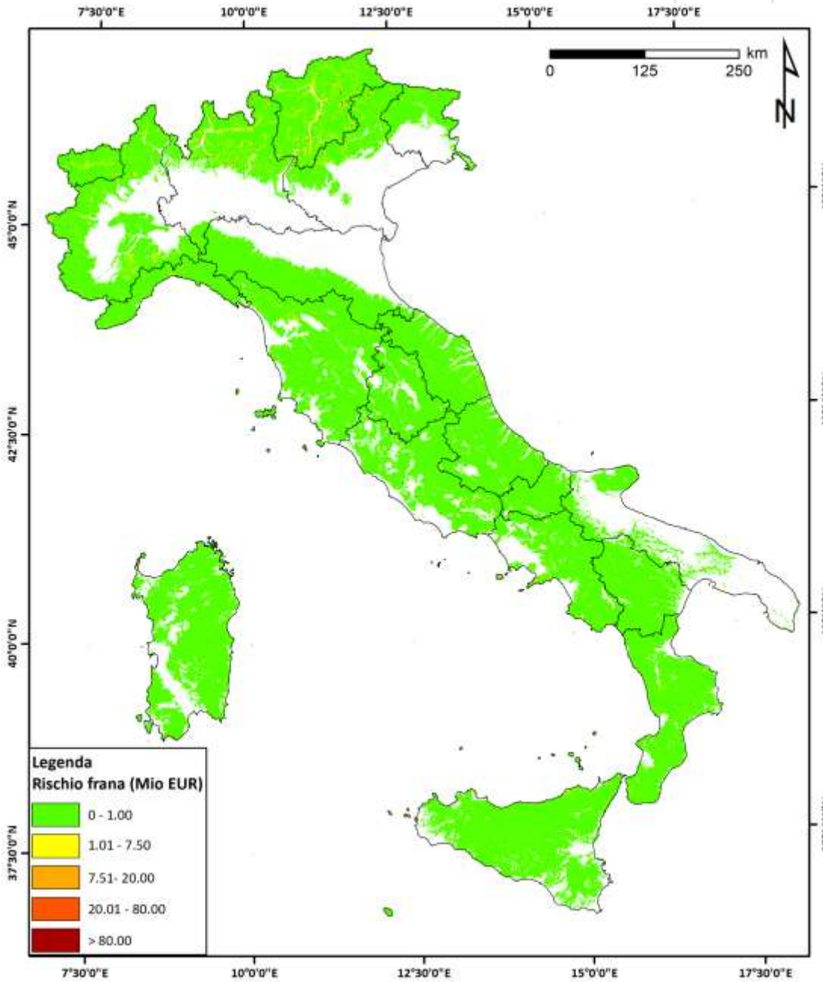
Urban areas at risk
1.306 areas to be stabilized
323 to be relocated
77 billions of potential loss

Introduction



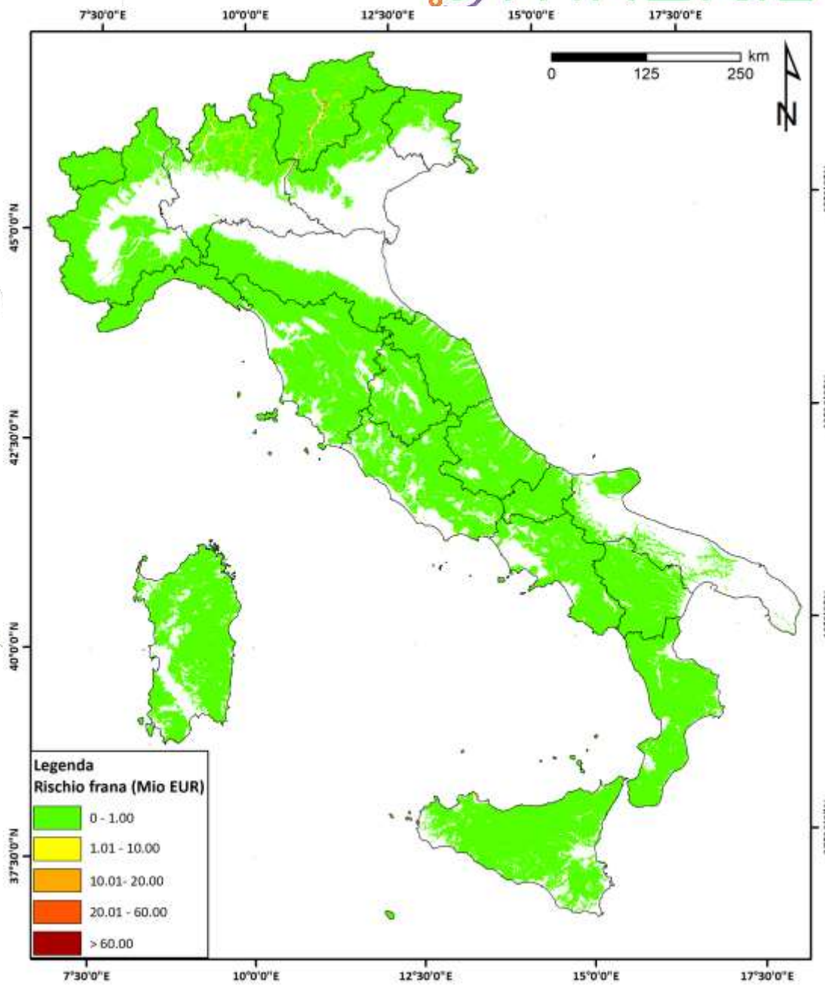
Slow-moving landslide

Highest risk (€): 269 mln
Total risk (€): 112 mld
Mean risk (1km^2 cell) (€): 521 K



Rapid-moving landslide

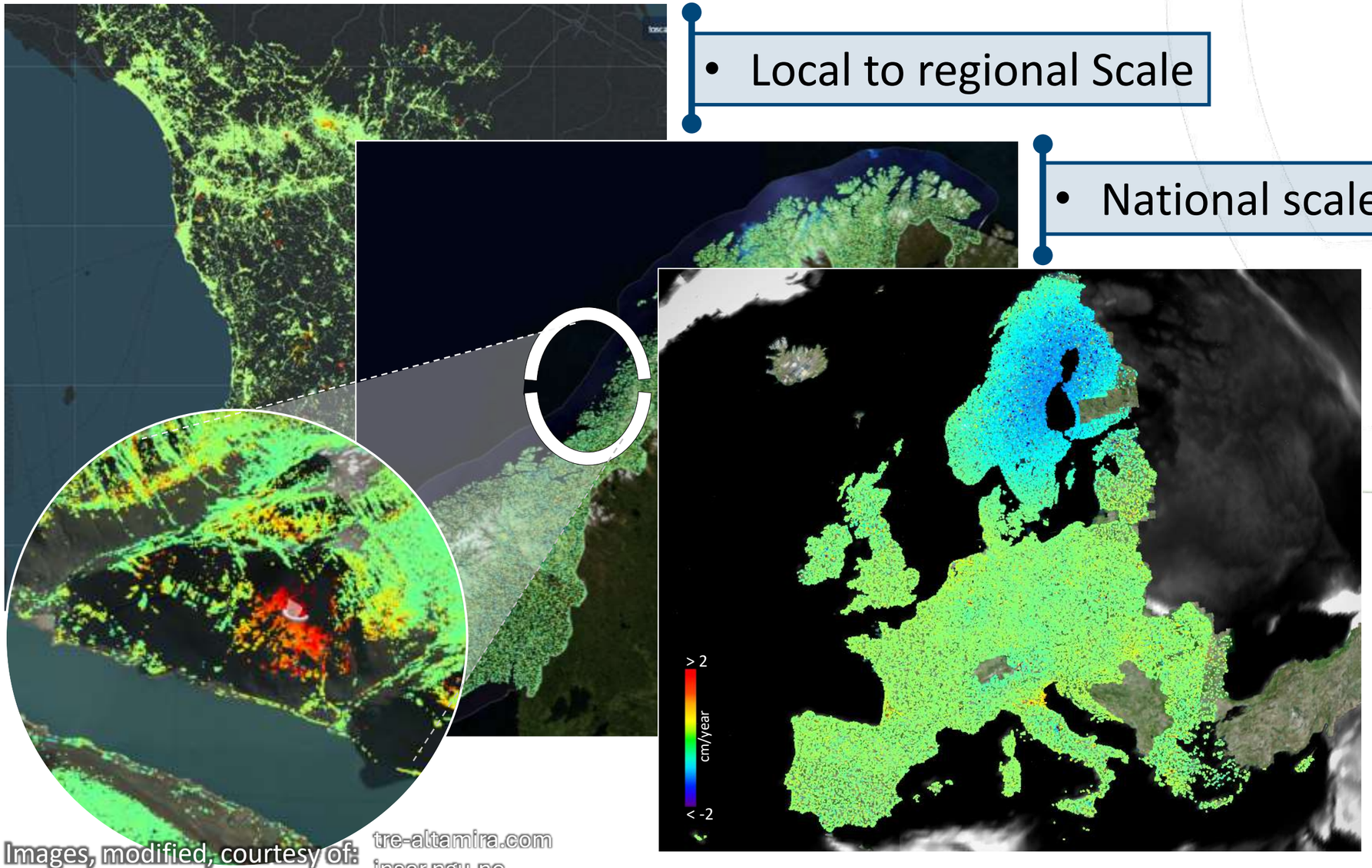
Highest risk (€): 240 mln
Total risk (€): 30 mld
Mean risk (1km^2 cell) (€): 138 K



Rockfall

Highest risk (€): 438 mln
Total risk (€): 21 mld
Mean risk (1km^2 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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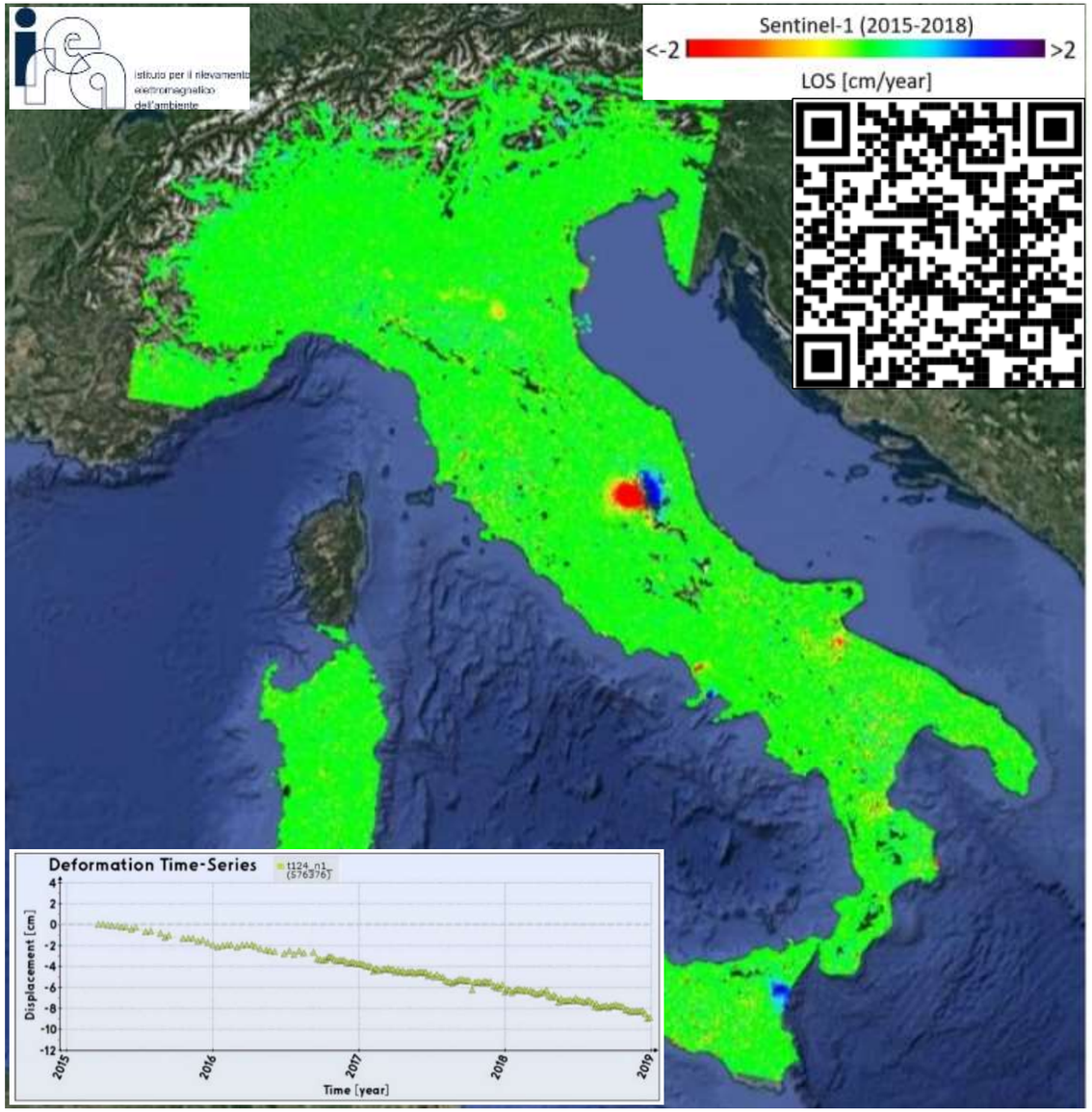
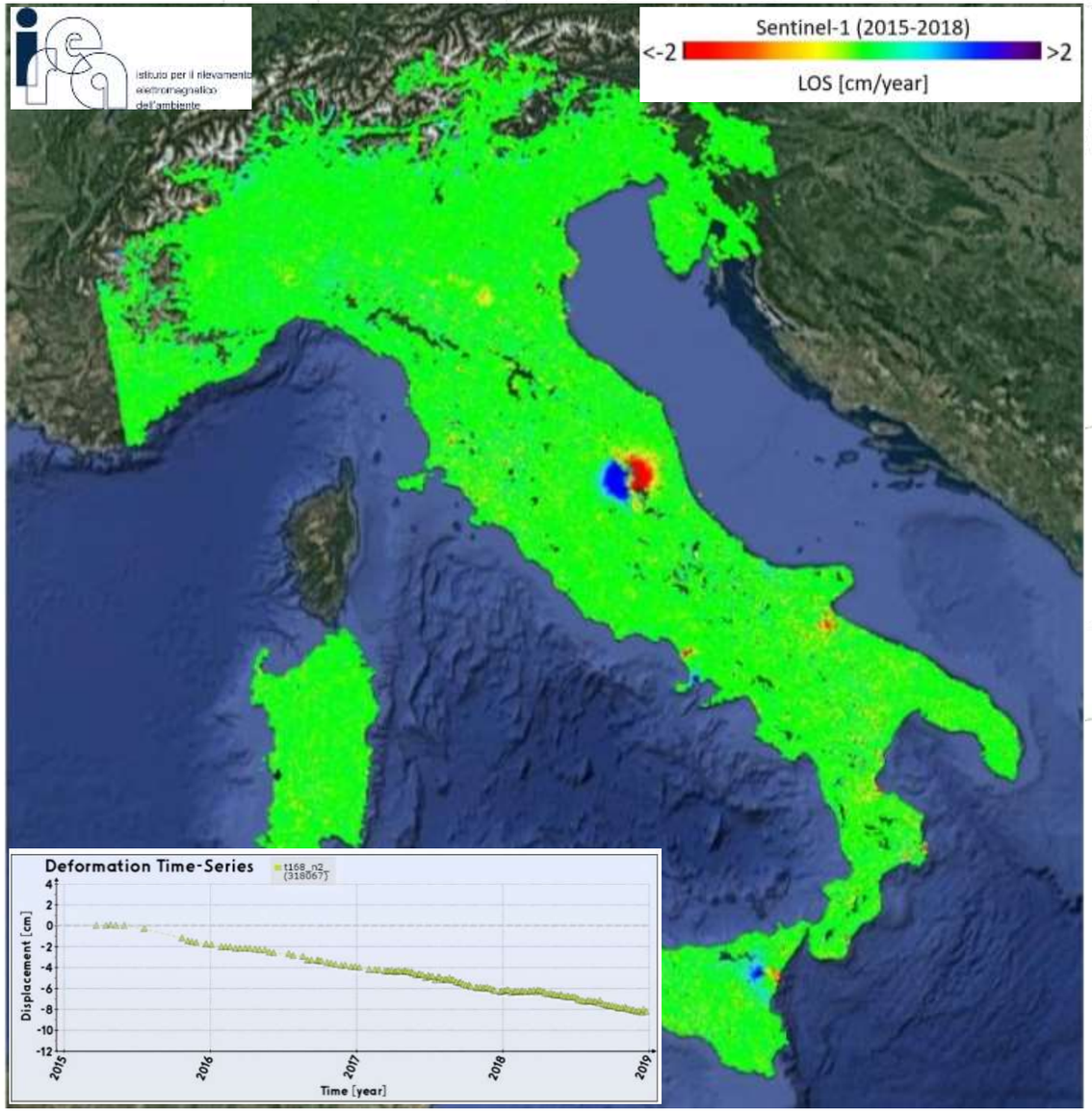
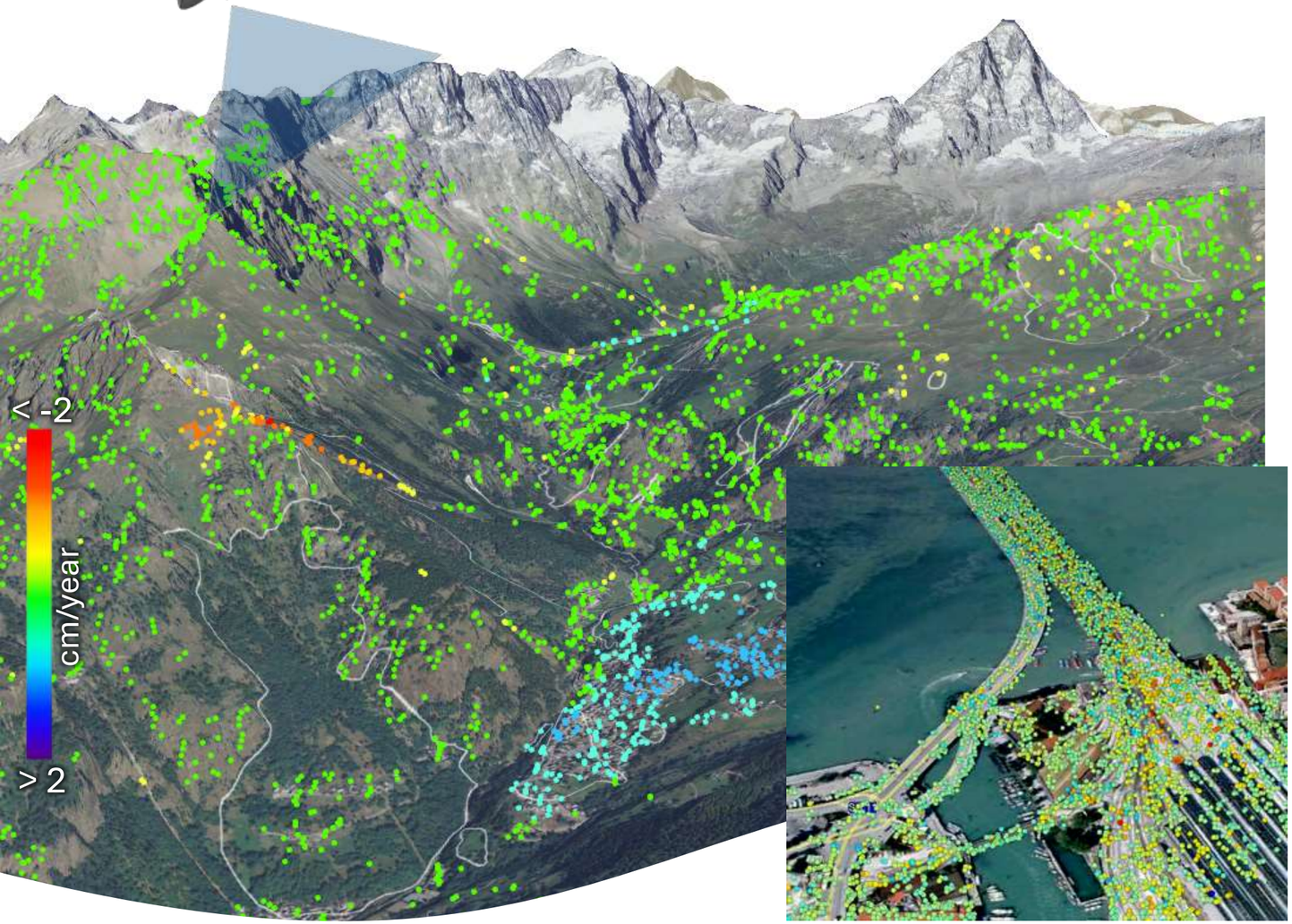
Satellite Interferometry

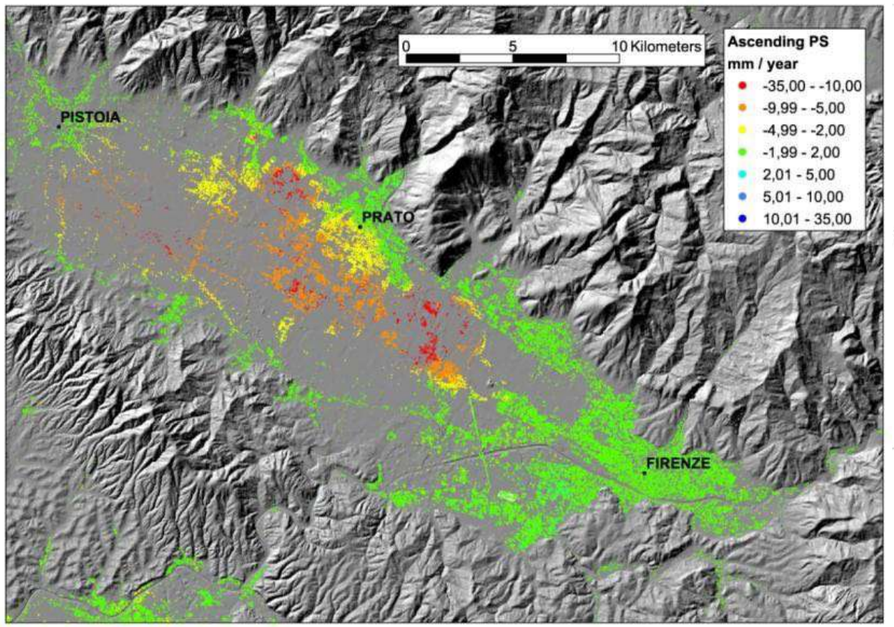


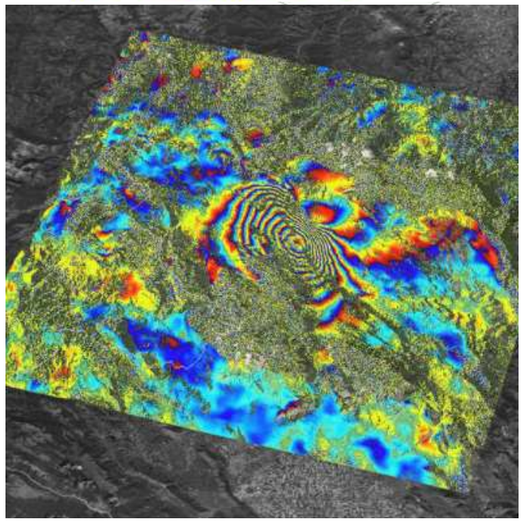


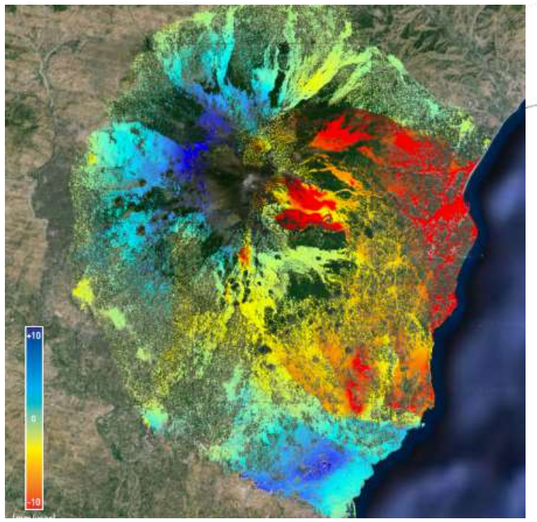
Output products: maps and time series

Satellite Interferometry









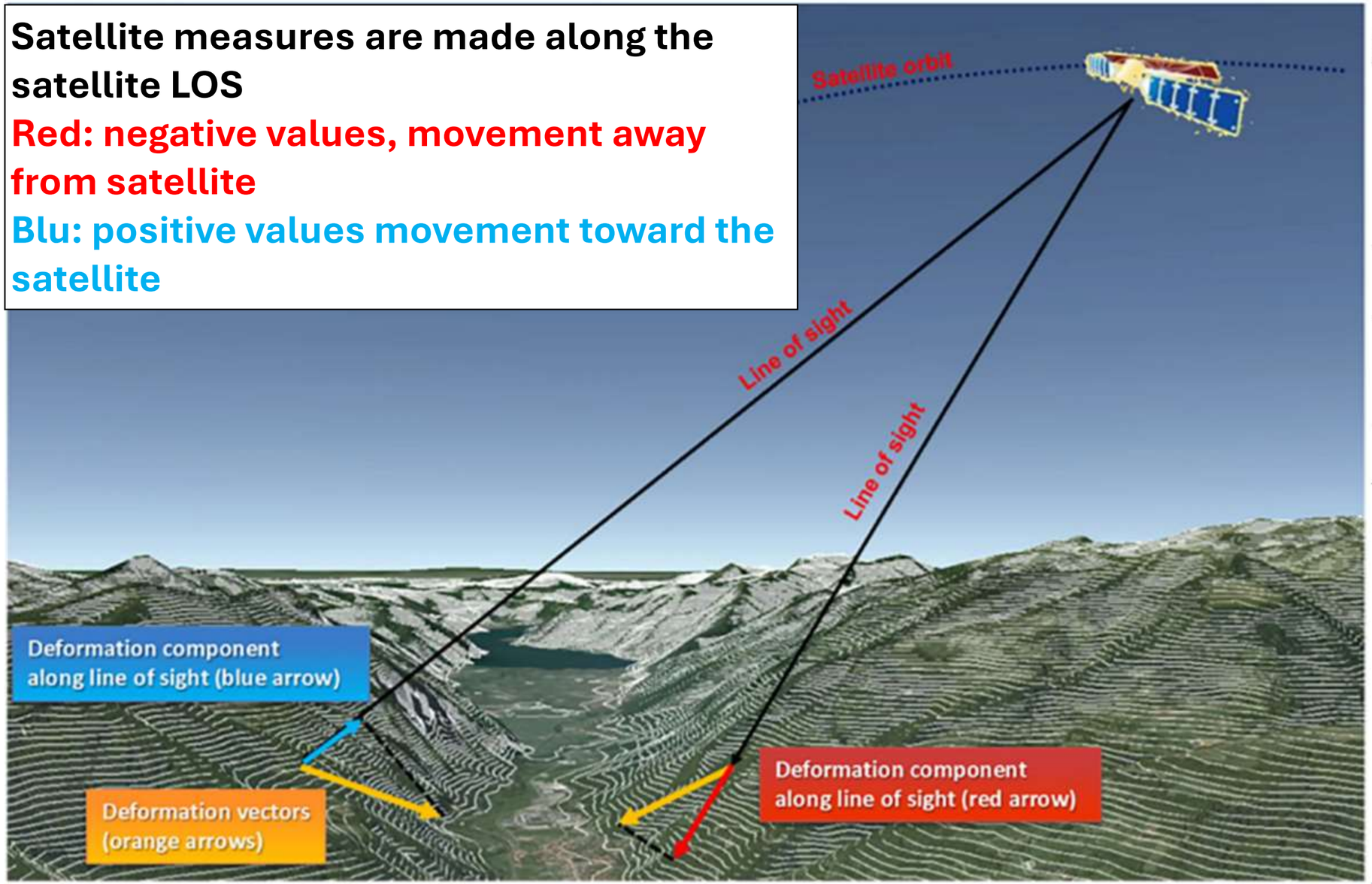
What is satellite InSAR and how it can be used for?

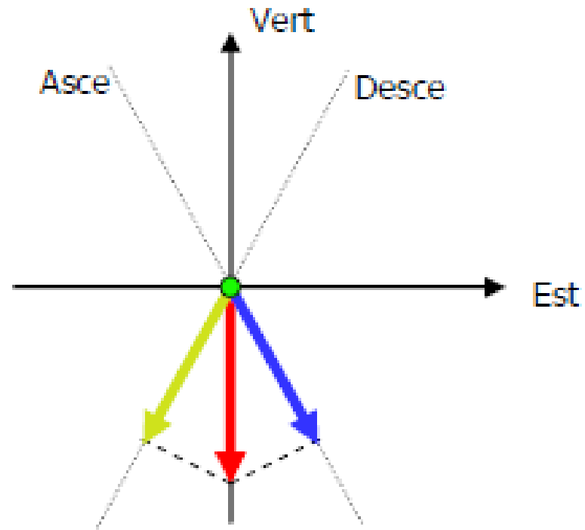
Satellite Interferometry

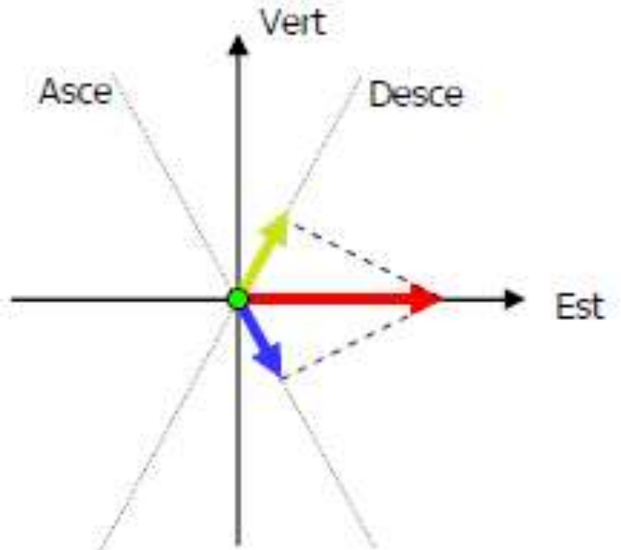
Satellite measures are made along the satellite LOS

Red: negative values, movement away from satellite

Blu: positive values movement toward the satellite







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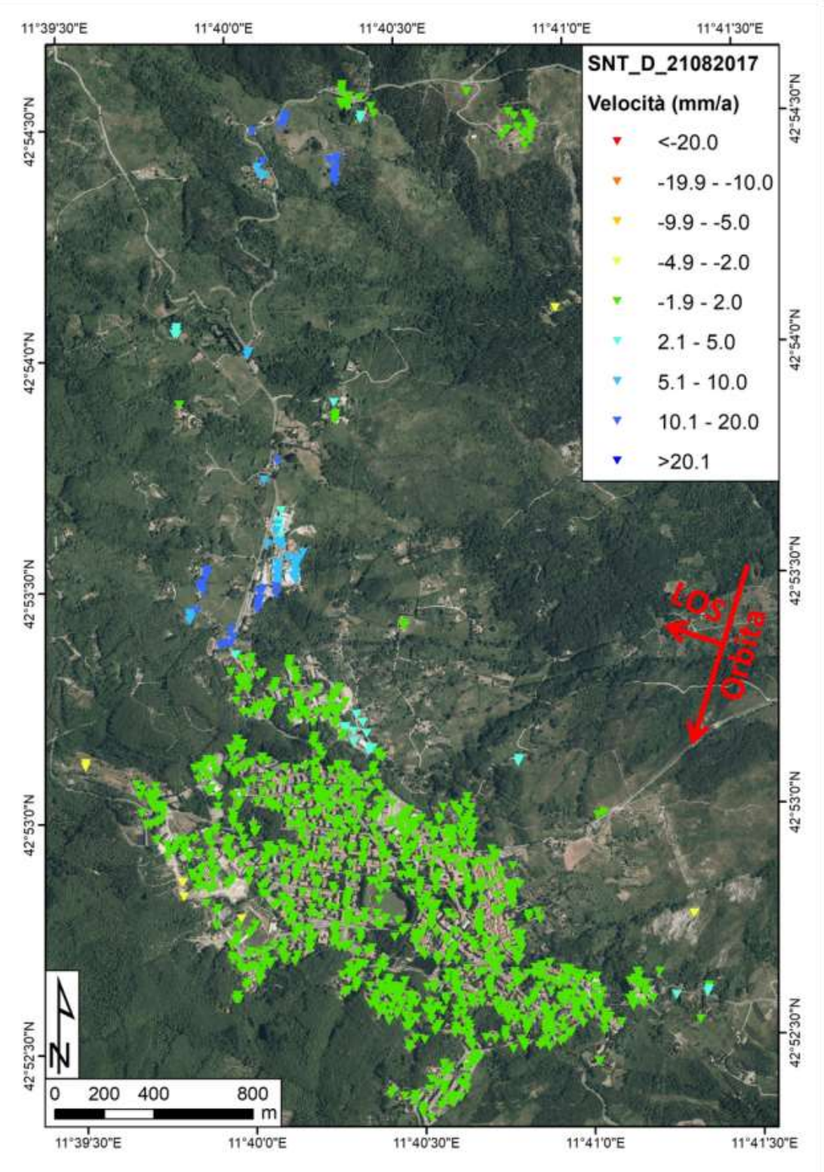
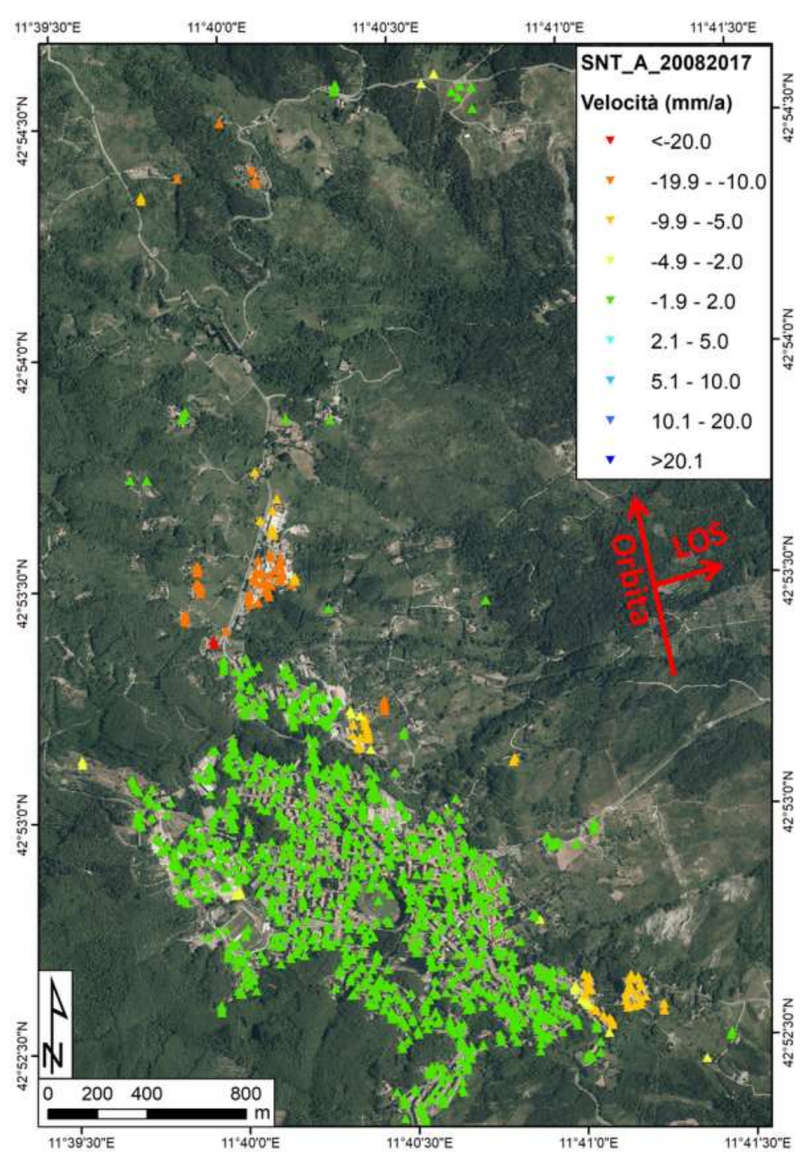
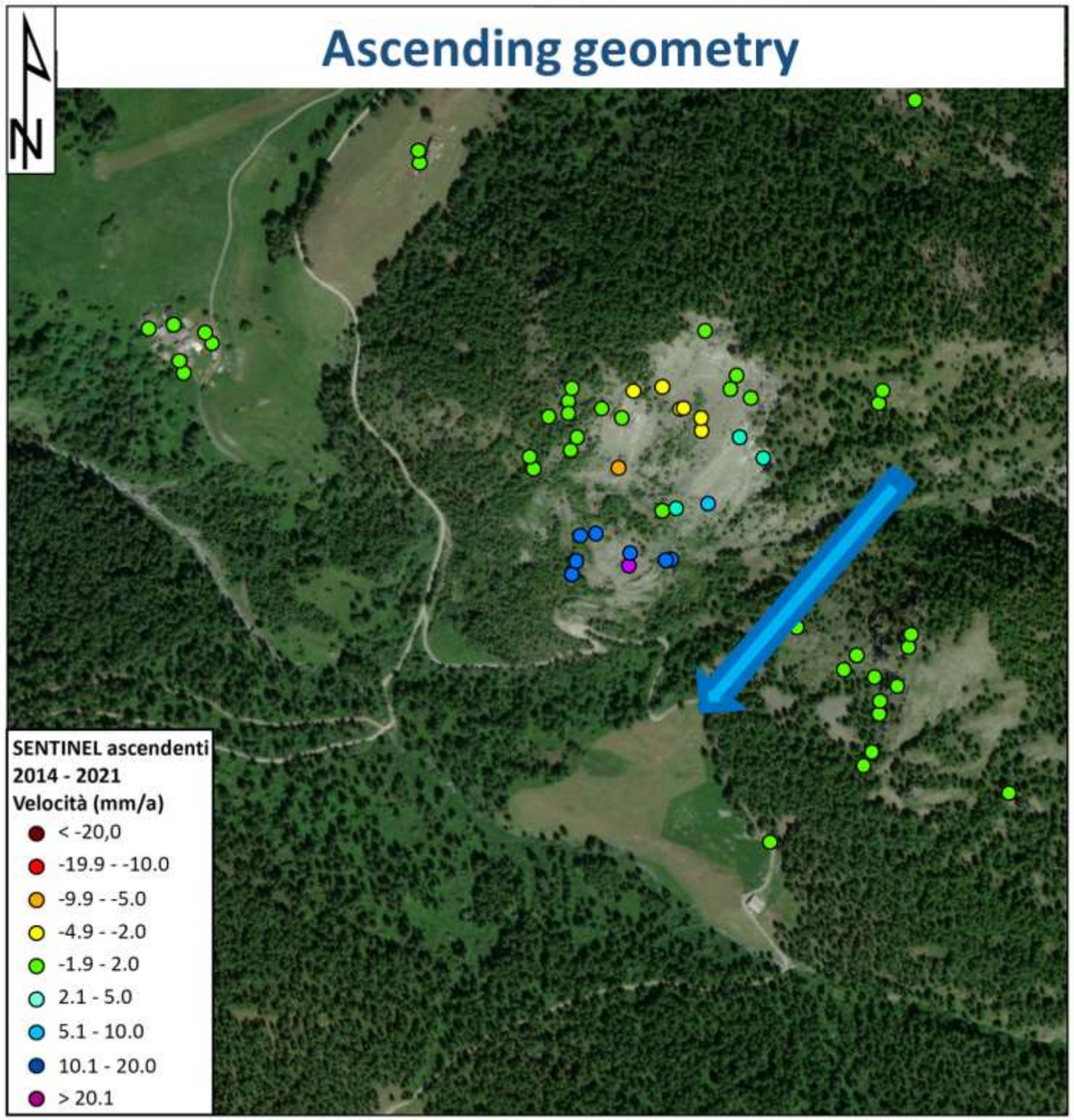


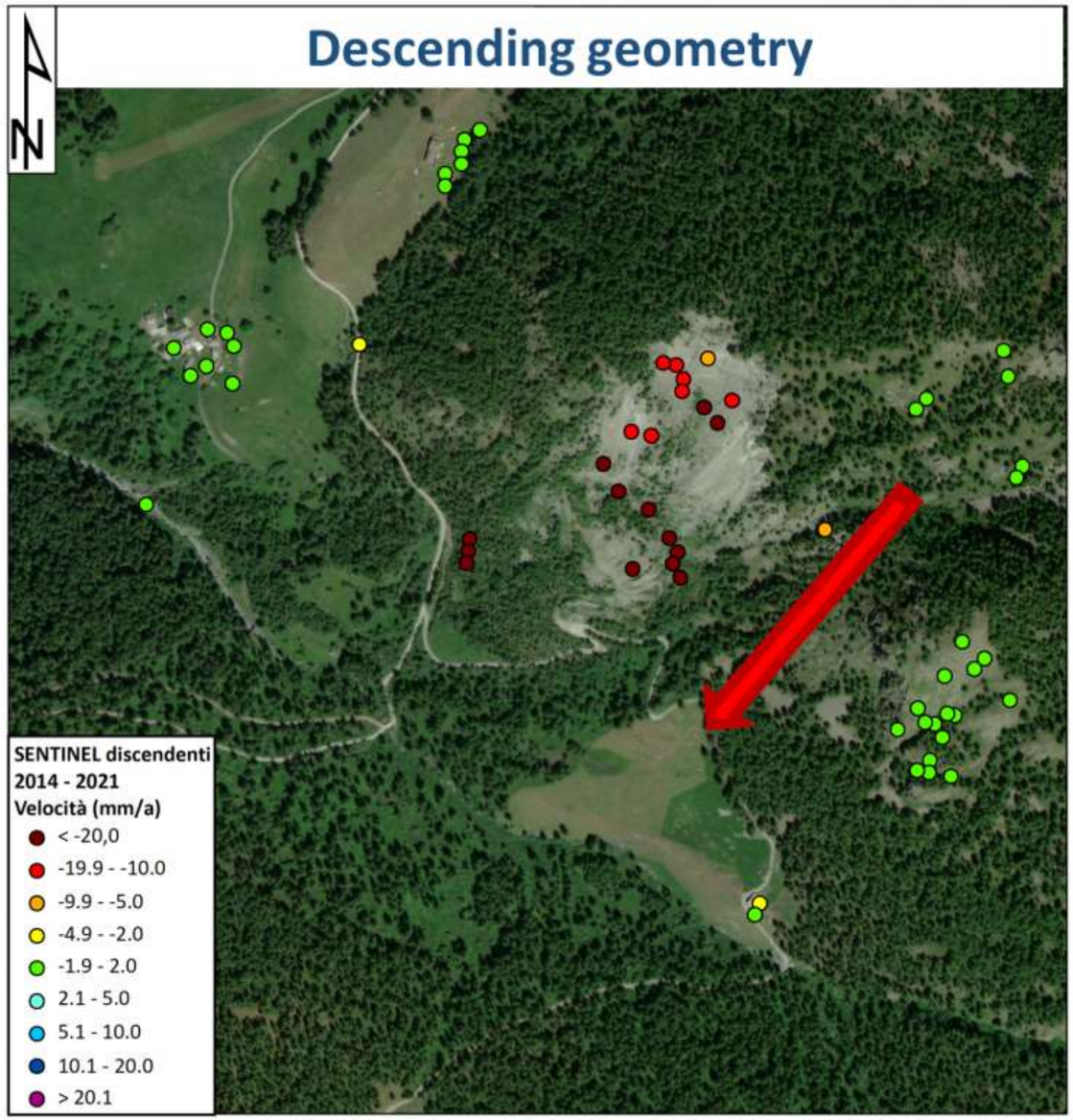


Output products: relative measurements

Satellite Interferometry

Satellite Interferometry





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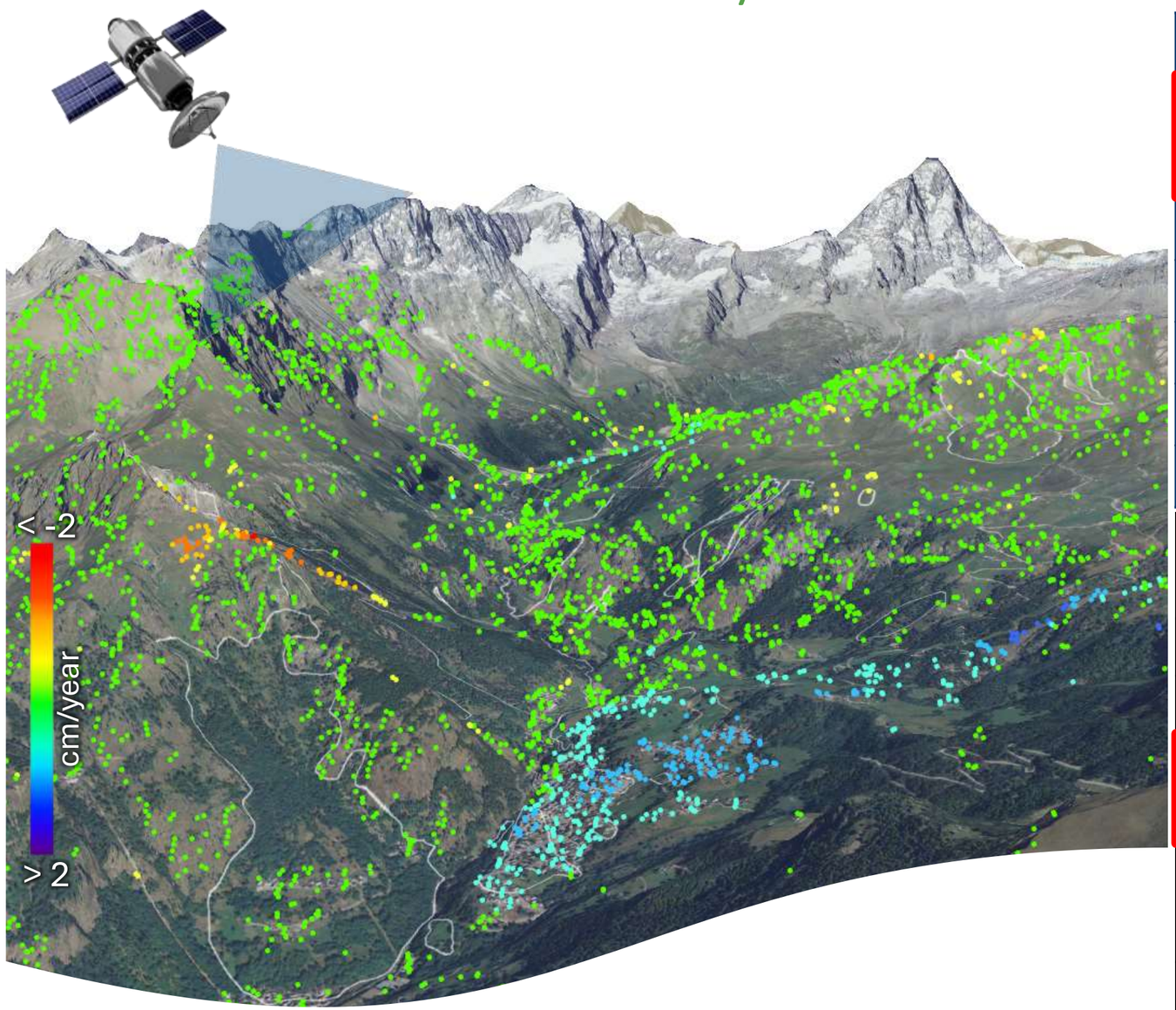
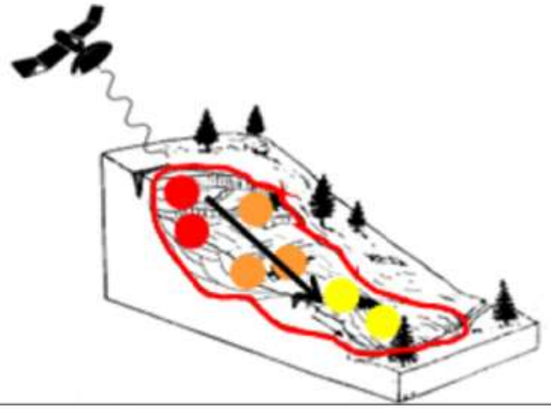


Class	Velocity *(Cruden & Varnes, 1996)*
Extremely slow	< 16 mm/yr
Very slow	0,016 – 1,6 m/yr
Slow	1,6 m/yr - 13 m/month
Moderate	13 m/month – 1,8 m/h
Rapid	1,8 m/h - 3 m/min
Very rapid	3 m/min - 5 m/s
Extremely rapid	> 5 m/s

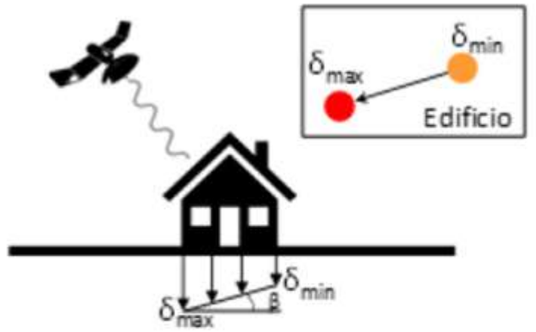
Type of movement	Type of material	Interferometry applicability
Fall	*Rock/debris/earth*	*NO*
Toppling	*Rock/debris/earth*	*NO*
Slide	*Debris/earth*	*YES*
	Rock	*YES*
Flow	*Earth*	*Partially*
	Debris	*NO*
Lateral spreading	*Rock/debris/earth*	*Partially*

Satellite Interferometry

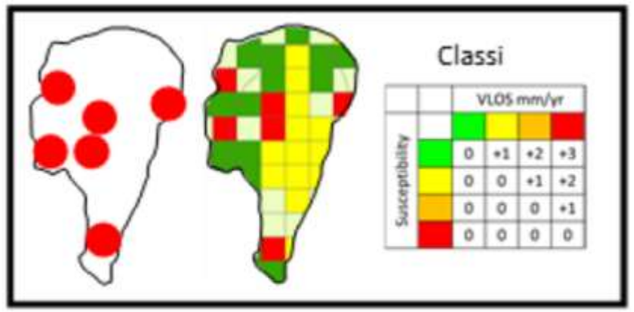


Local scale monitoring for single landslide

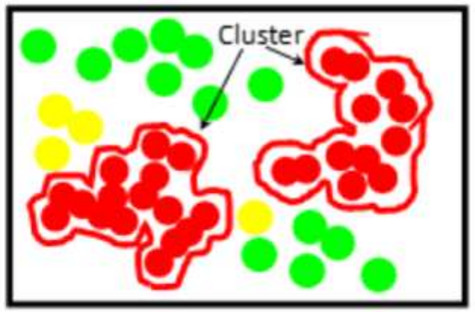
Updating of landslide inventory



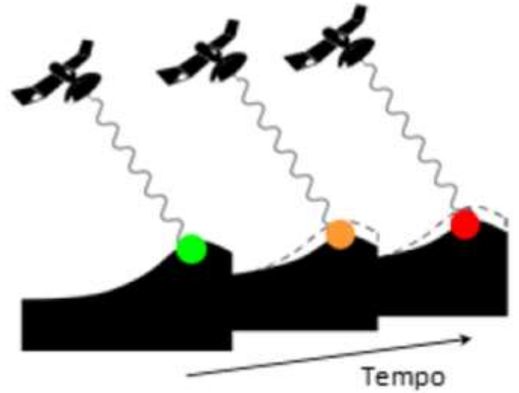
Analysis of differential settlement



Landslide intensity assesment
Landslide susceptiblity



Hot spot mapping at wide scale



Continuous monitoring.
Anomalies detection

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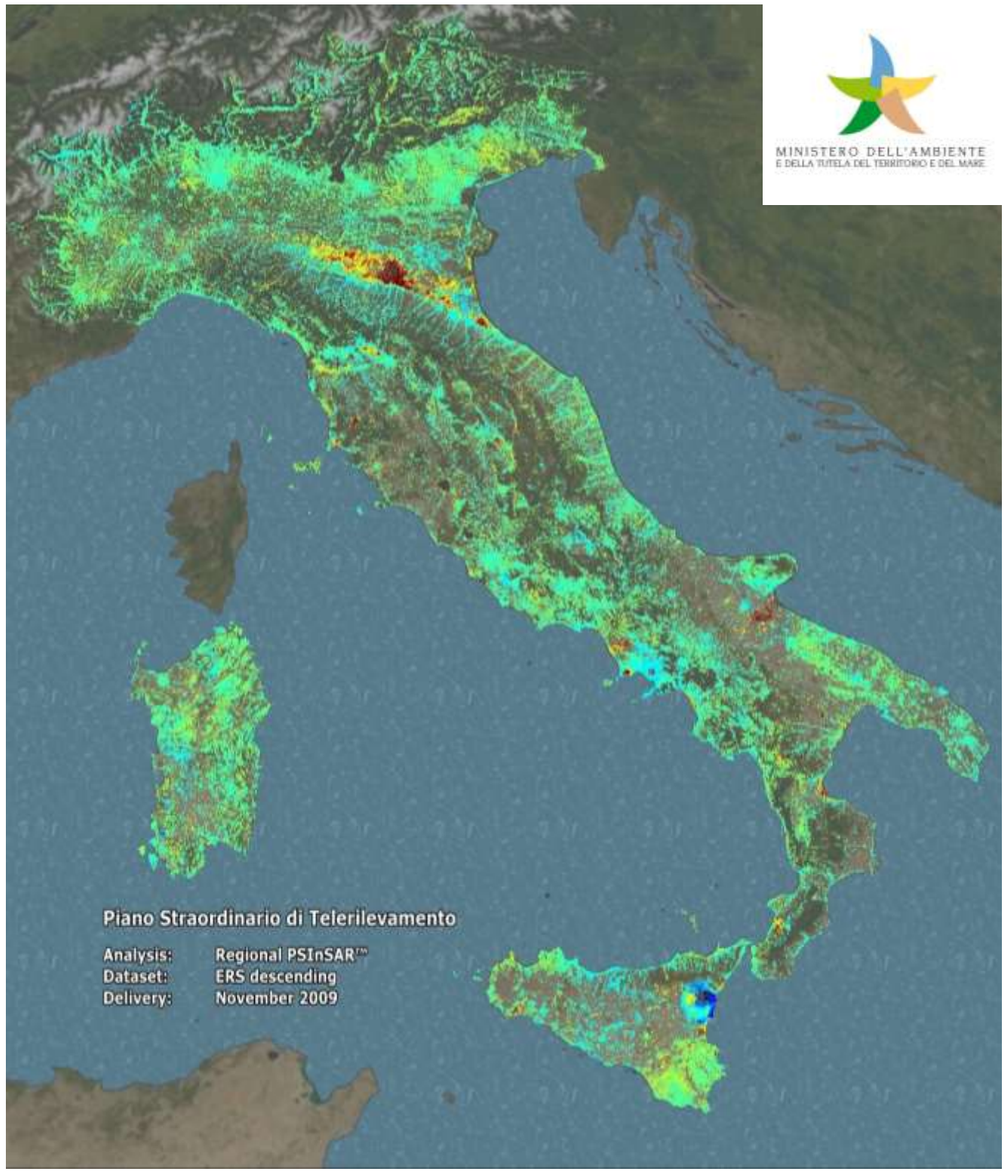
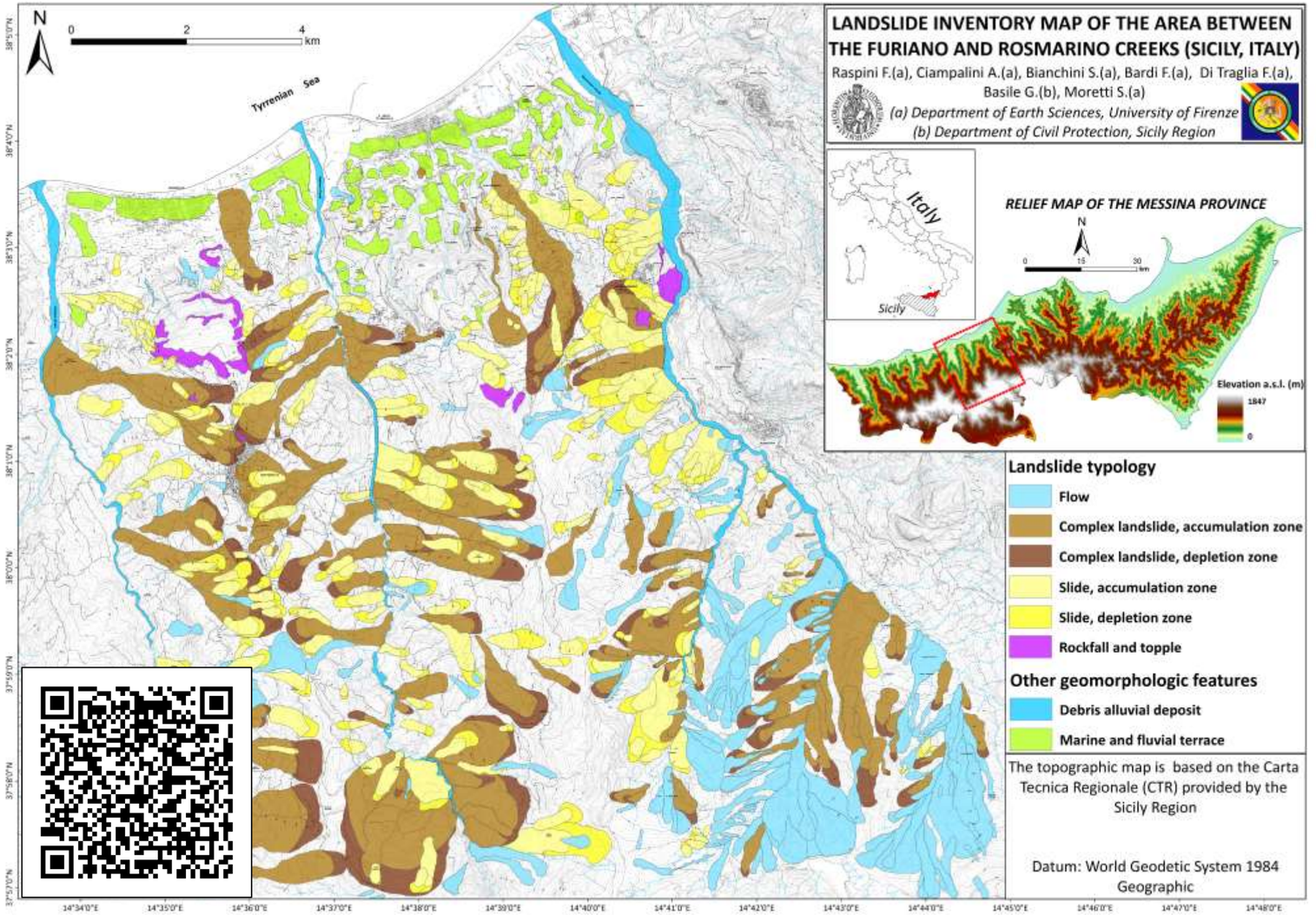


http://www.pcn.minambiente.it/viewer/

The past: archive elaboration

Italy

InSAR data for the update of regional landslide inventory maps



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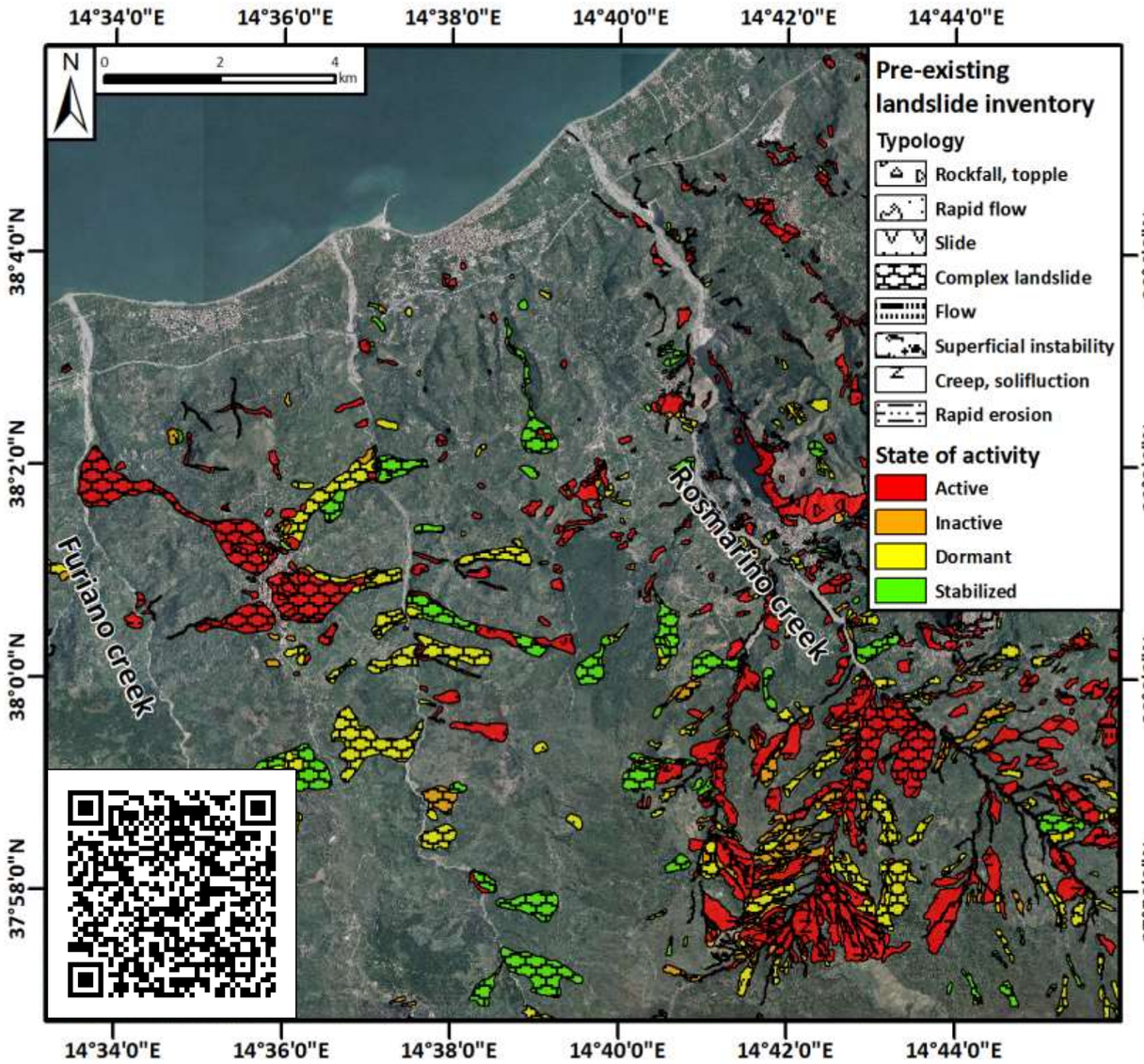

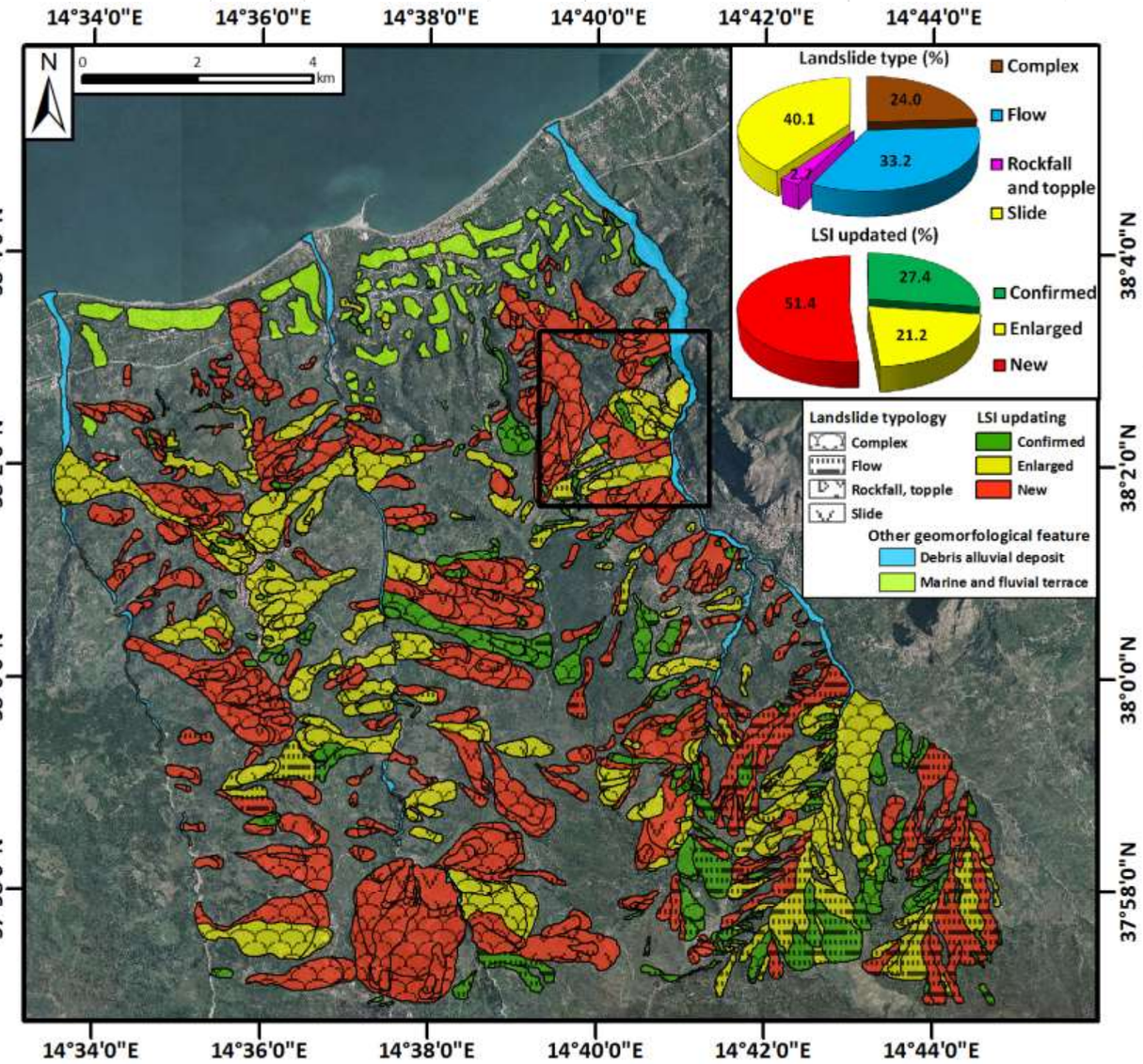

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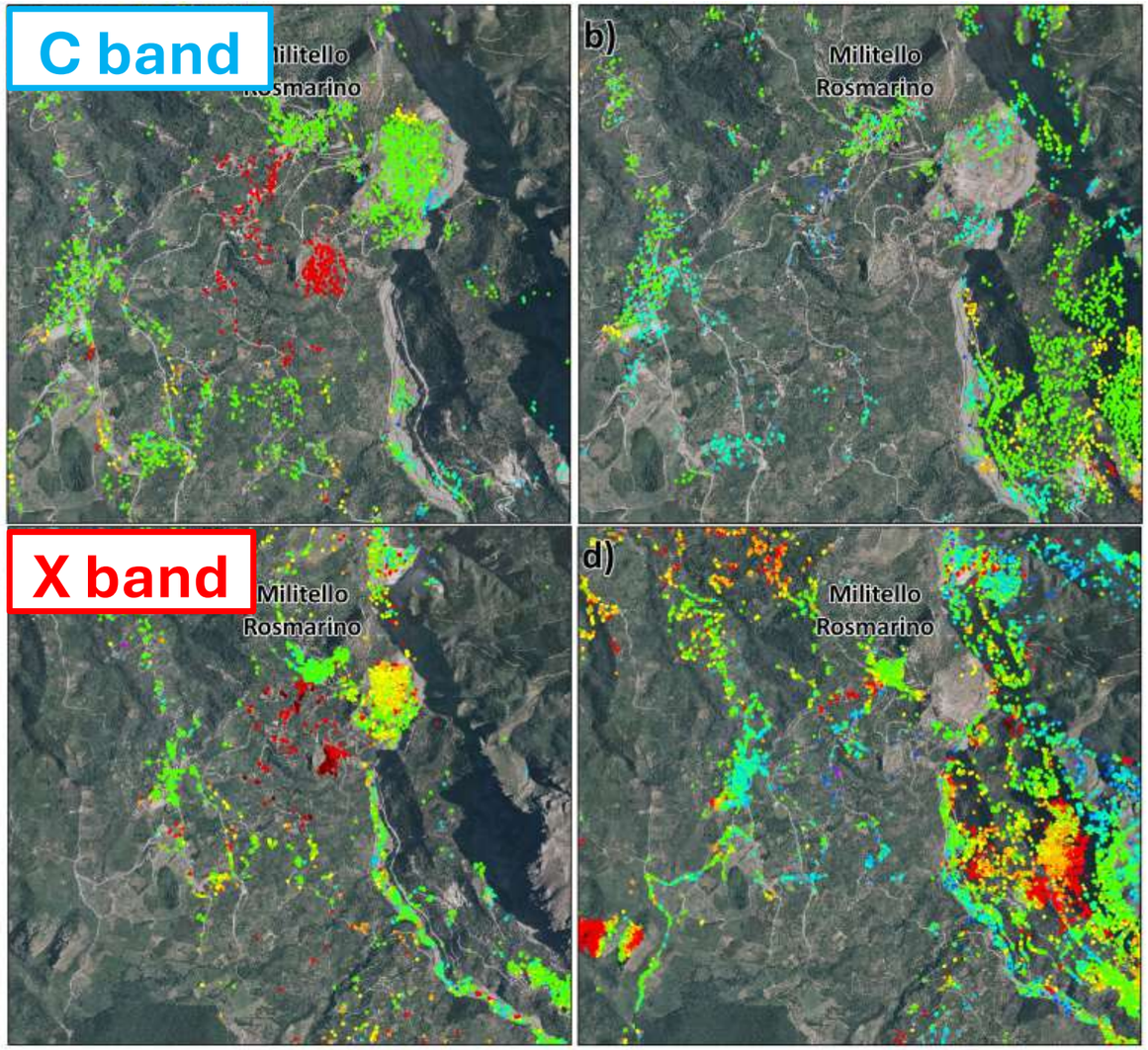
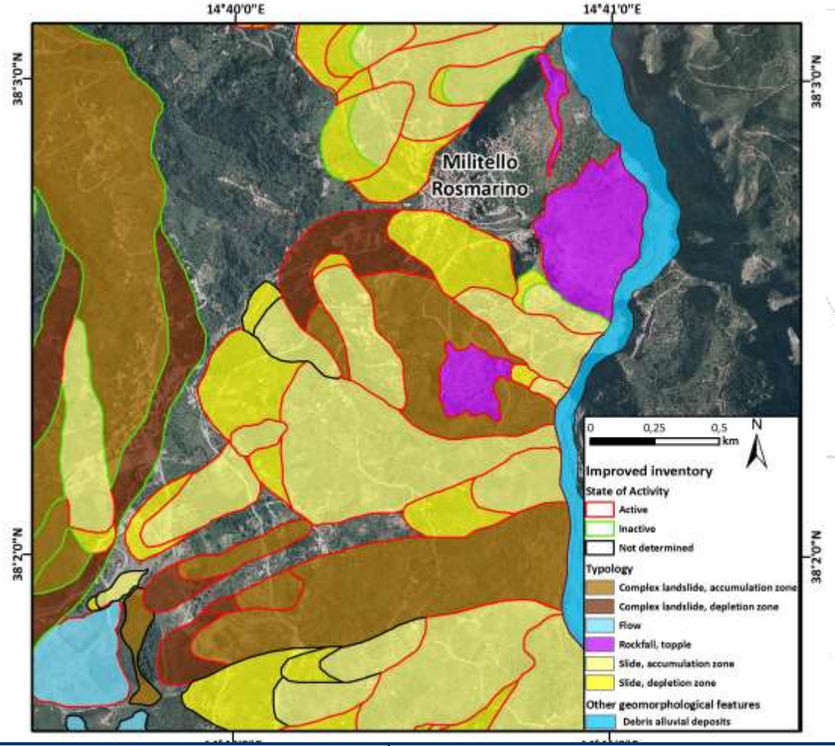


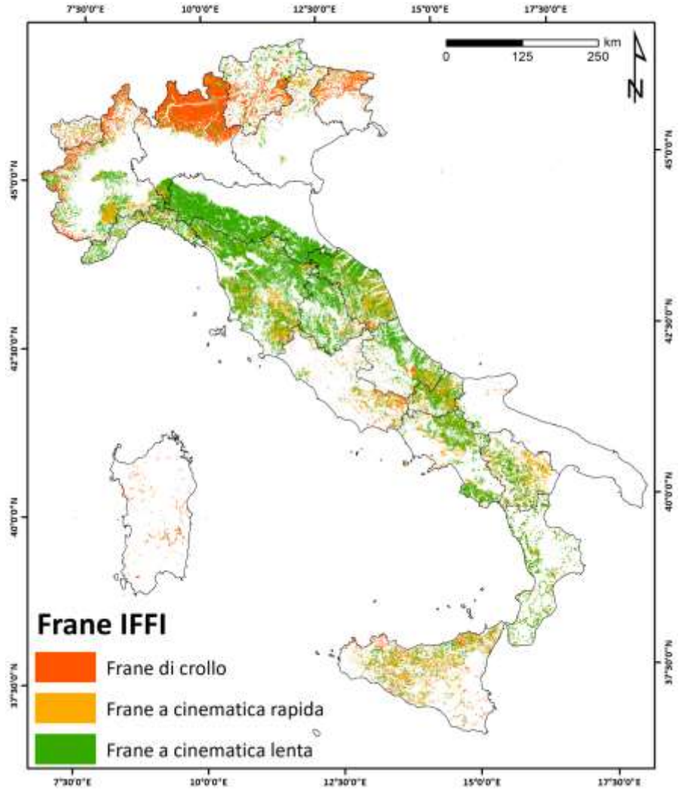


Land use	Satellite interferometry applicability		
	X band (3.1 cm)	C band (5.6 cm)	L band (23 cm)
Artificial surfaces	YES	YES	YES
Agricultural surfaces, bare soil, rocky outcrops	YES	YES	YES
Forest and seminatural areas	NO	NO	YES
Wetlands and water bodies	NO	NO	NO

The past: archive elaboration

Italy

InSAR data for the update of national landslide inventory maps

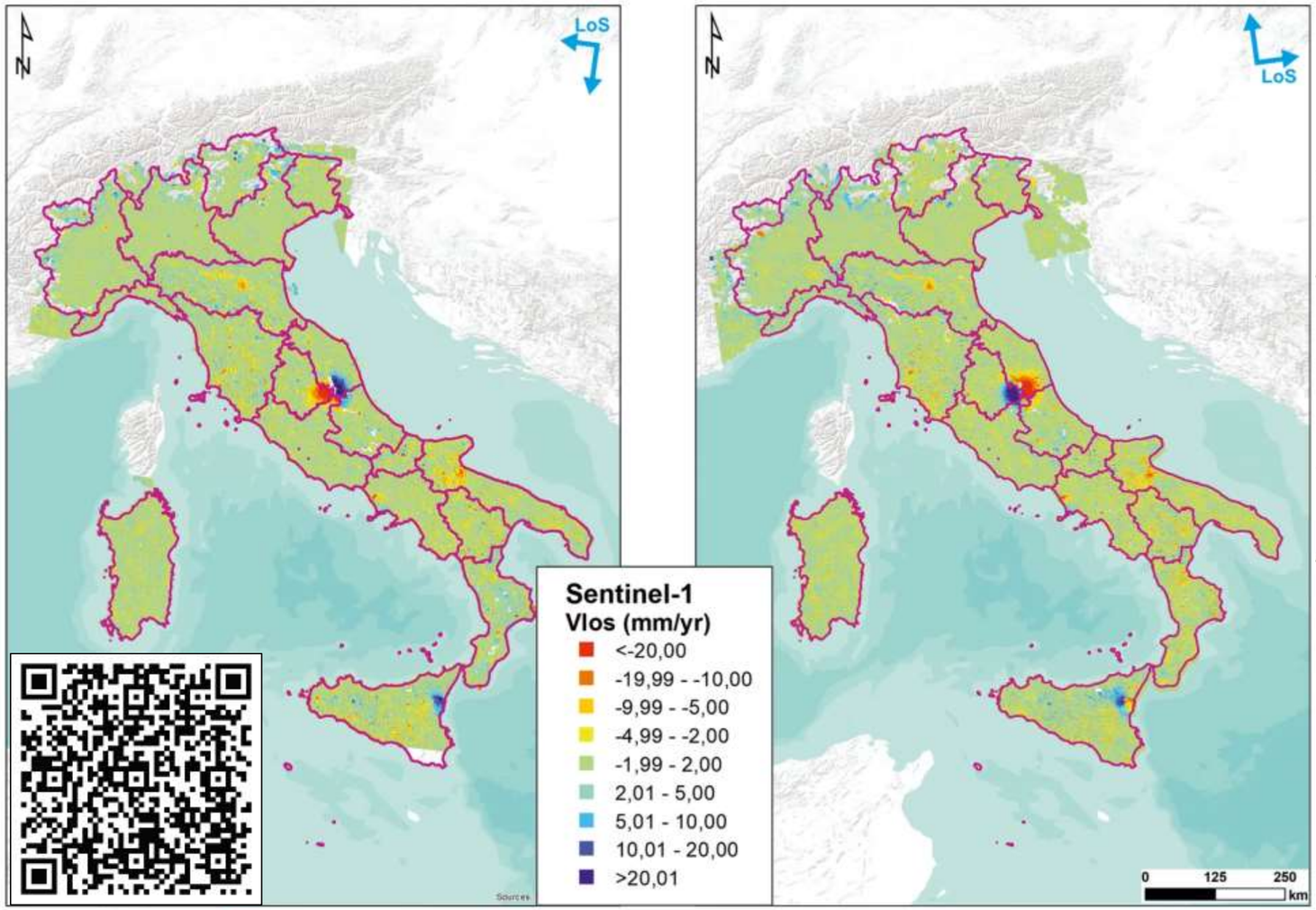


Landslide risk areas

about 2 millions of mapped landslides

Social impact (100 years)

About 4000 events affecting people



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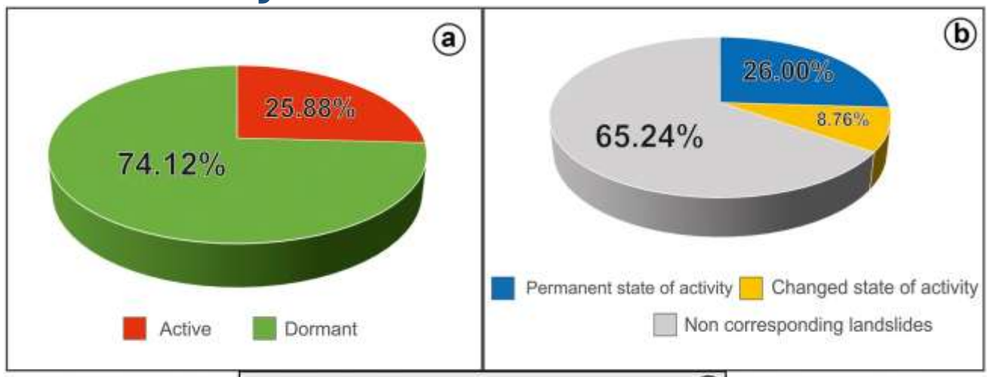
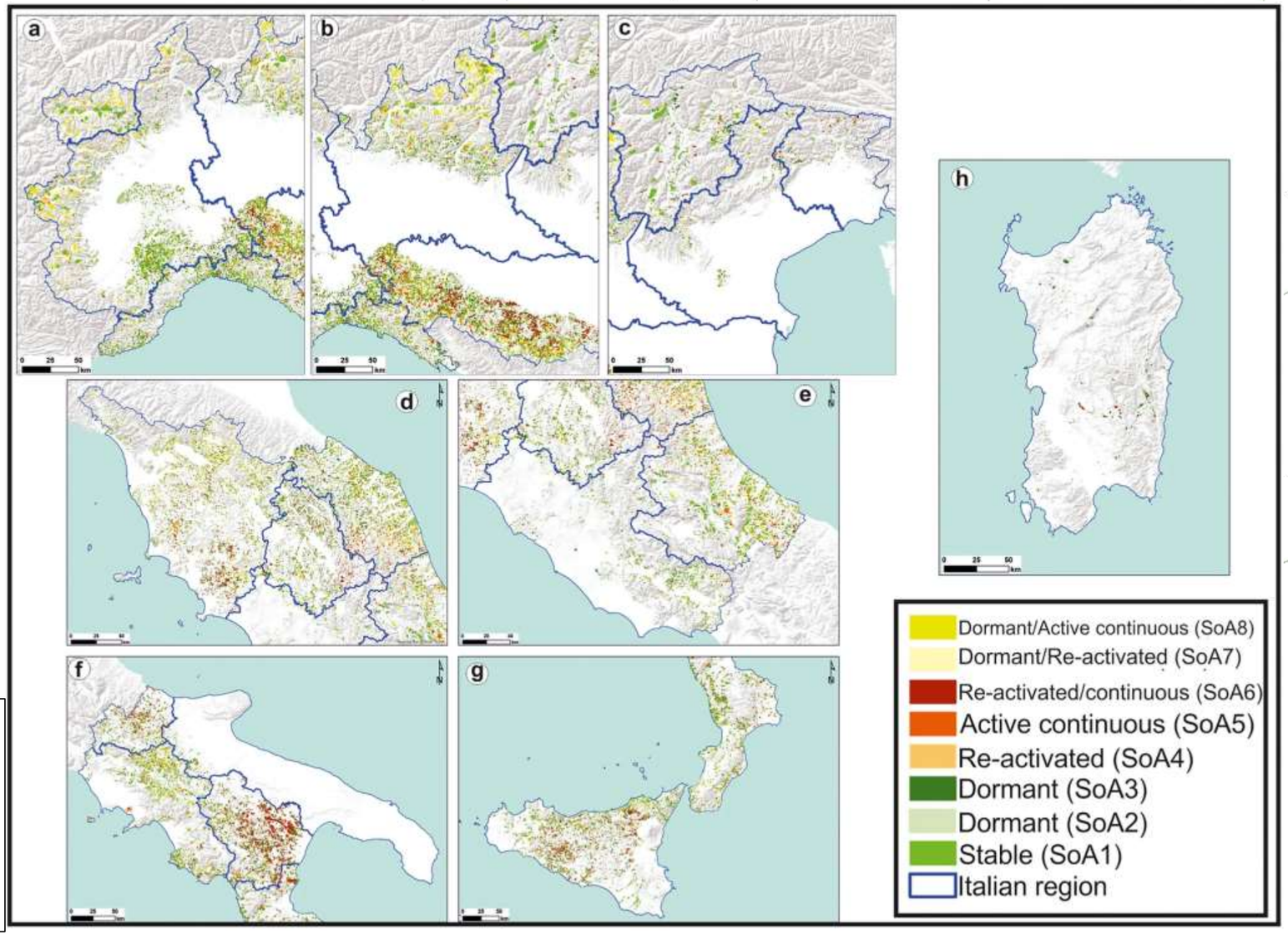
Italy

InSAR data for the update of state of activity



56,000 landslides
26% were classified as active



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Italy

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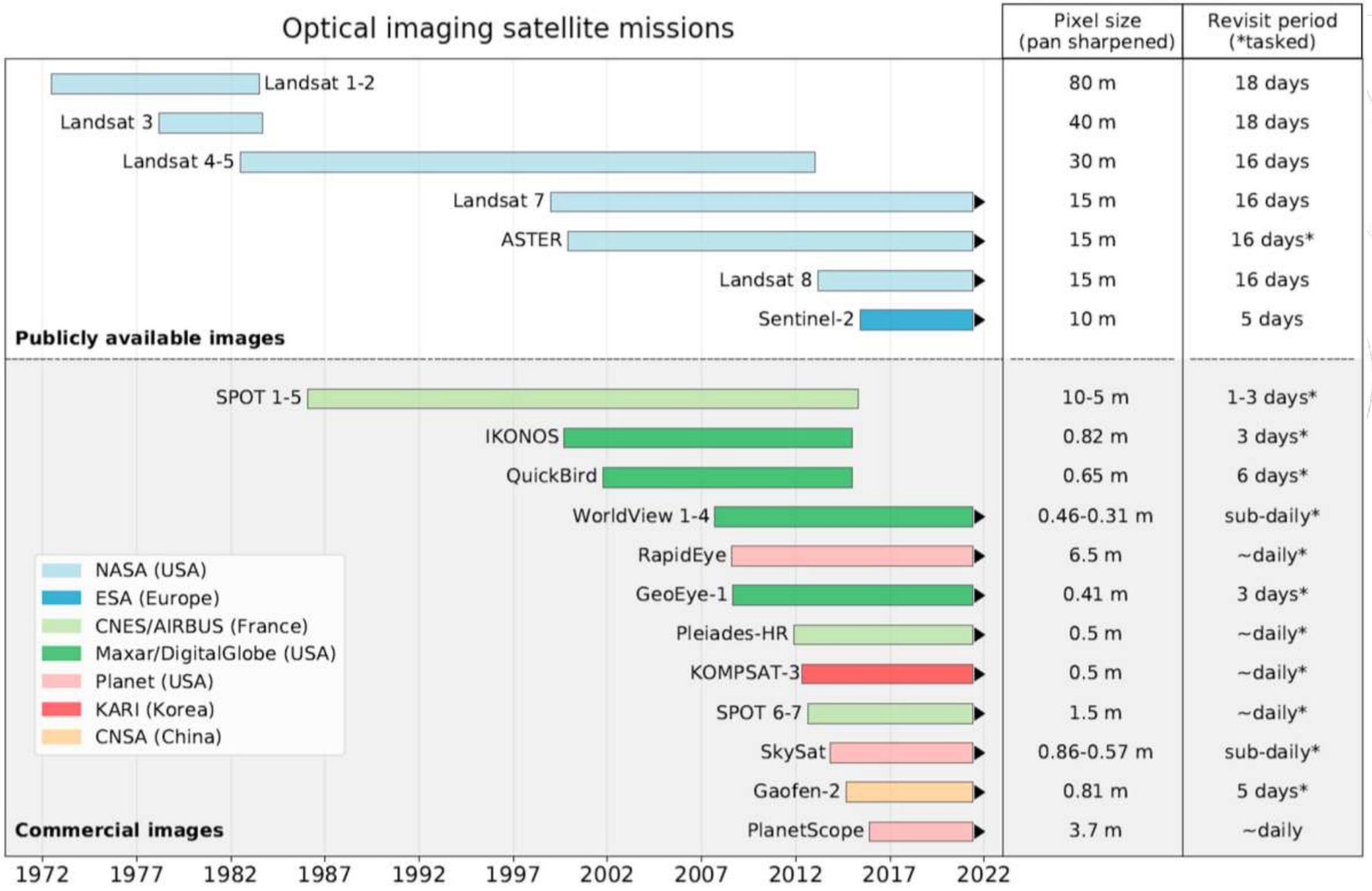

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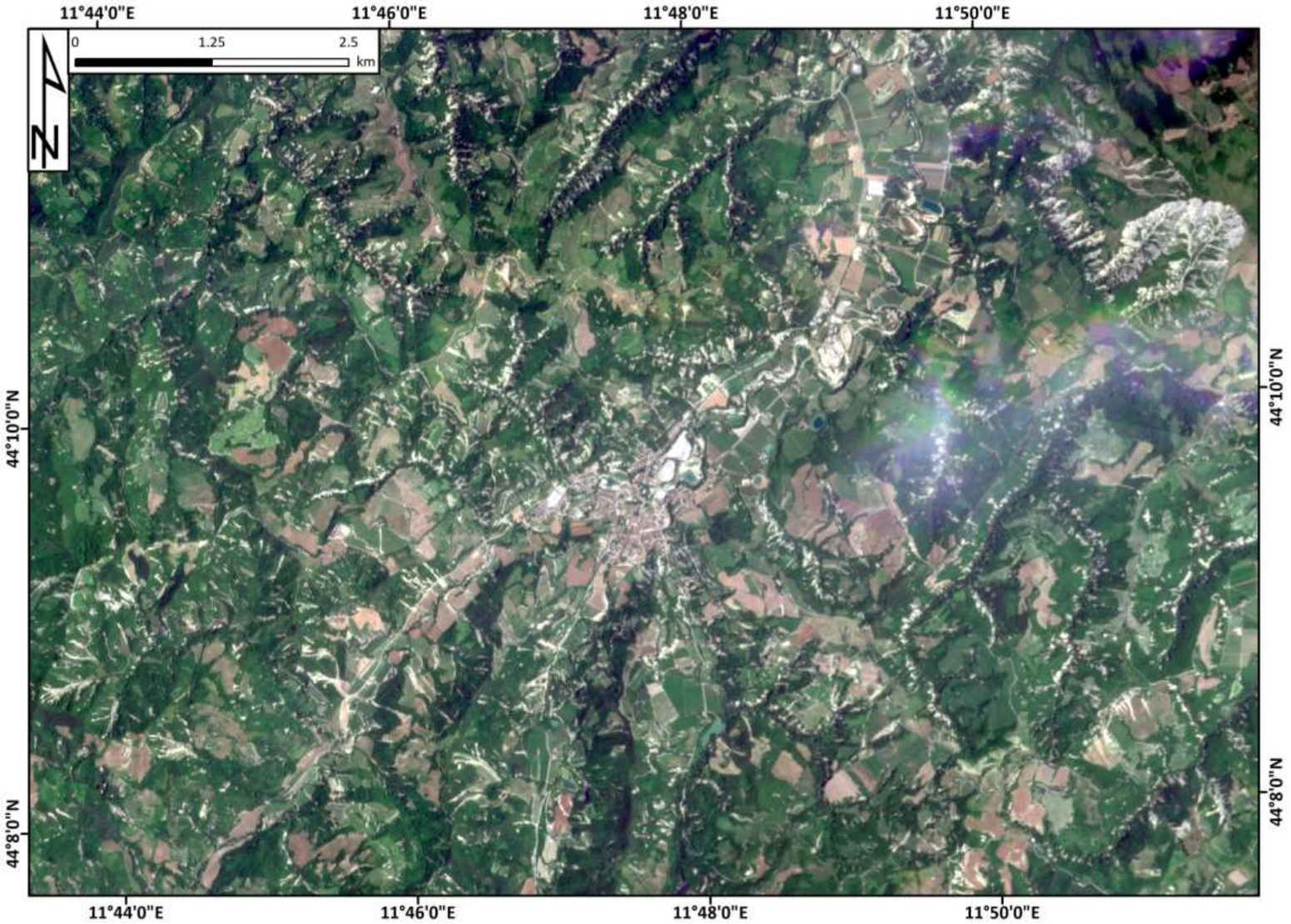


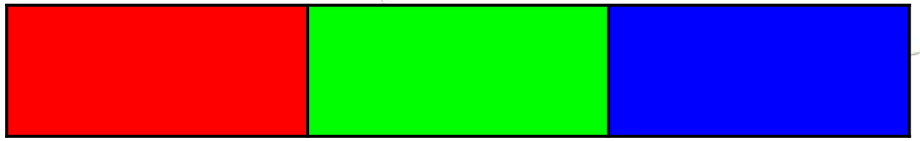
Planet images

Resolution: 3x3 m

Pre-event: 27 April 2023

Post event: 23 June 2023

True color composit



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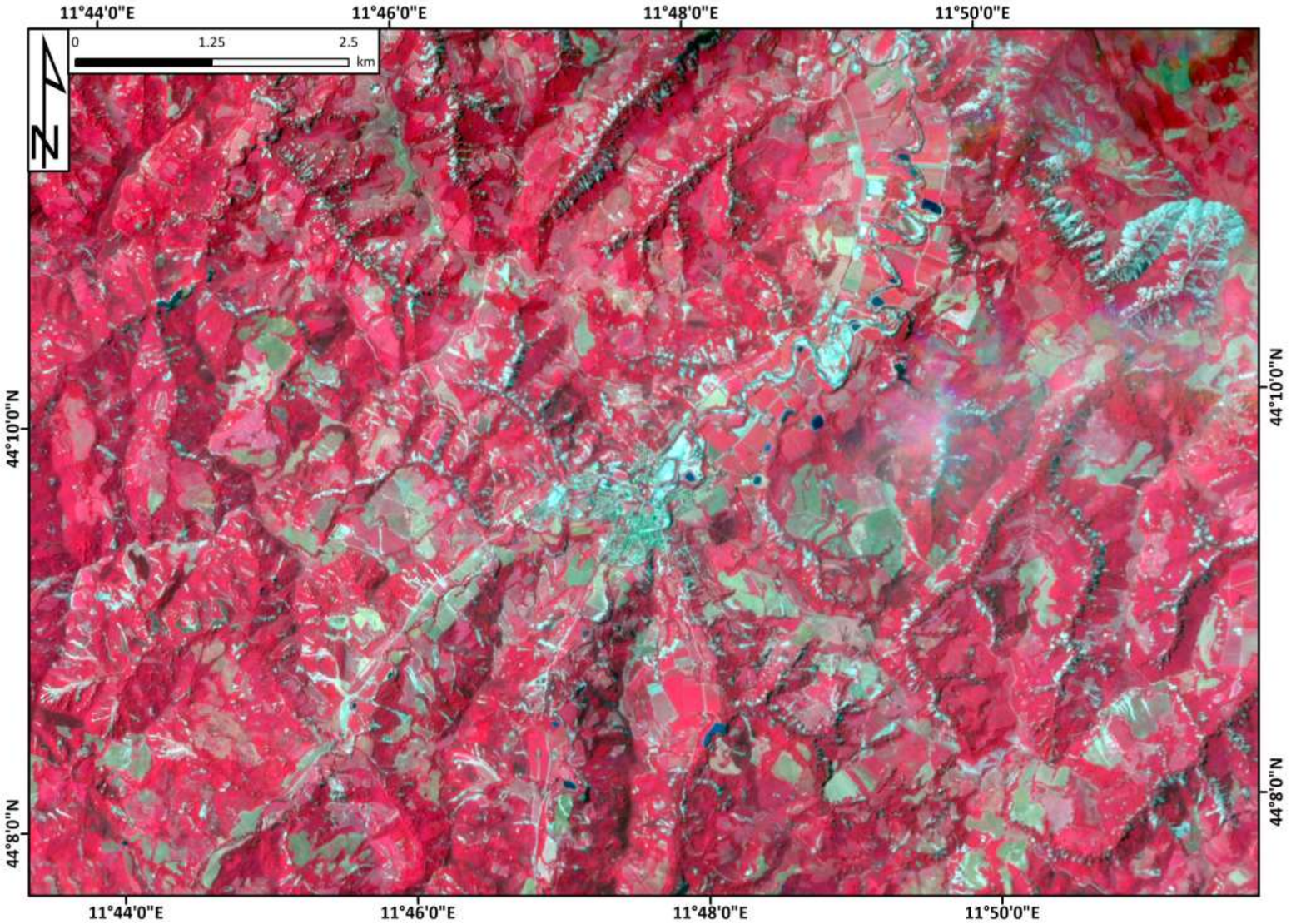

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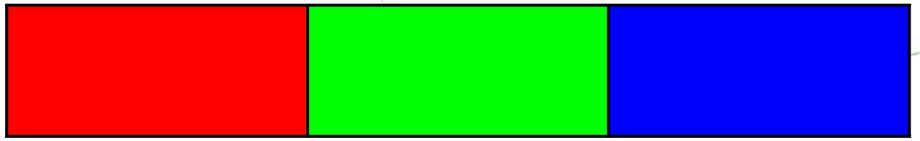
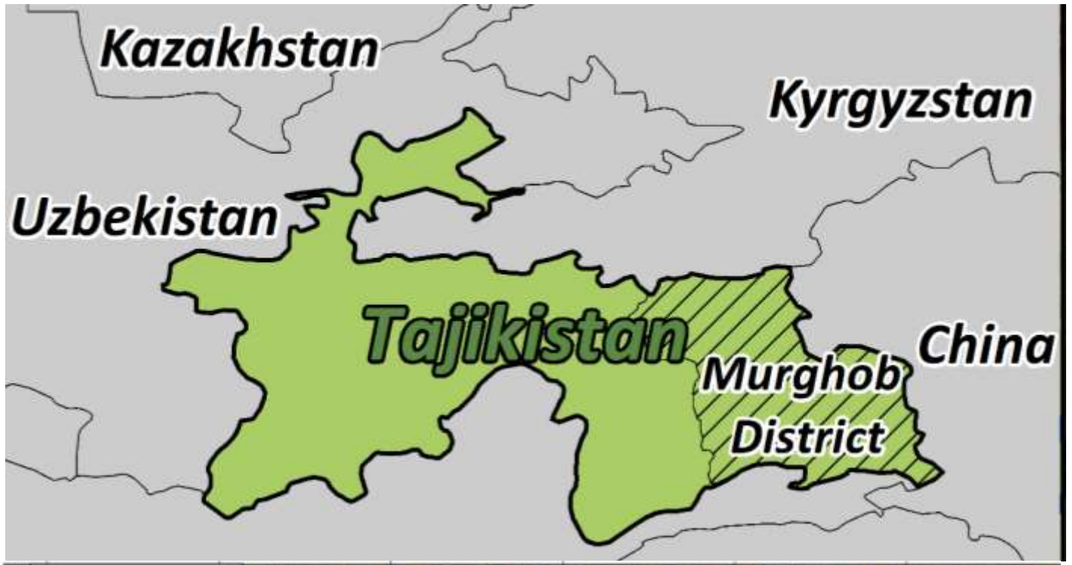
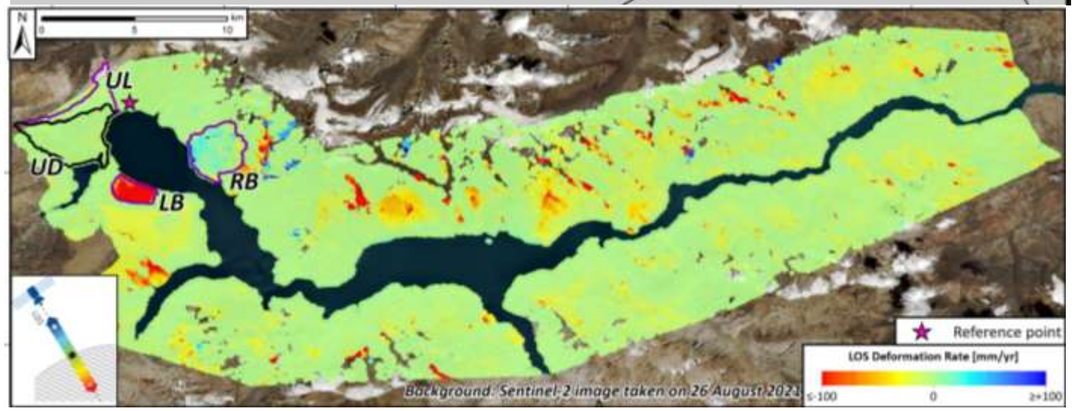
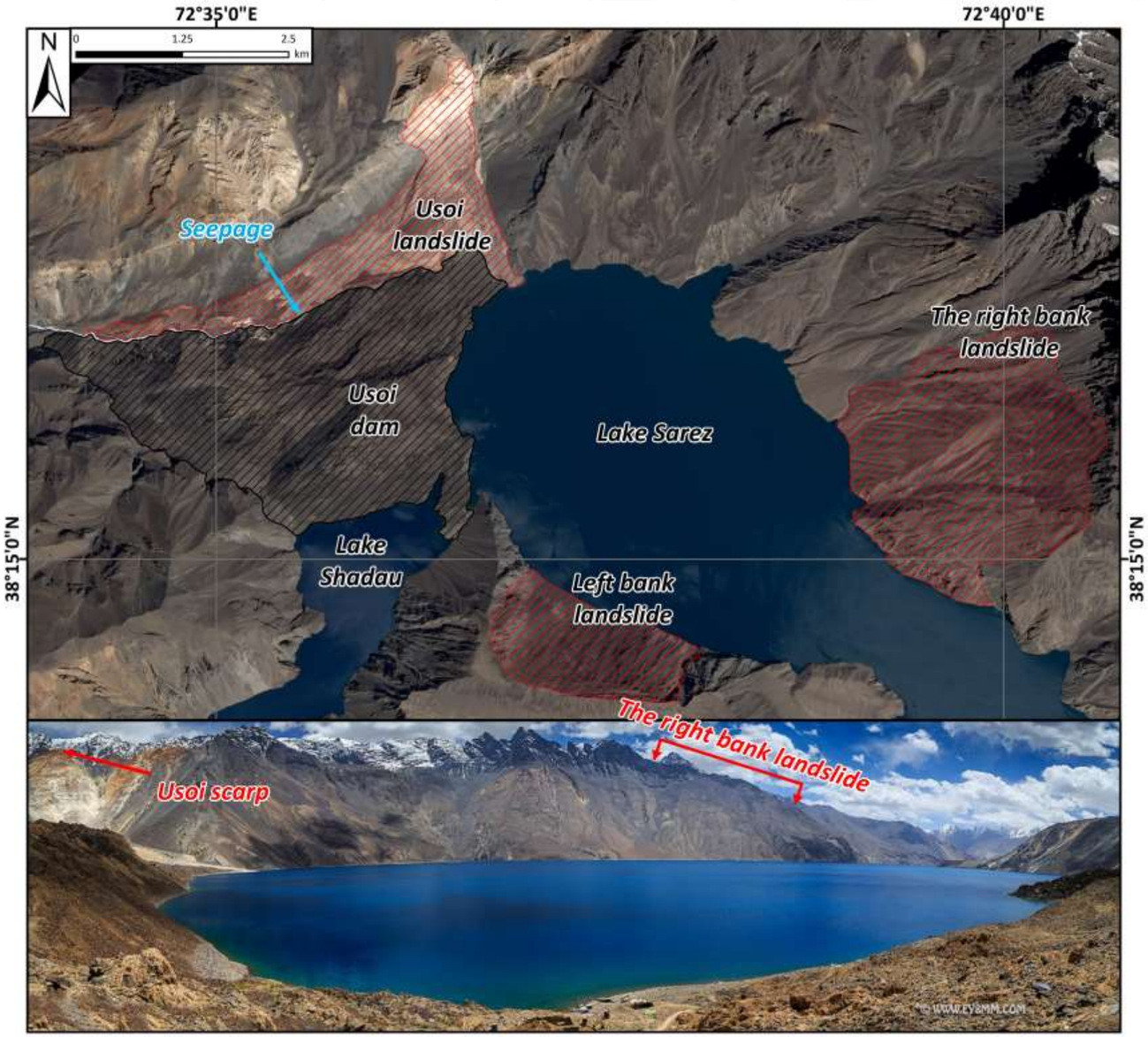


The past: archive elaboration

Lake Sarez landslide (Tajikistan)

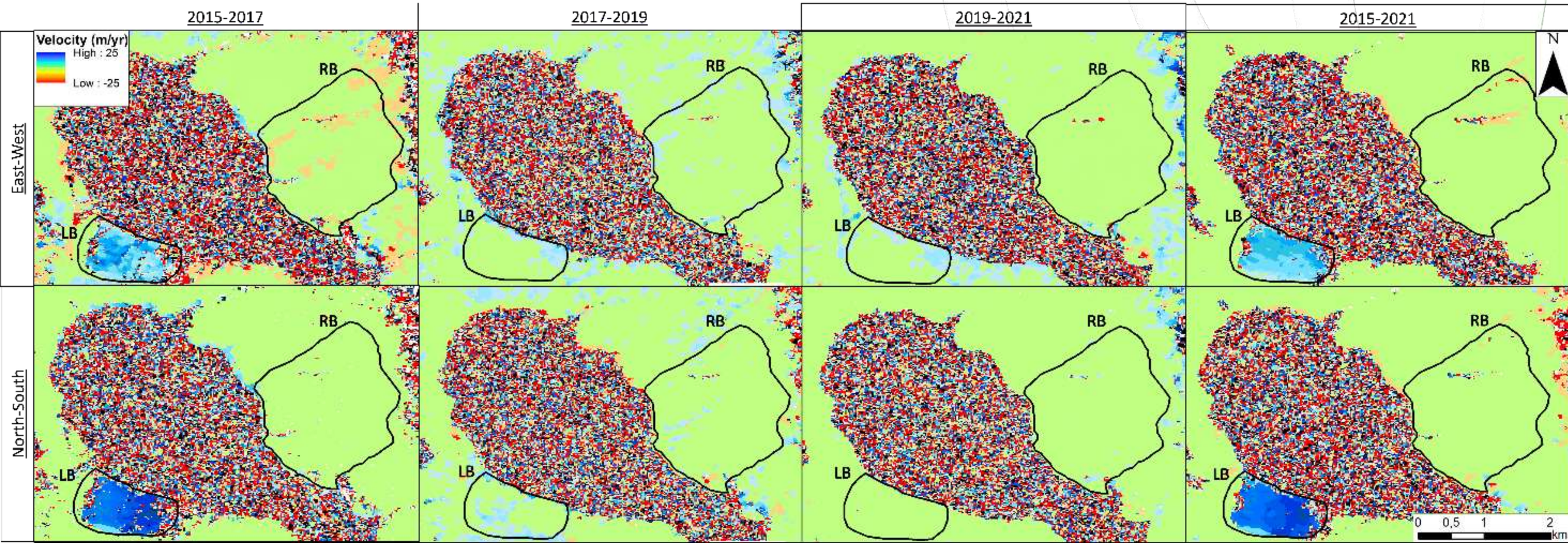






The past: archive elaboration

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.

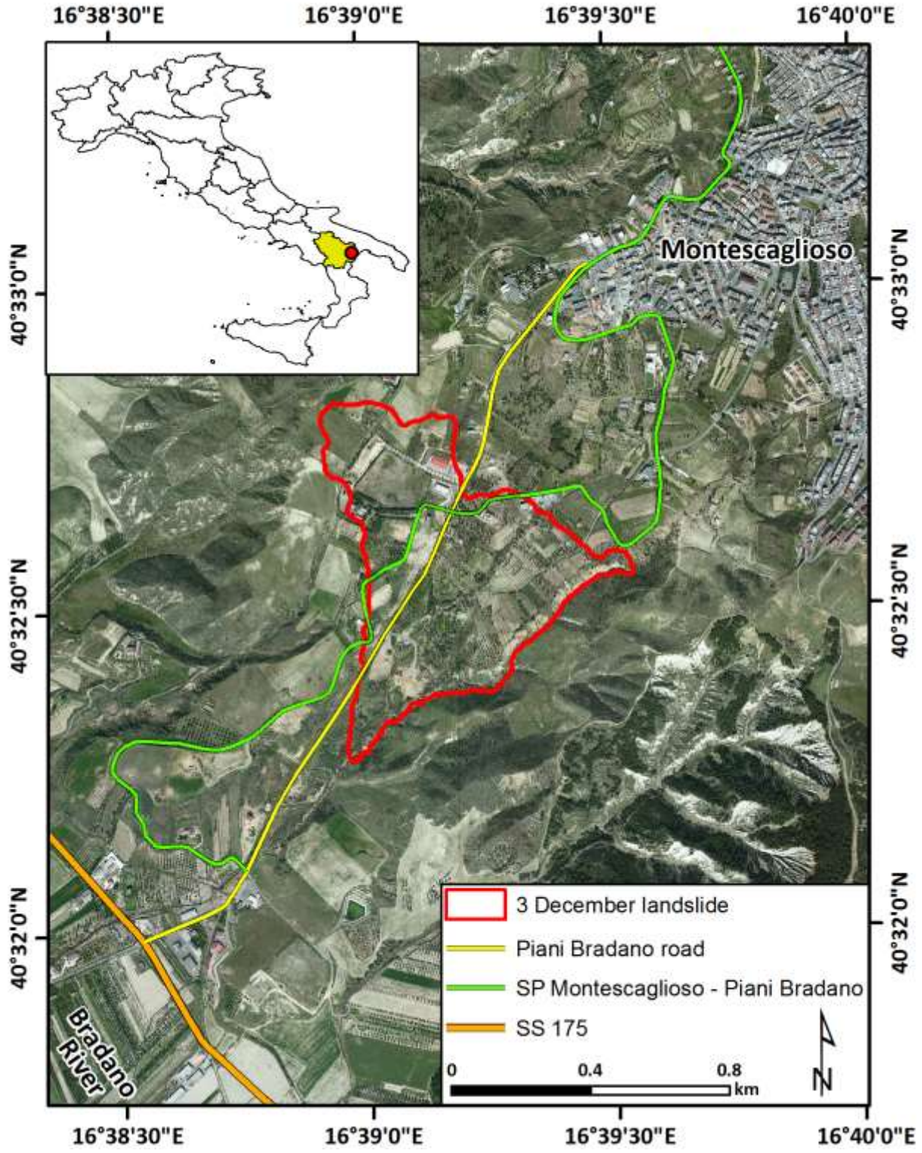


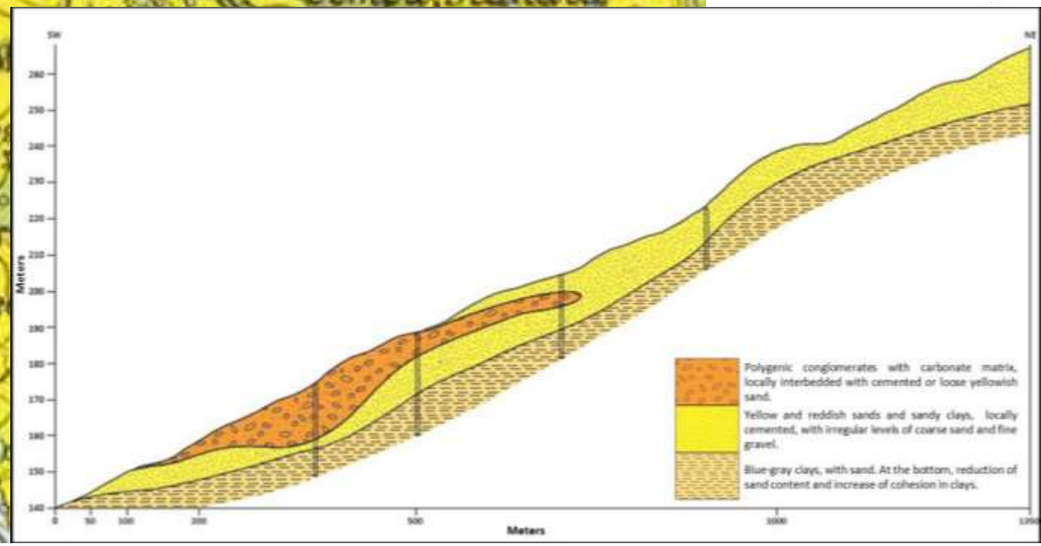
Velocity of 1.5 m/year for the E–W components and of 2.5 m/year for the N-S component

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

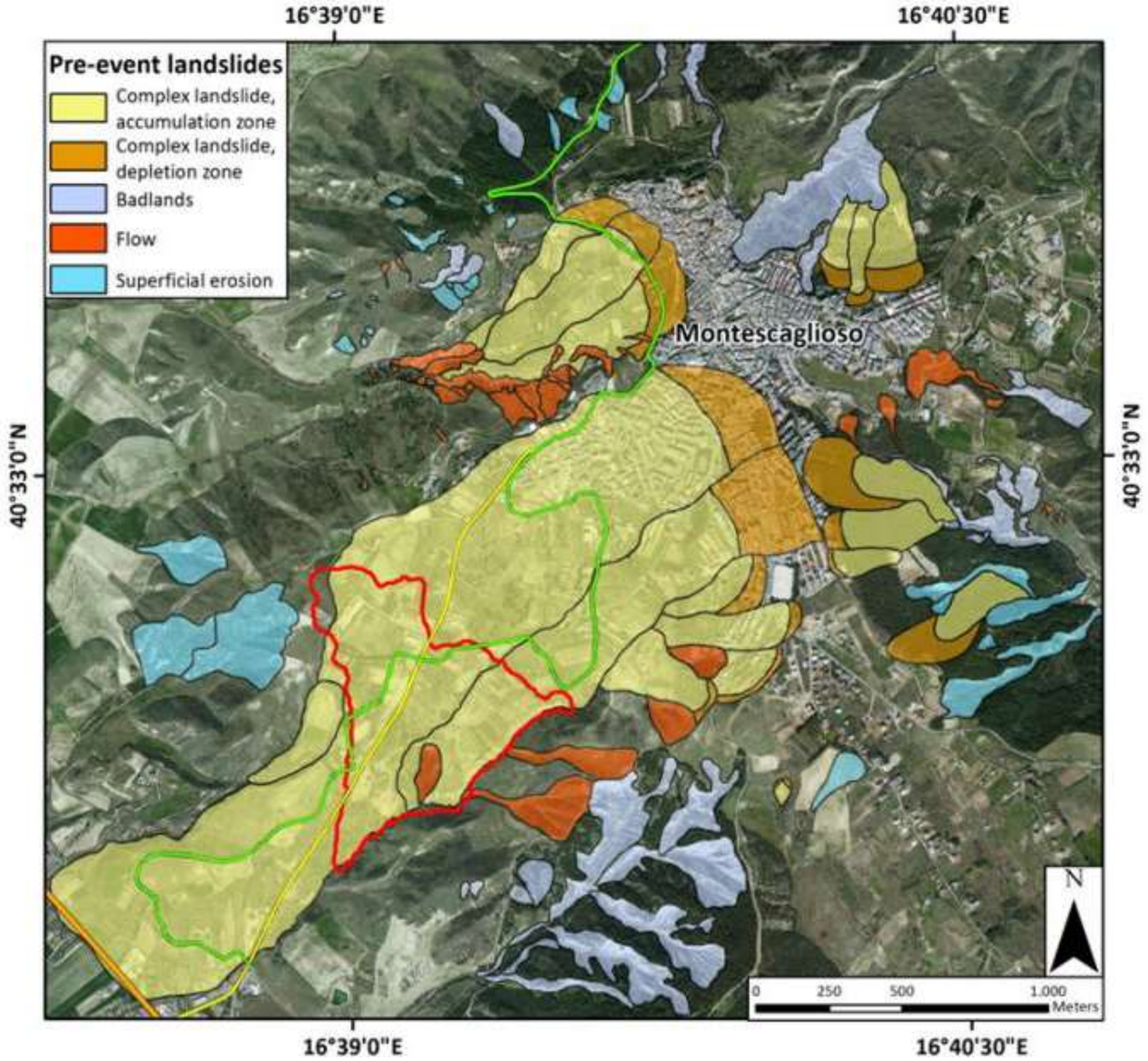
Optical analysis enables the detection of the **north-south component of the deformation**, a blind sight direction for SAR satellites

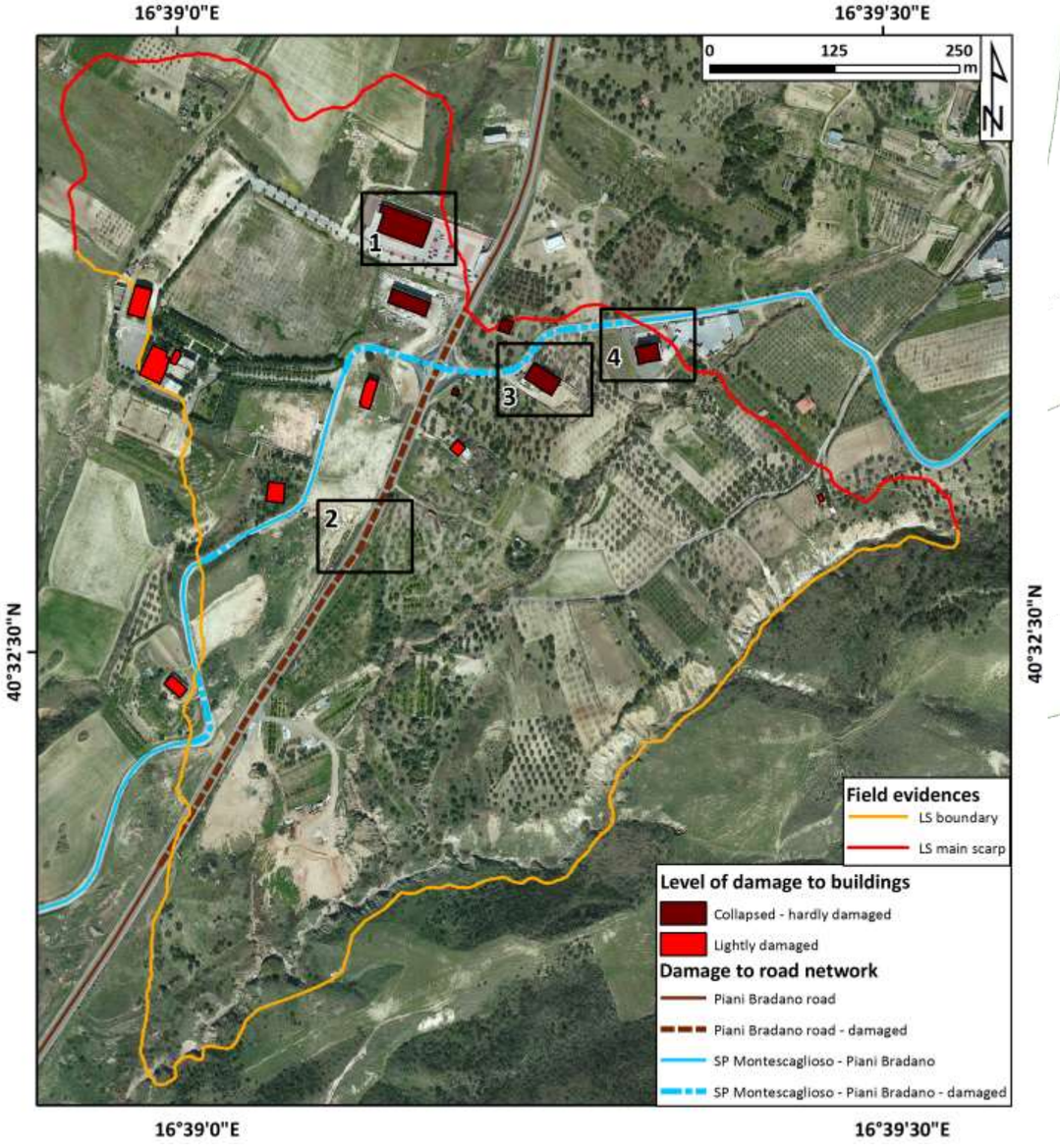
The past: archive elaboration





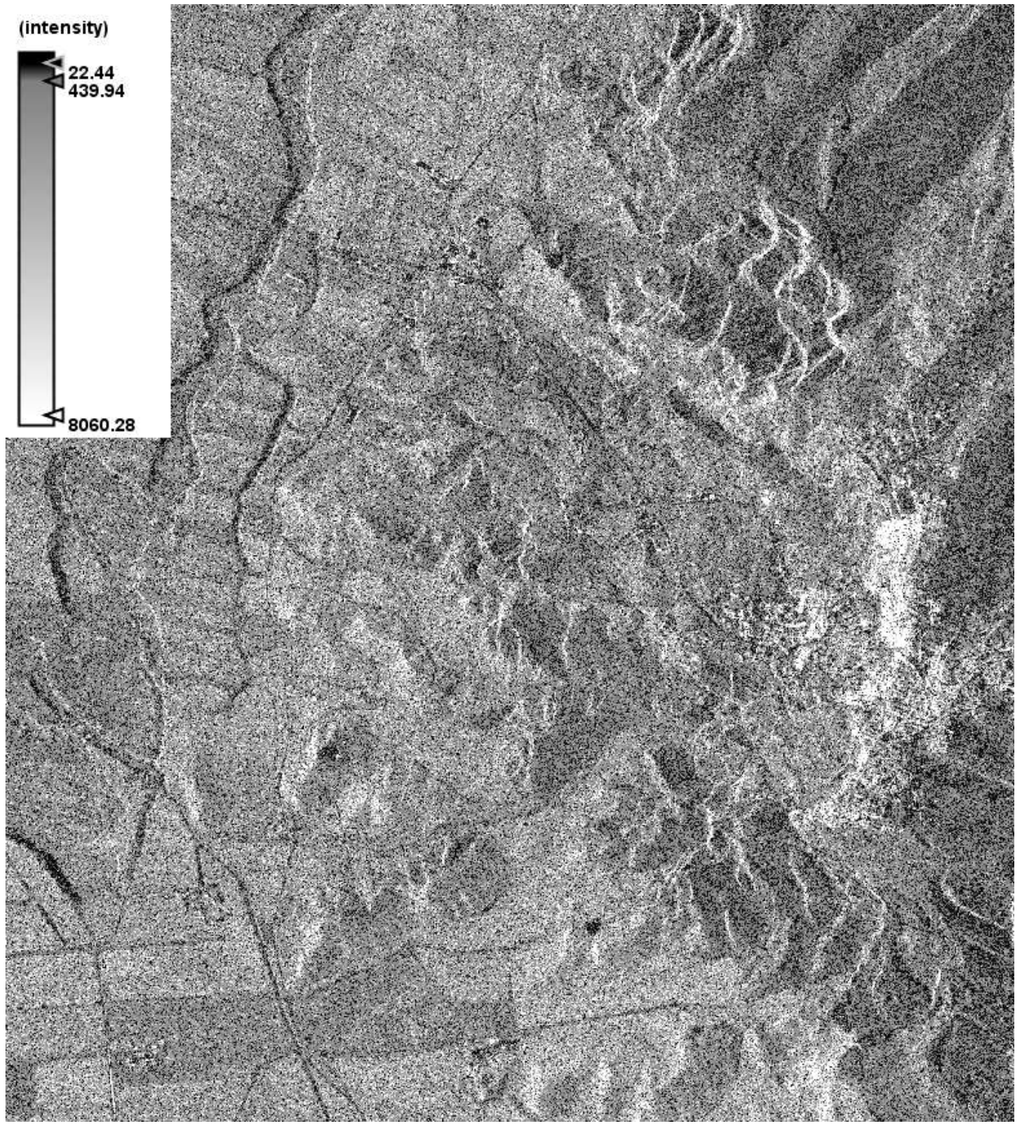
The past: archive elaboration

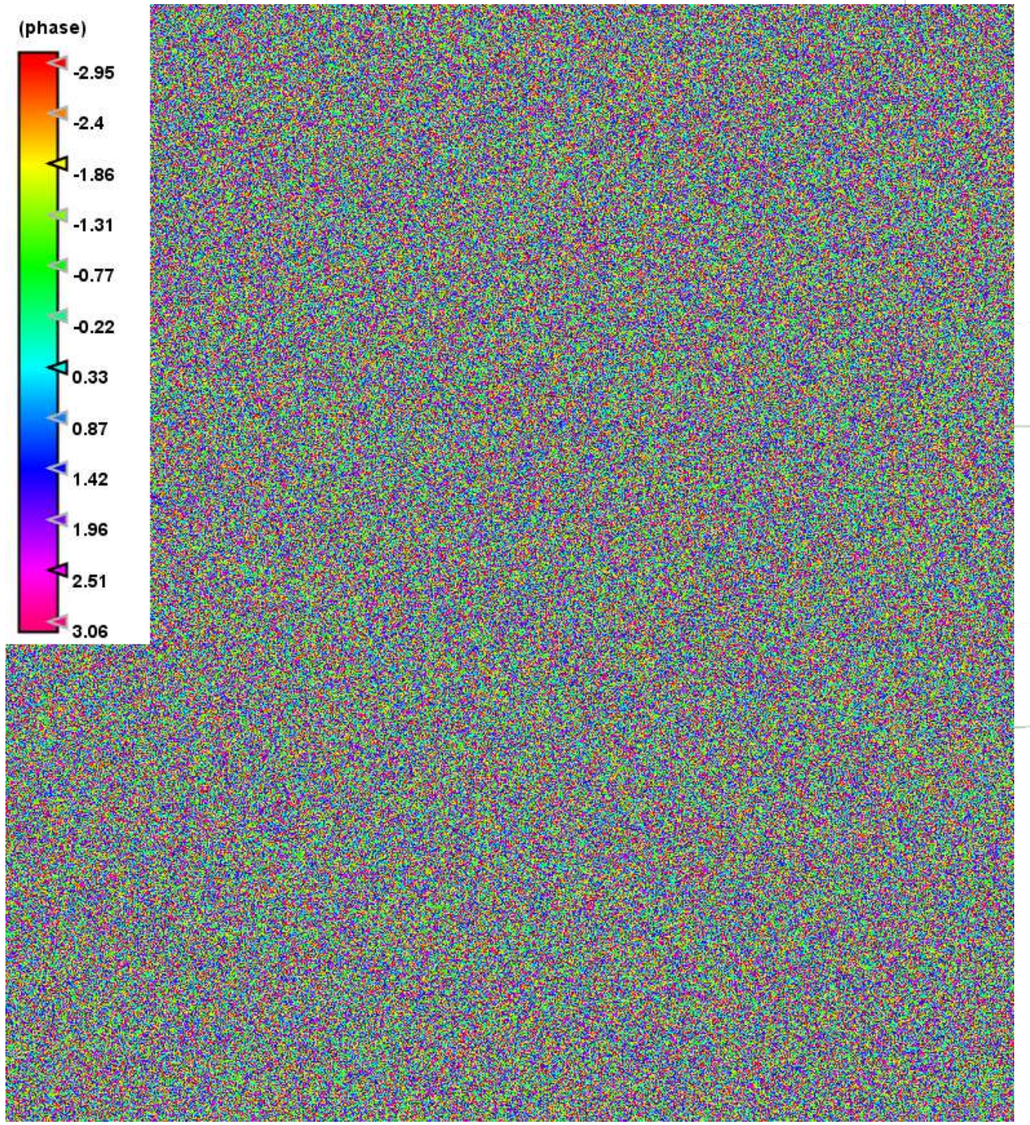




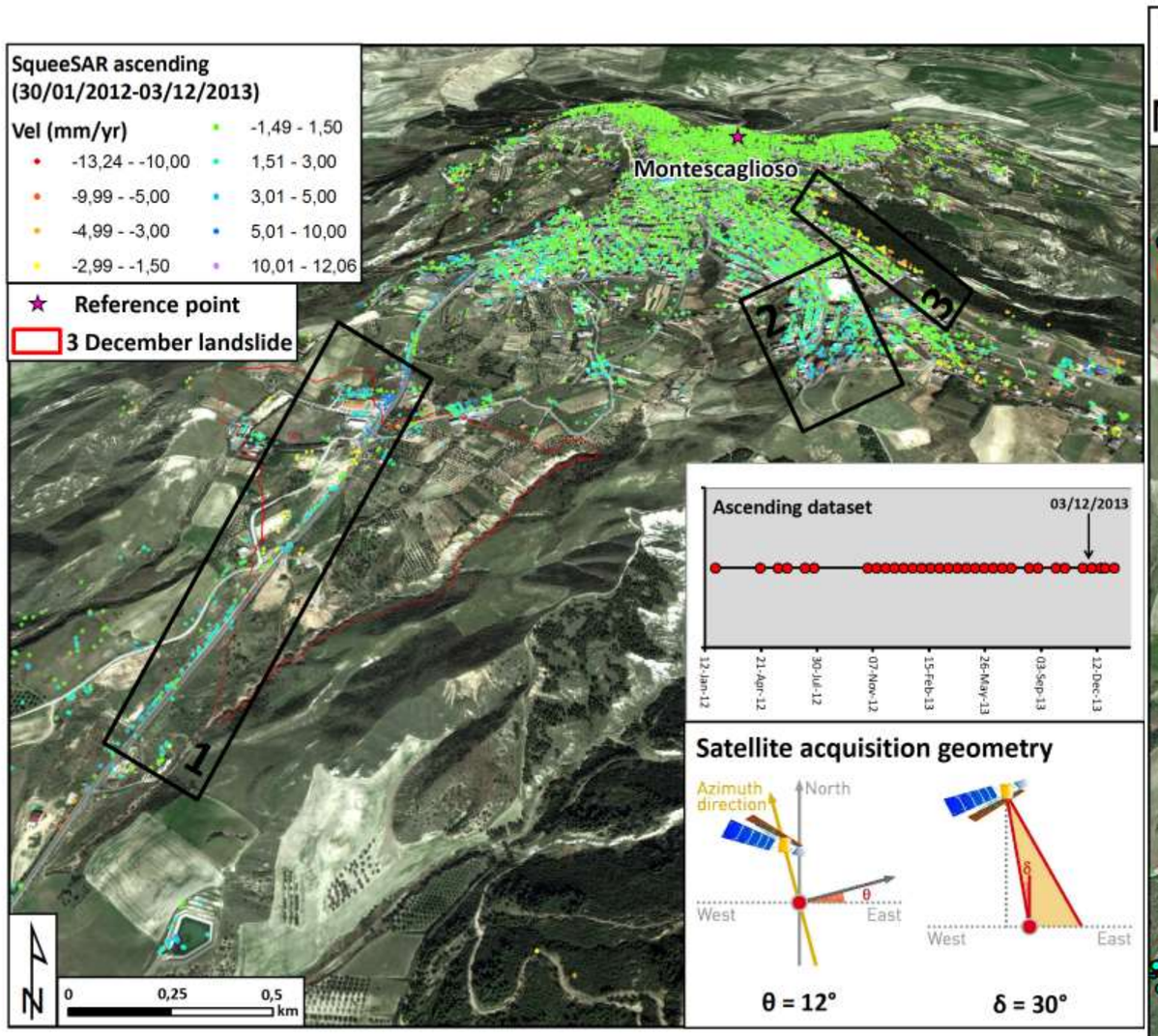
The past: archive elaboration

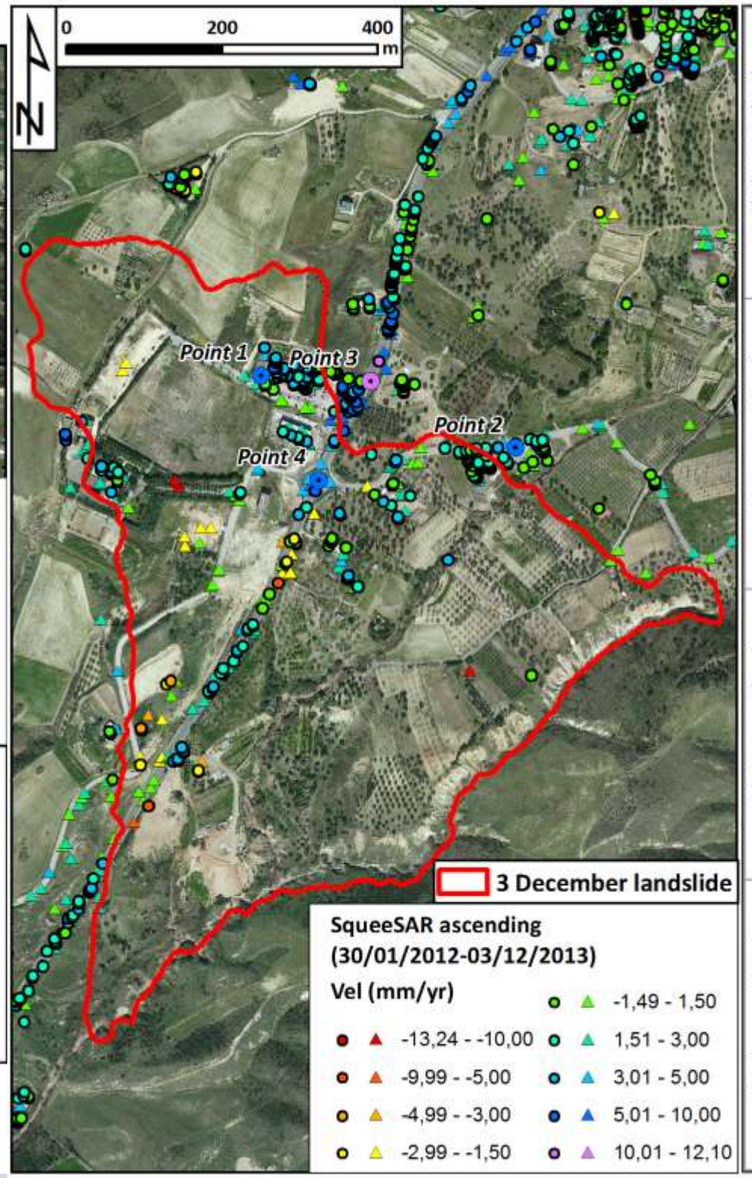
The past: archive elaboration

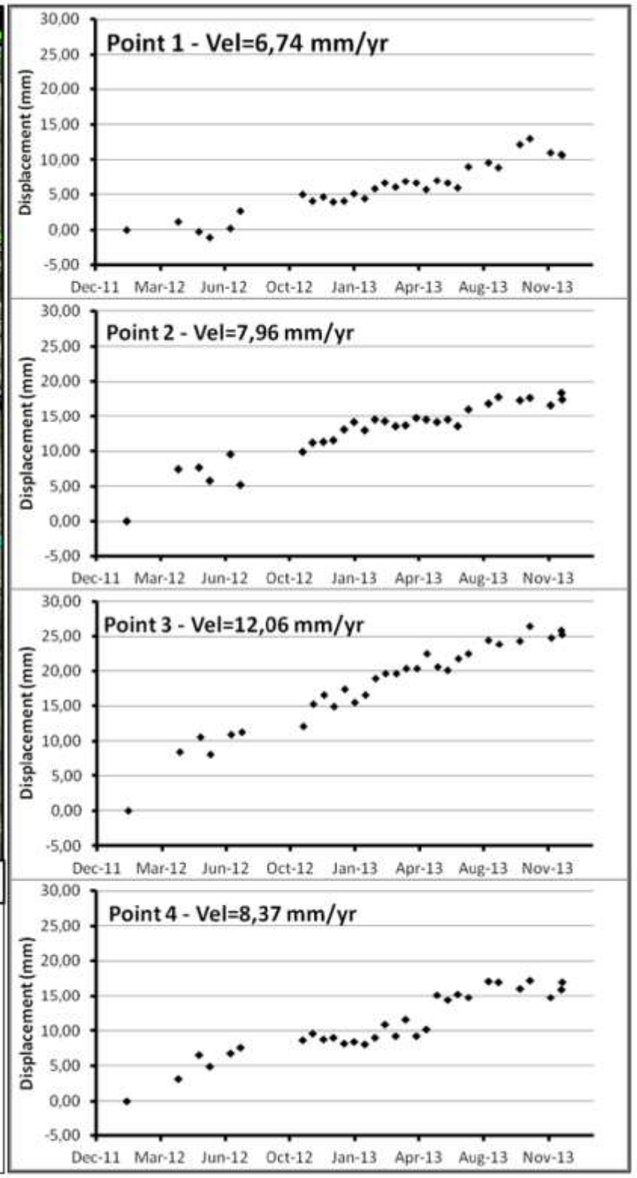




The past: archive elaboration







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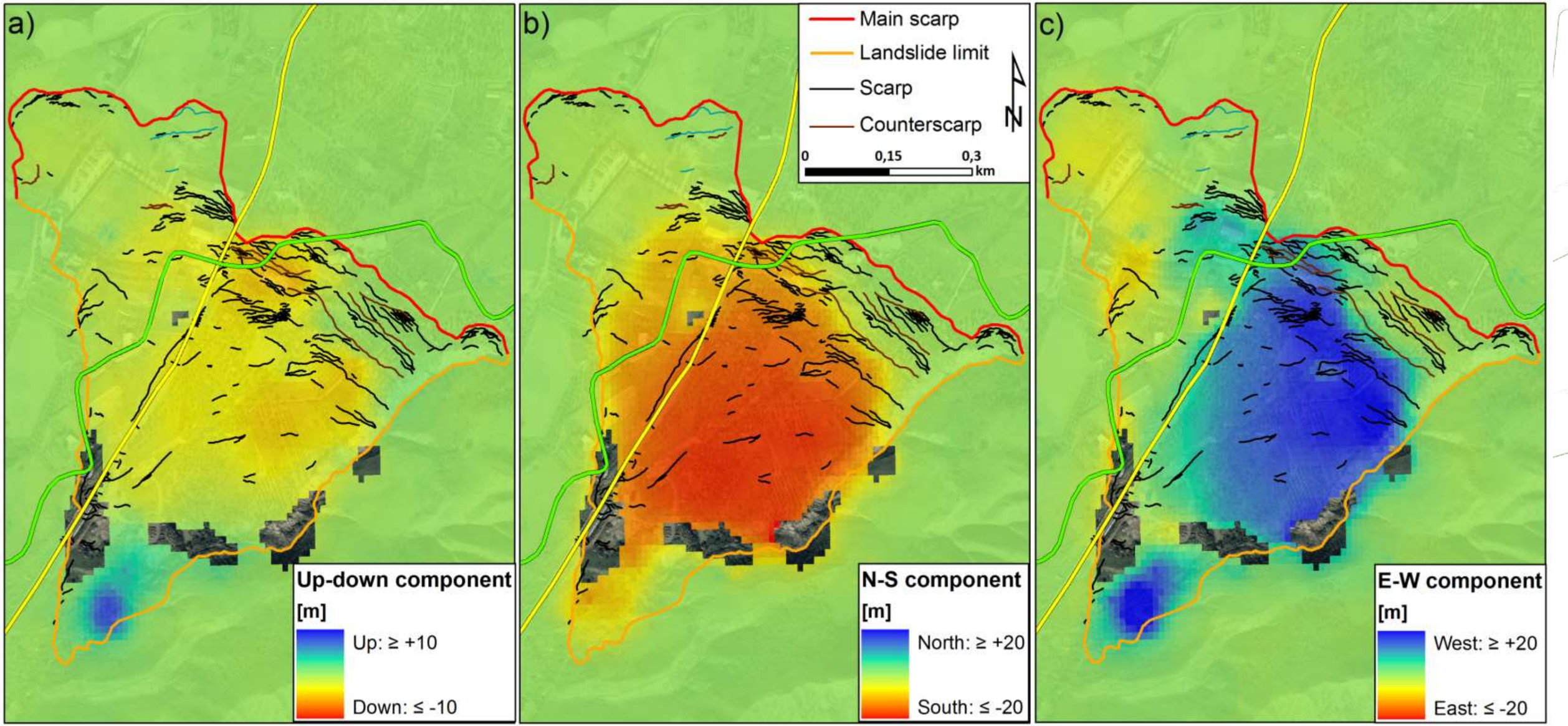

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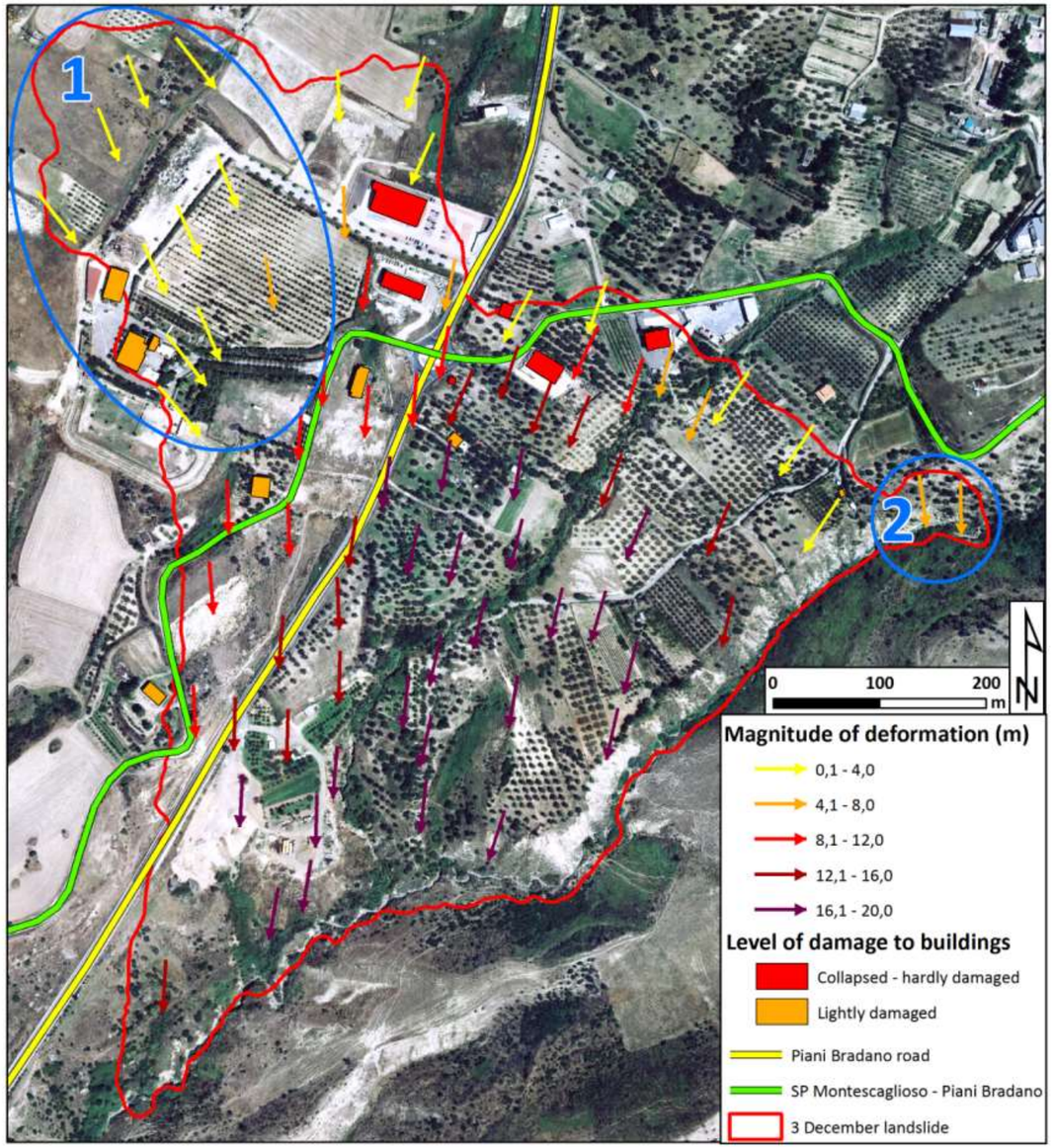

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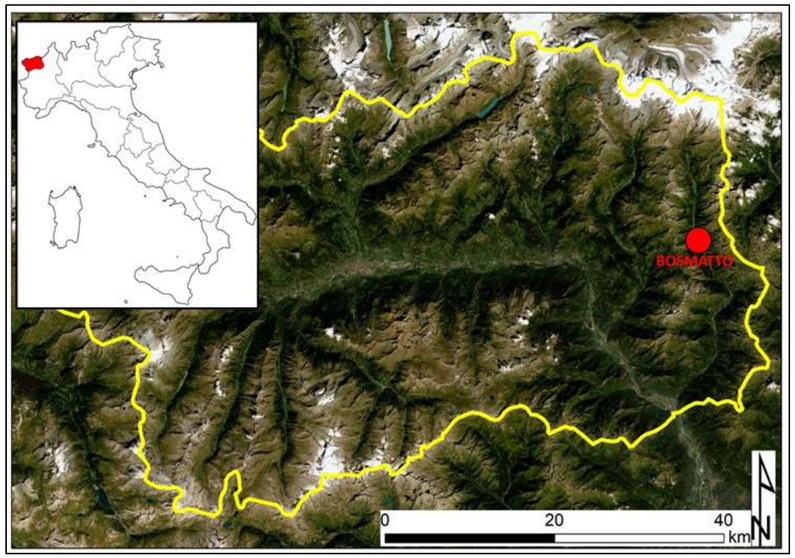
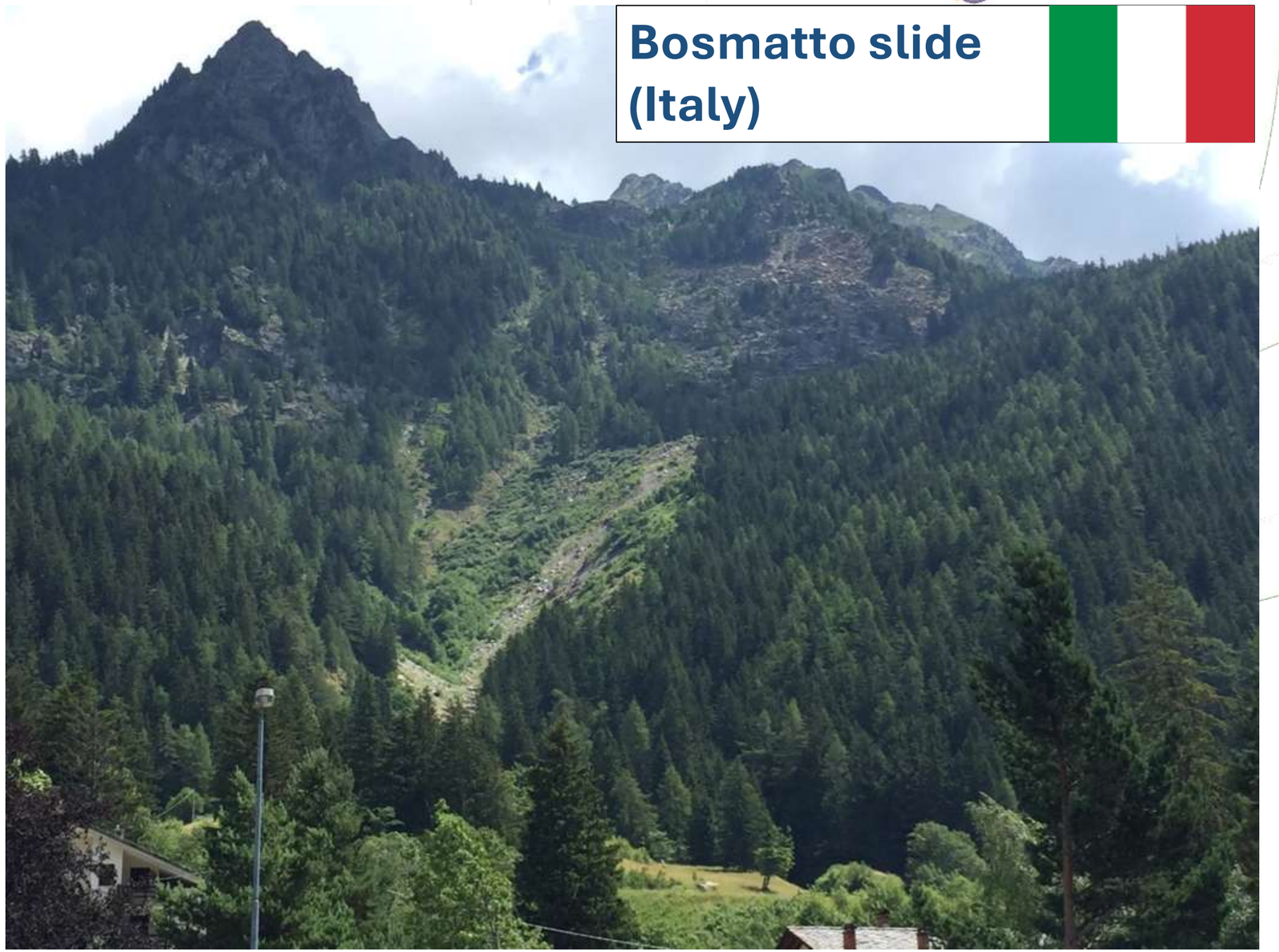
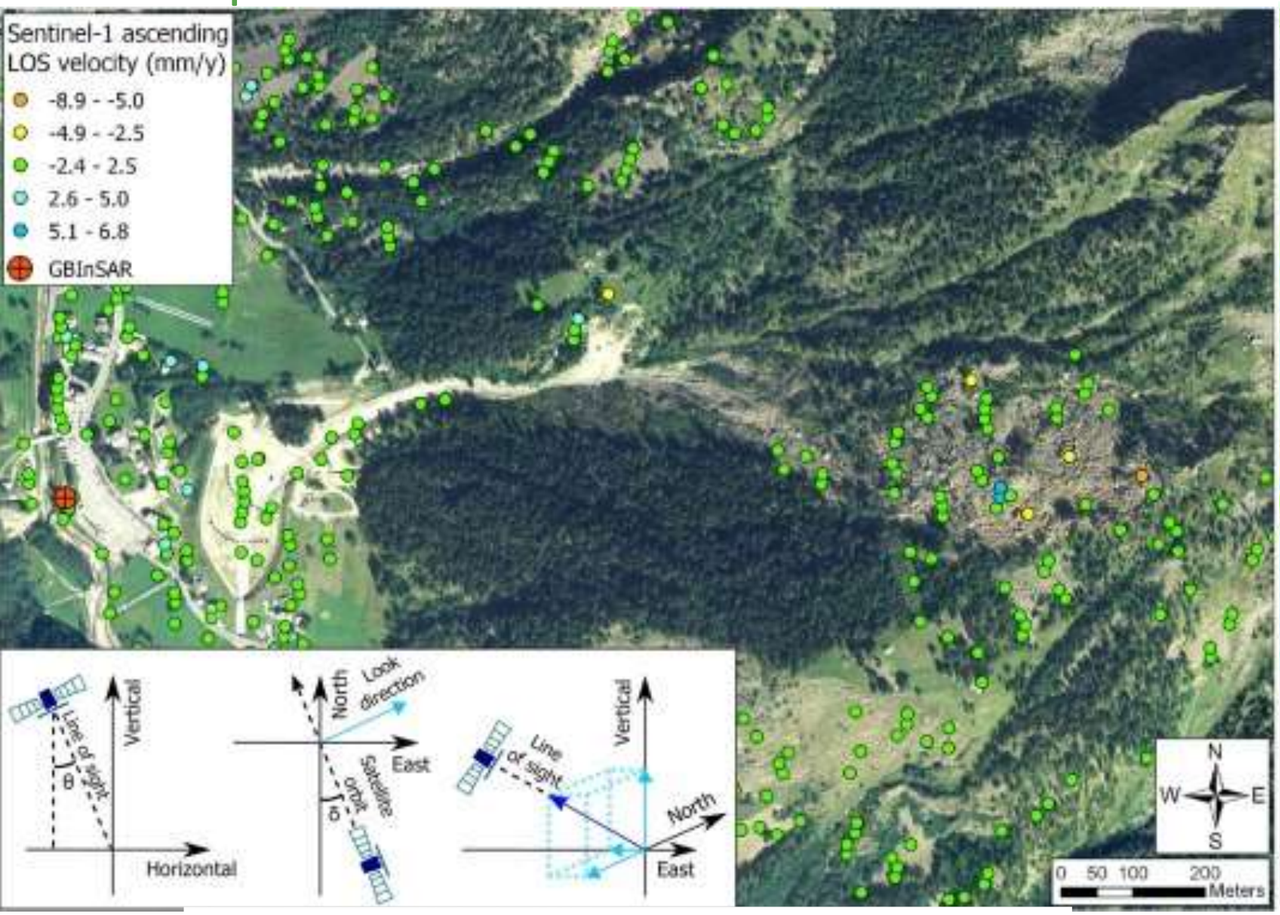
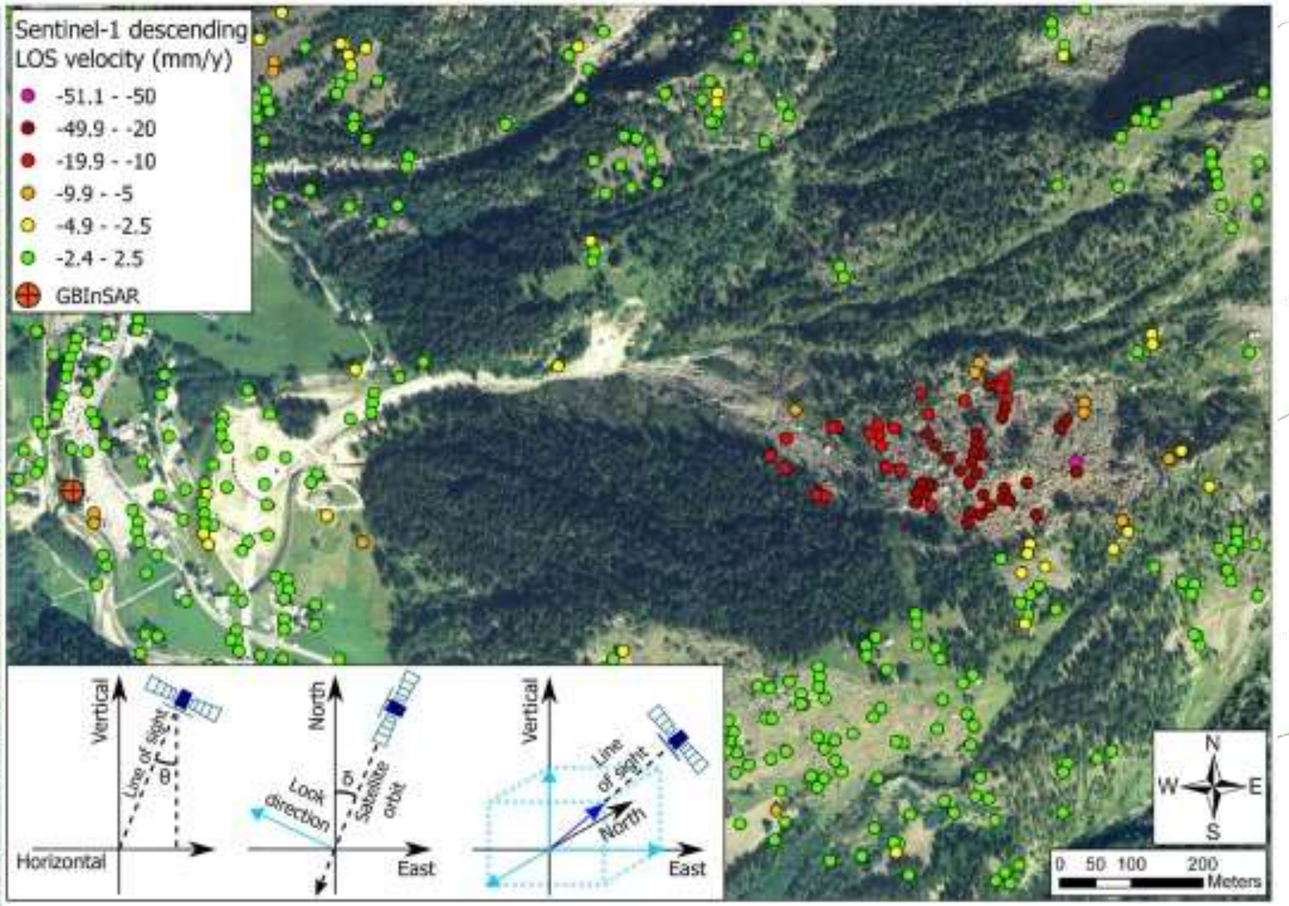


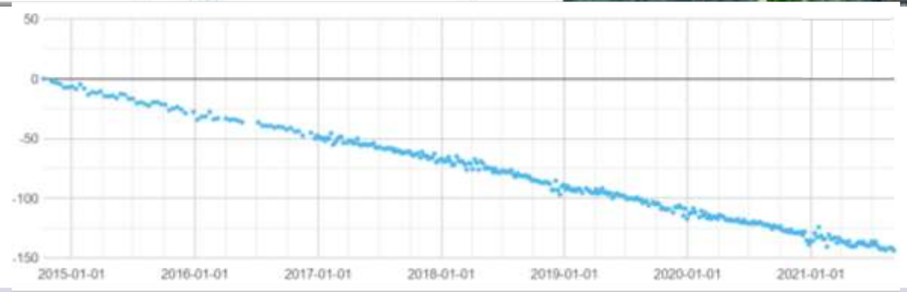
Bosmatto slide (Italy)



The past: archive elaboration







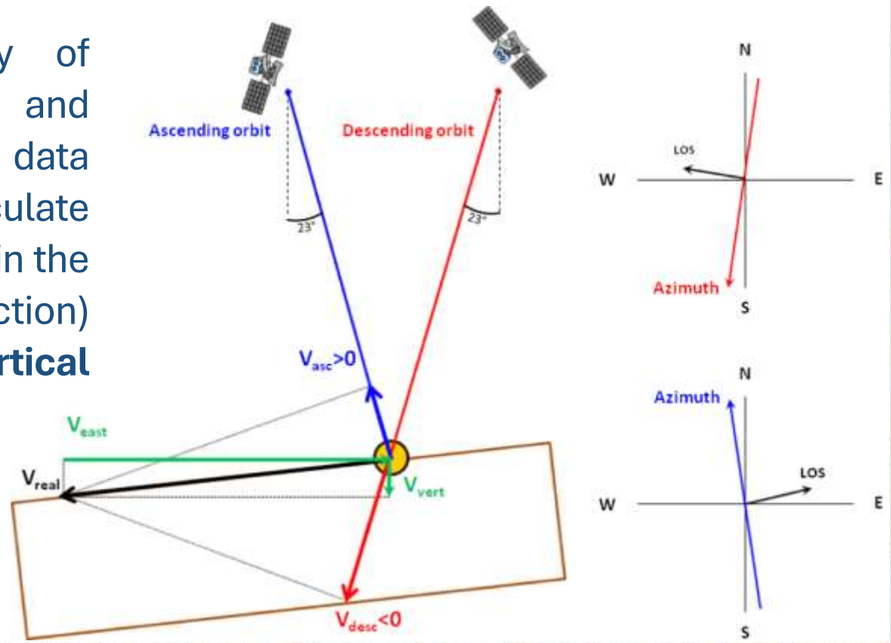
Satellite data show active movements in the upper part of the landslide

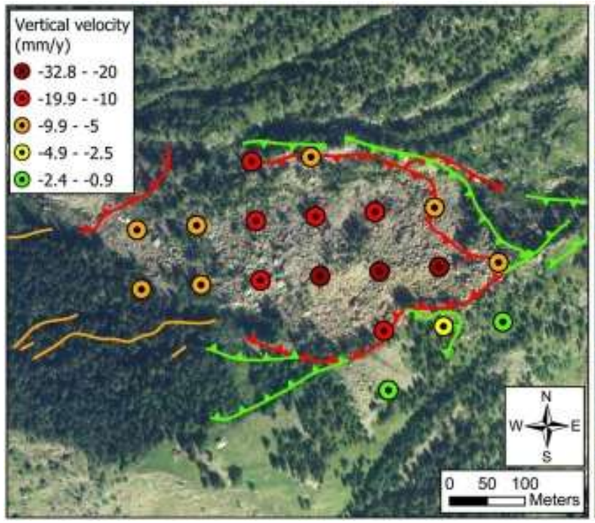
LOS velocity along descending orbits in the order of 40 mm/yr

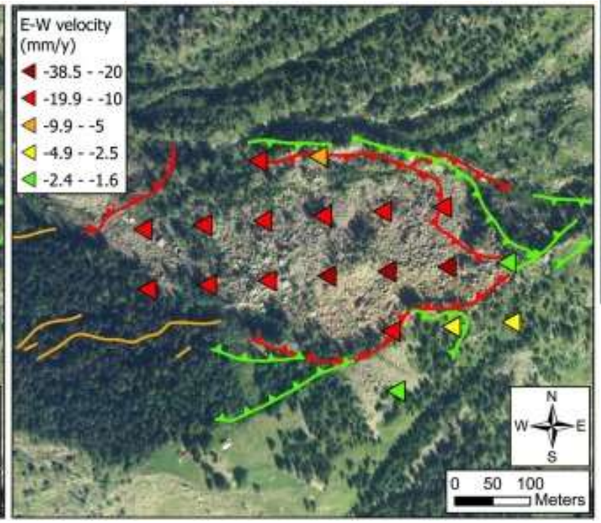
Displacement time series show a linear trend of movement, without any acceleration, deceleration or season variation

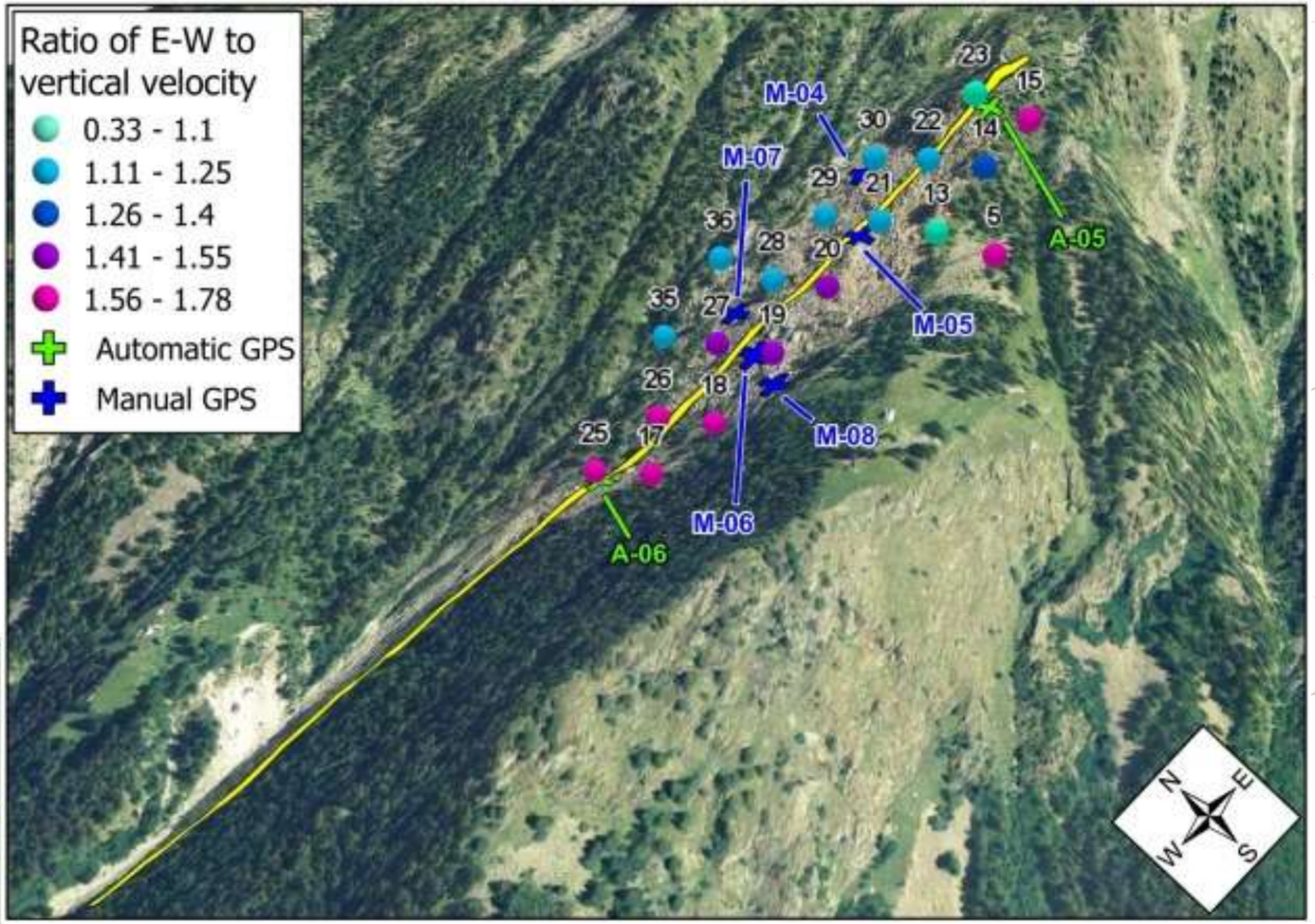
The past: archive elaboration

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



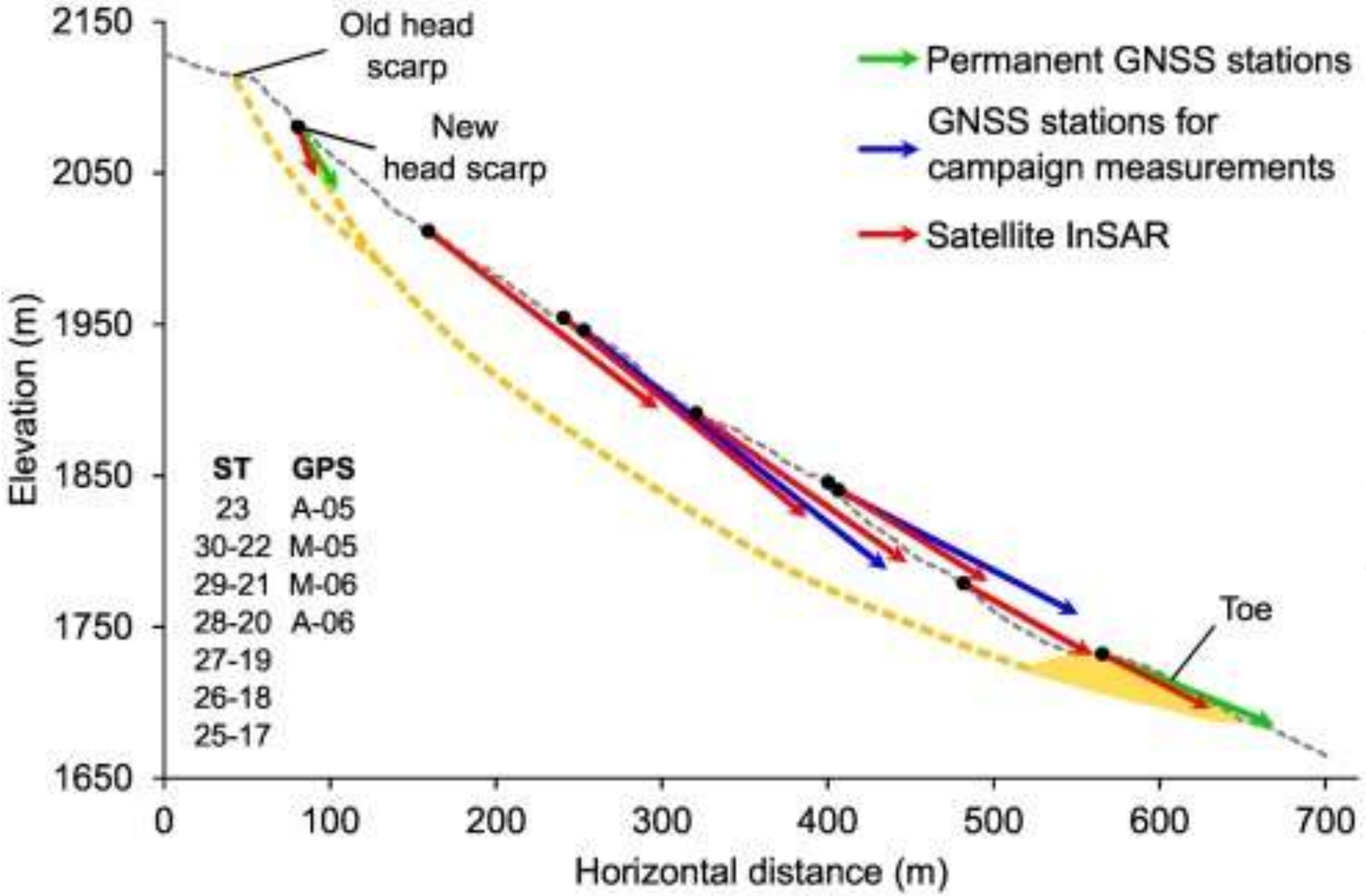






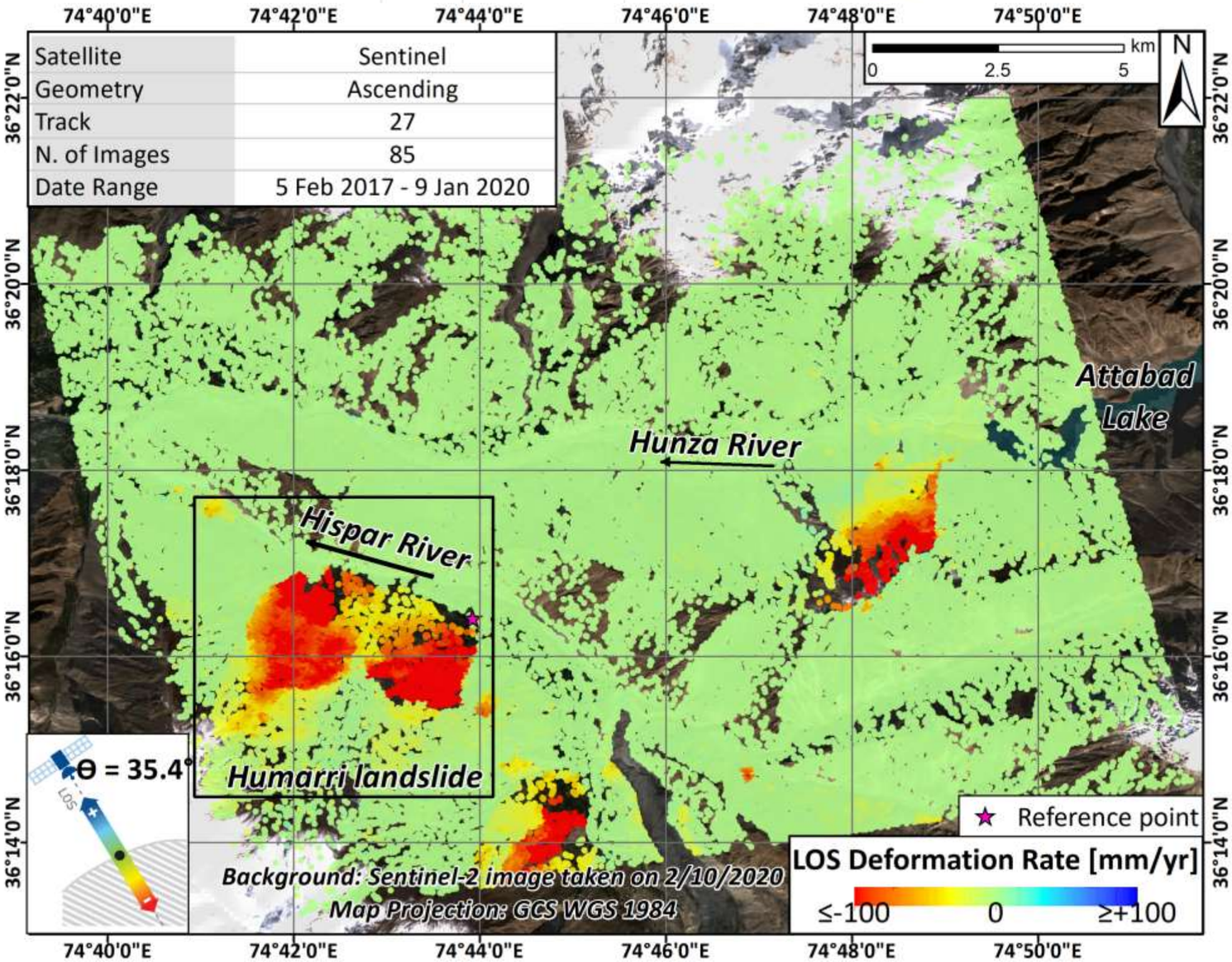
In the upper part of the landslide (crown area) the vertical deformation is dominant, while the horizontal component increases in downslope direction, according to a **roto-translational sliding phenomenon**.

The past: archive elaboration

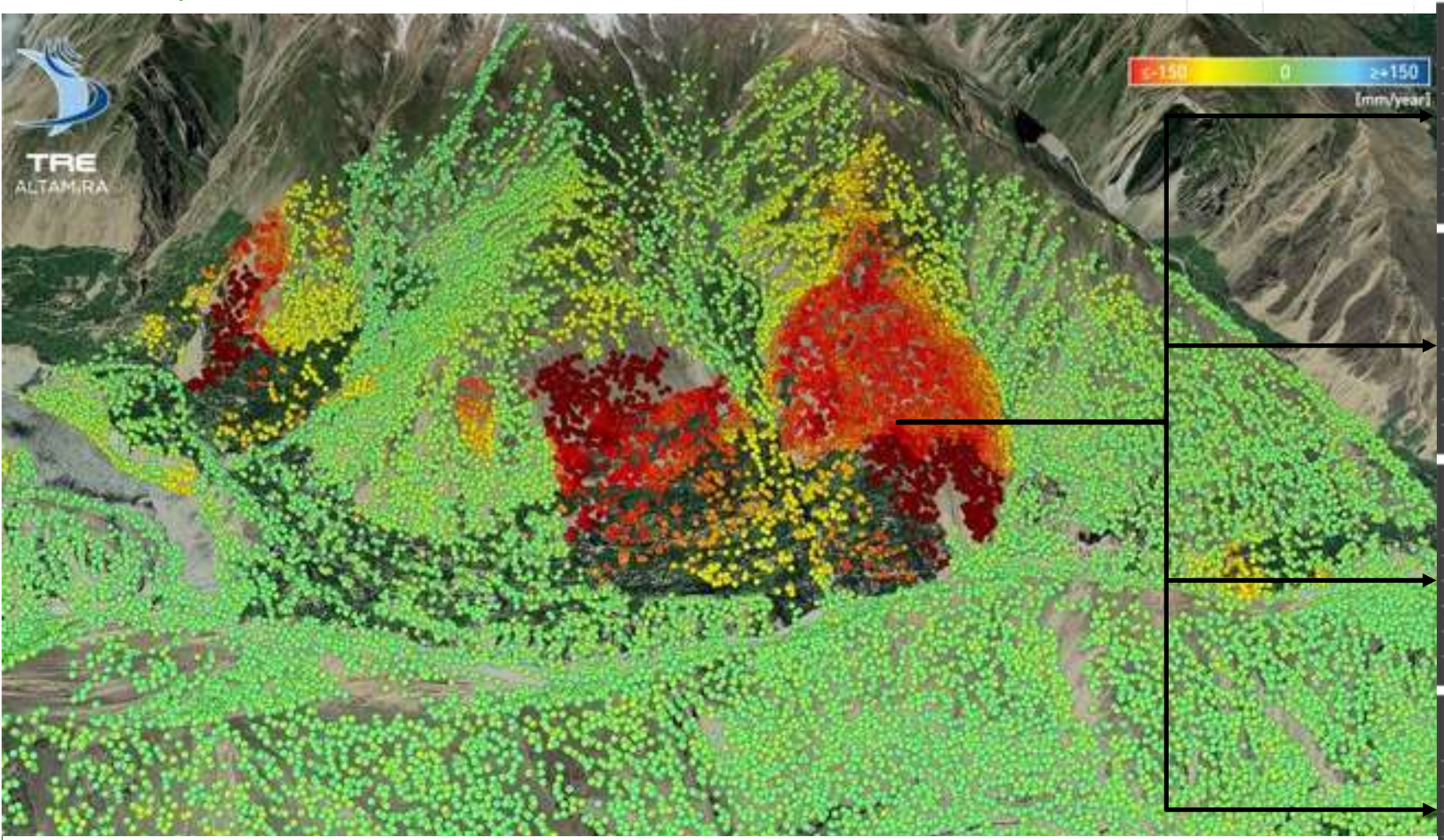


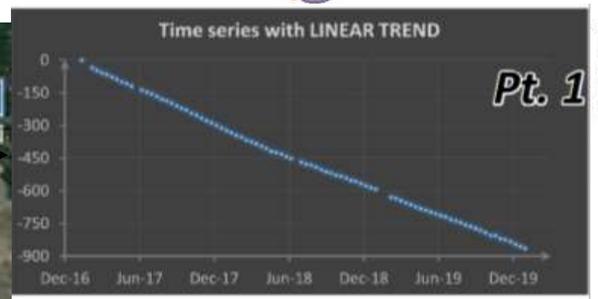
The past: archive elaboration

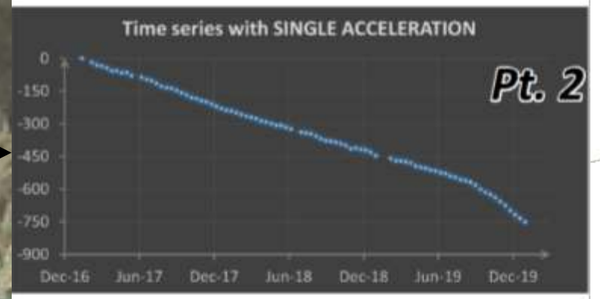
Humarri landslide (Pakistan)

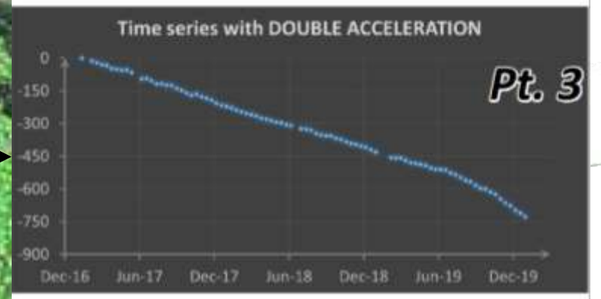


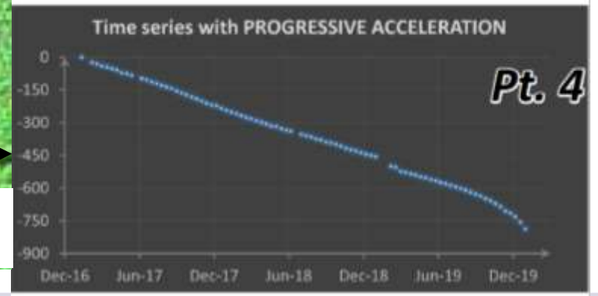
The past: archive elaboration







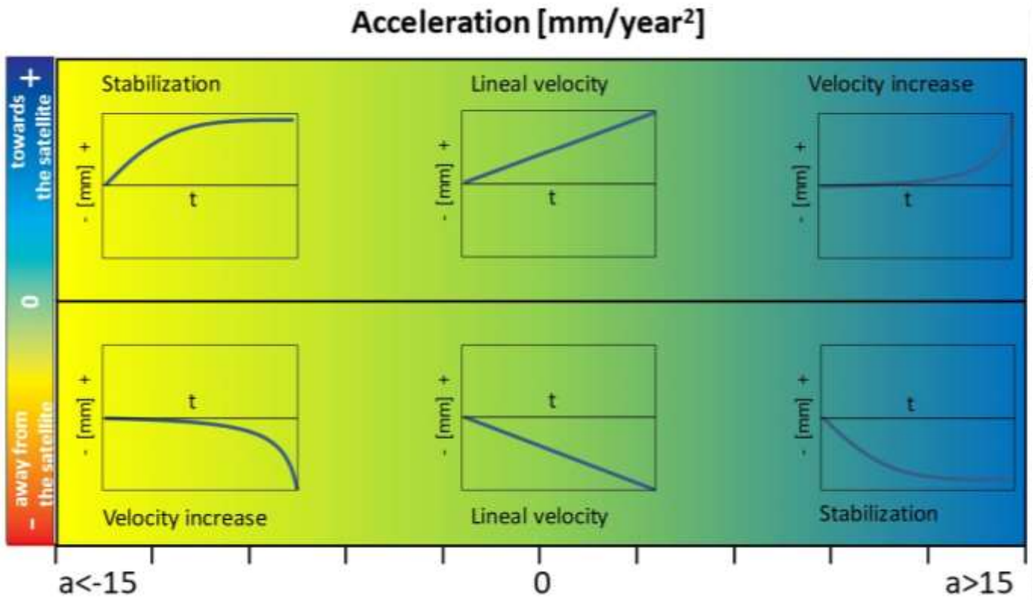




Analysis of displacement time series to define different **kinematic behaviour**

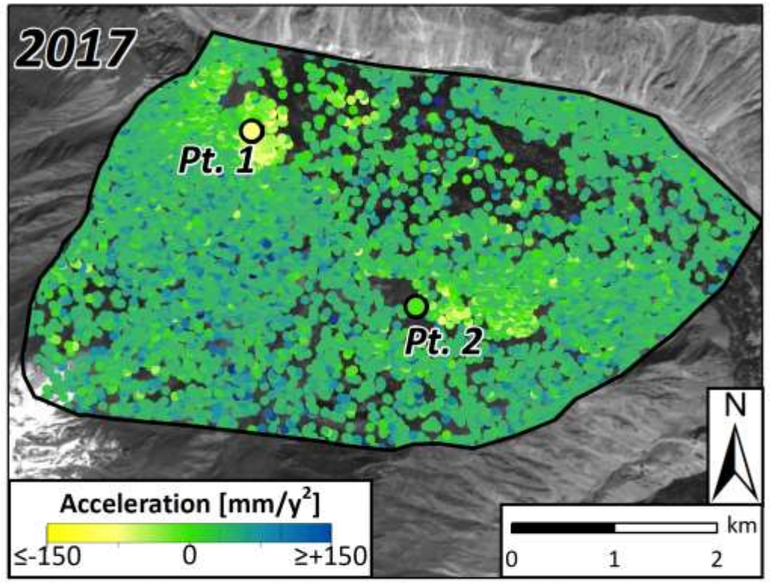
The past: archive elaboration

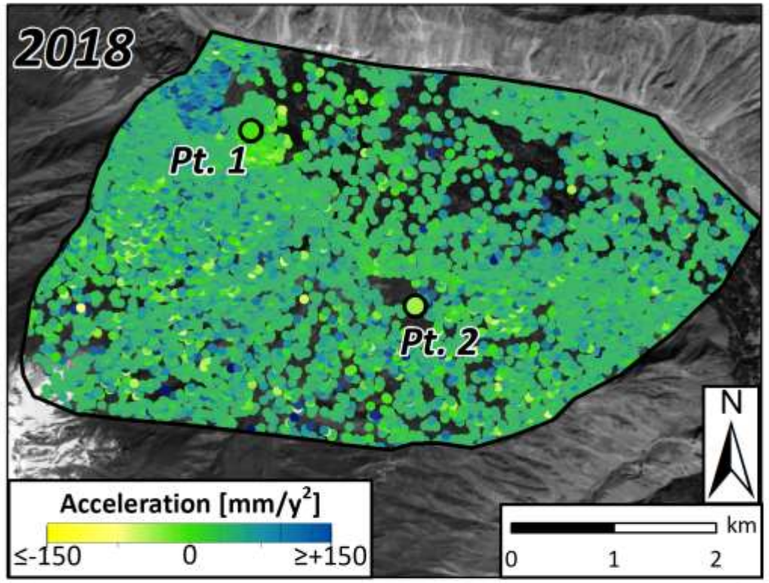
Analysis of displacement time series to identify **acceleration** and deceleration **in landslide movement**

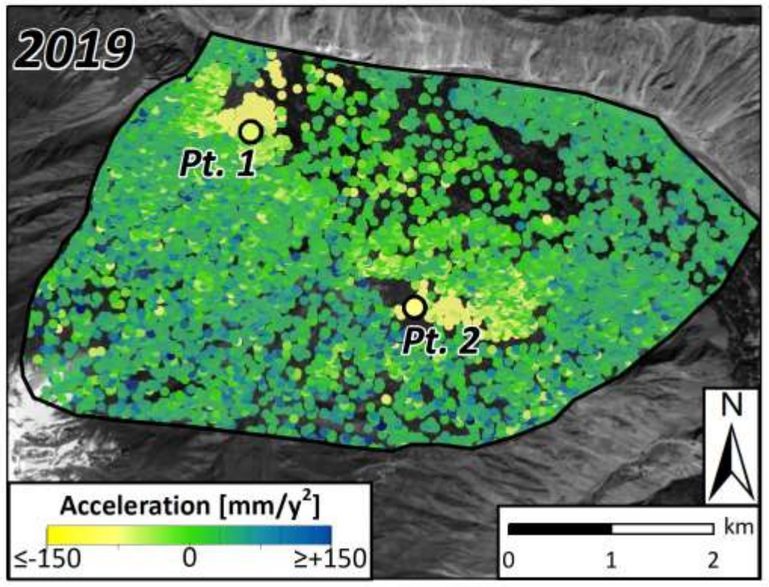


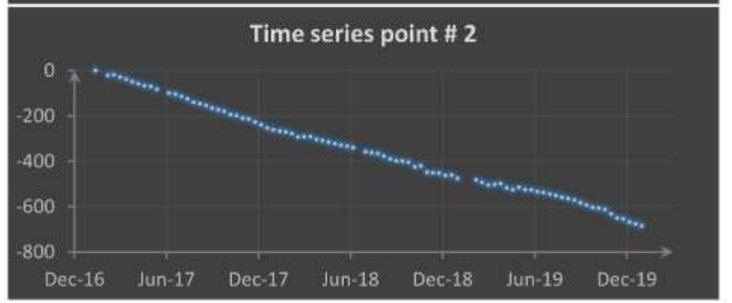
The early detection of accelerating areas is the main purpose of any landslide monitoring system.

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









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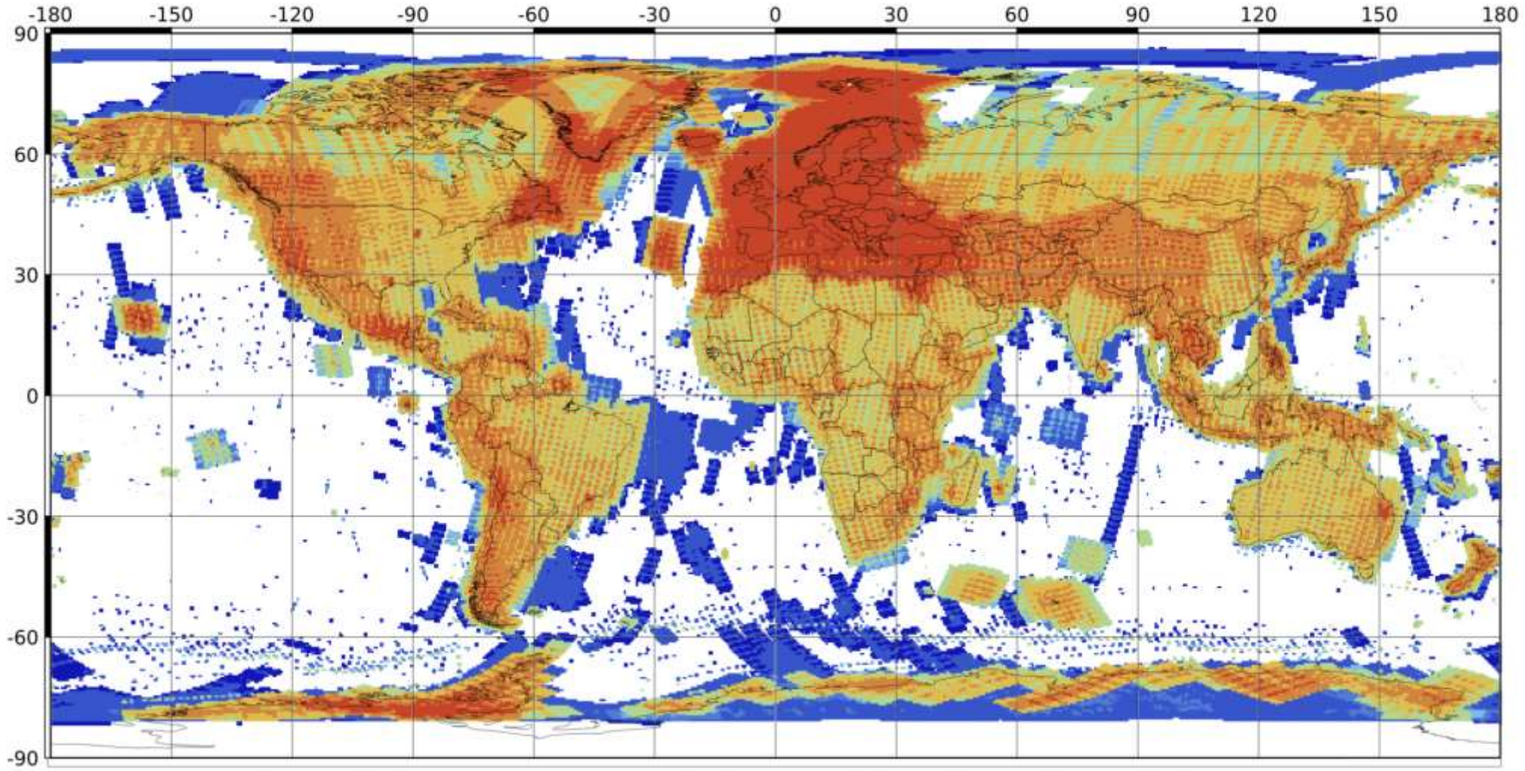
The present: wide area monitoring system



Sentinel-1 Level 1 SLC Data Coverage

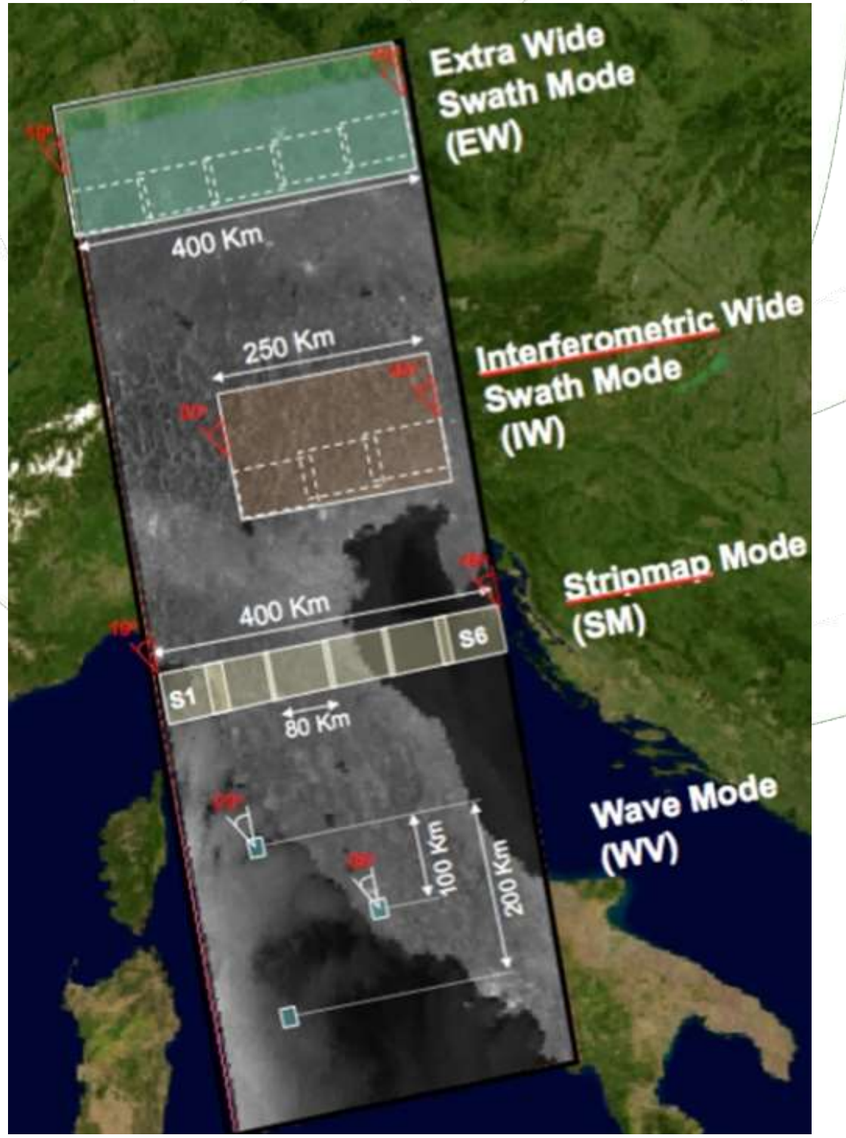
Copernicus Sentinel-1A and Sentinel-1B data, 2014-2021
Current: 30 September 2021

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]

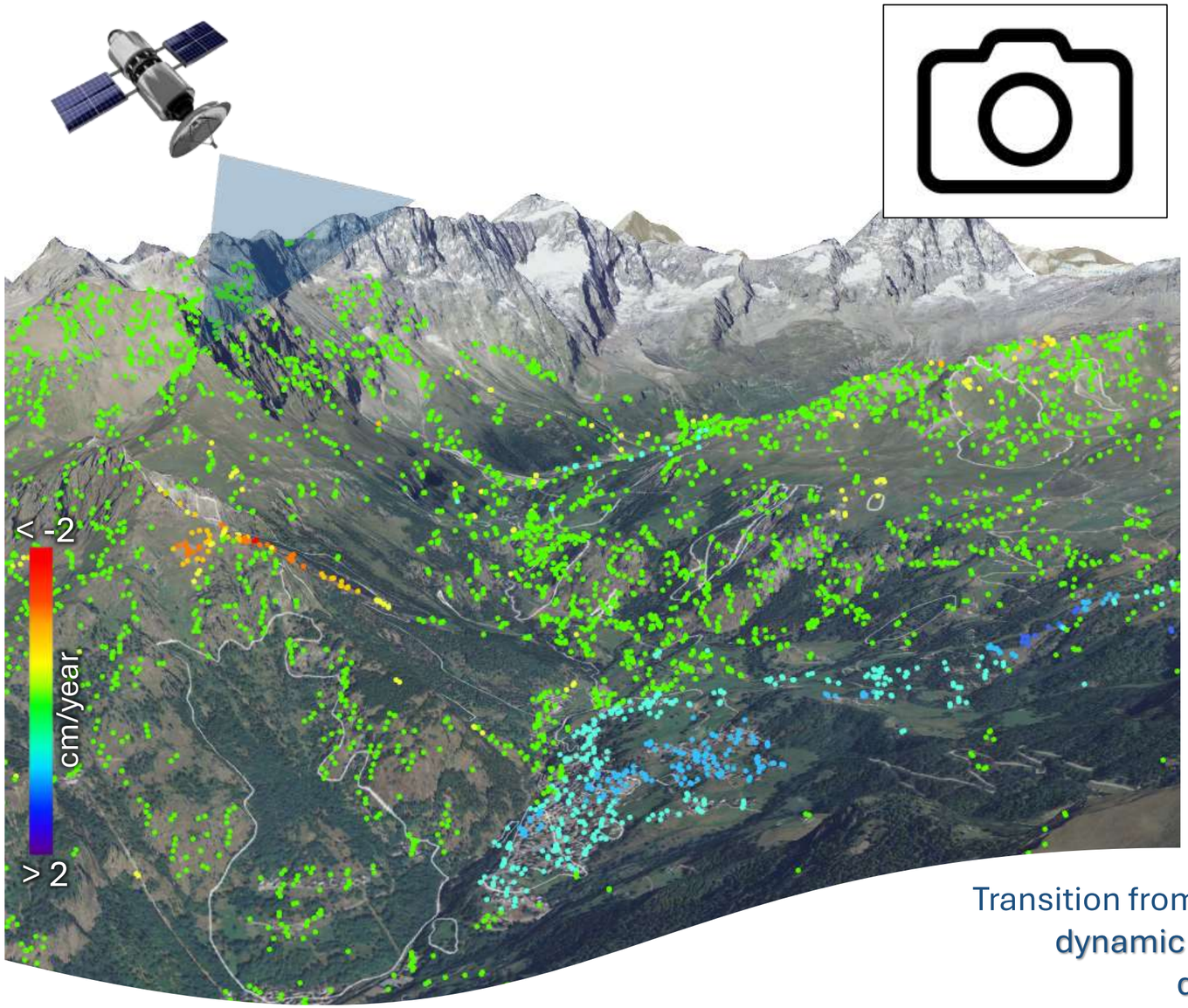
Legend

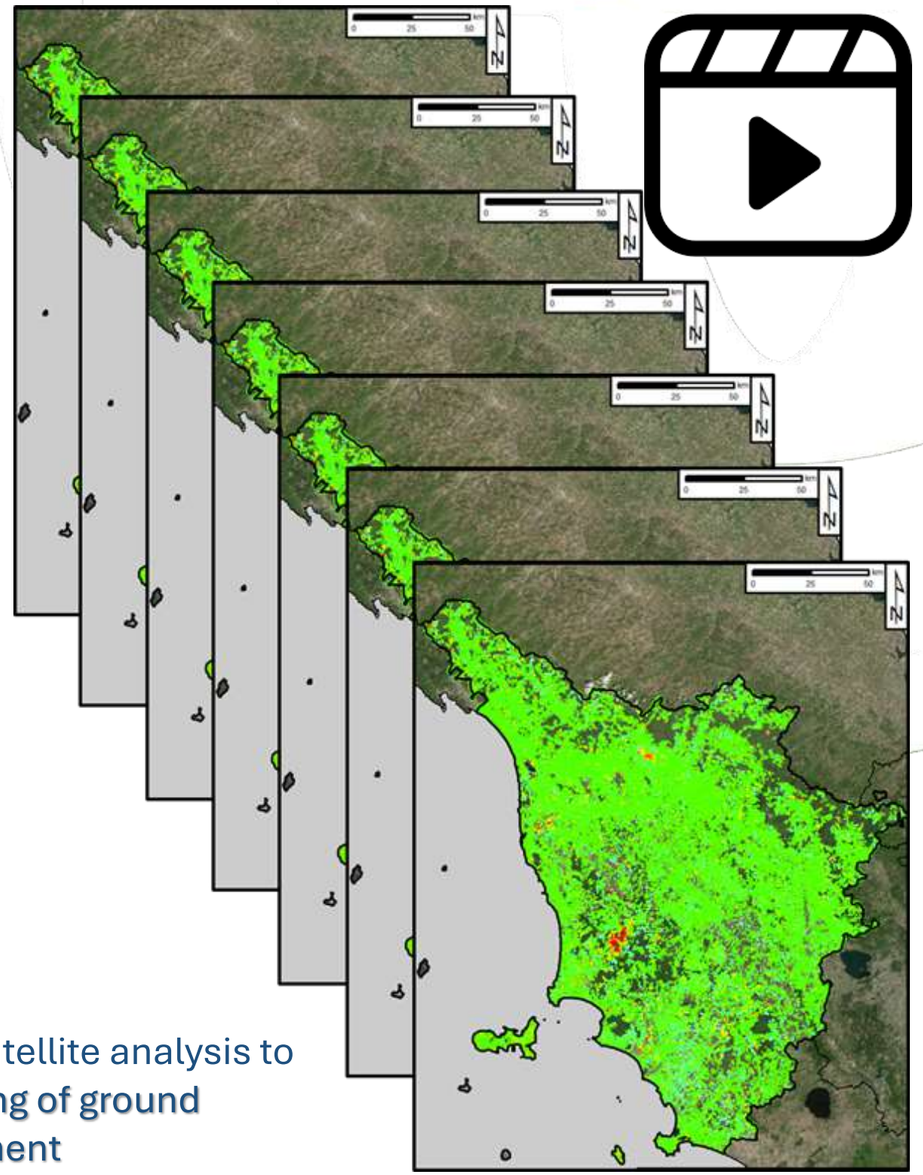
No. Observations

- <= 1
- 2 - 25
- 26 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 1000
- > 1000



The present: wide area monitoring system



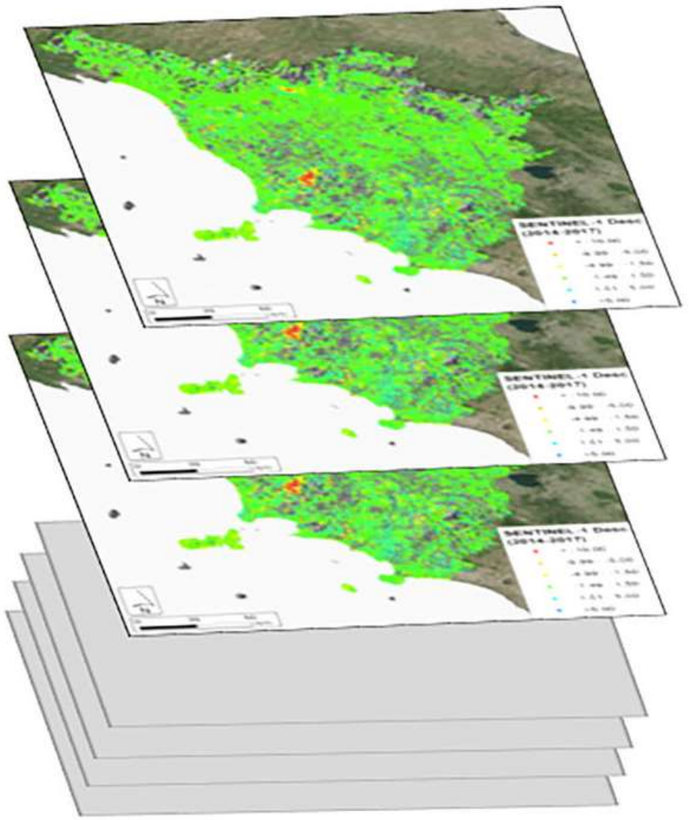


Transition from static satellite analysis to dynamic monitoring of ground displacement

The present: wide area monitoring system

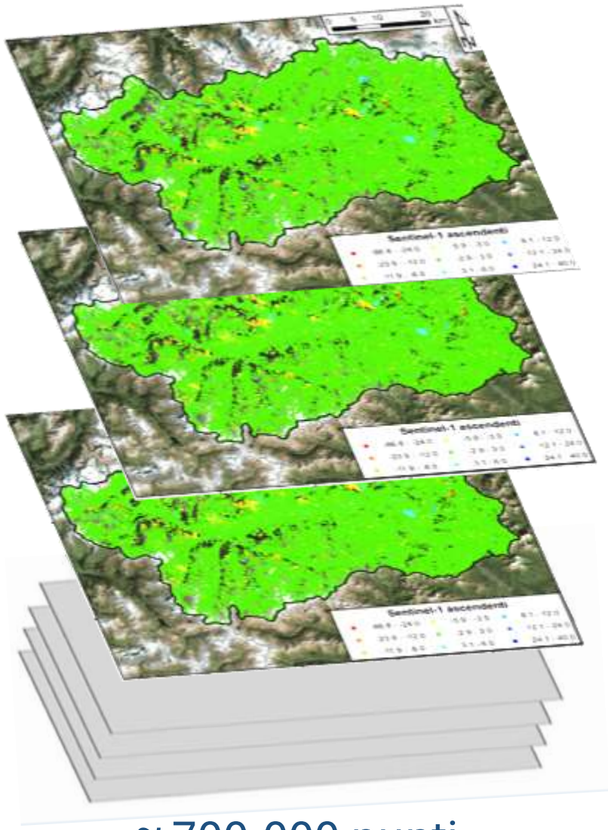
Ottobre 2016 → *Gennaio 2018* → *Giugno 2019*

Regione Toscana



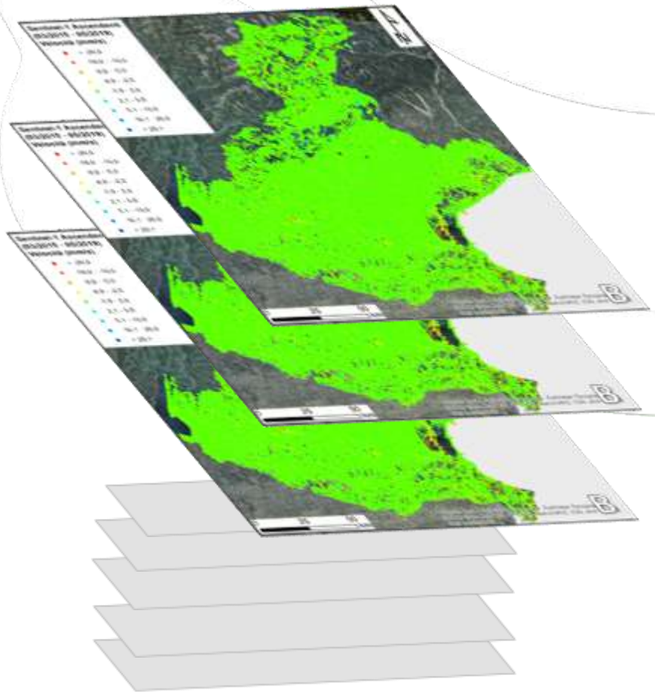
≈ 2.000.000 punti

Regione Valle d'Aosta



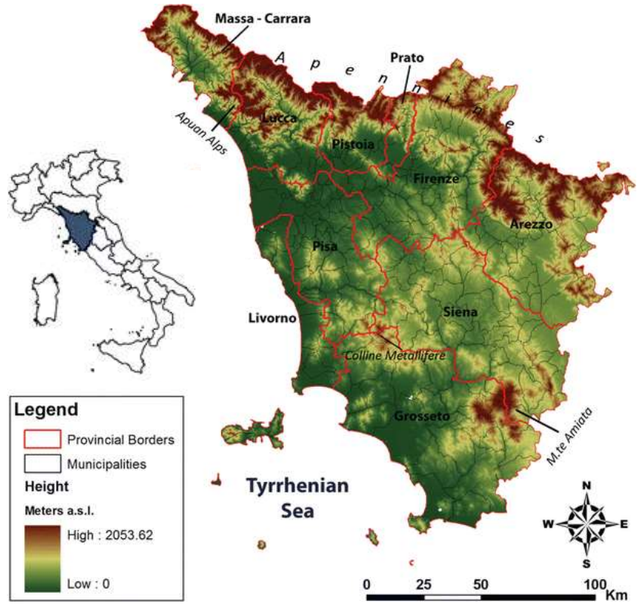
≈ 700.000 punti

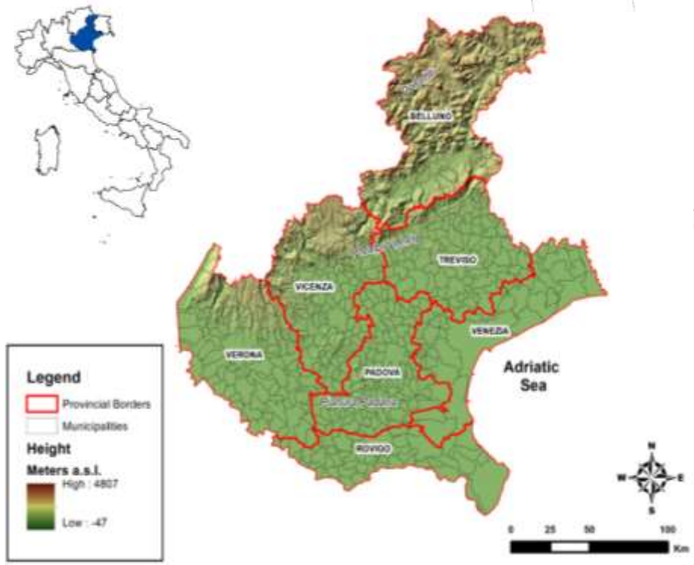
Regione Veneto

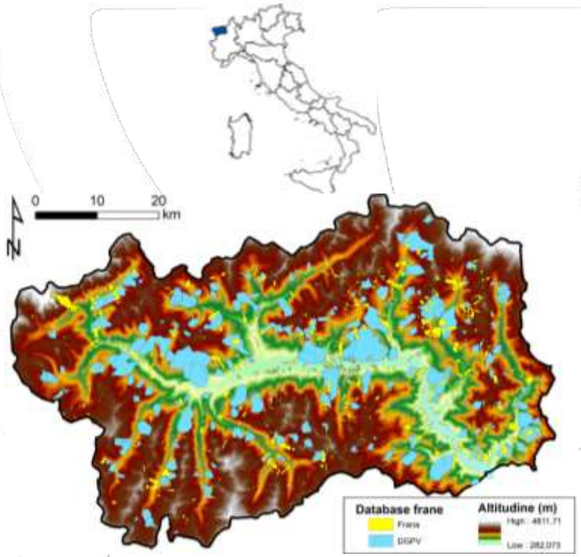


≈ 3.000.000 punti

The present: wide area monitoring system





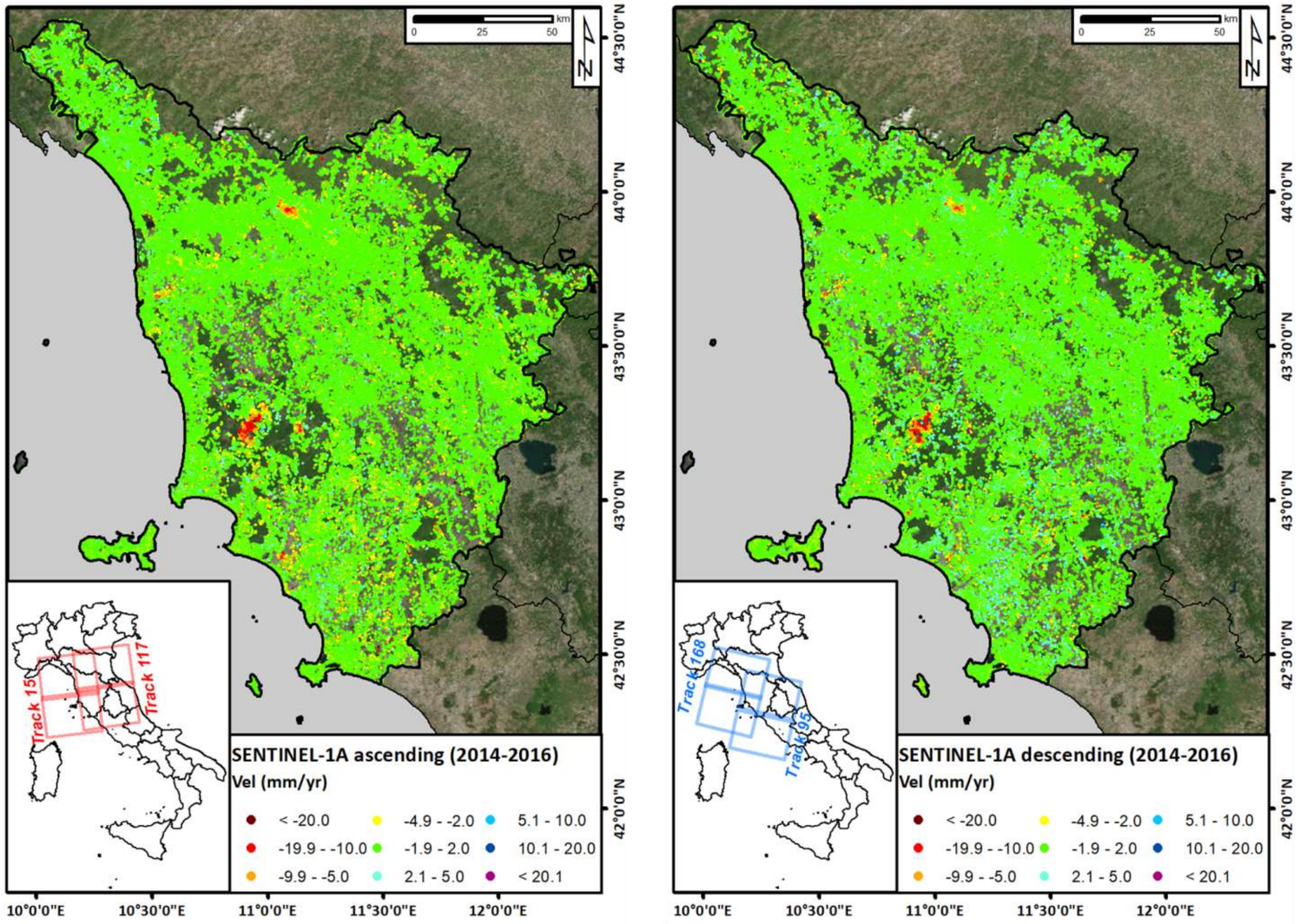


Complex landslides, slides

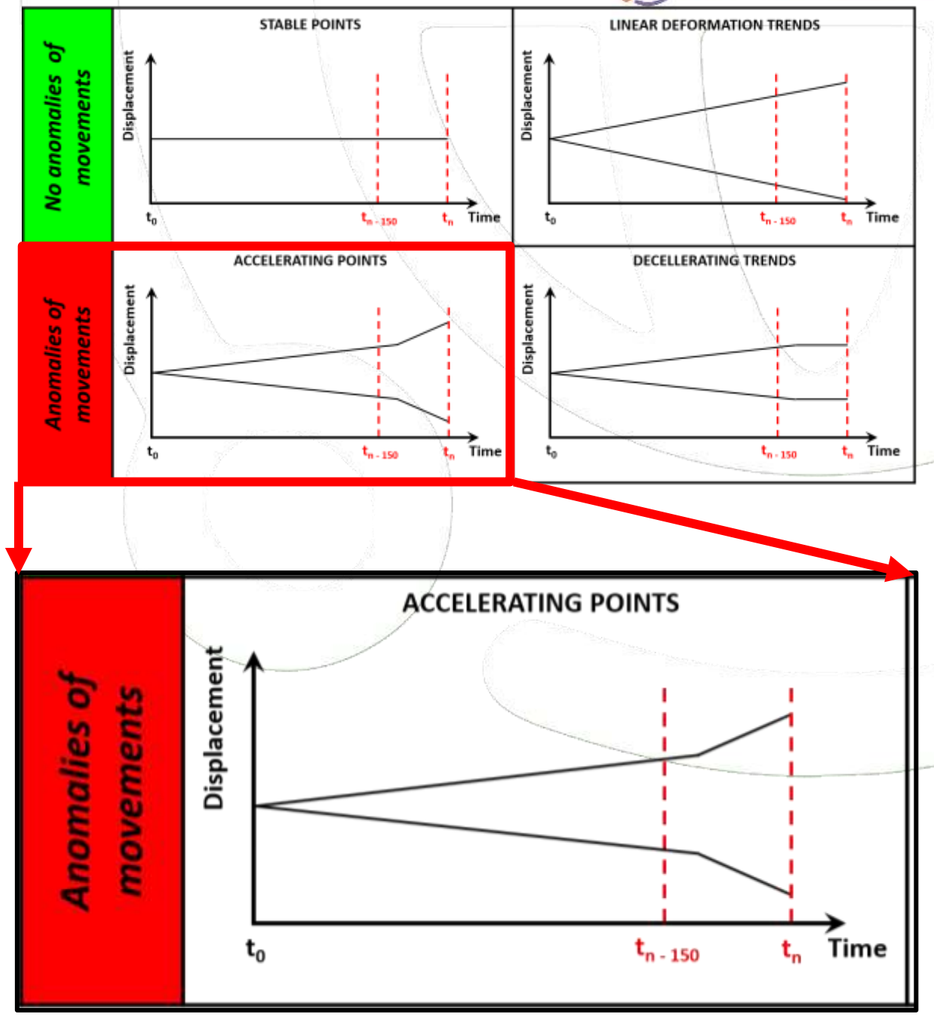
Complex landslides, earth flow

Complex, rockslides, deep-seated LS

The present: wide area monitoring system



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

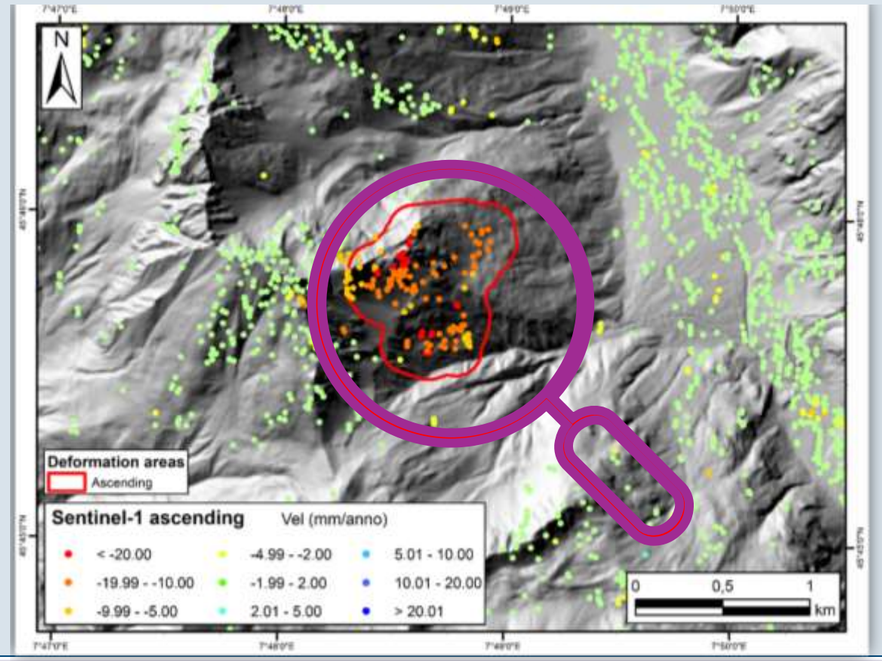


Anomaly of movement:
points where a change in the dynamic of motion is occurring. Information on **kinematics** of movement

The present: wide area monitoring system

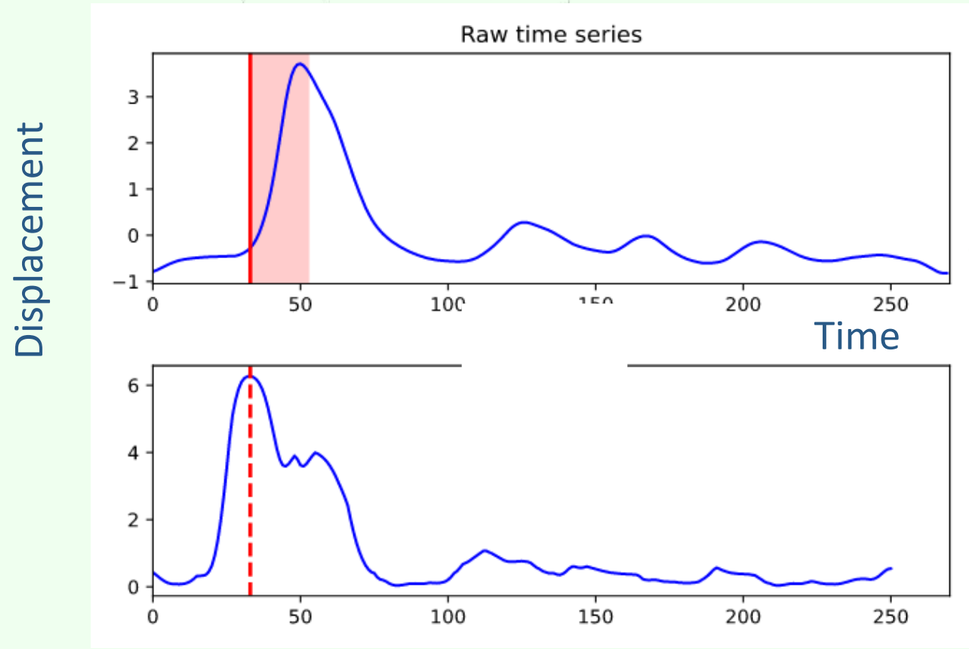
PS Mapping

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



PS Monitoring

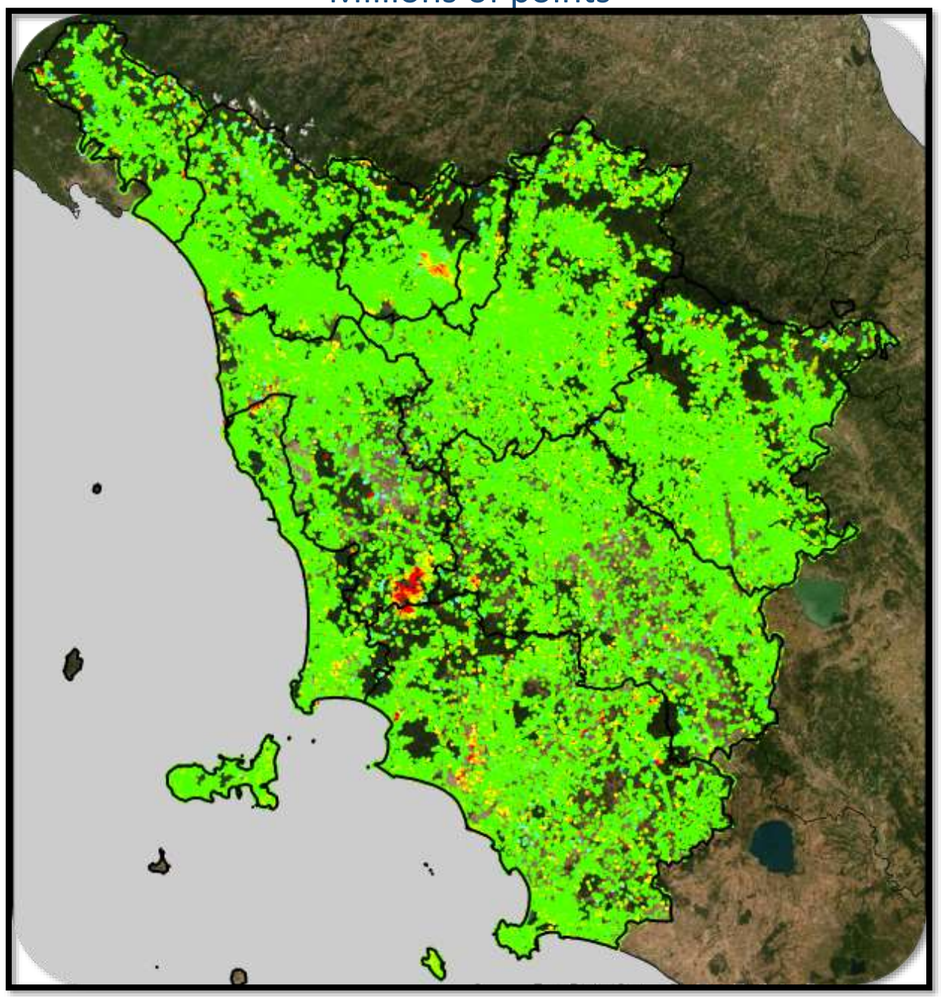
- Online activity
- Time Series analysis
- Continuous service, every Sentinel-1 acq.
- Near-real time
- Early warning of geohazard risk scenarios



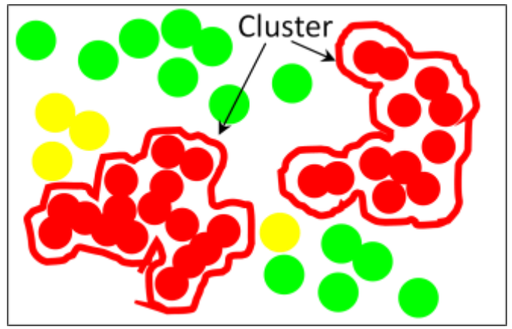
The present: wide area monitoring system

Deformation maps

Millions of points

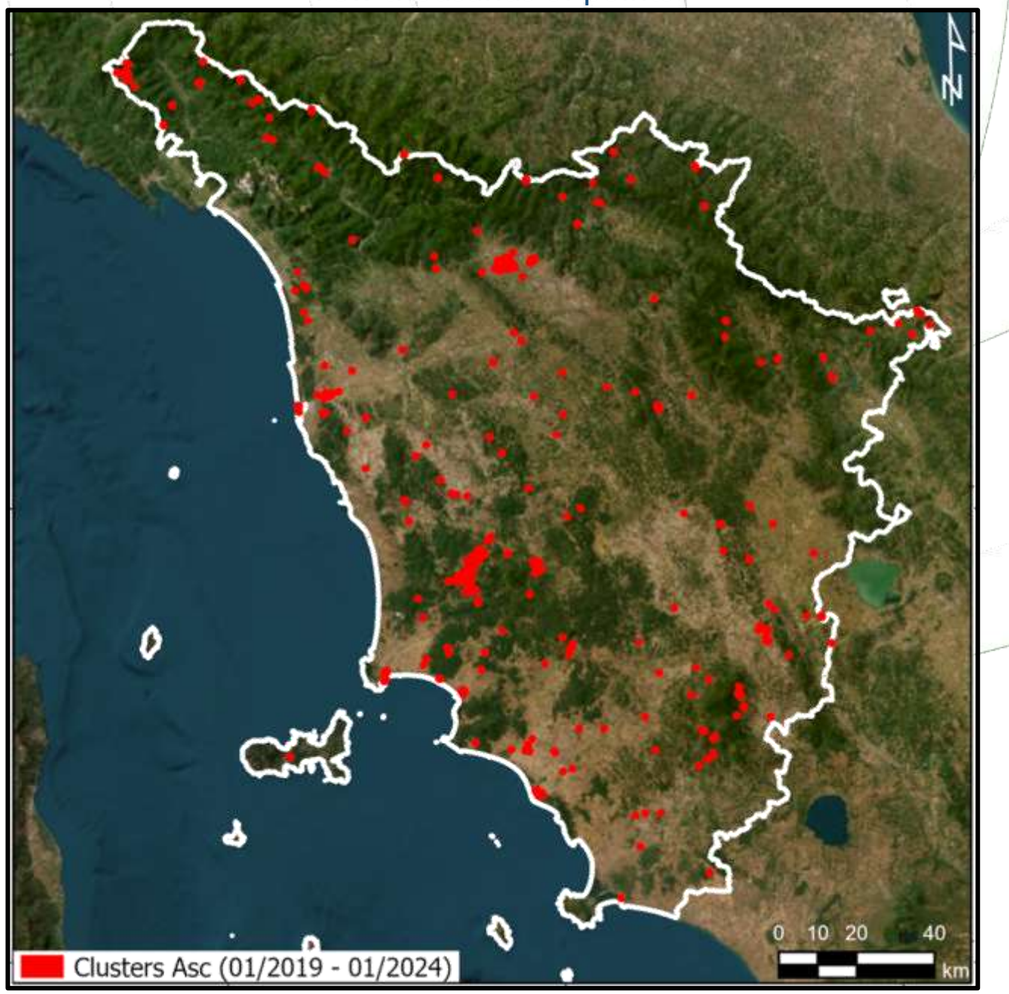


Thresholds and clustering



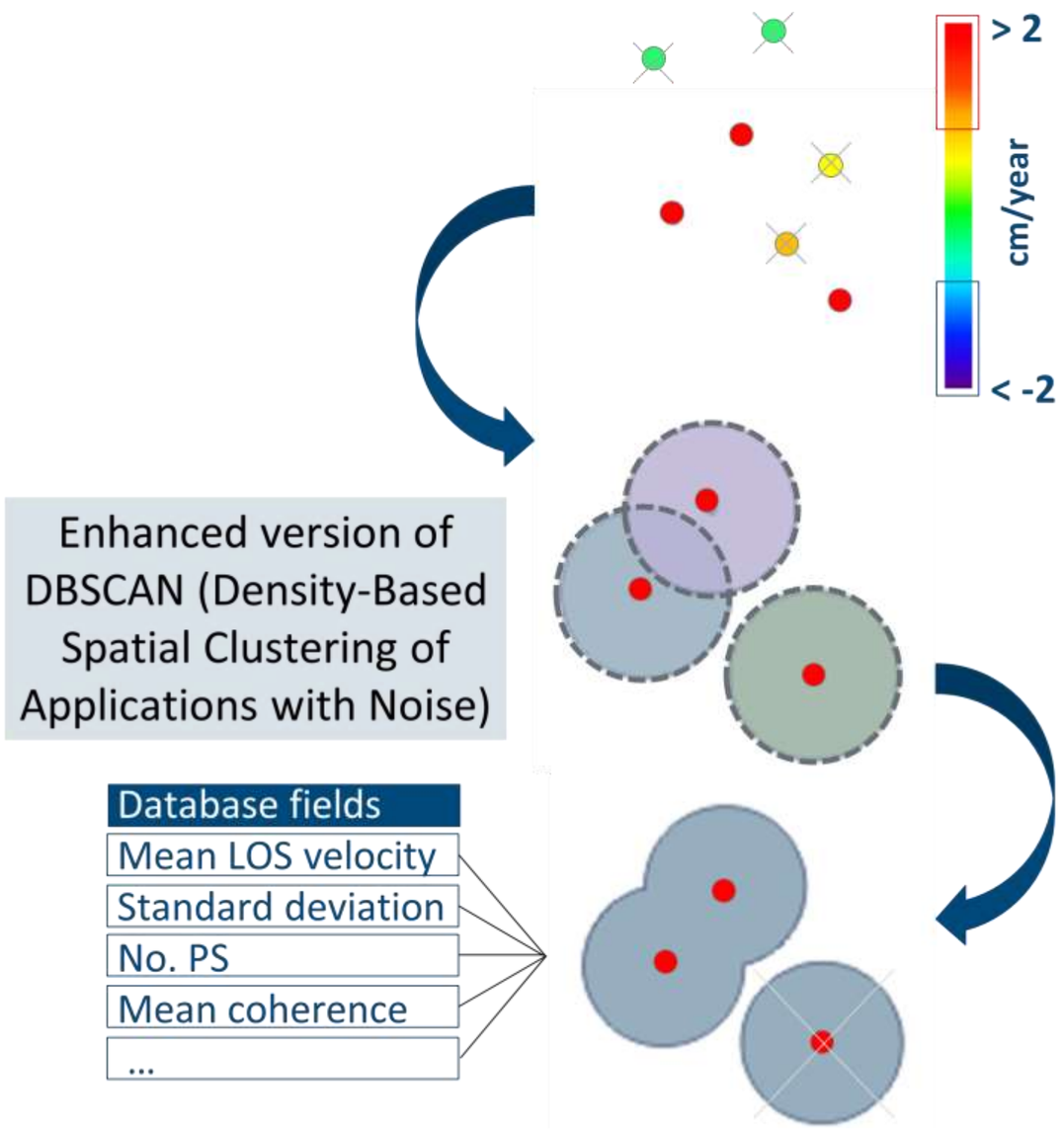
High-moving areas

Few thousands of points



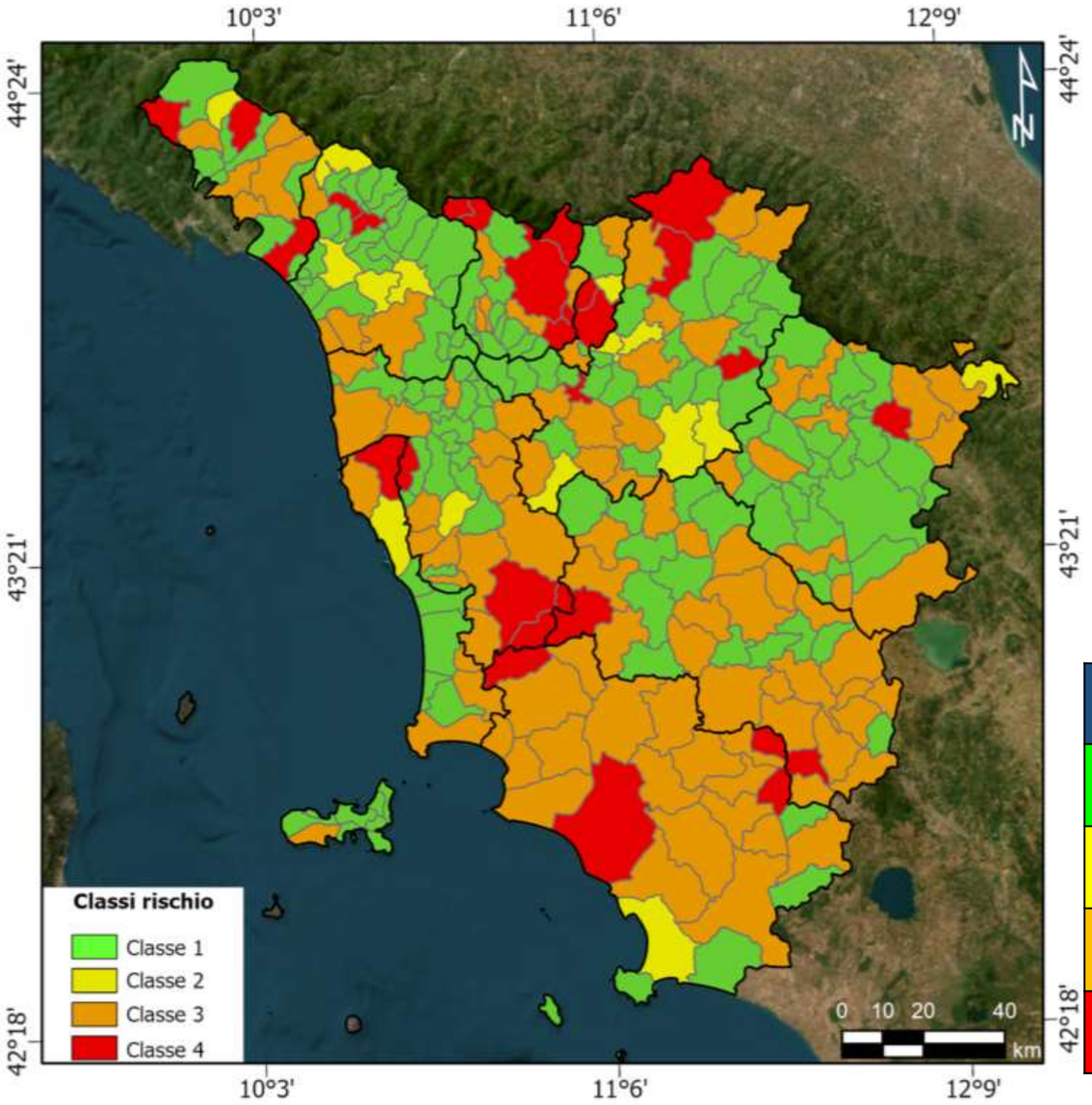
Wide area scanning to spot active deformation zones

The present: wide area monitoring system



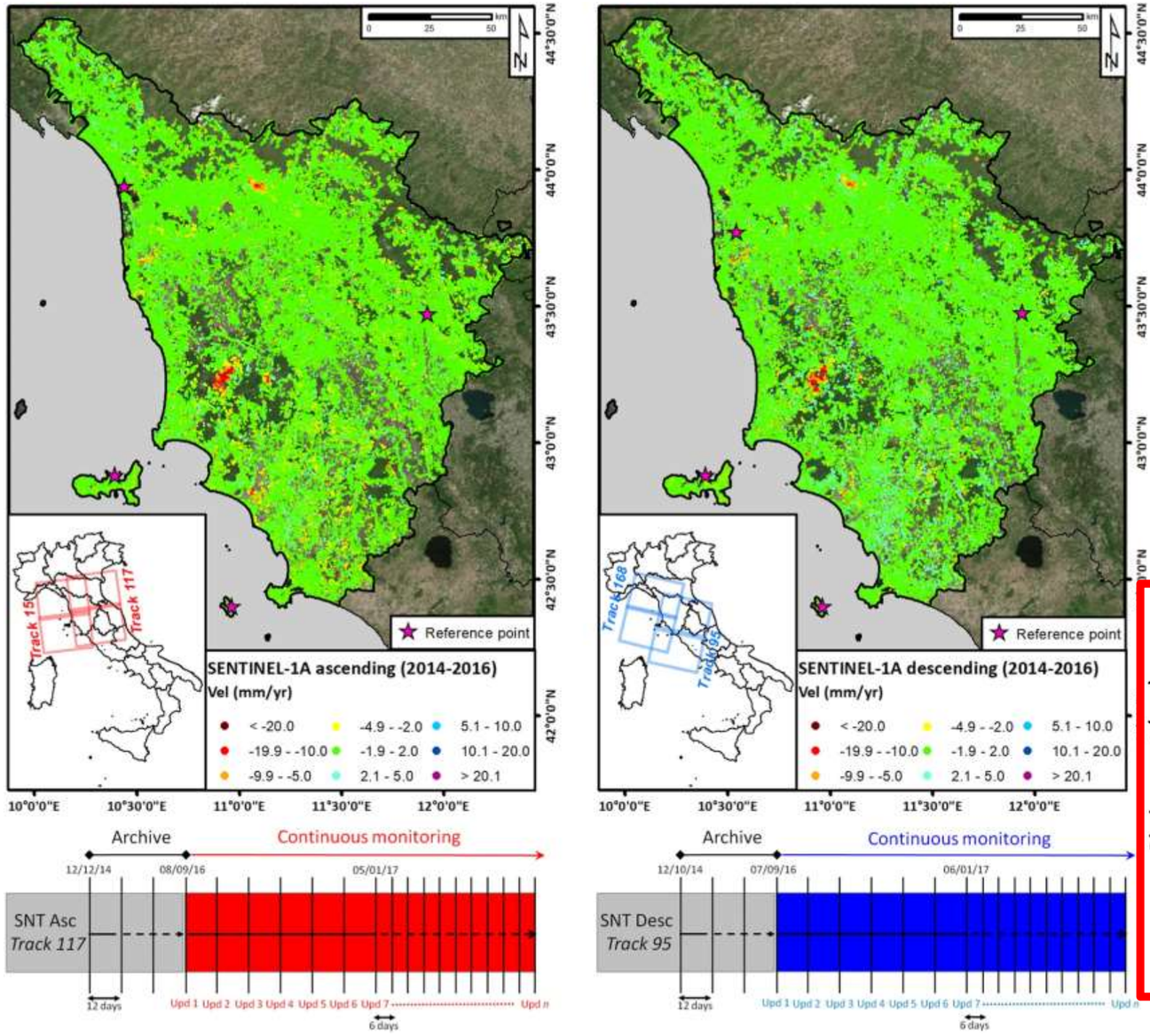
1. PS filtering: setting the displacement rate threshold to retain “outliers” data and to remove stable PS (noise).
2. Buffer size: PS radius of “influence” in accordance with the dataset spatial resolution to retrieve hotspots.
3. Minimum cluster size: PS number threshold to find core samples of high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

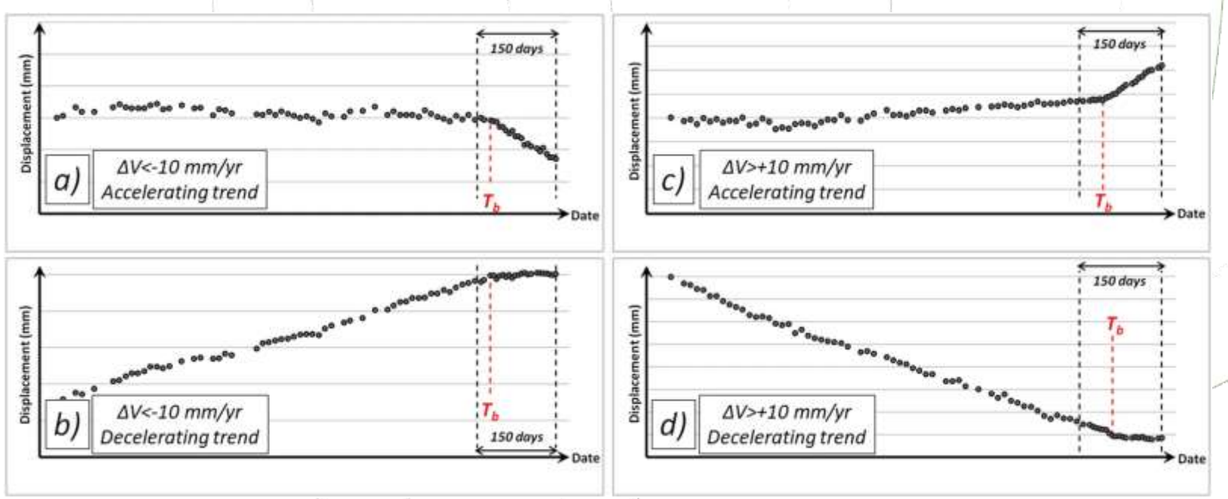
The present: wide area monitoring system

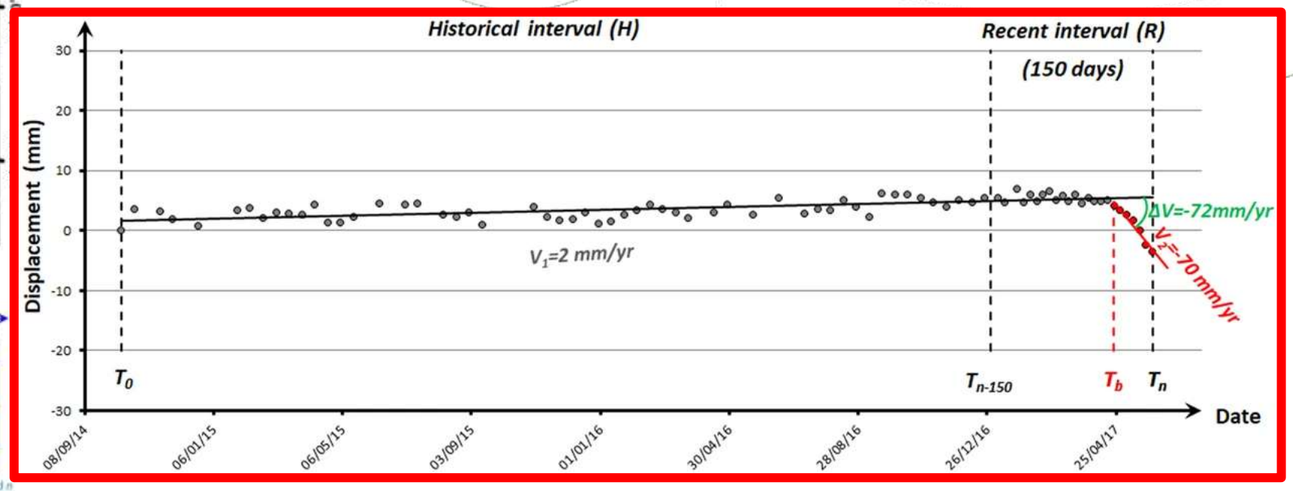


Level of risk	Description
1	No elements at risk within the active areas
2	Isolated elements at risk within the active areas
3	Distributed elements at risk within the active areas
4	Several elements at risks within the active areas

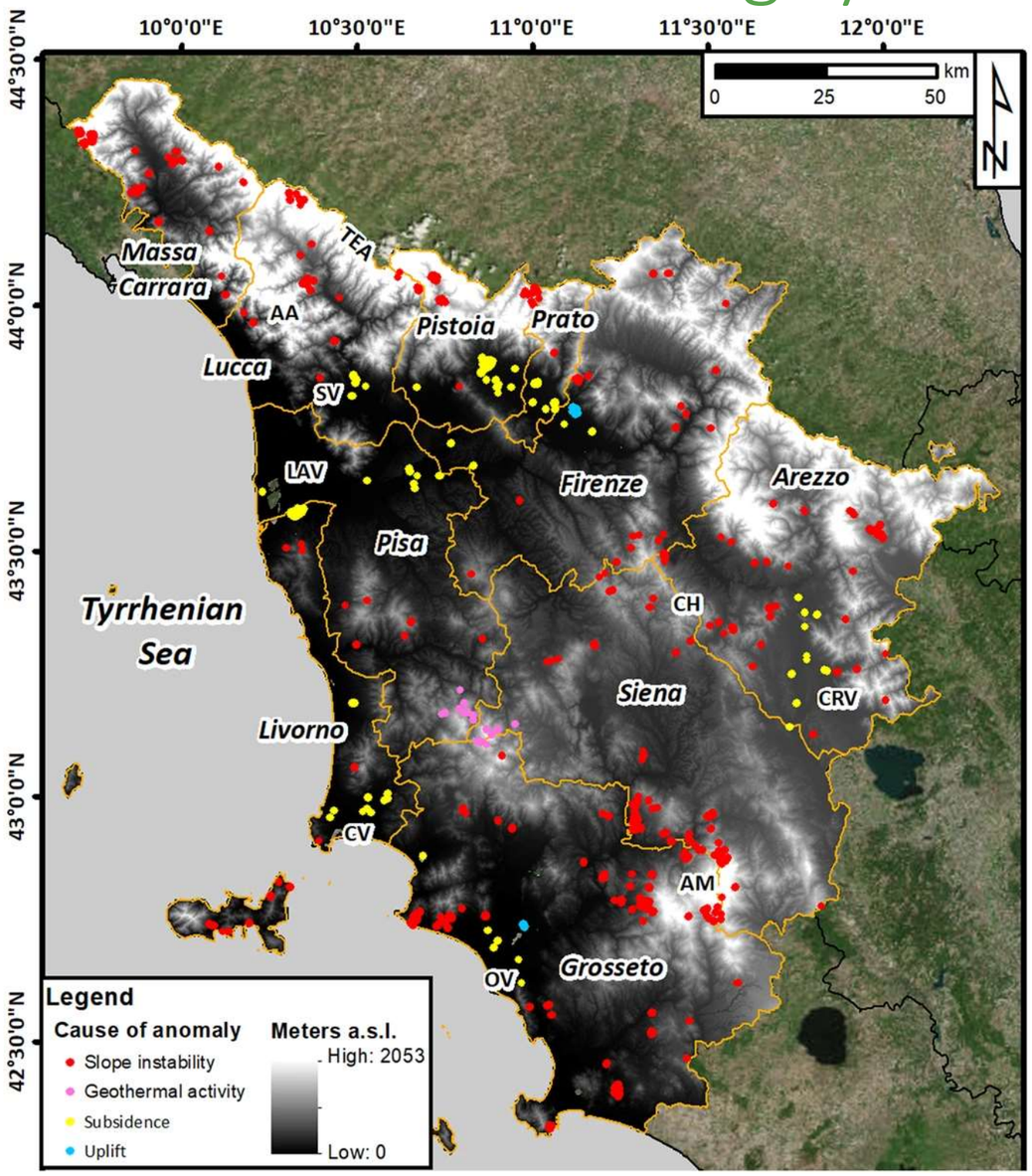
The present: wide area monitoring system







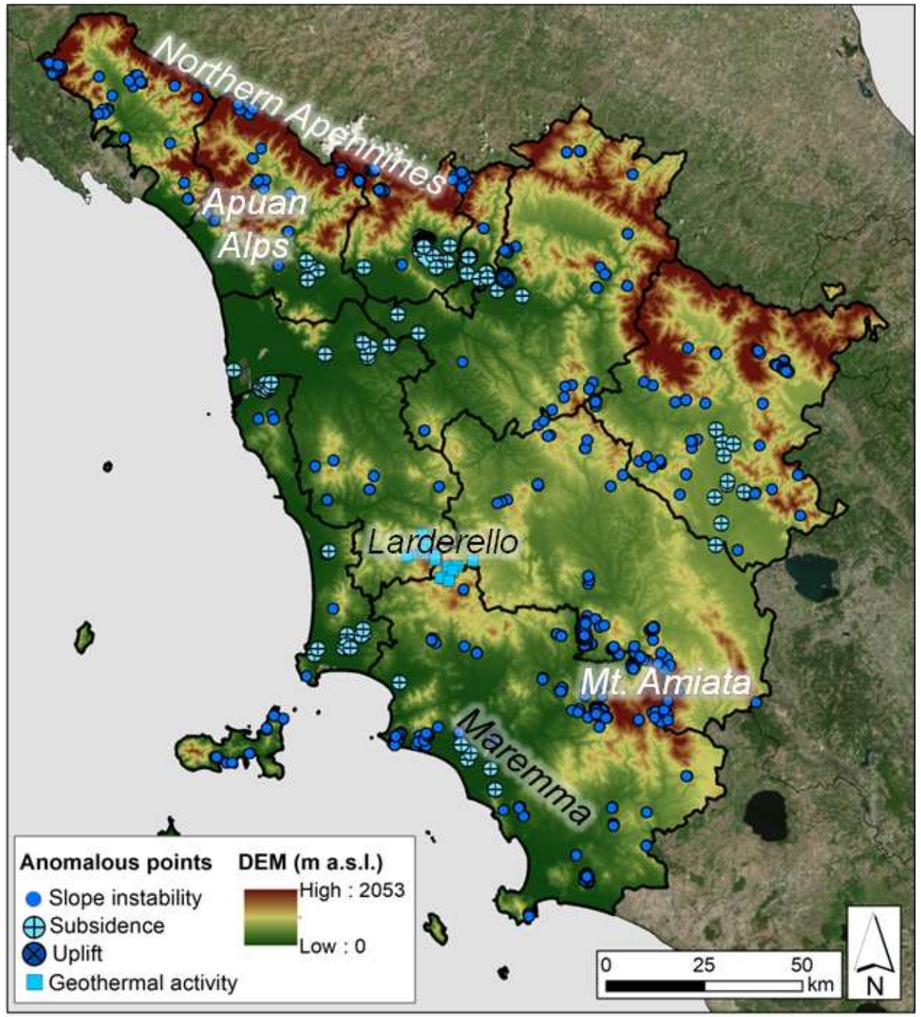
The present: wide area monitoring system

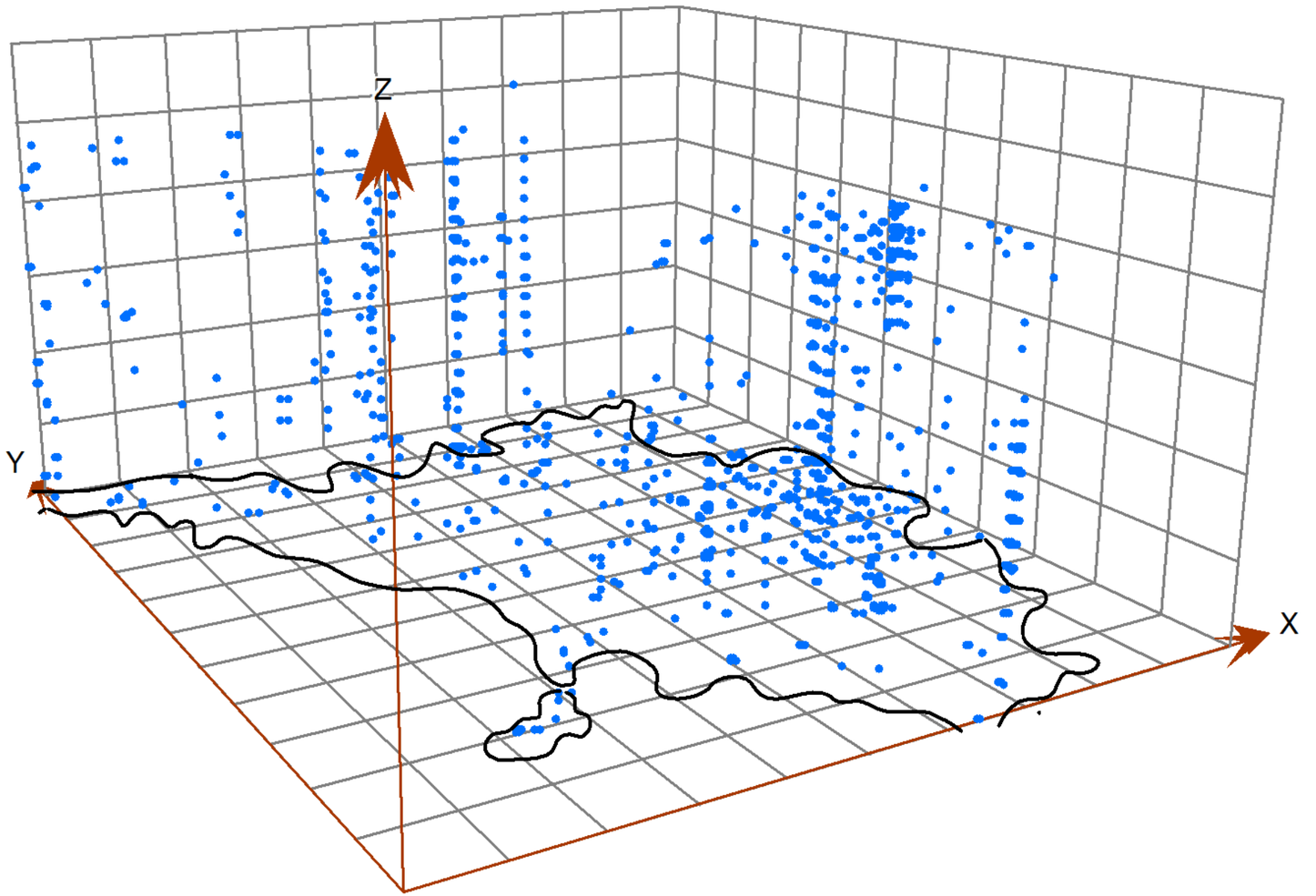


Update	Last acqusition (track 117)	# of Anomalies	# of ghost anomalies
2	07/11/2016	70	133
3	19/11/2016	90	104
4	01/12/2016	60	72
5	13/12/2016	95	76
6	25/12/2016	121	86
7	06/01/2017	130	55
8	18/01/2017	84	57
9	30/01/2017	94	86
10	11/02/2017	195	154
11	23/02/2017	304	86
12	07/03/2017	341	56
13	19/03/2017	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

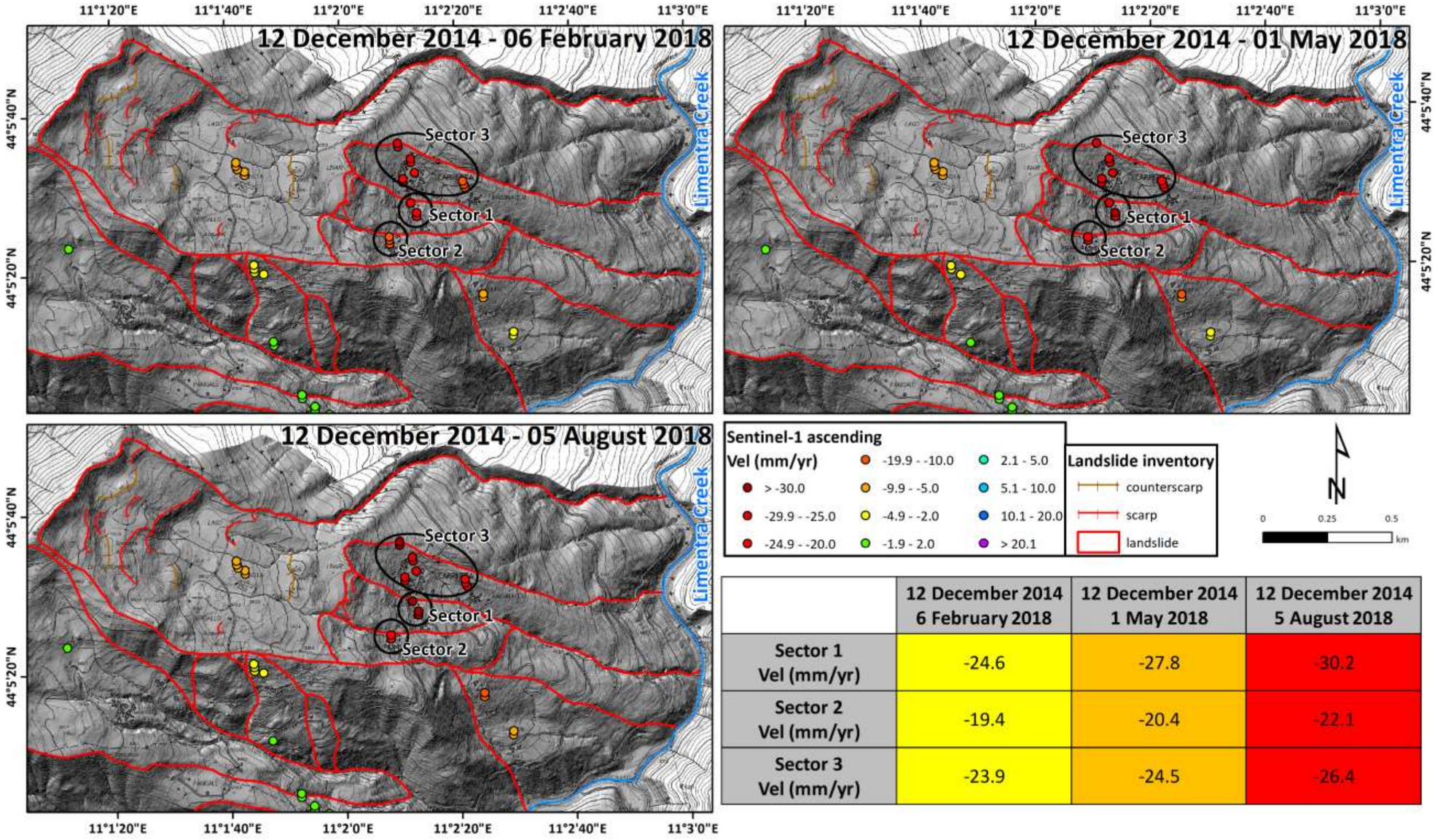




Spatial consistency: only a group of neighbour points (*i.e.*, a cluster) sharing similar trends are considered representative of a change in the kinematics of a given phenomenon

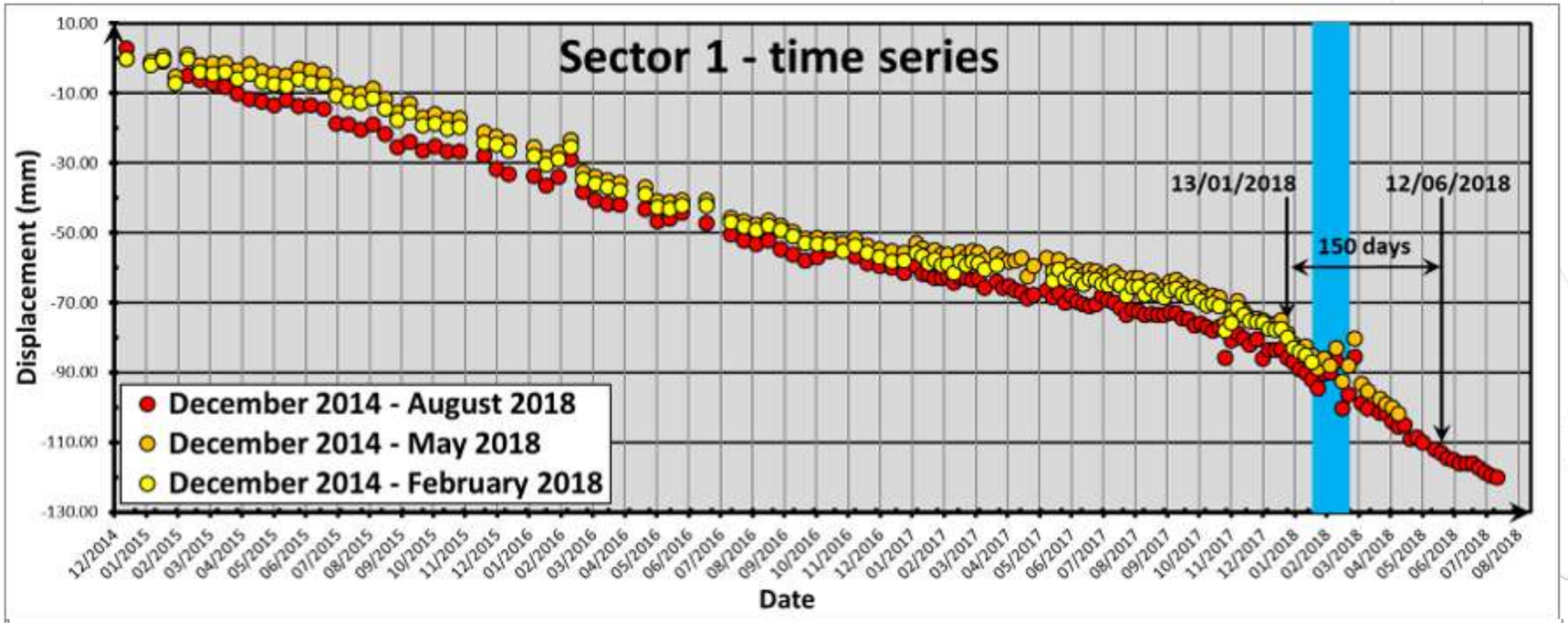
Temporal persistency: a cluster of points labelled as "anomalous" in at least two consecutive updates can generate a "change" to be further considered.
Ghost anomalies: anomalies identified only in one single update

The present: wide area monitoring system

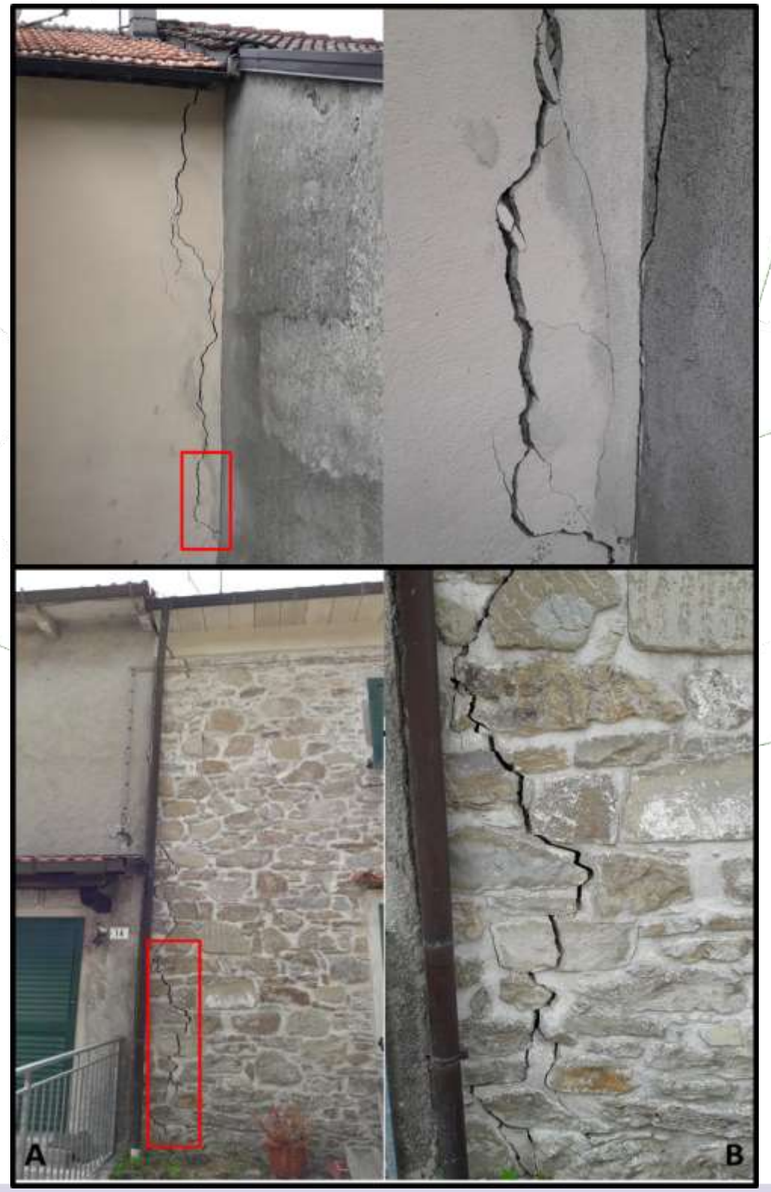


	12 December 2014 6 February 2018	12 December 2014 1 May 2018	12 December 2014 5 August 2018
Sector 1 Vel (mm/yr)	-24.6	-27.8	-30.2
Sector 2 Vel (mm/yr)	-19.4	-20.4	-22.1
Sector 3 Vel (mm/yr)	-23.9	-24.5	-26.4

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

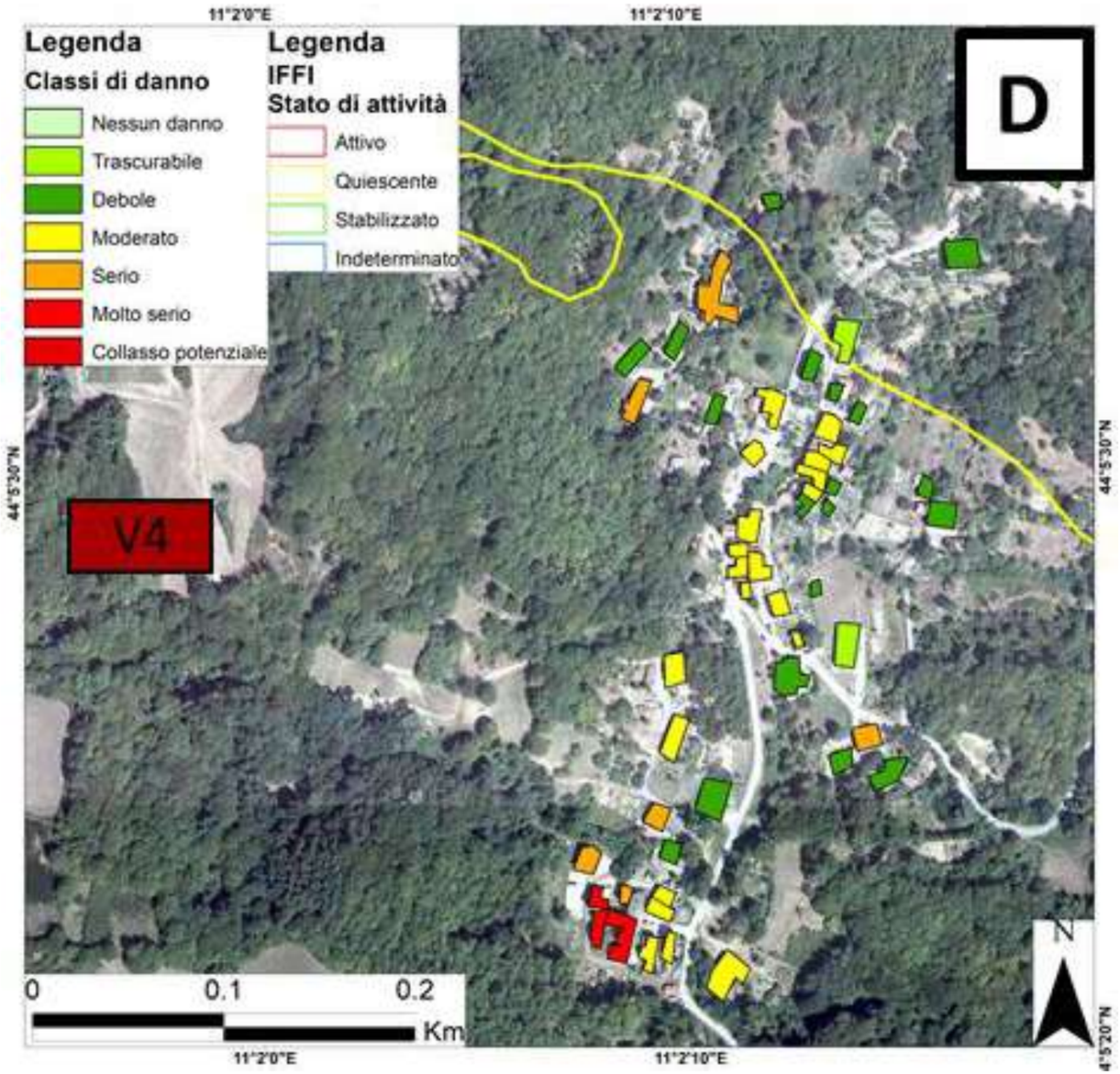


The present: wide area monitoring system

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

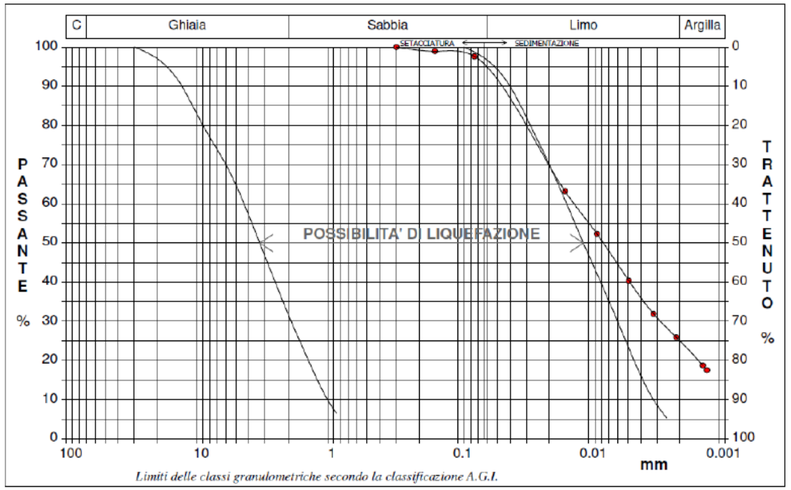
The present: wide area monitoring system

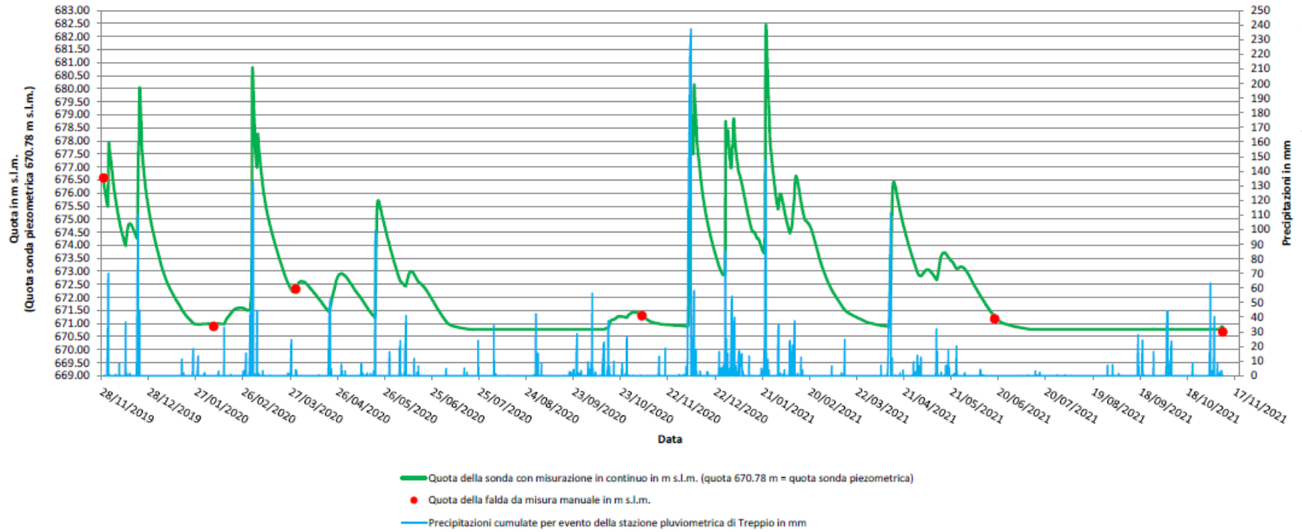


The present: wide area monitoring system

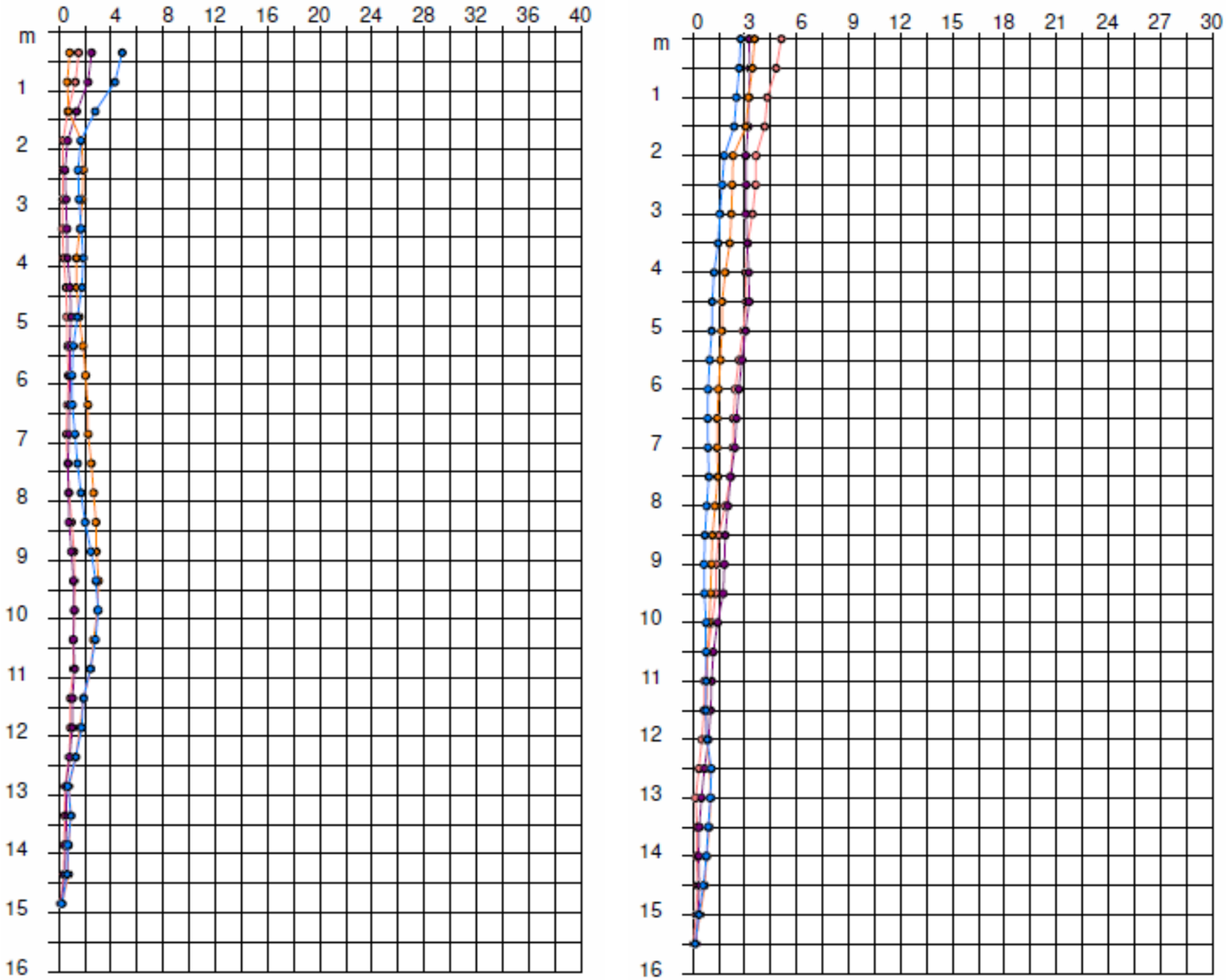
Profondità da p.c. (m)	STRATIGRAFIA	Descrizione litologica	PERCENTUALE DI RECUPERO 50 %	SPT N1	SPT N2	SPT N3	VANE TEST Kg/cmq	POCKET PENETR. Kg/cmq	NOTE
0.00		Terreni di riporto							
0.30		Limi argillosi con rari inclusi di dimensioni mm							
1.00		Limi sabbiosi e sabbie limose con inclusi clasti arenacei di dimensioni da mm a cm a spigoli vivi							
2.00				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 S1C1							
5.50		Sabbie limose e limi sabbiosi con inclusi clasti arenacei e siltititci molto degradati. Presenza di acqua a circa 4 m		5	5	6			SPT4.55m
16.00		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 %	D_{10}	0,00079 mm
Sabbia	7,2 %	Passante setaccio 40 (0.42 mm)	100,0 %	D_{30}	0,00280 mm
Limo	67,9 %	Passante setaccio 200 (0.075 mm)	97,6 %	D_{50}	0,00776 mm
Argilla	24,9 %			D_{60}	0,01286 mm
Coefficiente di uniformità	16,25	Coefficiente di curvatura	0,77	D_{90}	0,05265 mm





The present: wide area monitoring system

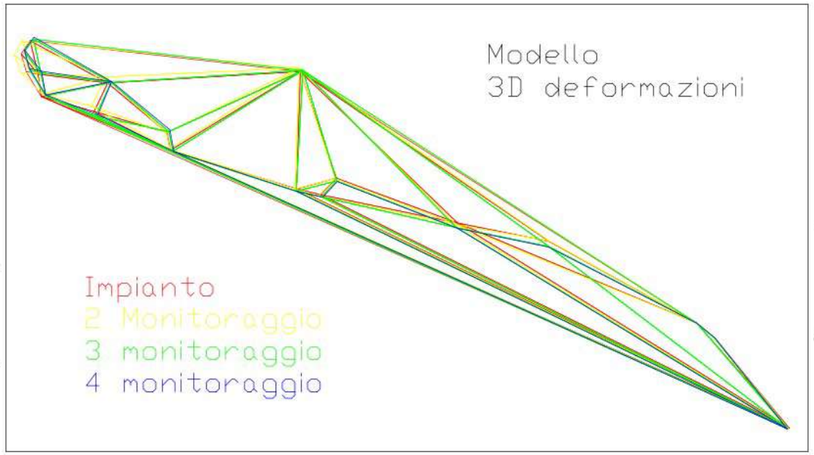


Monitoring of sliding surface with inclinometers

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

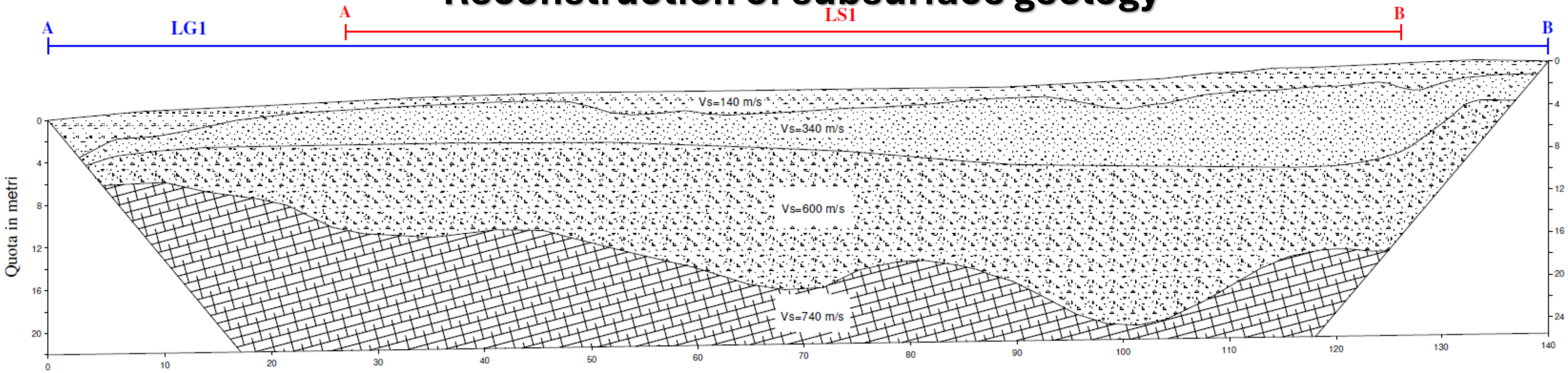
The present: wide area monitoring system

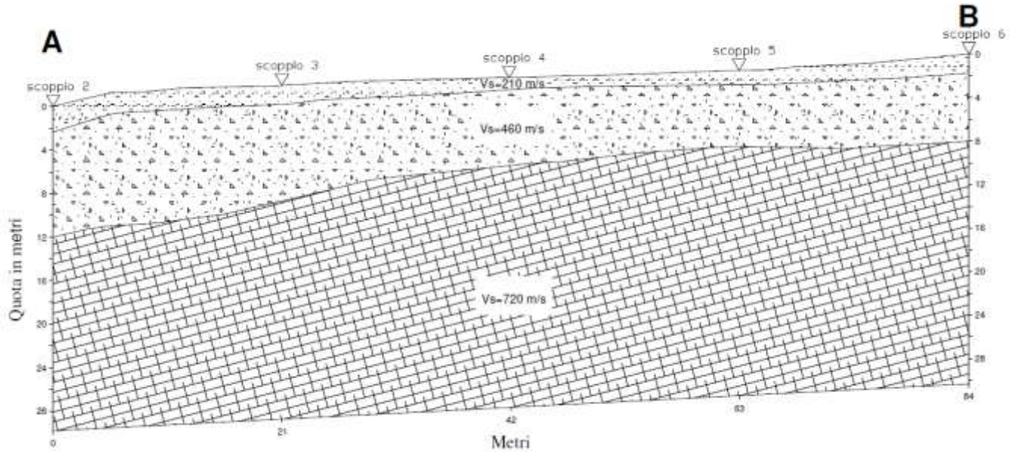
In situ monitoring plan

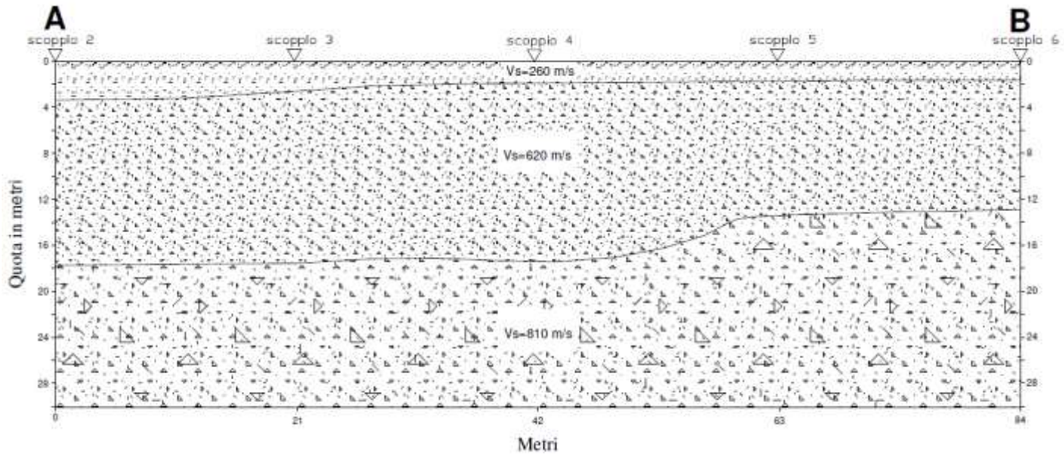


The present: wide area monitoring system

Reconstruction of subsurface geology







The present: wide area monitoring system

Ascending orbit

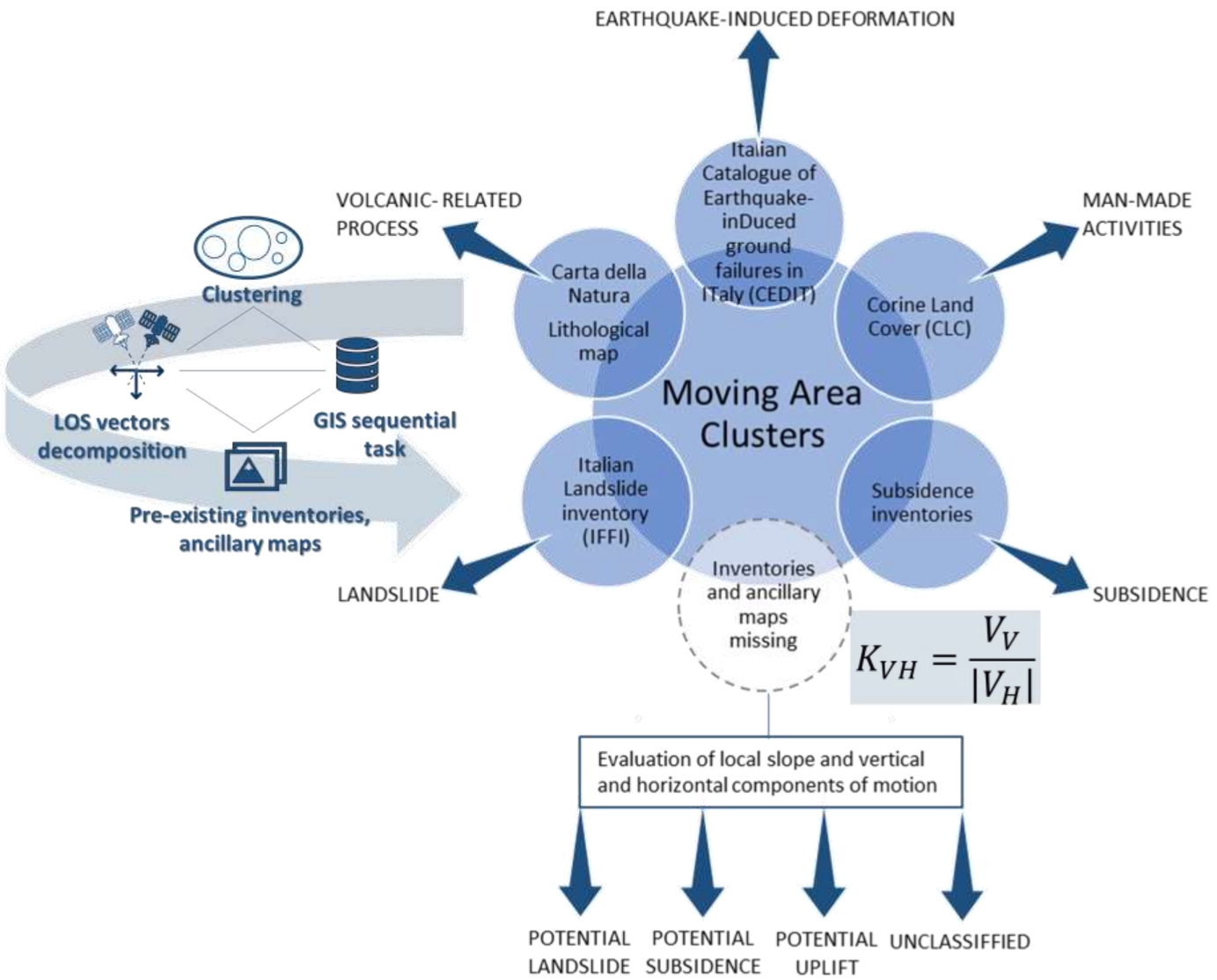
Descending orbit

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

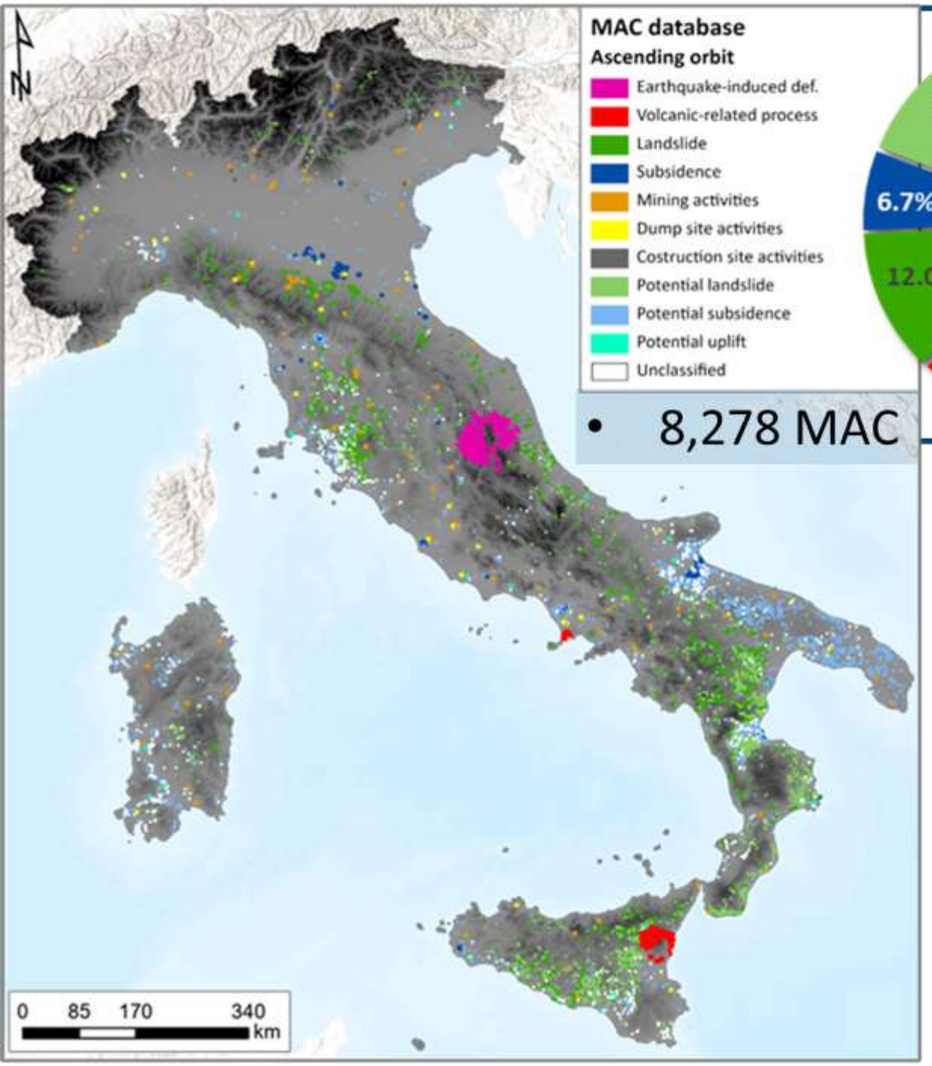


- Combined use of: inventories, DEM-derived maps, ancillary data and VLOS displacement vectors decomposition

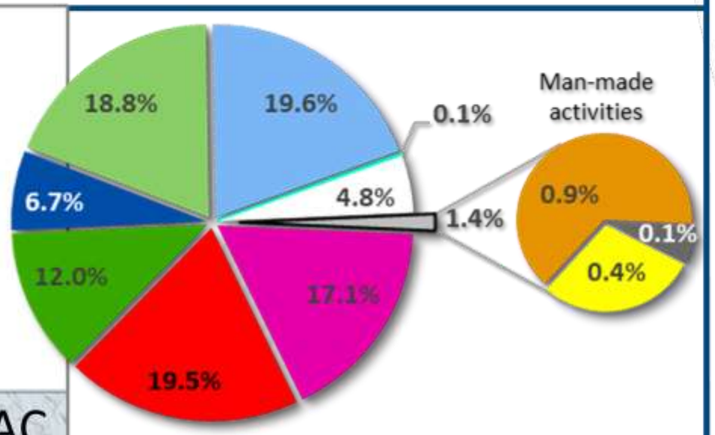
- Classification in:
  - Earthquake-induced deformation
  - Volcanic-related process
  - Landslide (potential landslide)
  - Subsidence (potential subsidence)
  - Uplift
  - Mining activities
  - Dump site activities
  - Construction site activities

The present: wide area monitoring system

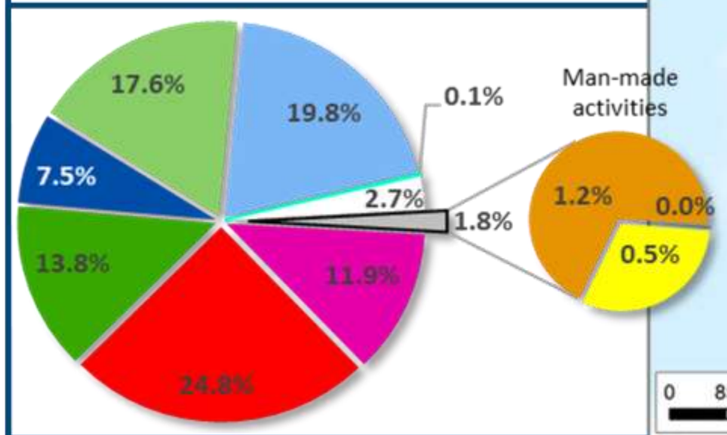
Clustering parameters: **|VEL|** >= 1 cm/yr ; **Buffer radius** = 100 m ; **Min. number of PS** = 3

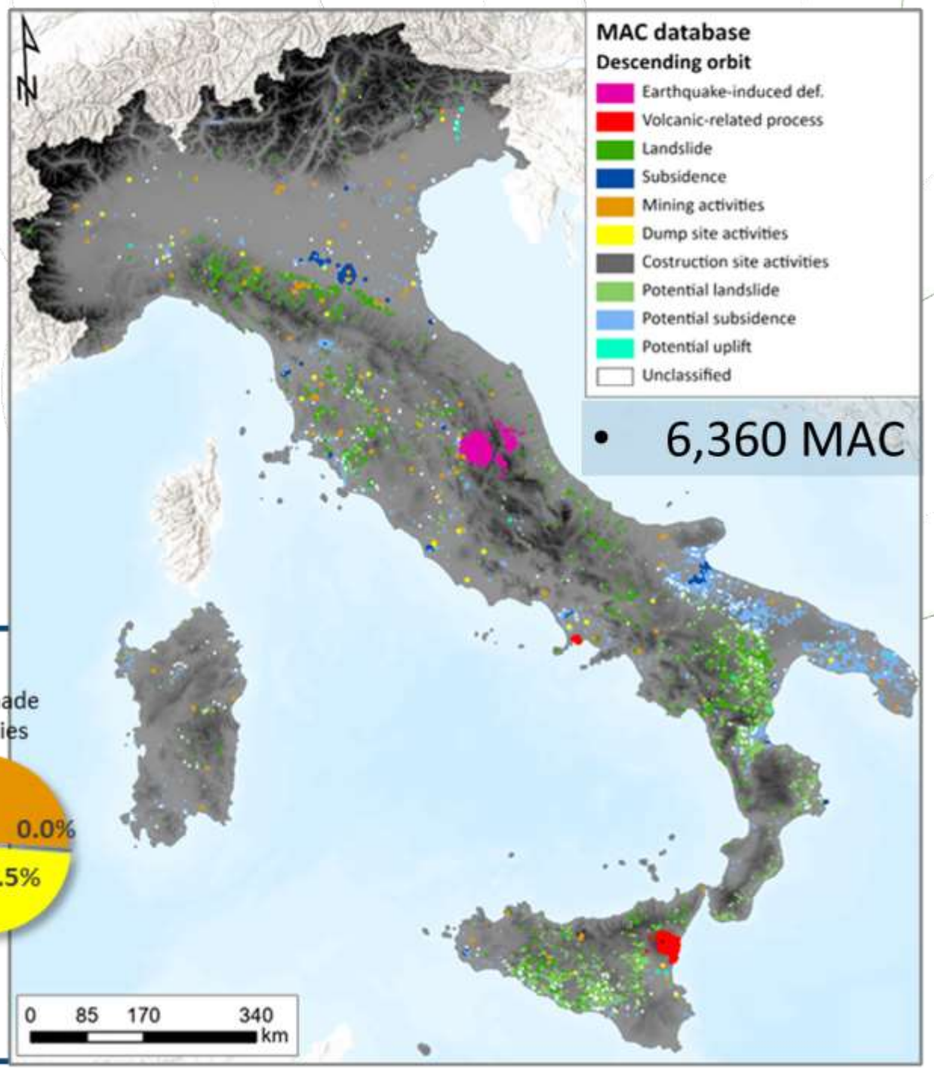


- 8,278 MAC



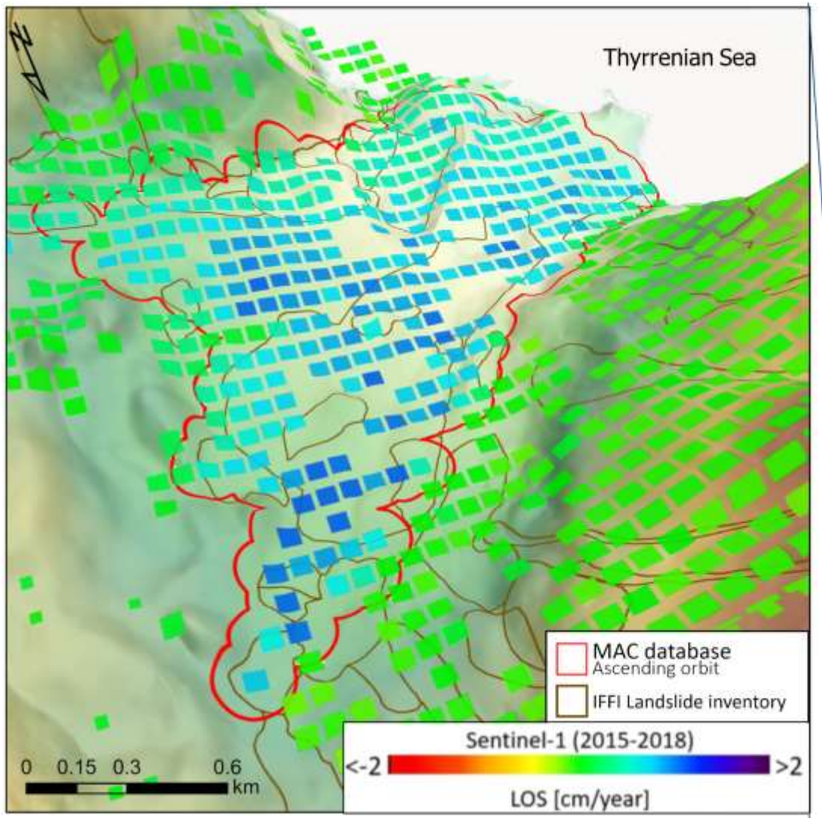
MAC area per category / MAC total area

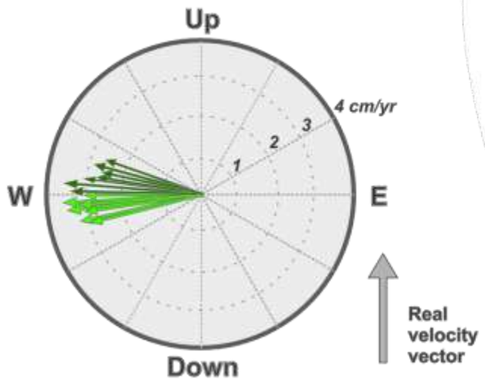


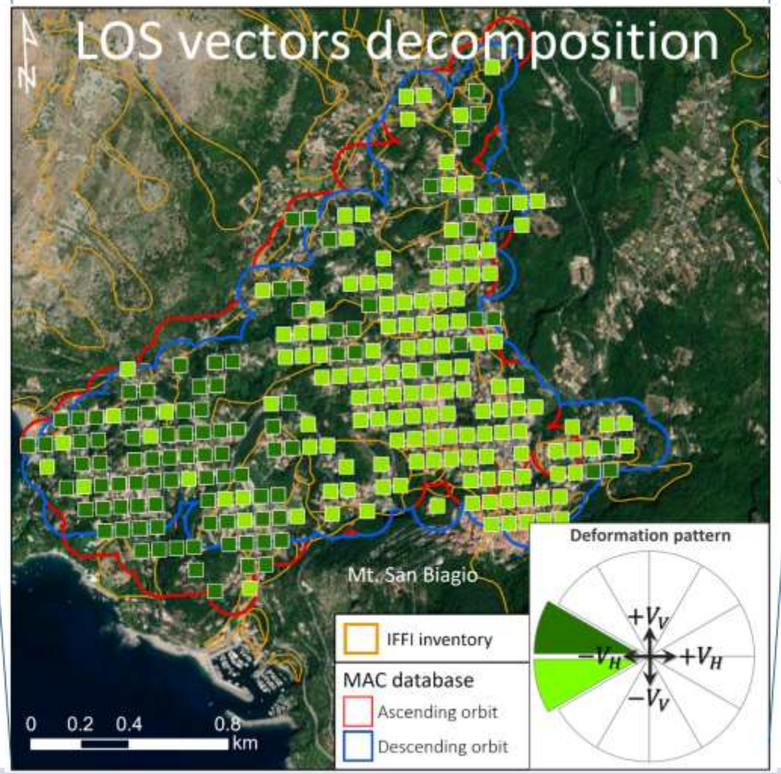


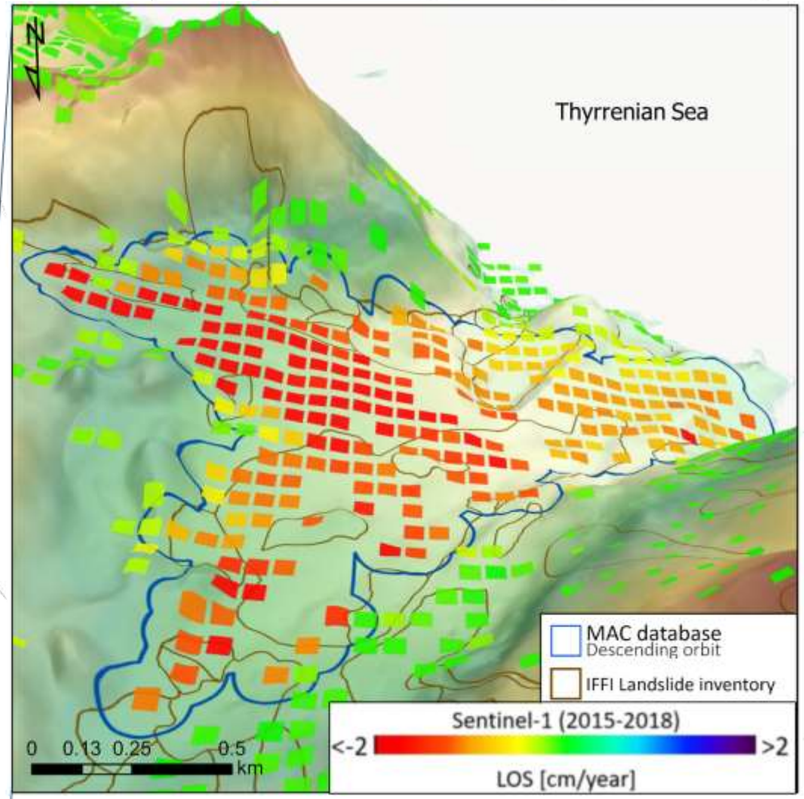
- 6,360 MAC

The present: wide area monitoring system



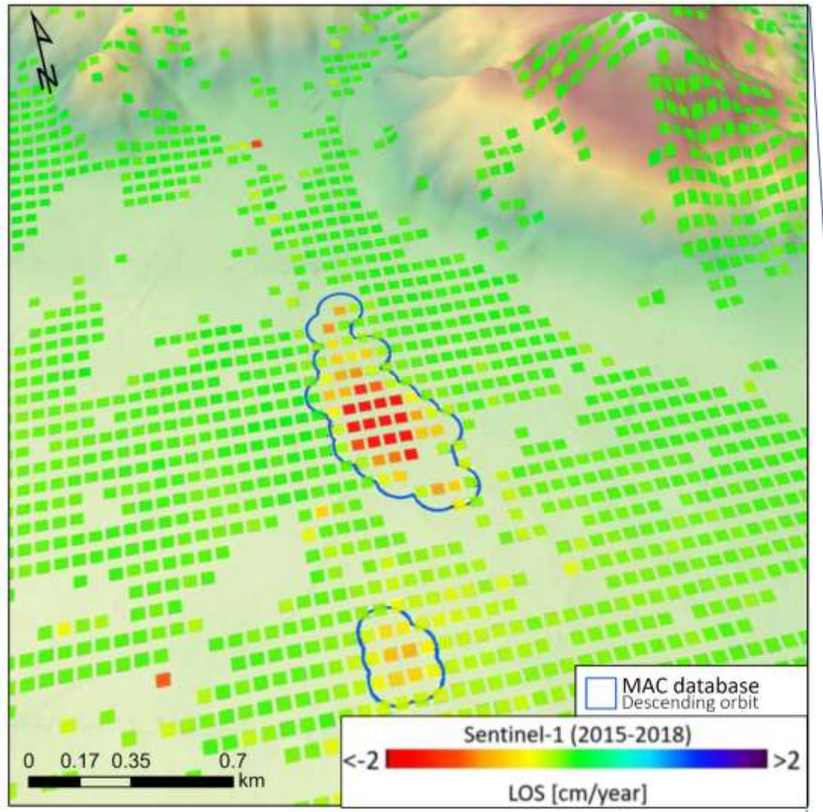


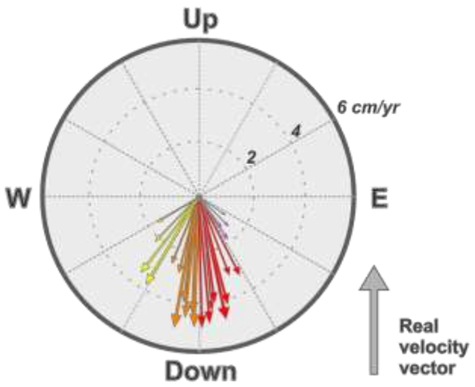


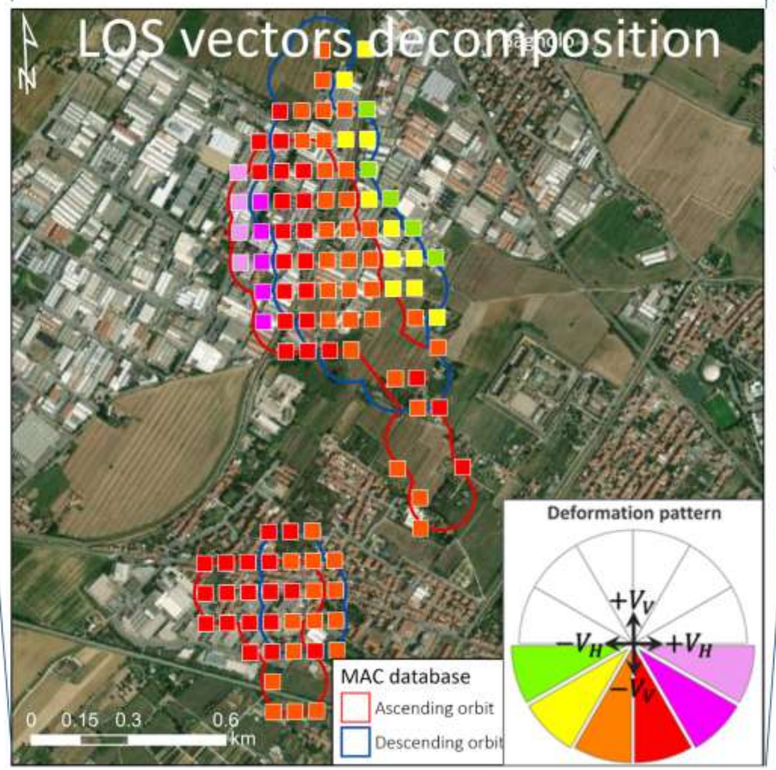


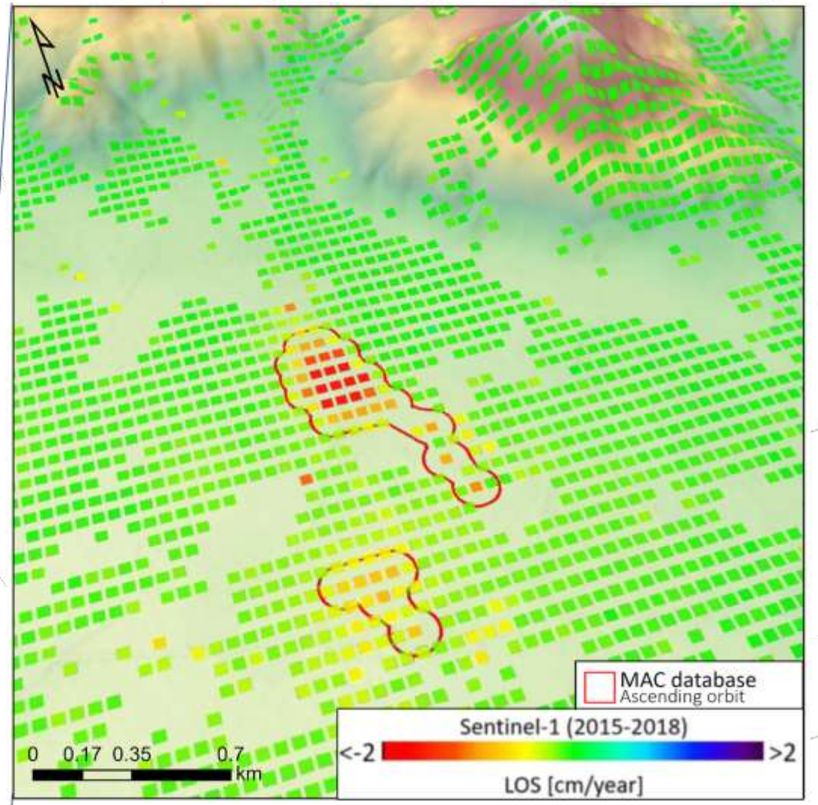
- Composite DSGSD
- Prevalent horizontal mov.
- Retrieved “Real” velocity reaching 3.8 cm/yr

The present: wide area monitoring system



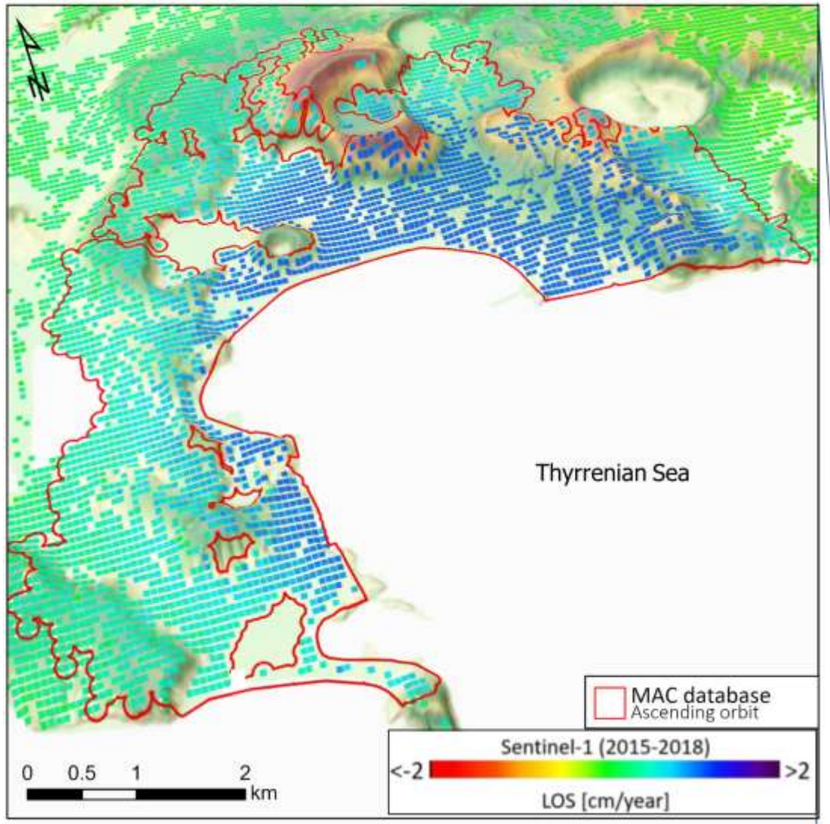


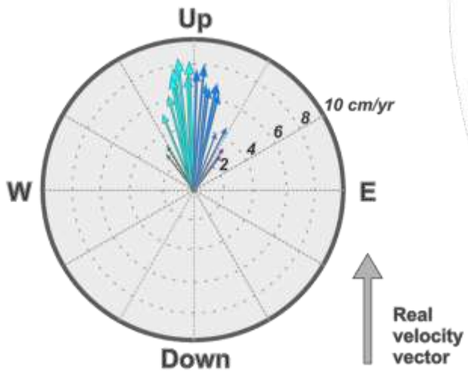


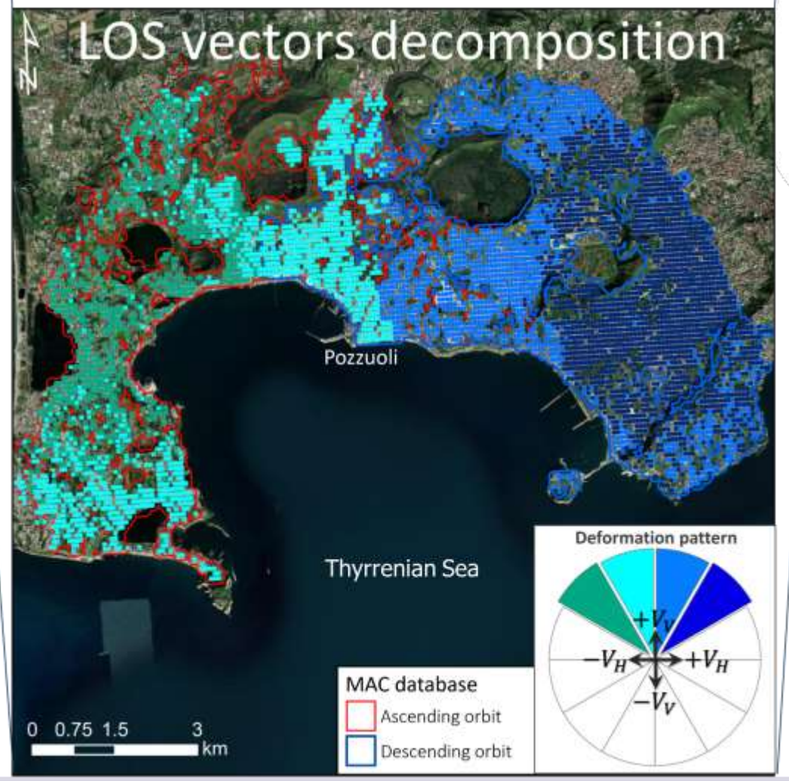


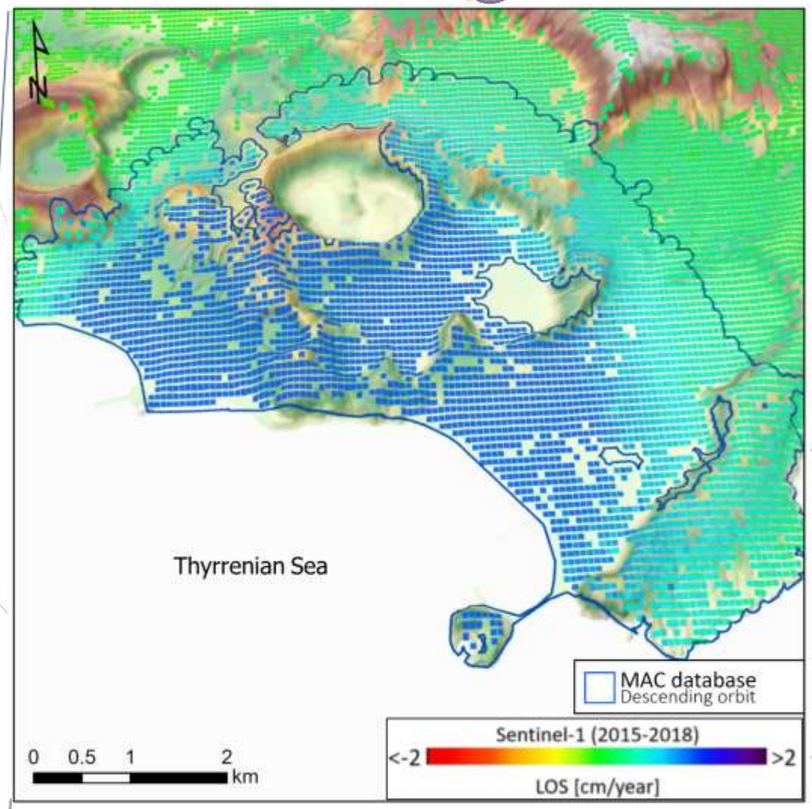
- Resources over-exploitation
- Downward vertical mov.
- Retrieved “Real” velocity reaching 4.8 cm/yr

The present: wide area monitoring system





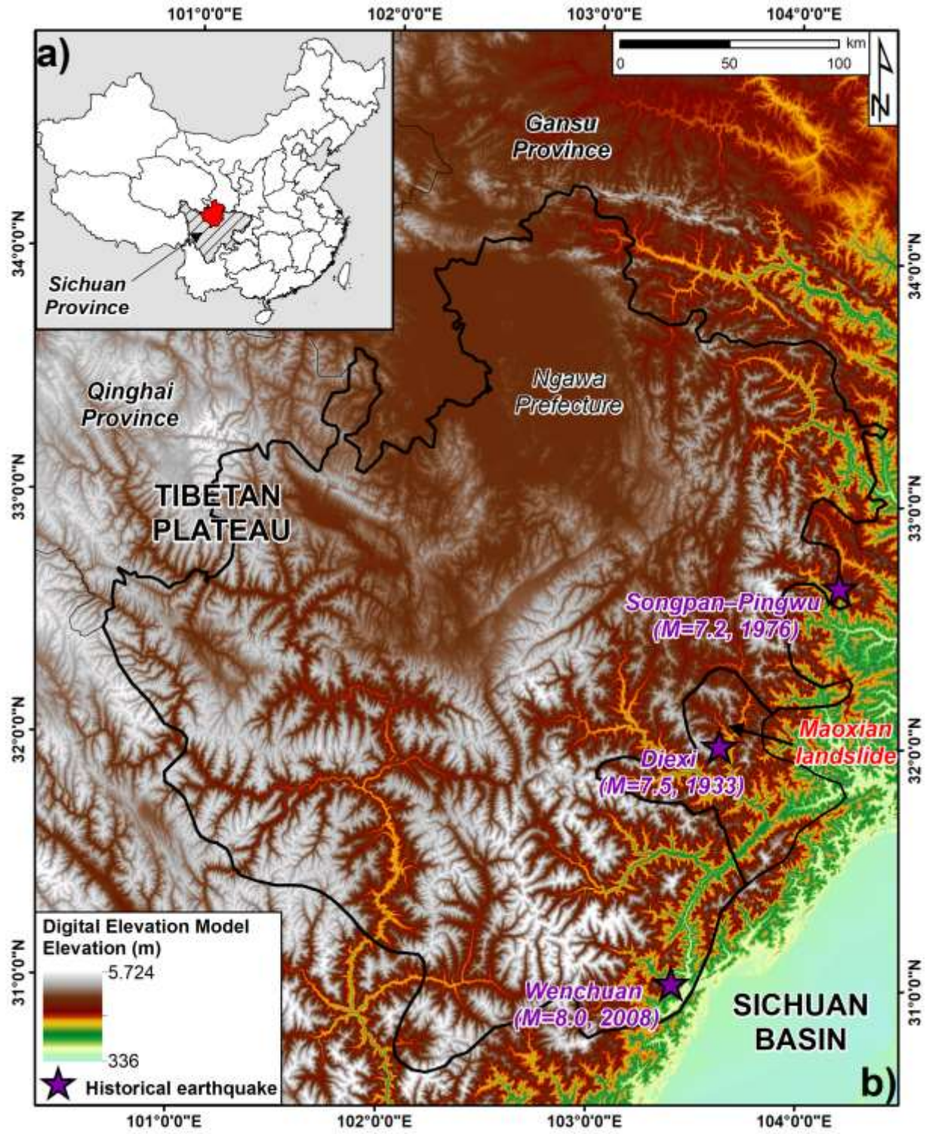




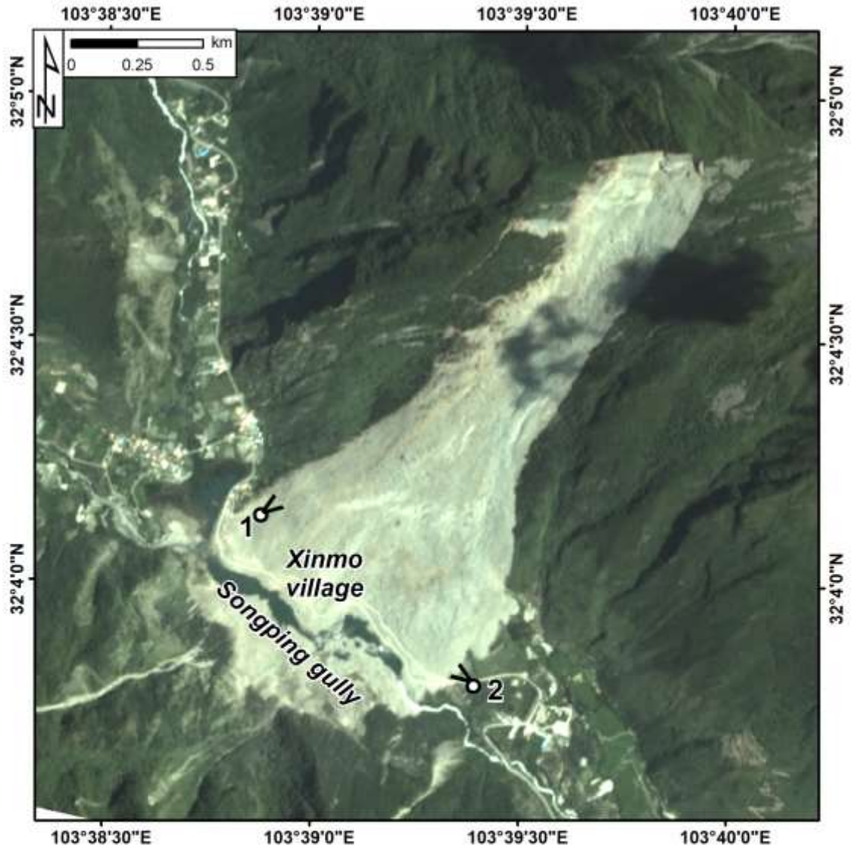
- Bradyseism phenomenon
- Upward vertical movement
- Retrieved “Real” velocity reaching 8.6 cm/yr

The present: wide area monitoring system

24 June 2017 - 5:45 am



The present: wide area monitoring system



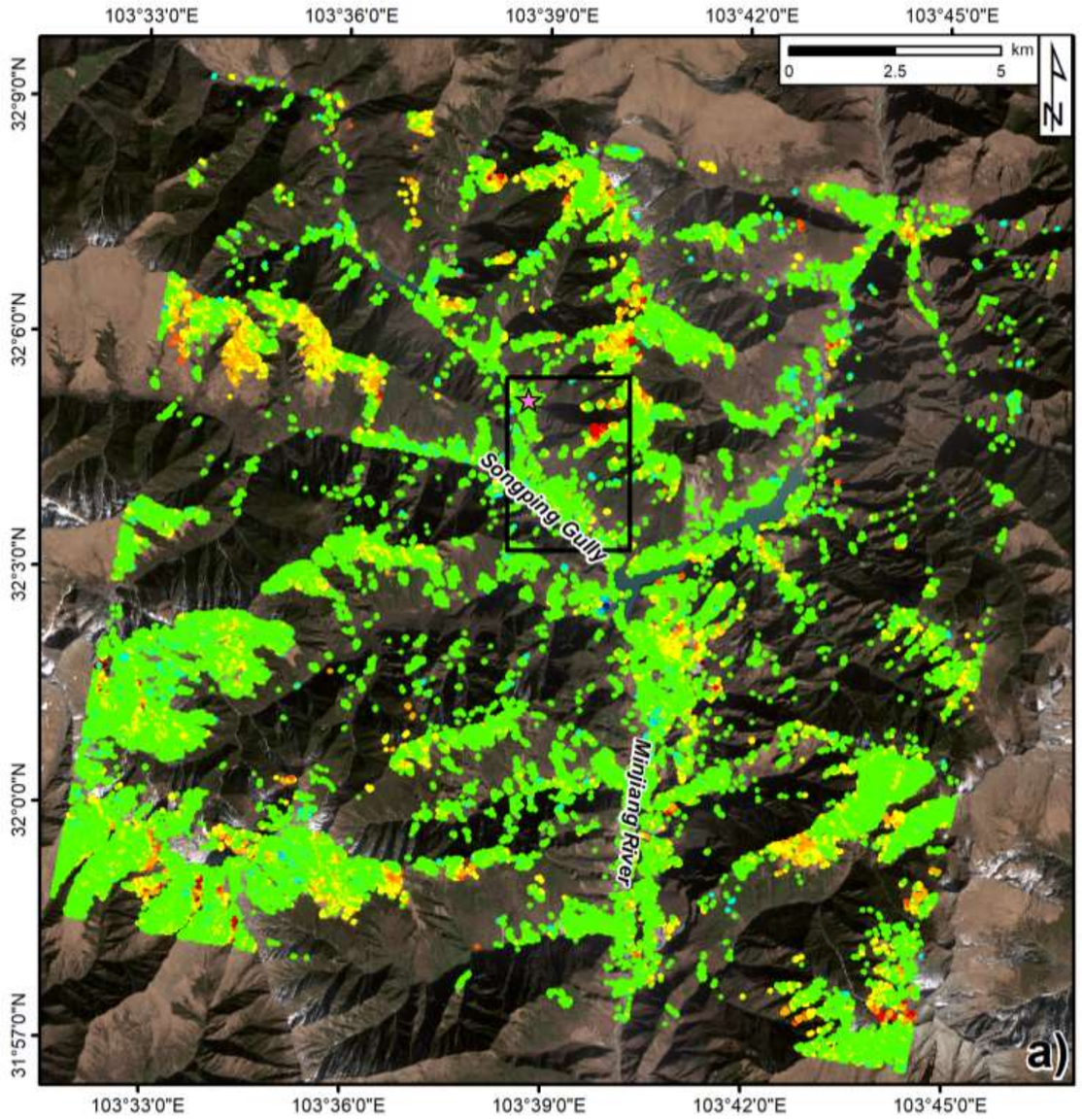
V: 13-18 million m^3

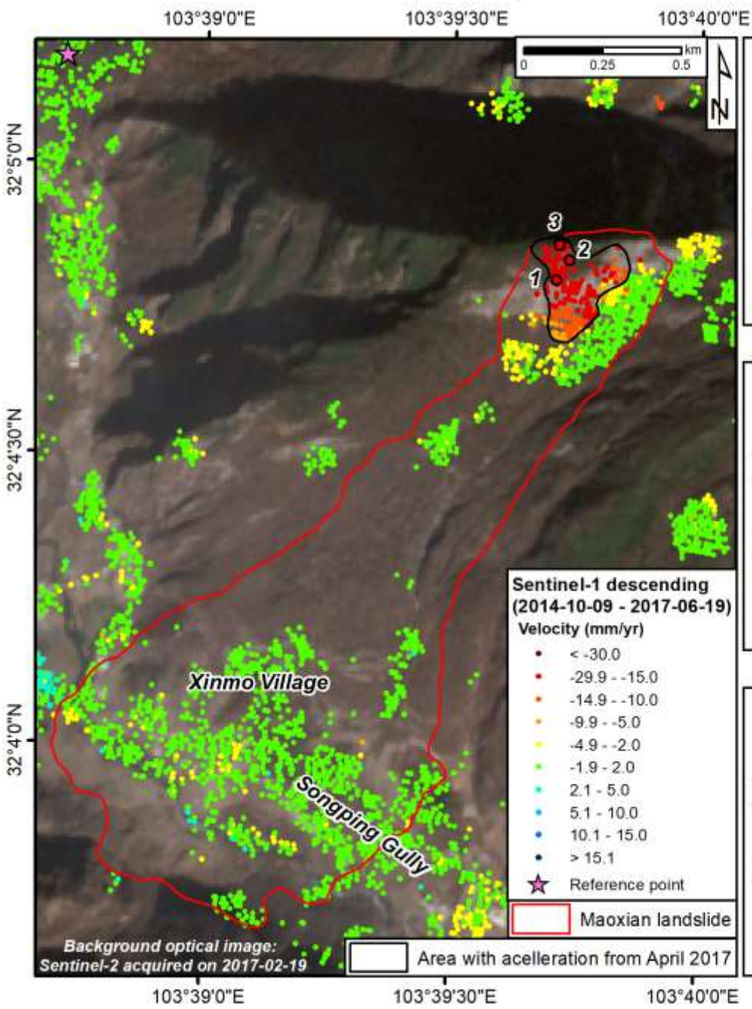
A: 1.5 km^2.

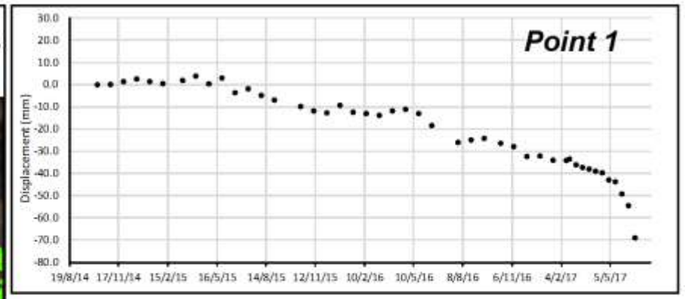
H: 1,100 m

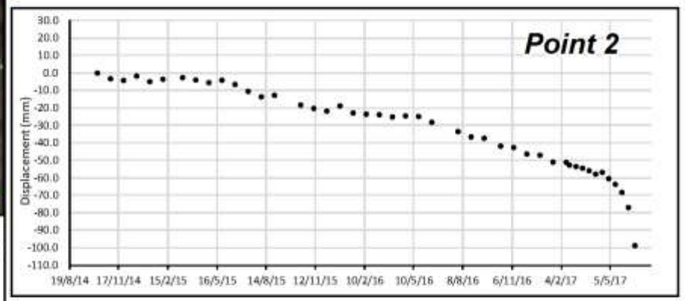
L: 2,600 m

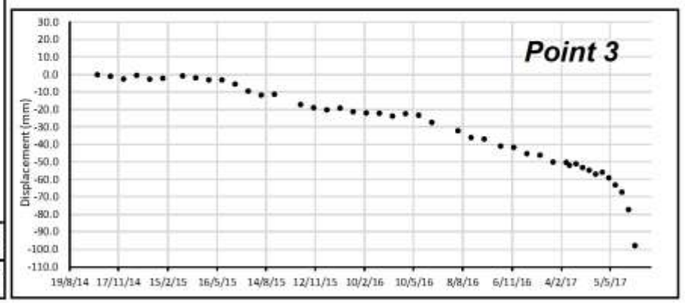
The present: wide area monitoring system



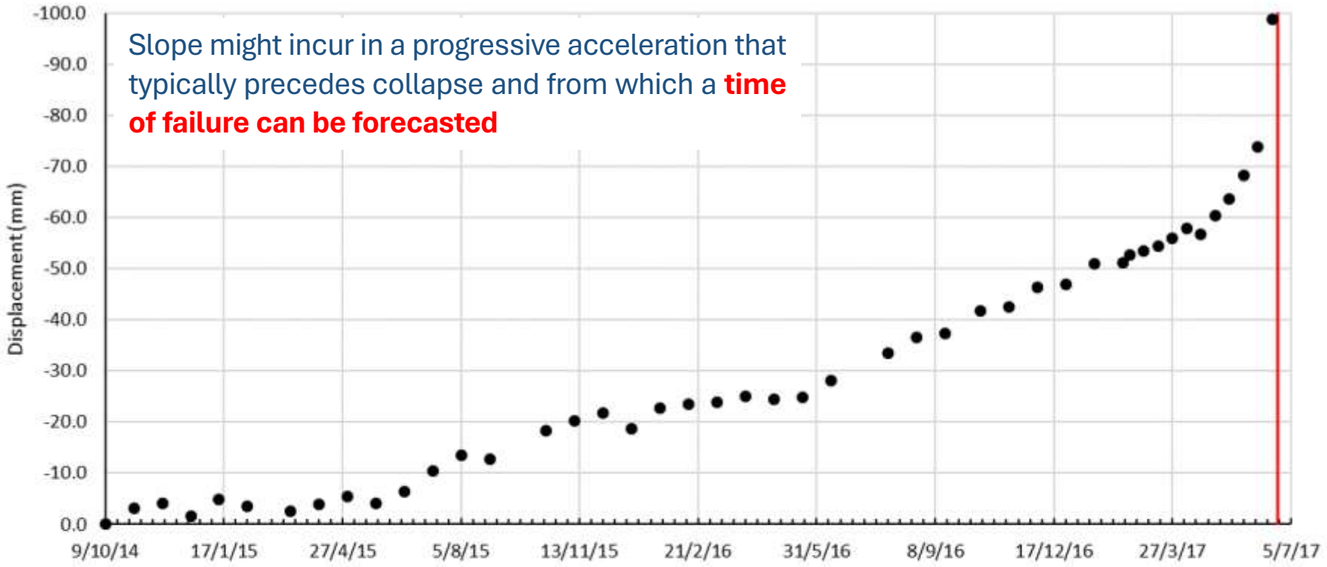


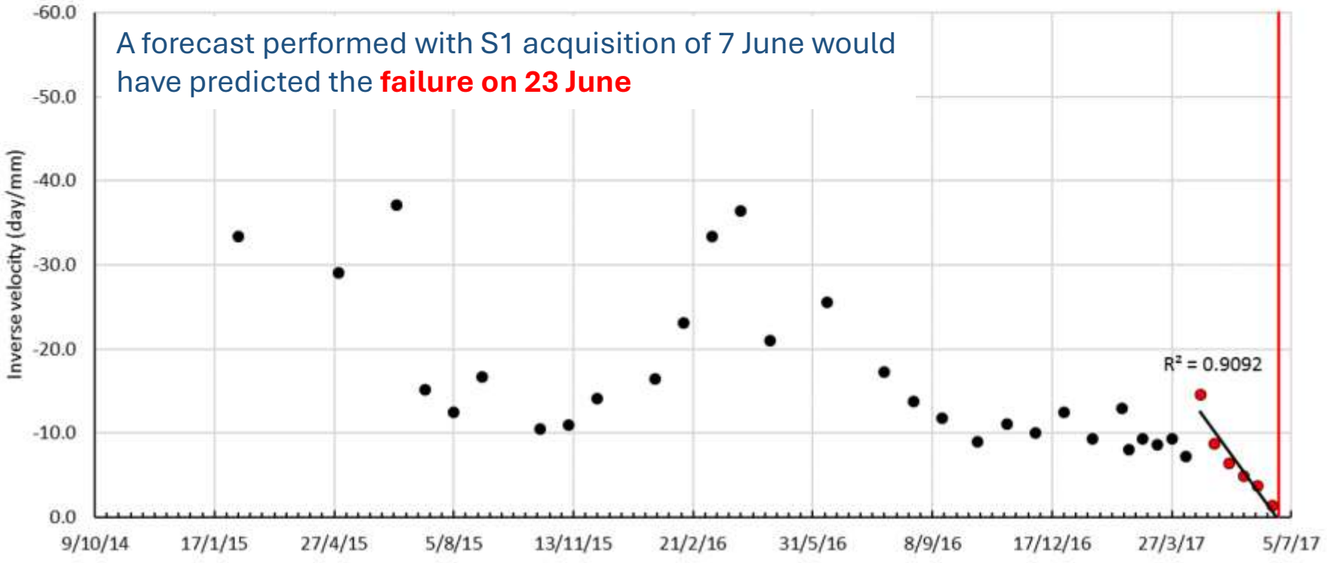


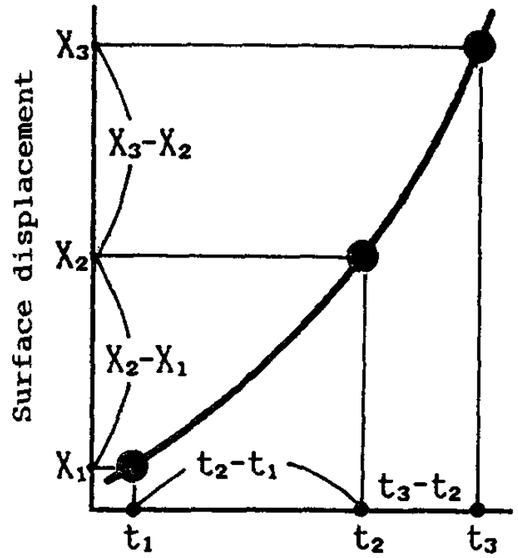


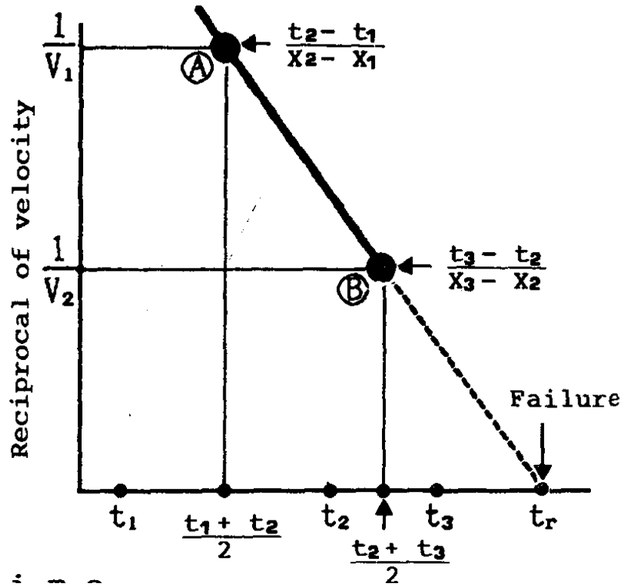


The present: wide area monitoring system

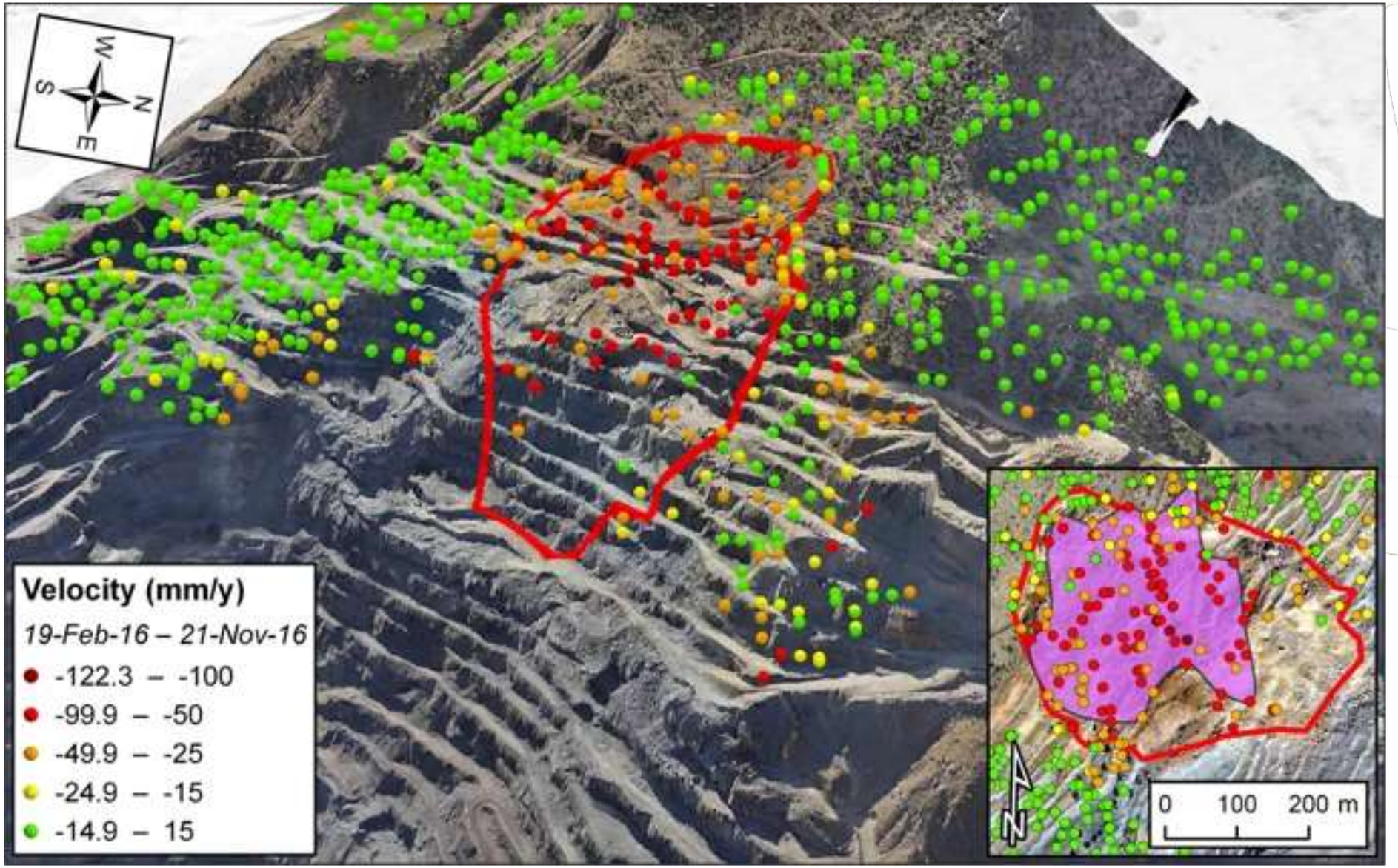




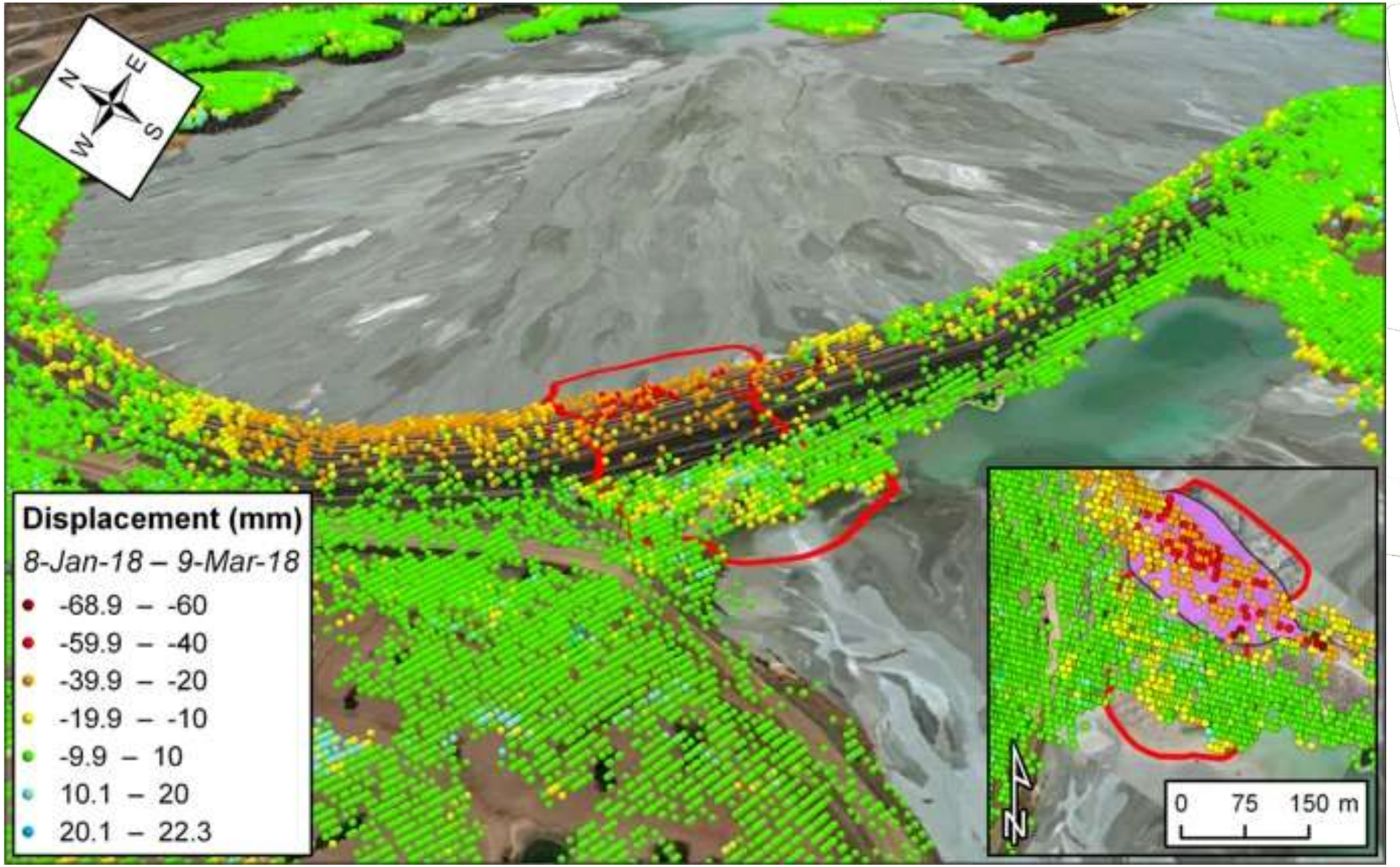




The present: wide area monitoring system



The present: wide area monitoring system



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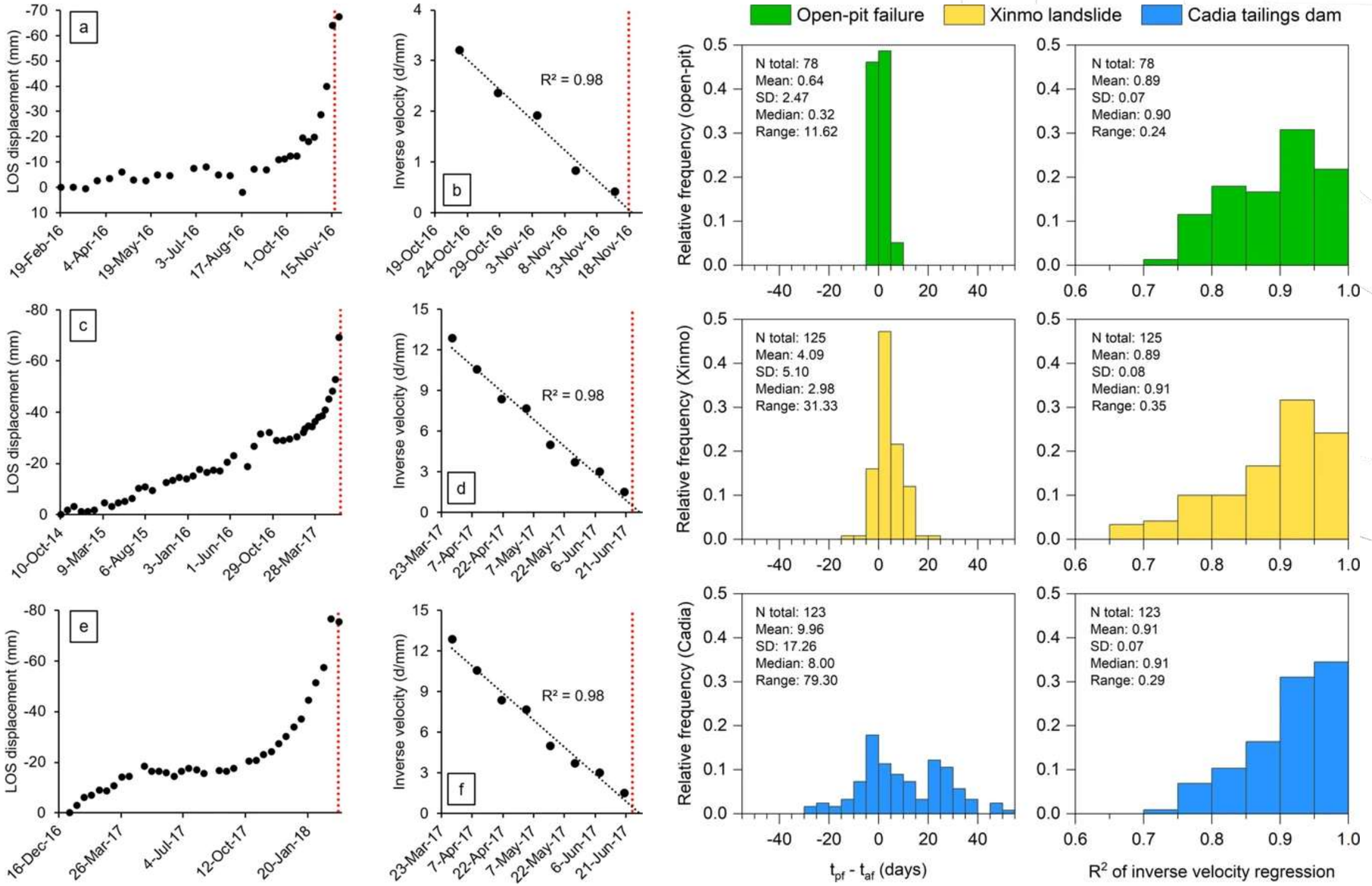
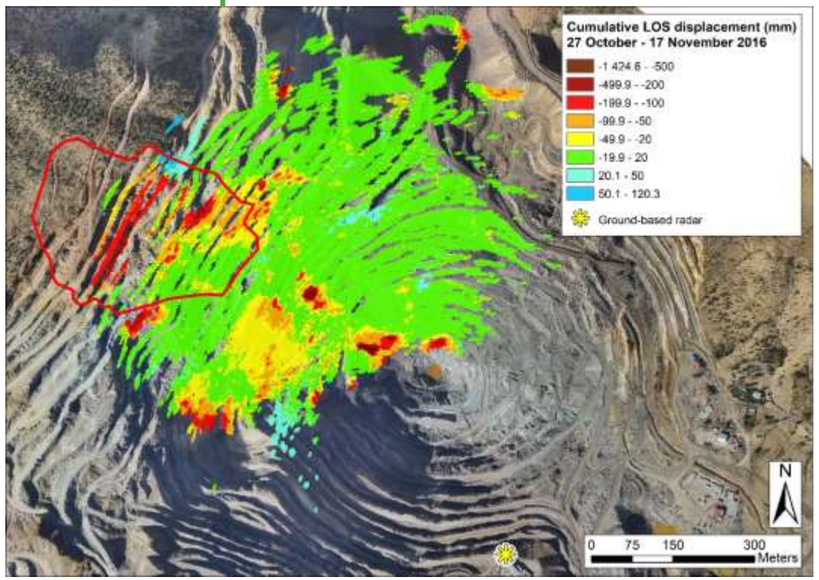
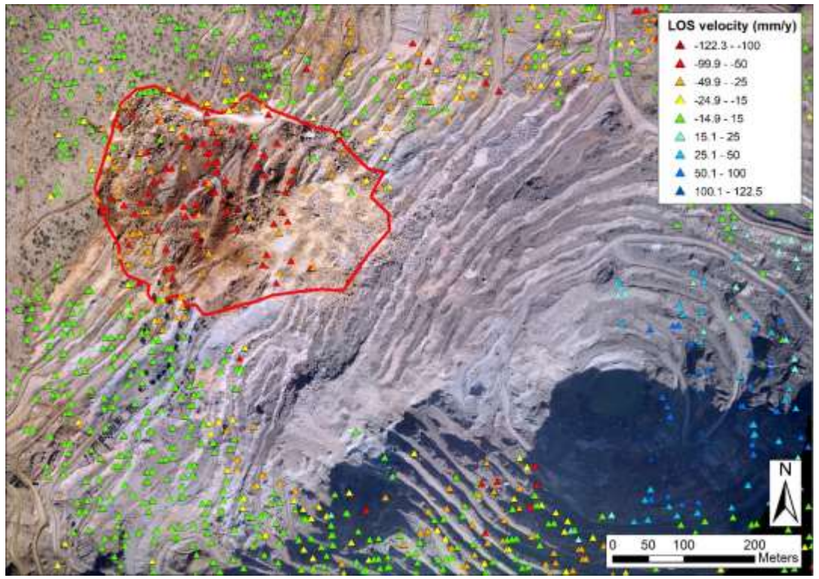
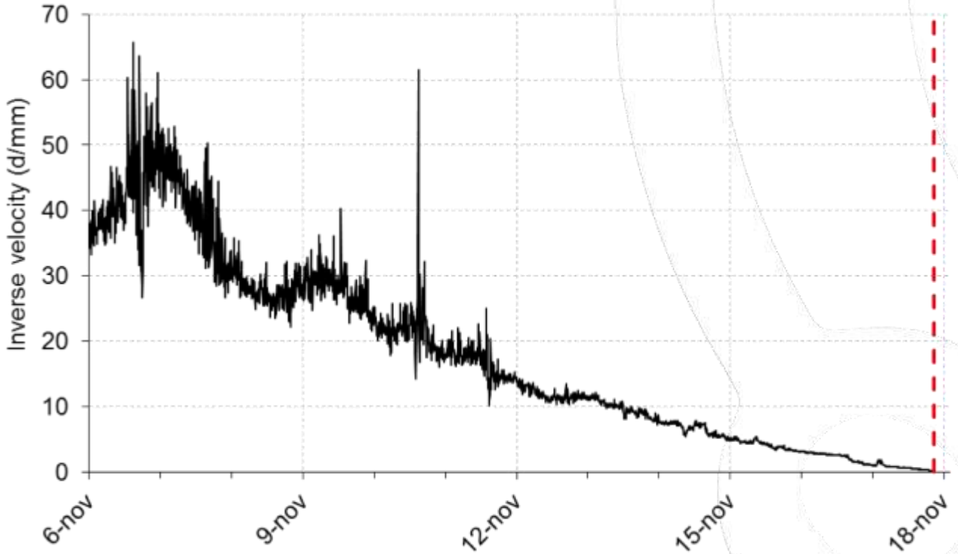
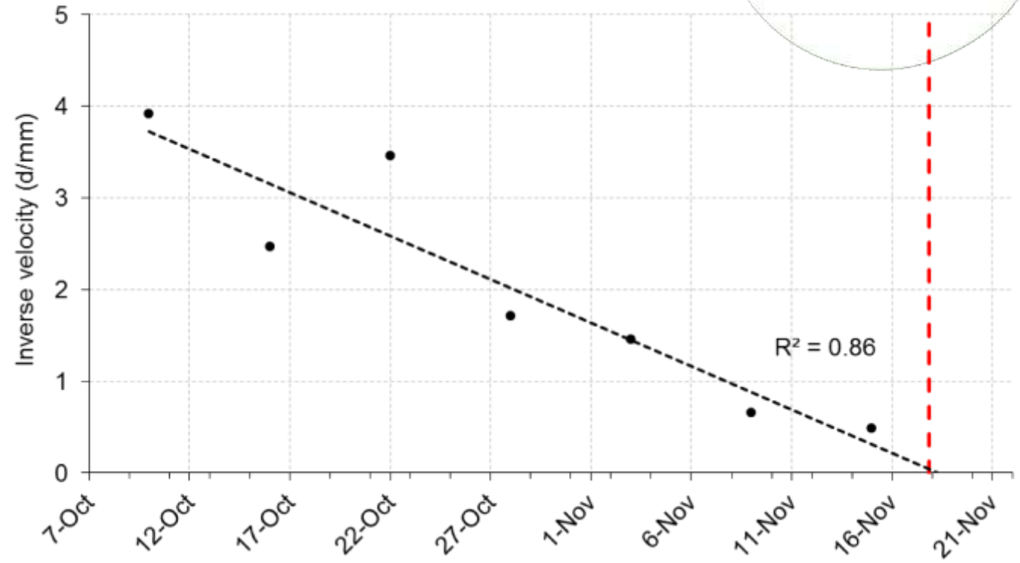


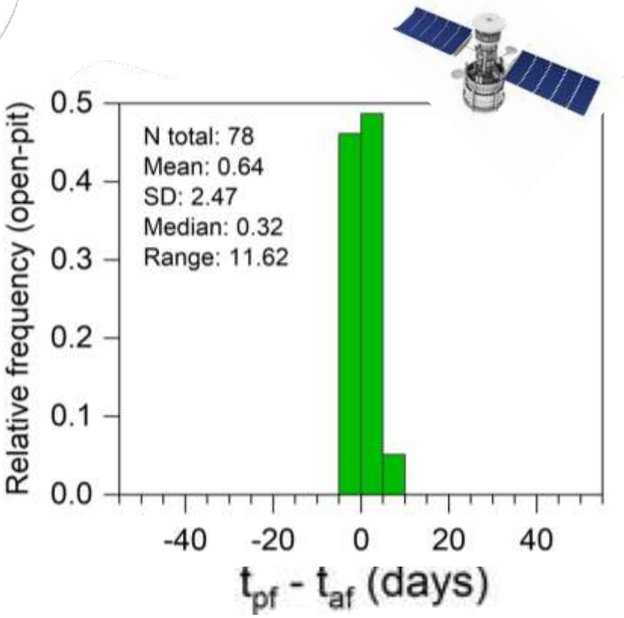
The present: wide area monitoring system











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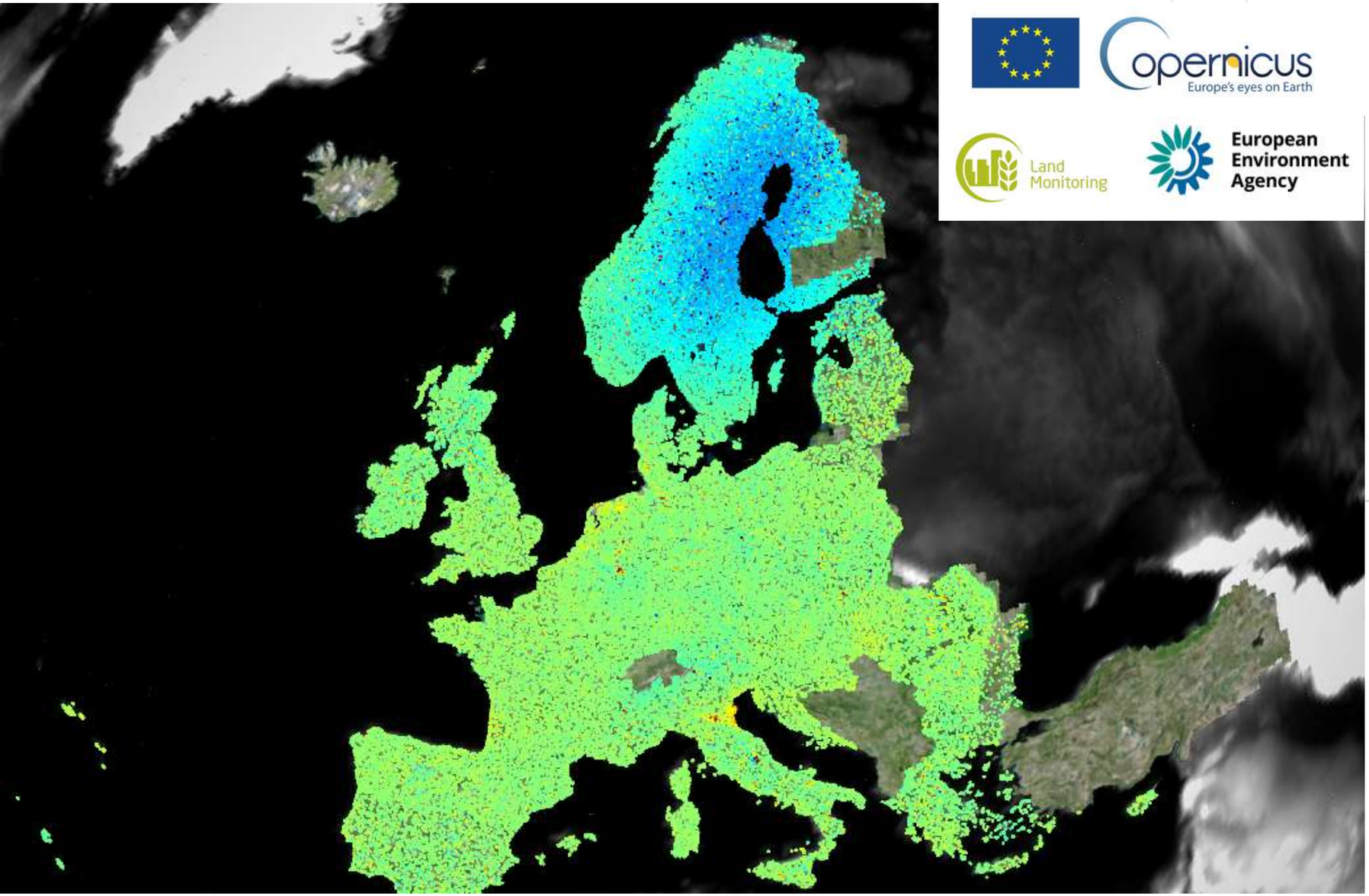
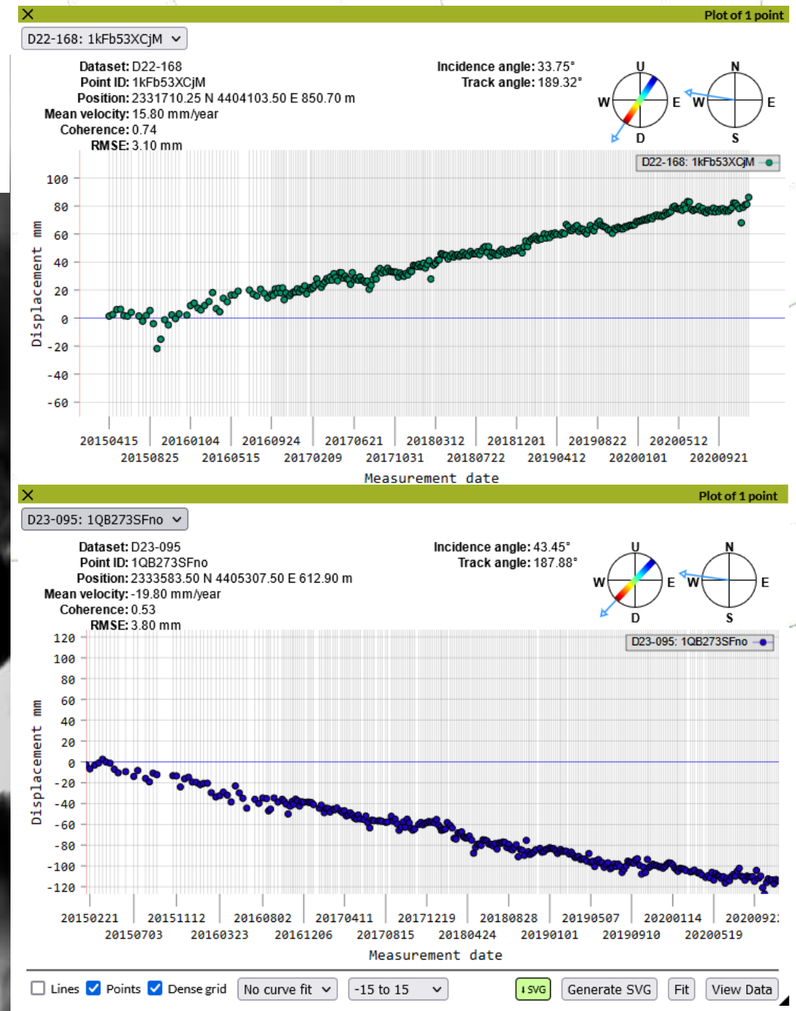
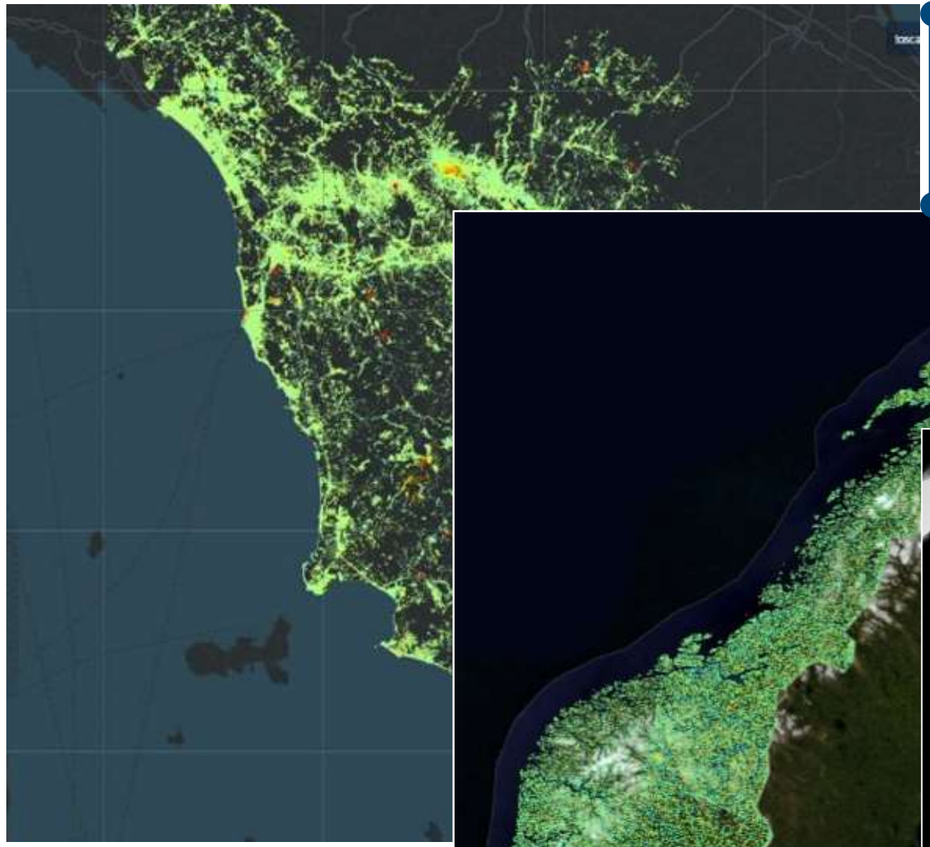
The future: continental scale



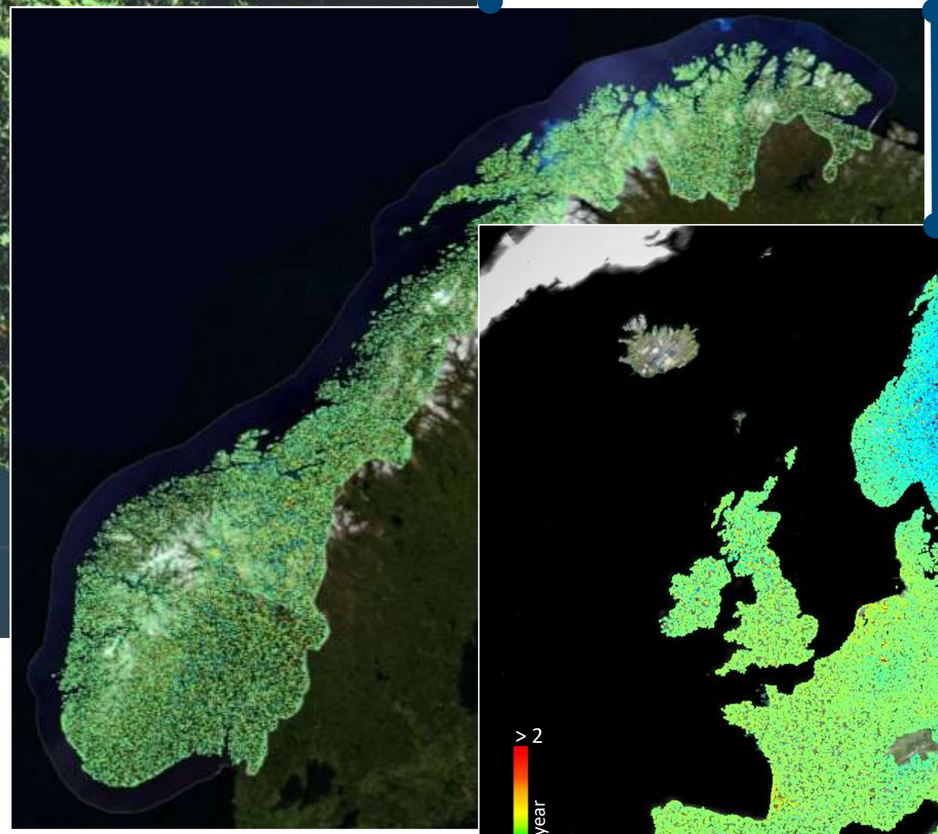


Perspective: continuous stream of Big radar Data

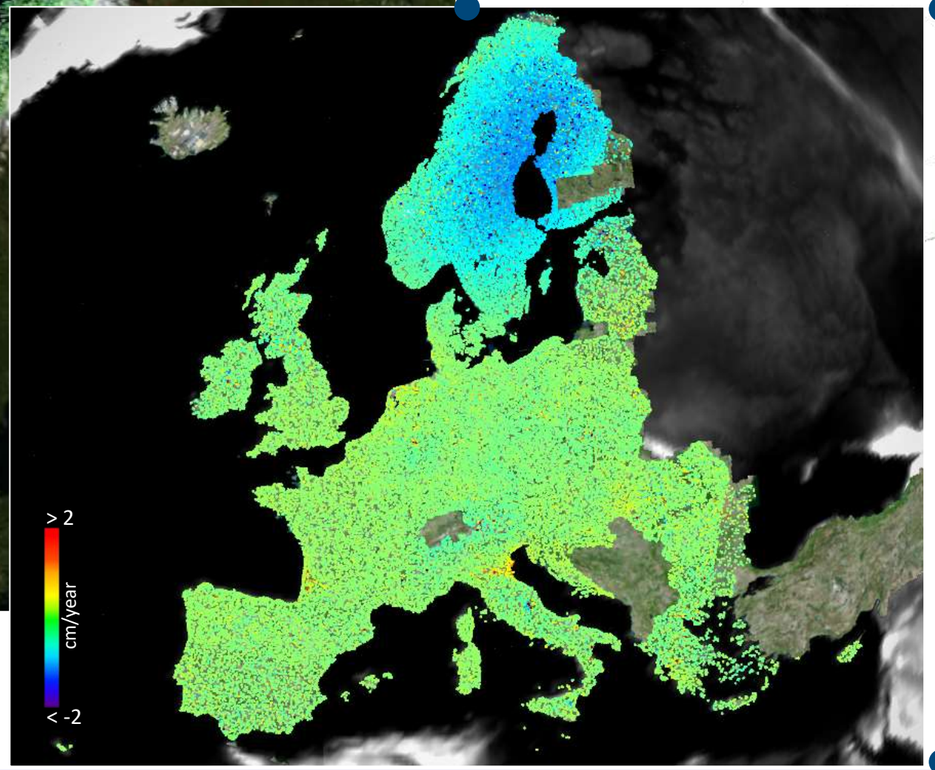
The future: continental scale



- Local to regional Scale



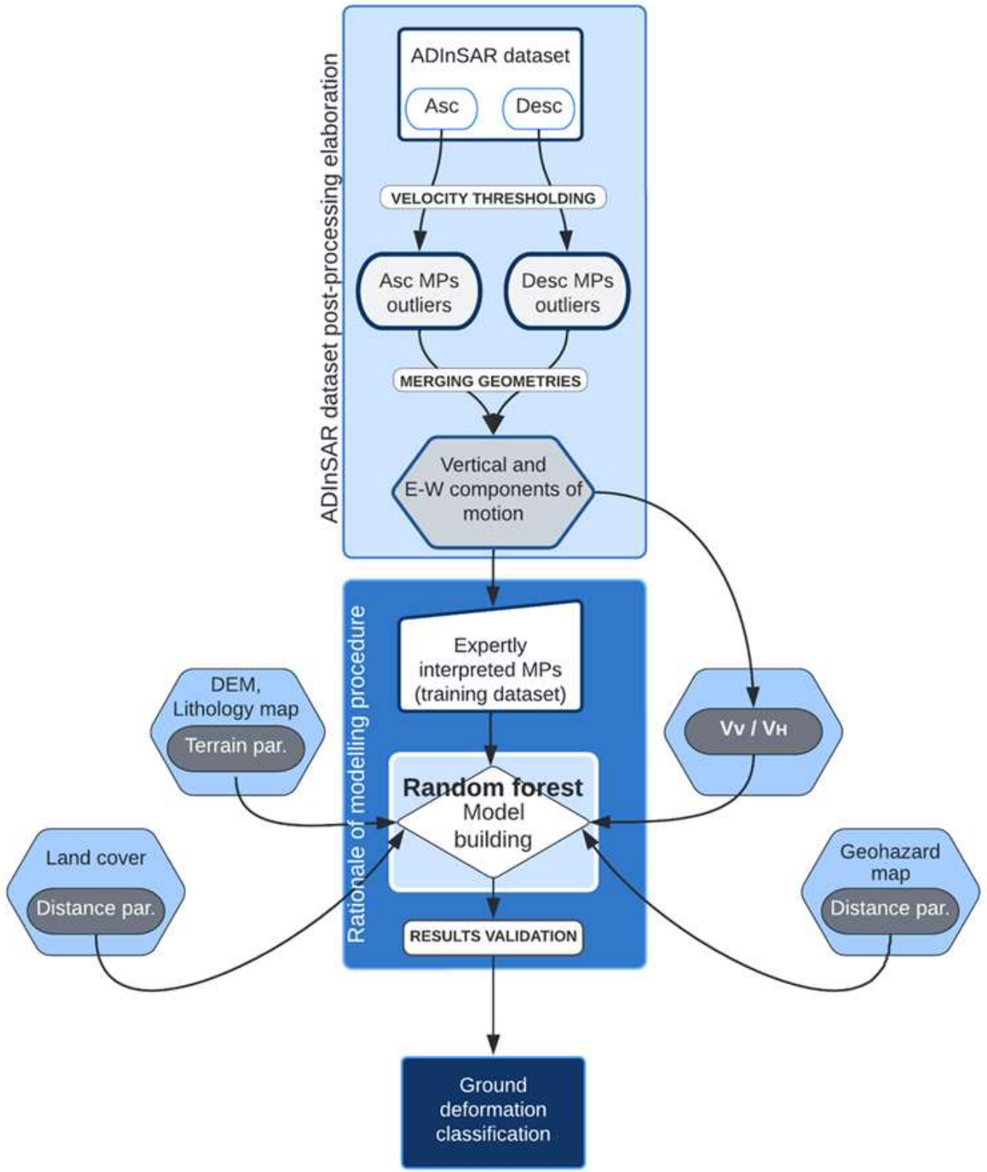
- National scale



- 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:

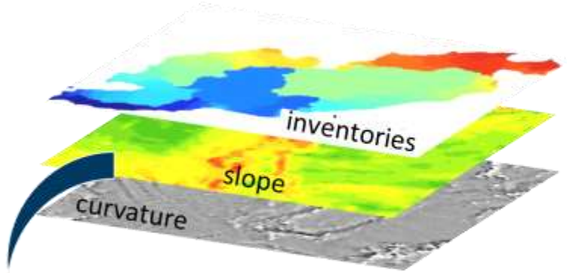
- Velocity thresholding
- Vertical and horizontal components retrieval

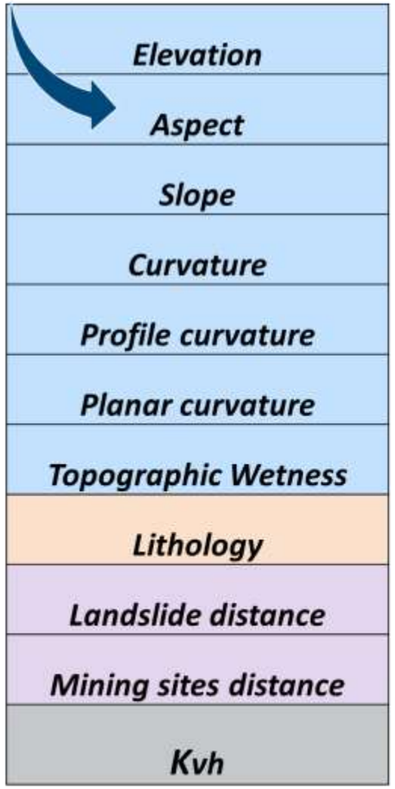
2. Rationale of modelling procedure:

- 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





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

(Predictors) Input (InSAR dataset)

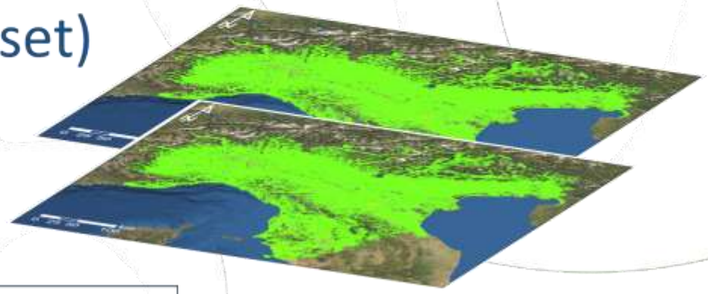
Tree 1 . . . Tree n

Class prediction 1 Class prediction n

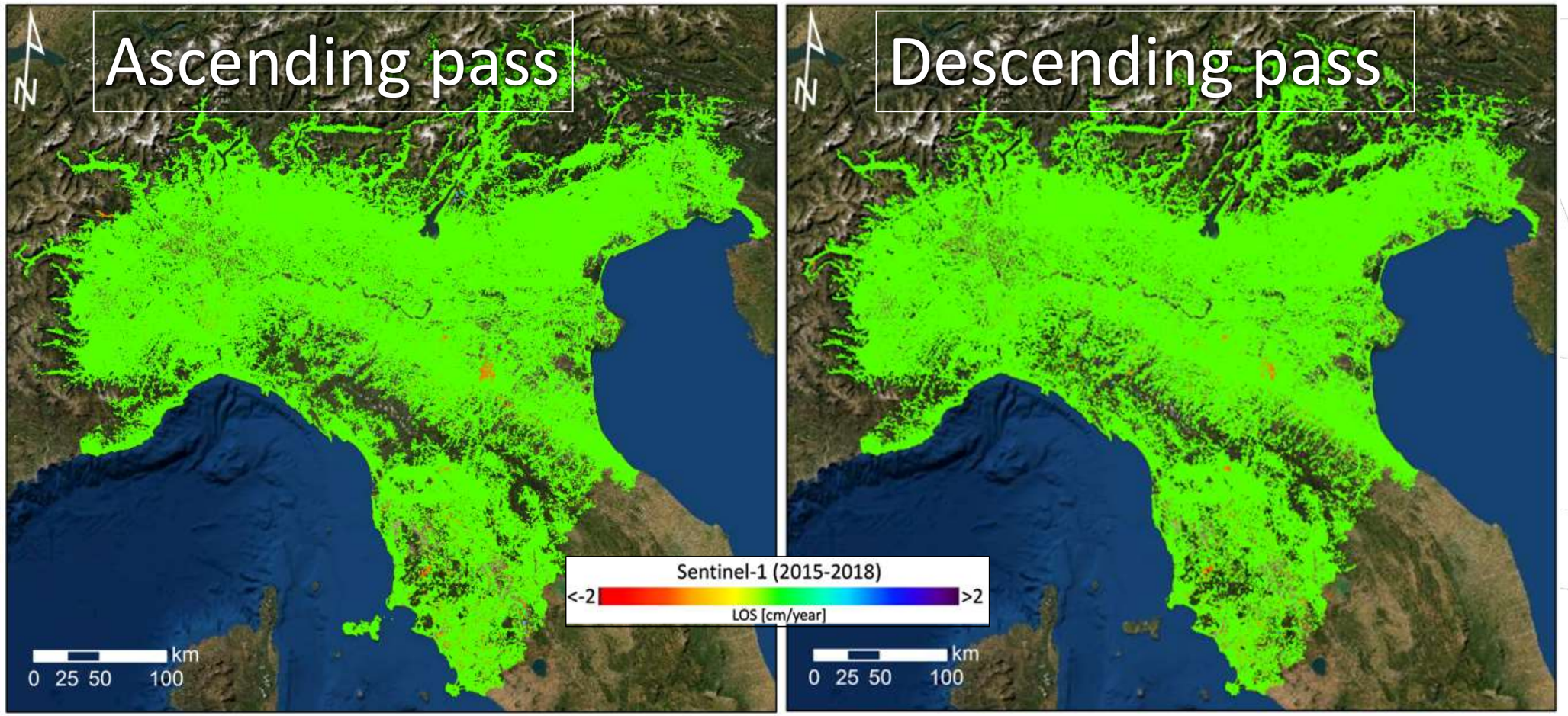
Majority voting

Random Forest prediction

(Ground motion classification)

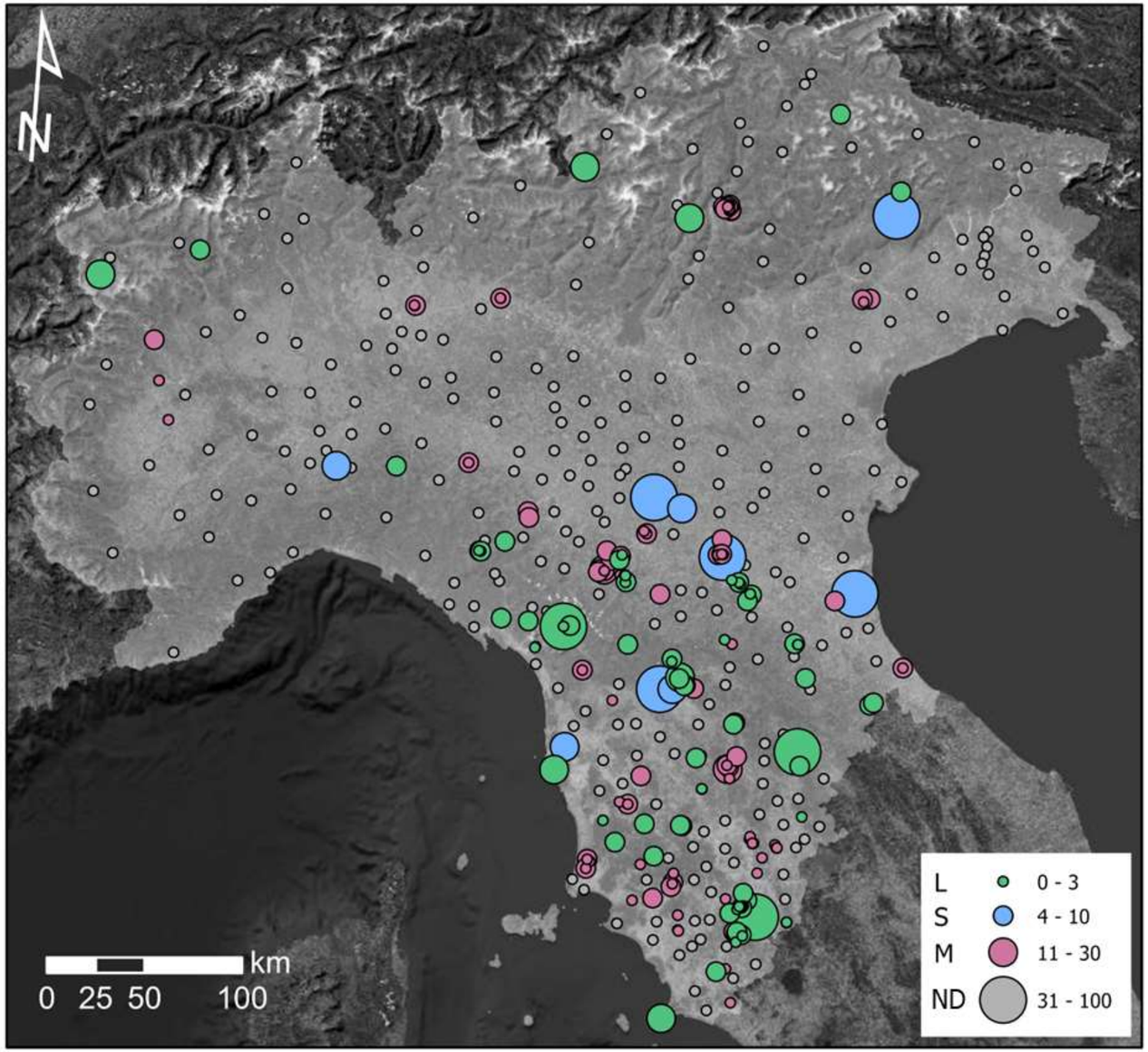


The future: continental scale



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



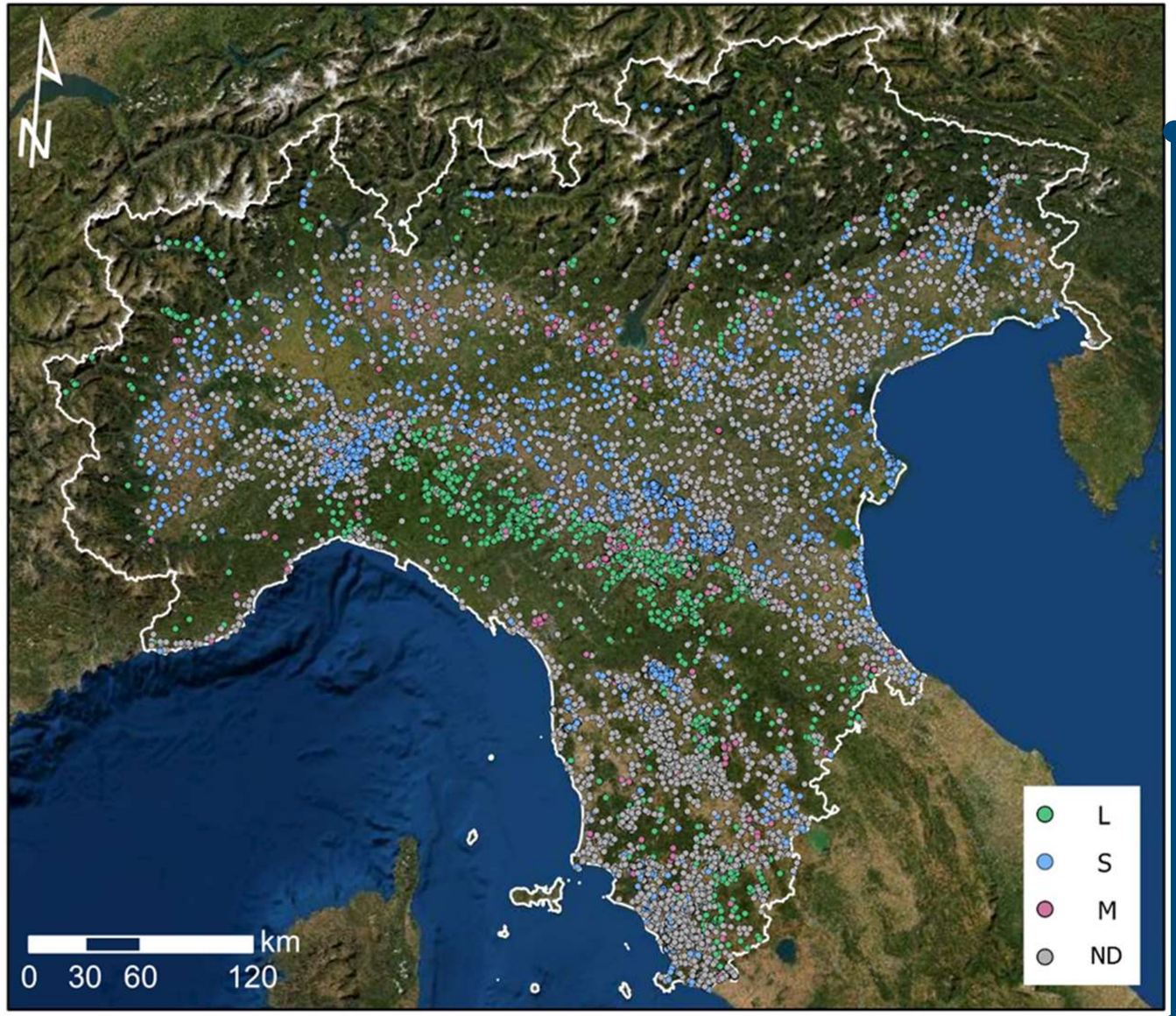
Training dataset

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

The future: continental scale



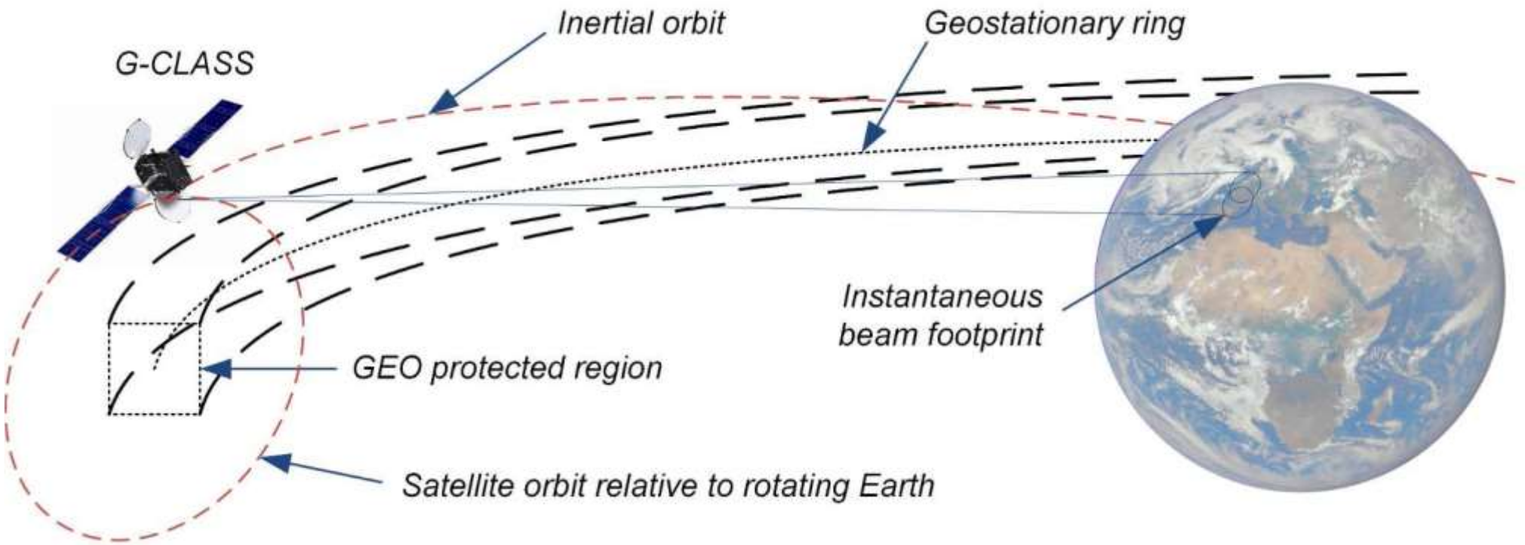
Classification outcomes

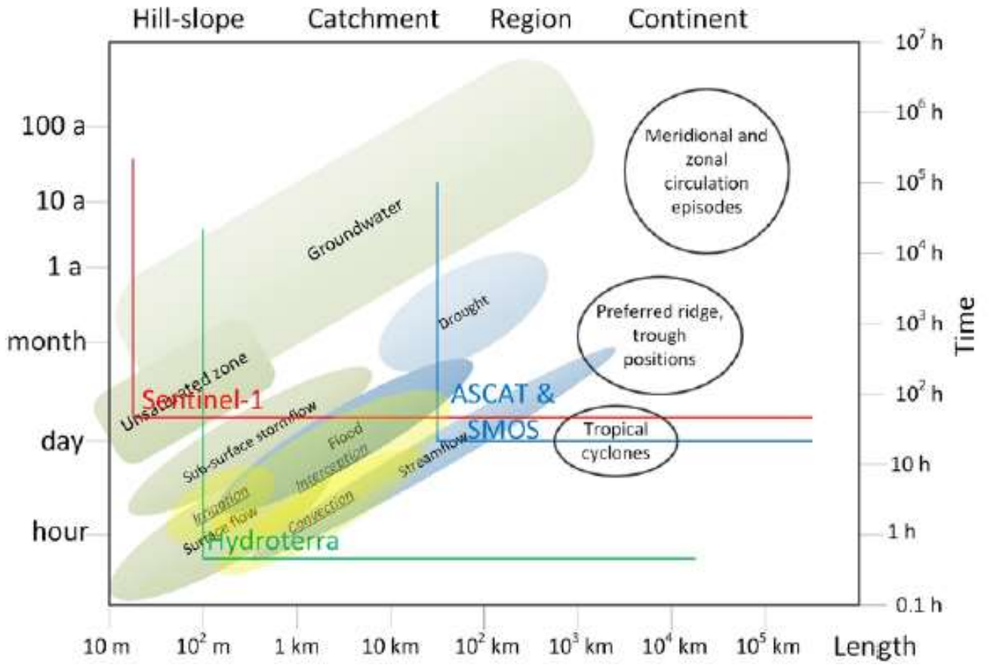
Automated classification of 20,212 features:

- 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 = ±9.4°)
- Mean slope for S features = 0.5° (standard deviation = ±1.3°)
- 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

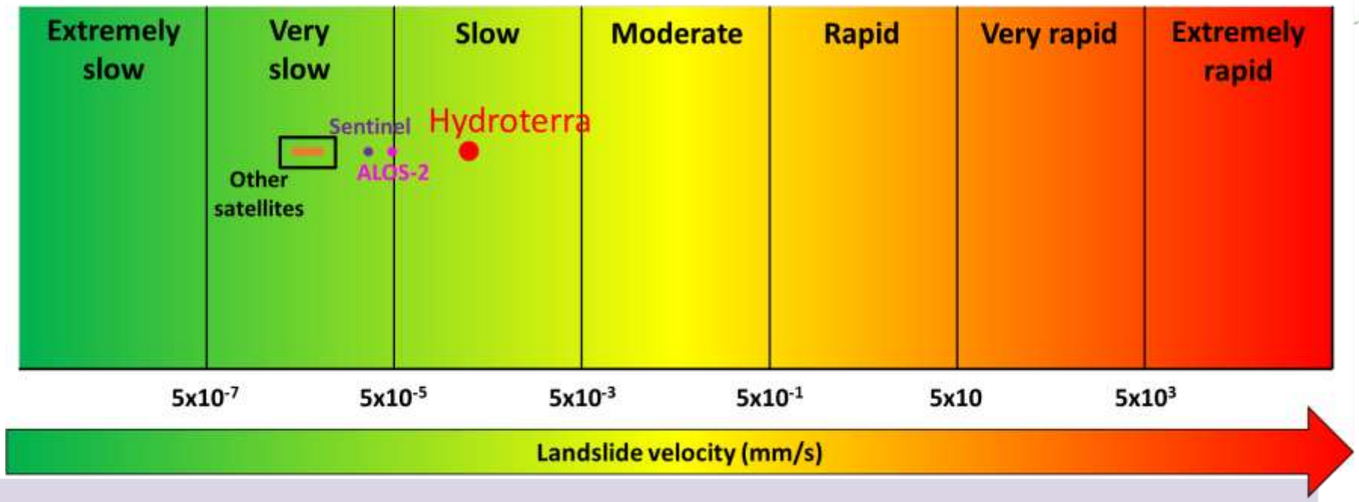
The future: continental scale





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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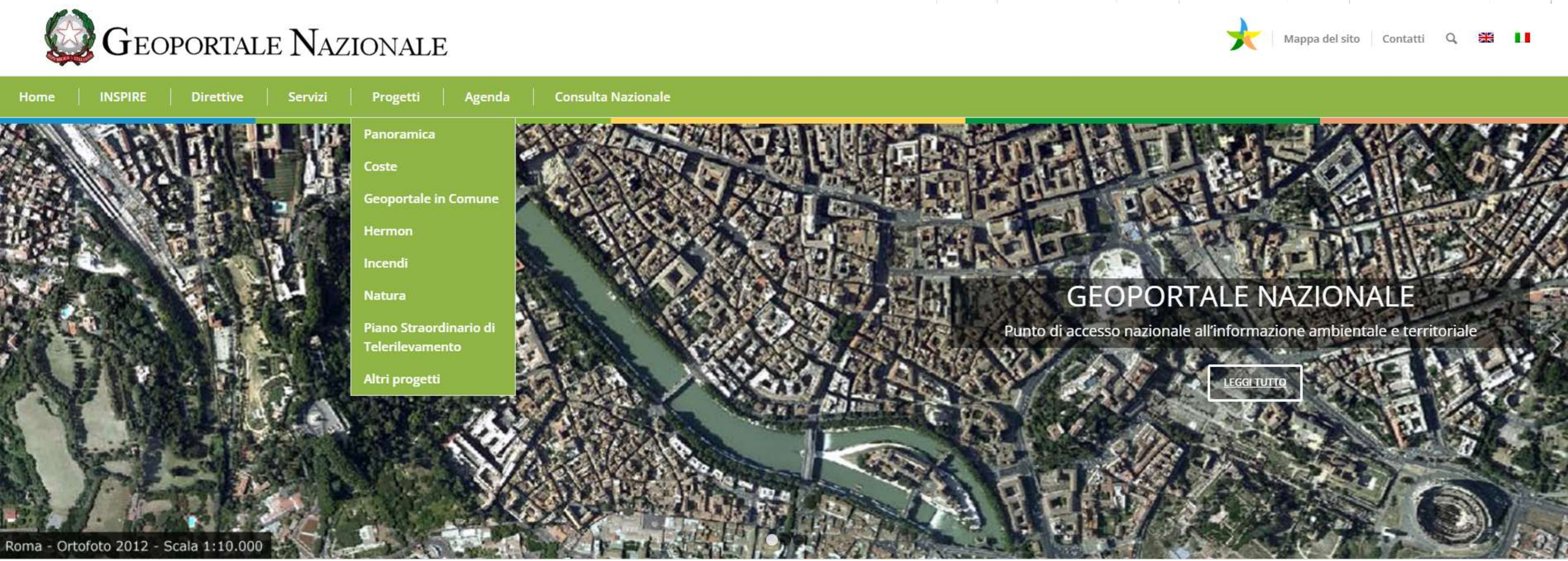
Il geoportale nazionale (PCN miniambiente)

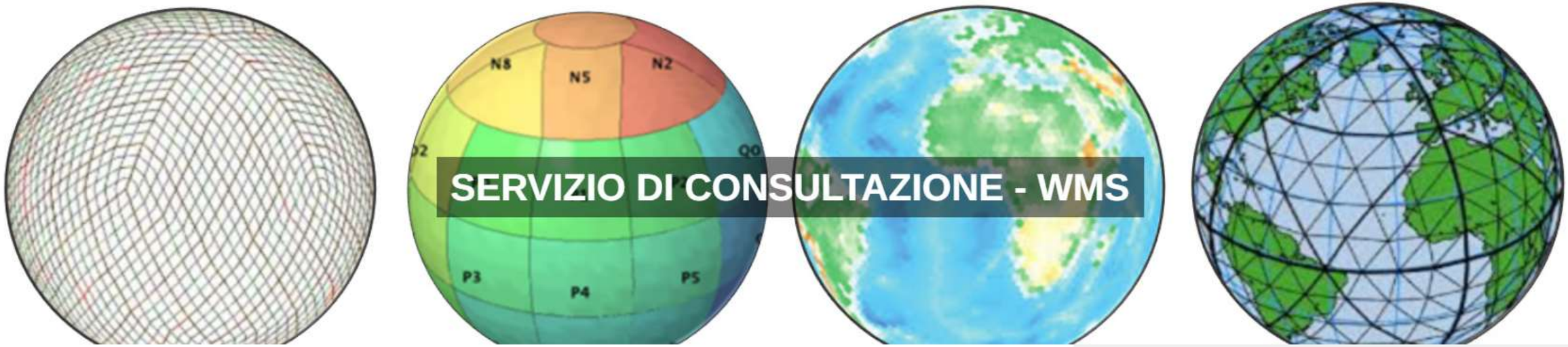


I dati PS nel geoportale

GEOPORTALE NAZIONALE

Mappa del sito | Contatti

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



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 utilizzandolo 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

I dati PS nel geoportale

Historical data: ERS, Envisat and COSMO-SkyMed

I dati PS nel portale della Regione Toscana

Monitoraggio radar delle deformazioni del terreno

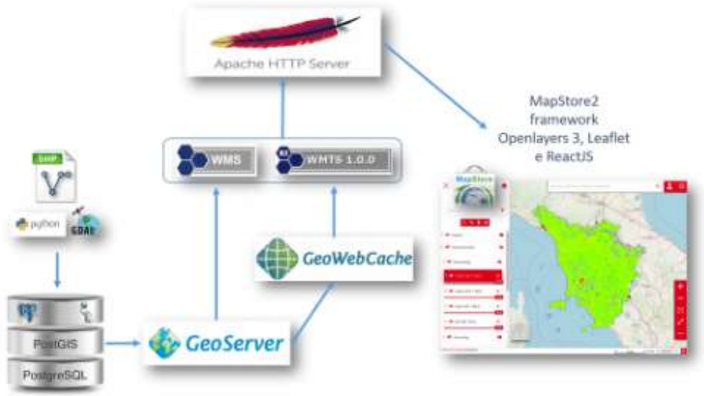
Condividi

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

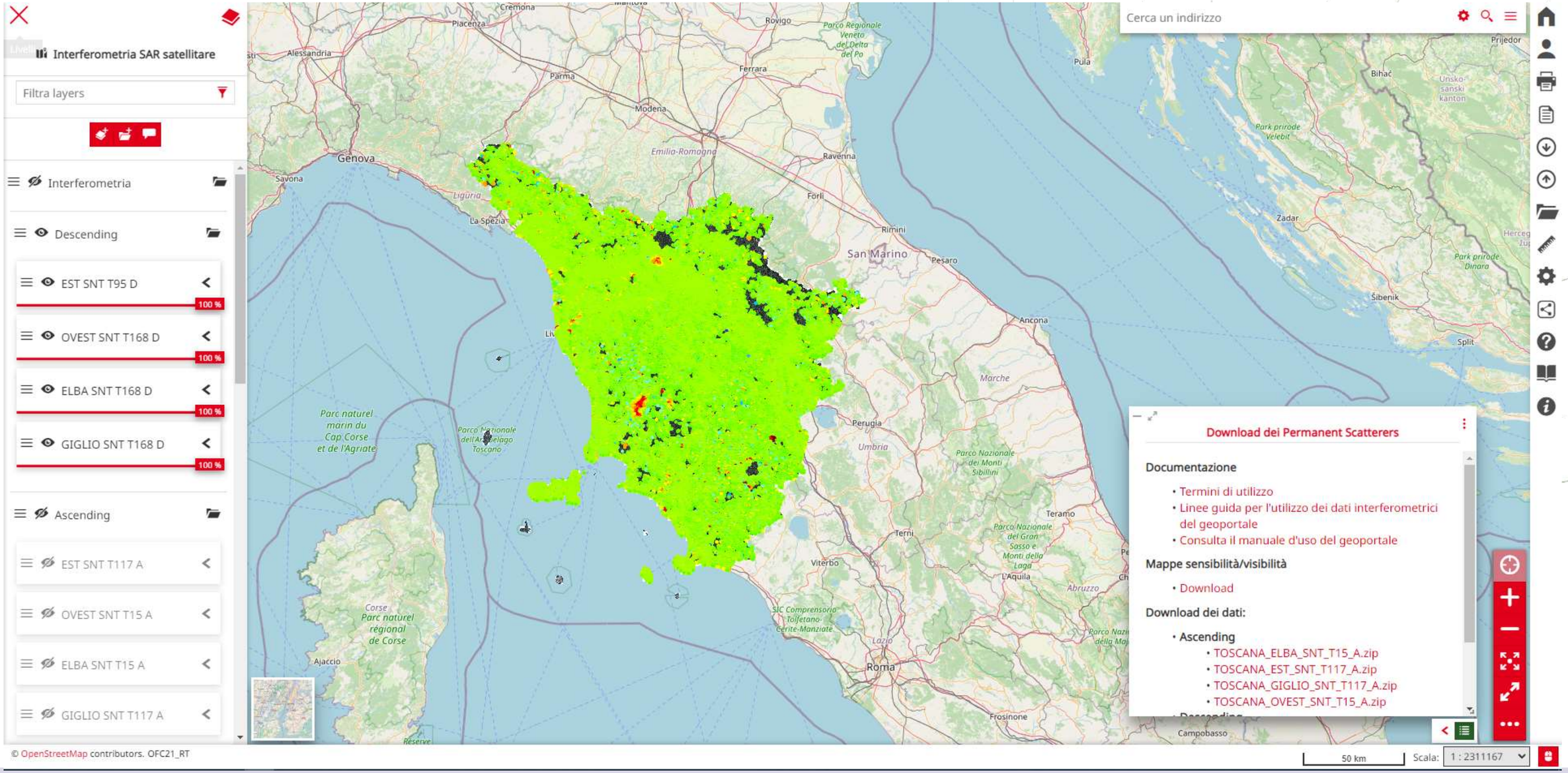
Documentazione utile:

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

Download dei dati:

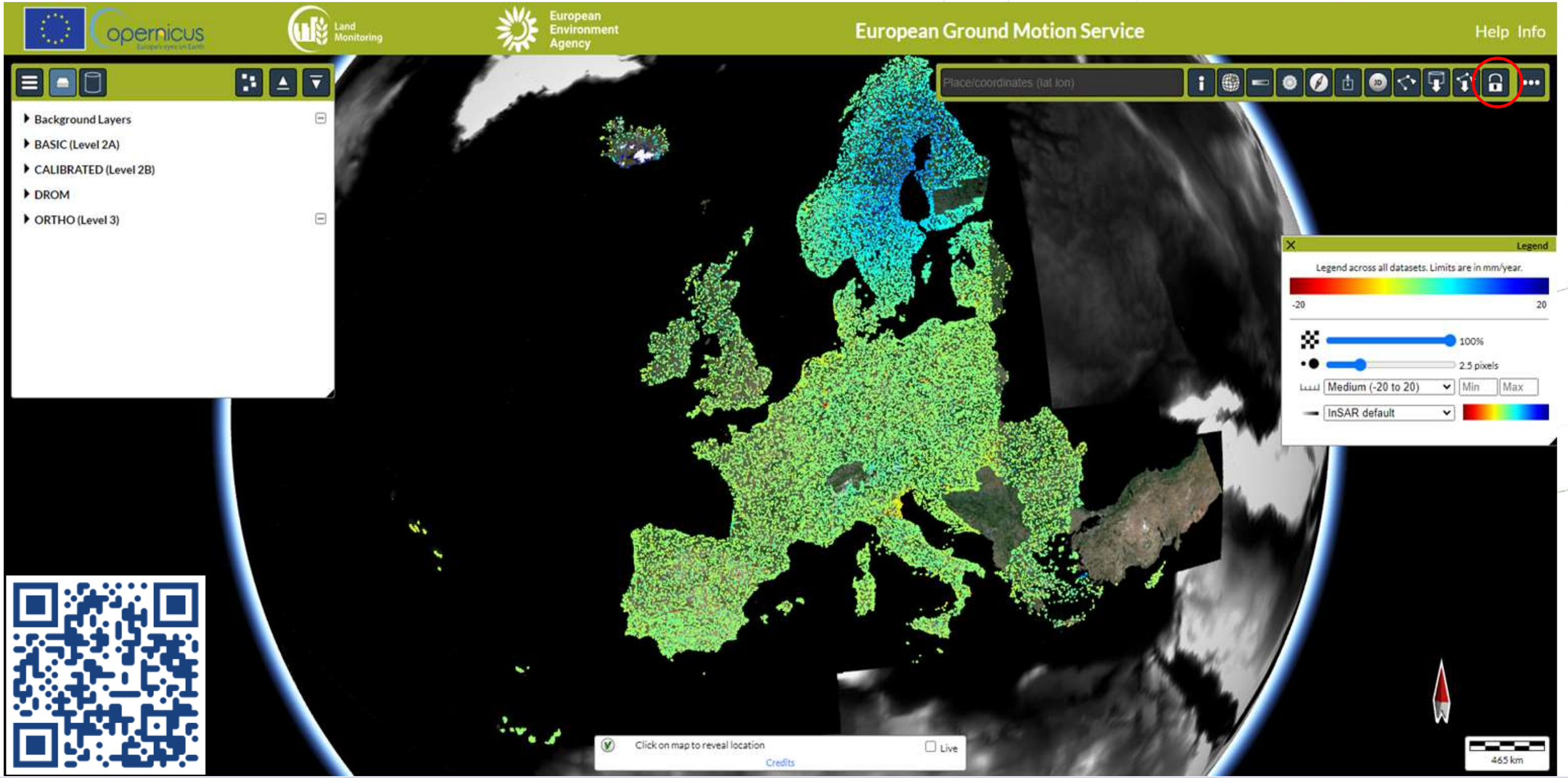
Ascending	Descending	Mappe sensibilità/visibilità
• TOSCANA_ELBA_SNT_T15_A.zip	• TOSCANA_ELBA_SNT_T168_D.zip	
• TOSCANA_EST_SNT_T117_A.zip	• TOSCANA_EST_SNT_T95_D.zip	• Download
• TOSCANA_GIGLIO_SNT_T117_A.zip	• TOSCANA_GIGLIO_SNT_T168_D.zip	

I dati PS nel portale della Regione Toscana



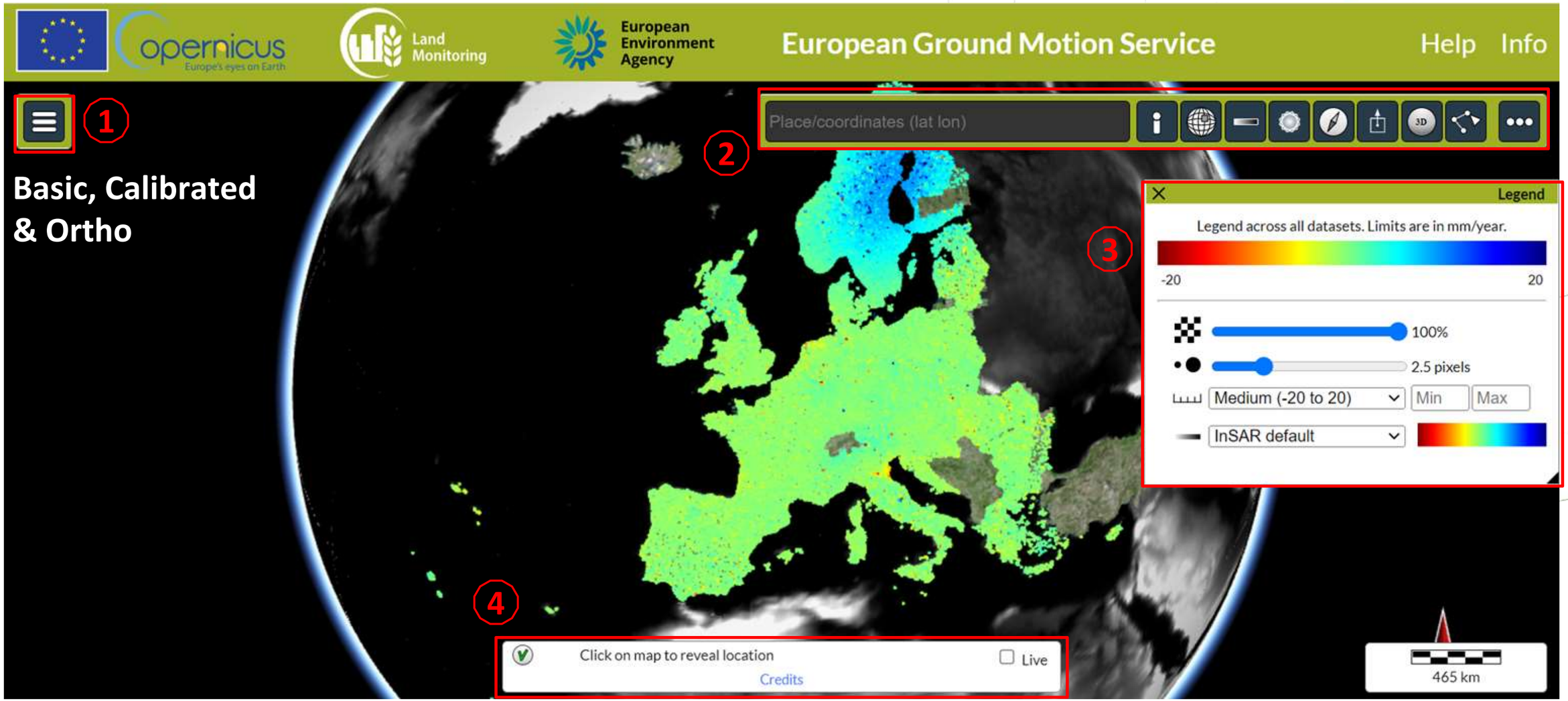
Current data: Sentinel-1 at regional scale

EGMS Explorer



Current data: Sentinel-1 at continental scale

EGMS Explorer

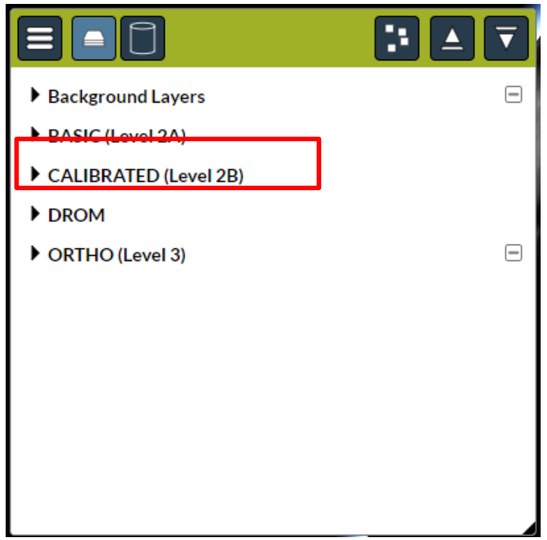


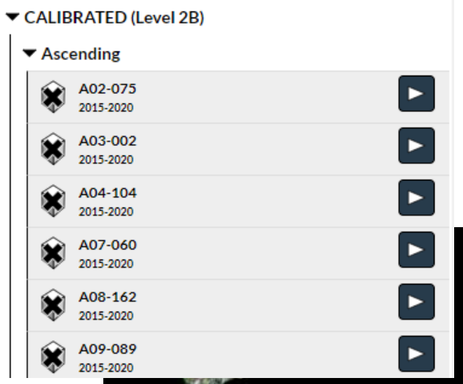
1 --> Data drop-down menu 2 --> Toolbar 3 --> Color bar adjustment 4 --> Coordinates

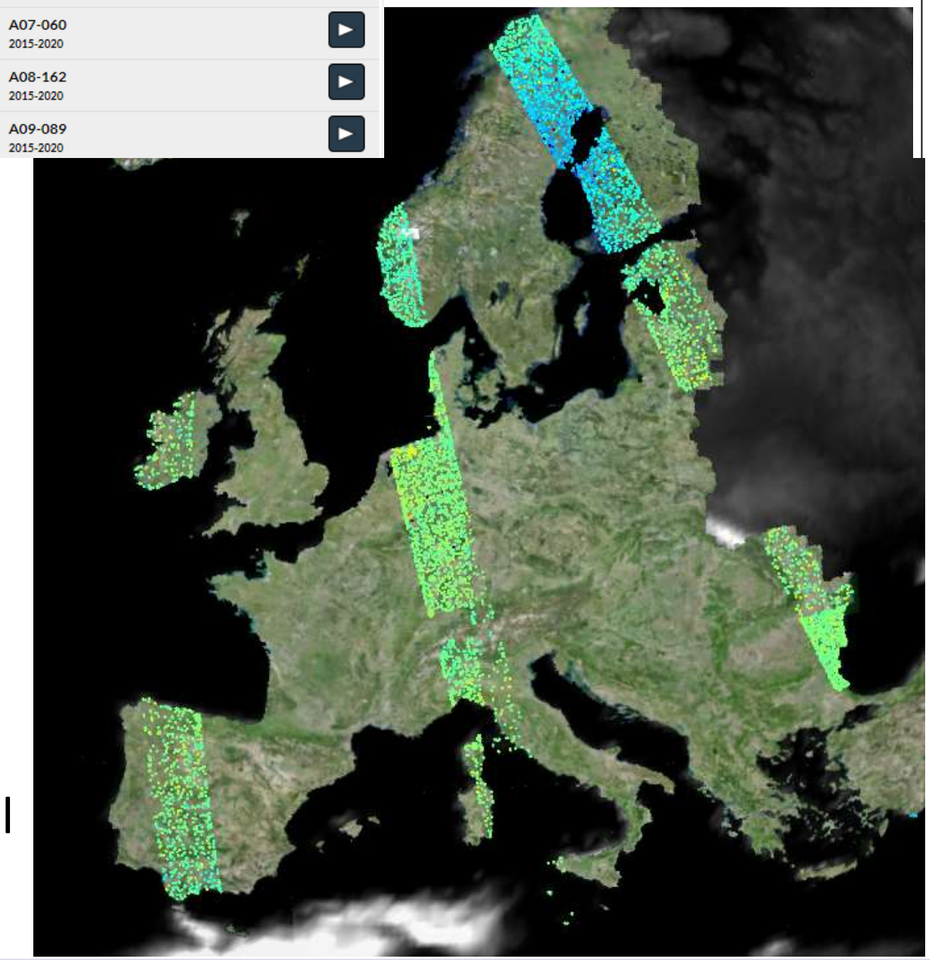
Current data: Sentinel-1 at continental scale

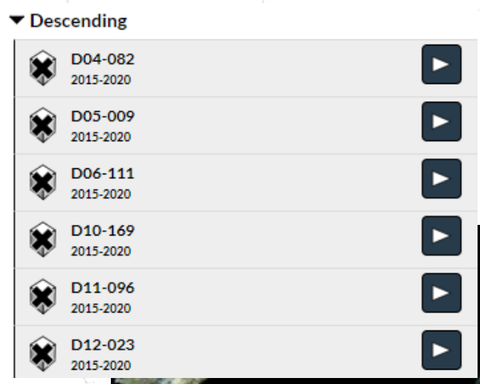
https://egms.land.copernicus.eu/

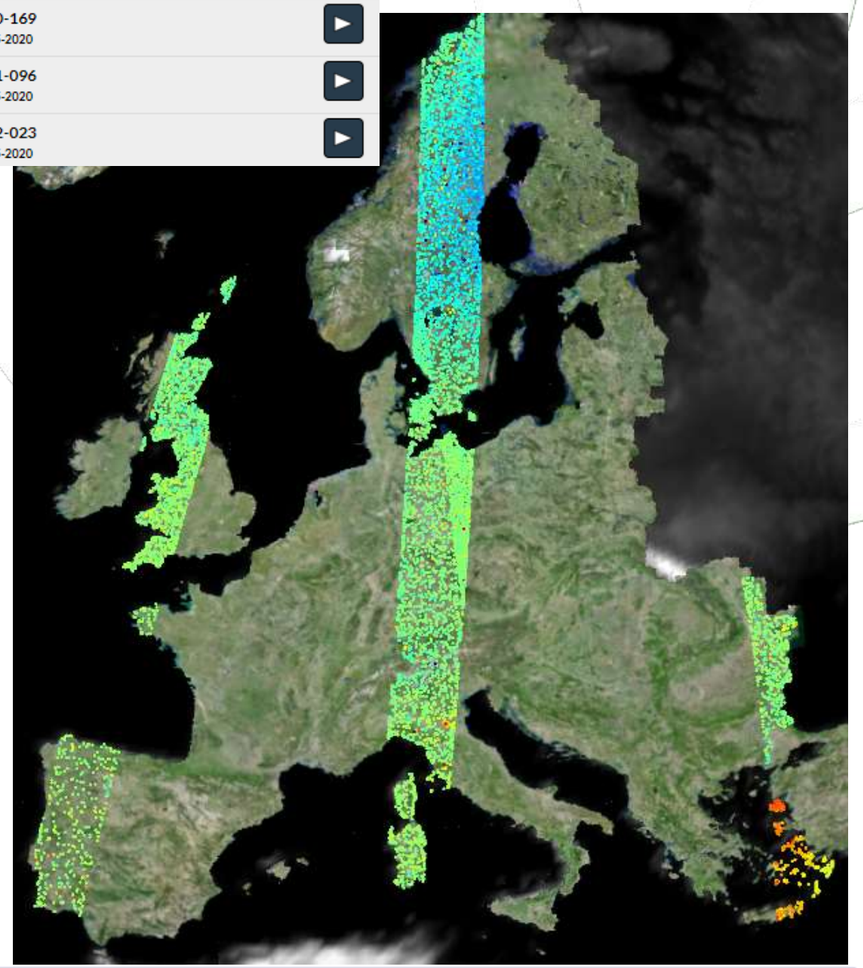
EGMS Explorer - LoS velocity







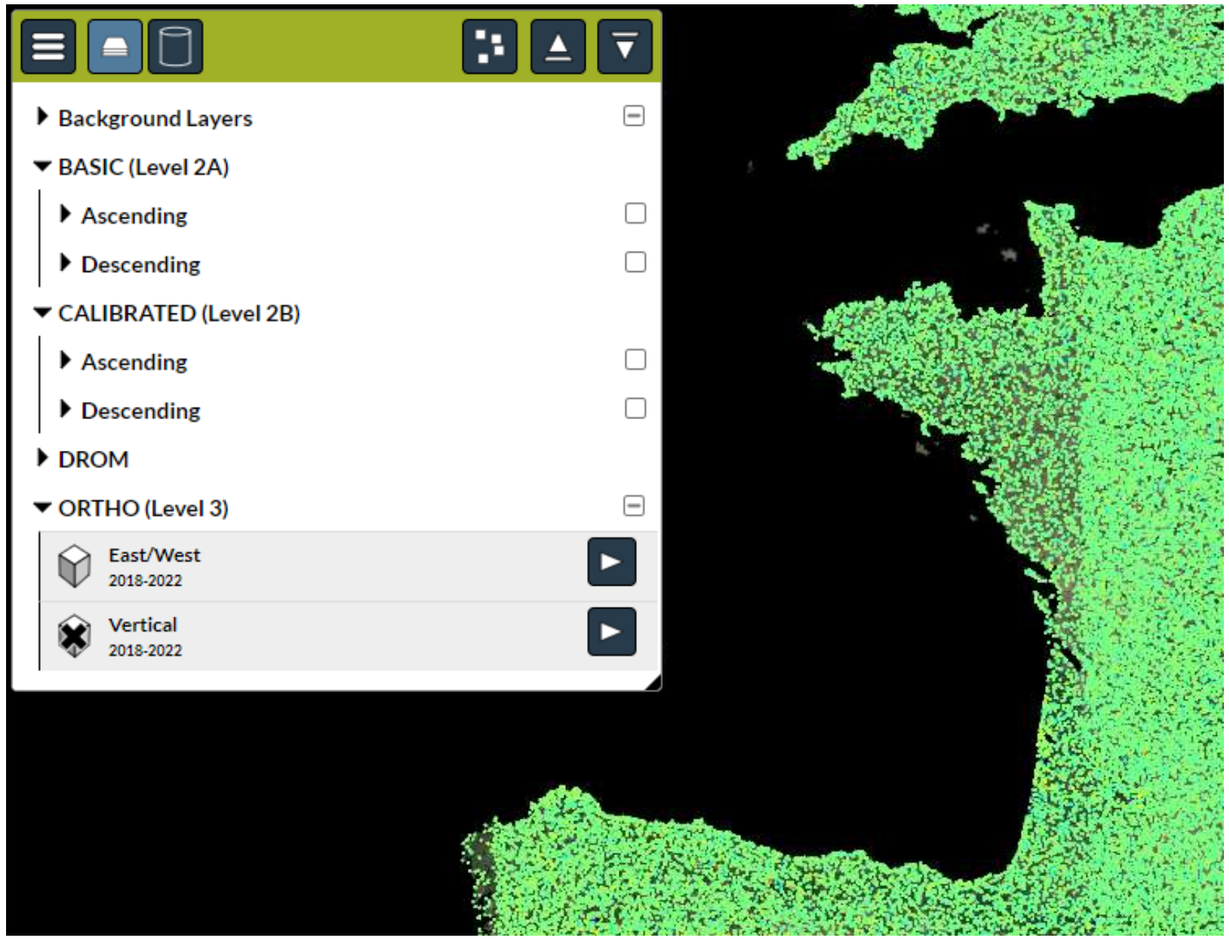


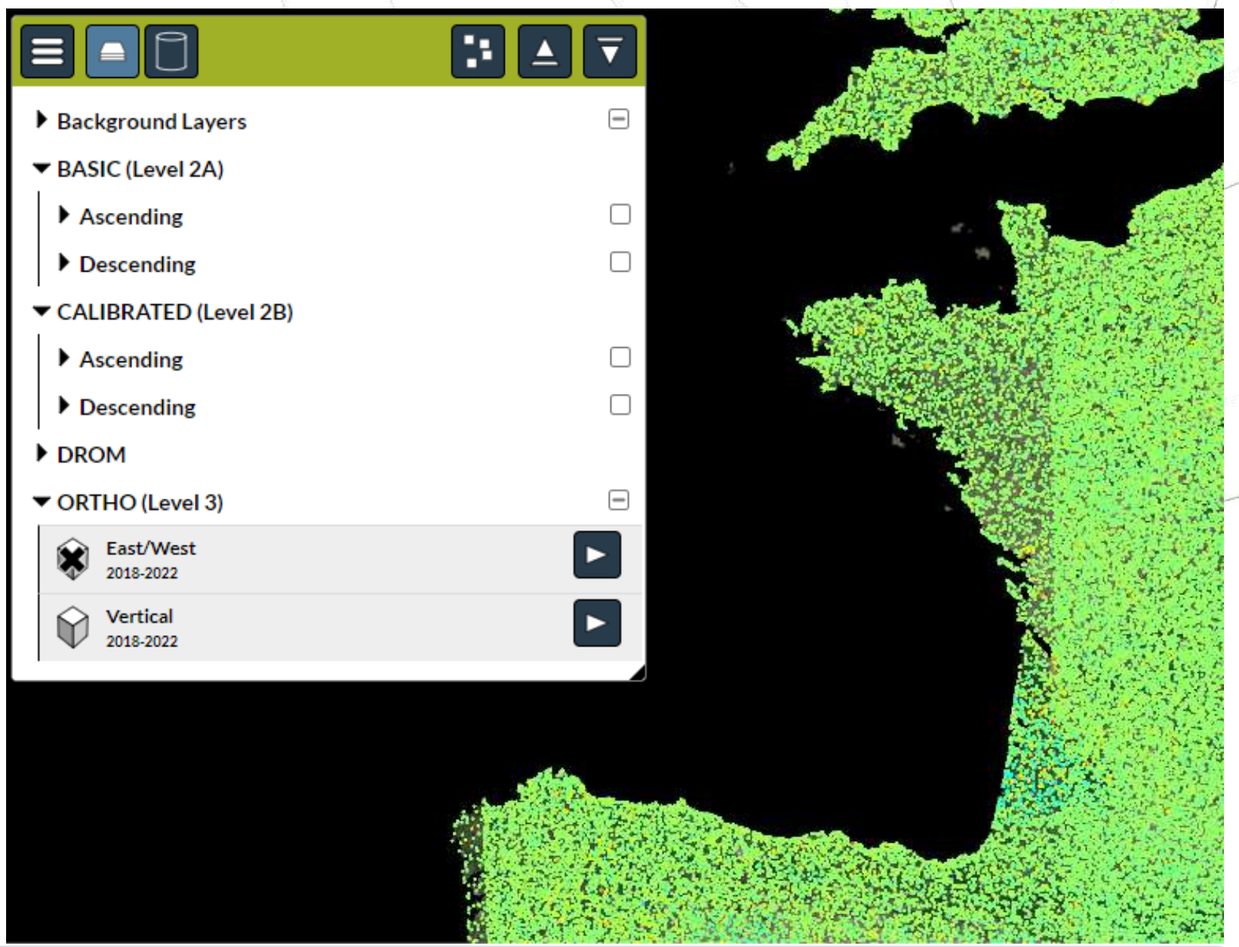


Numbering of the tracks increases from W to E

It does not follow the original SNT-1 track numbering

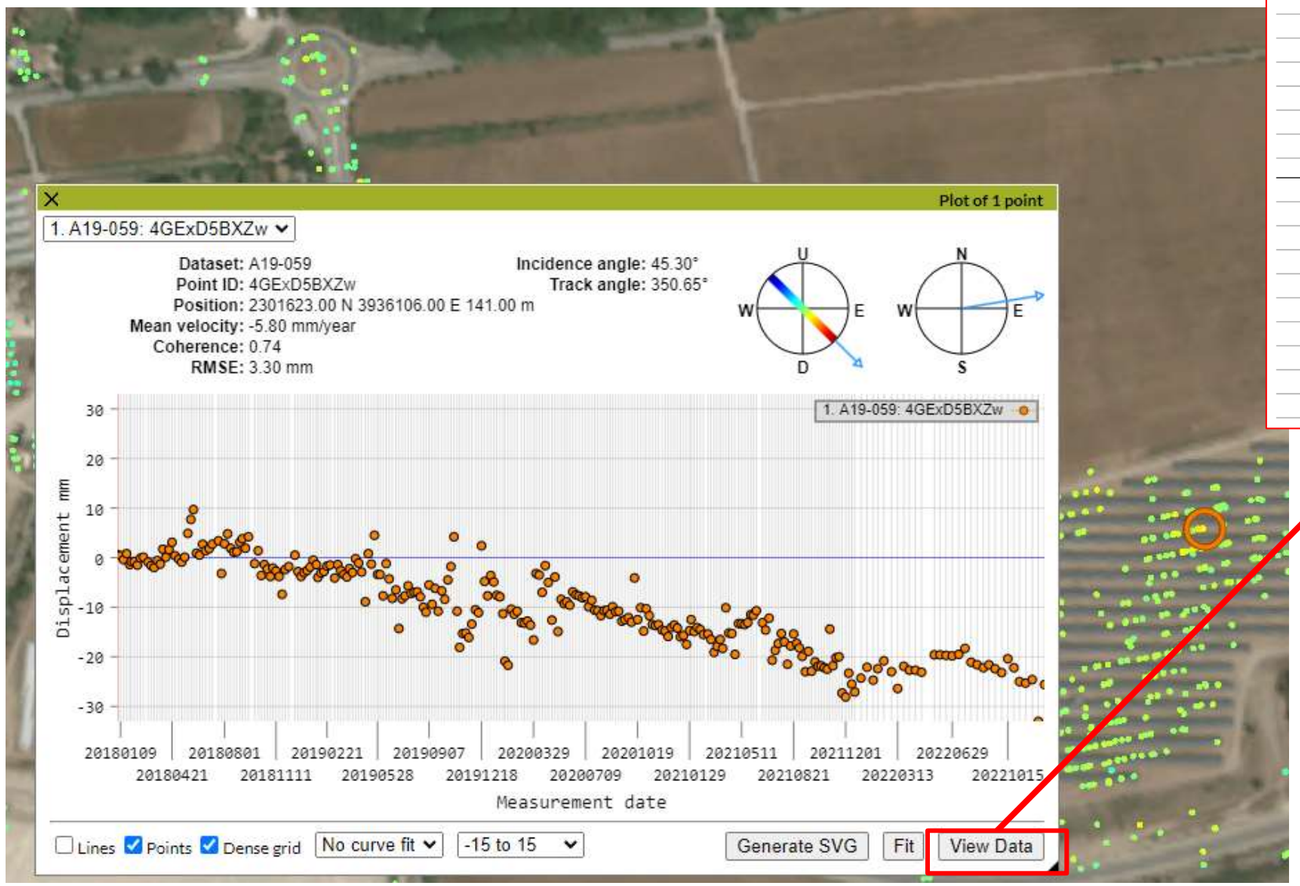
EGMS Explorer - velocity components

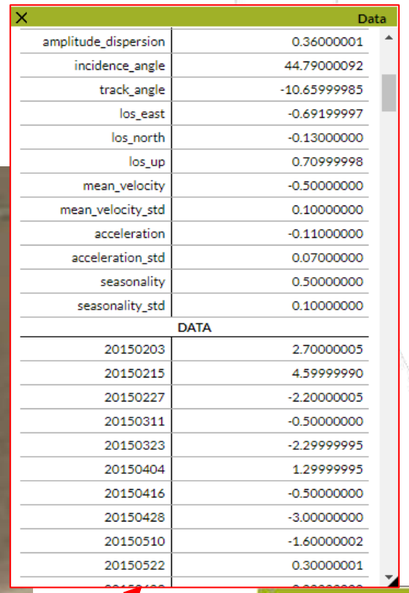




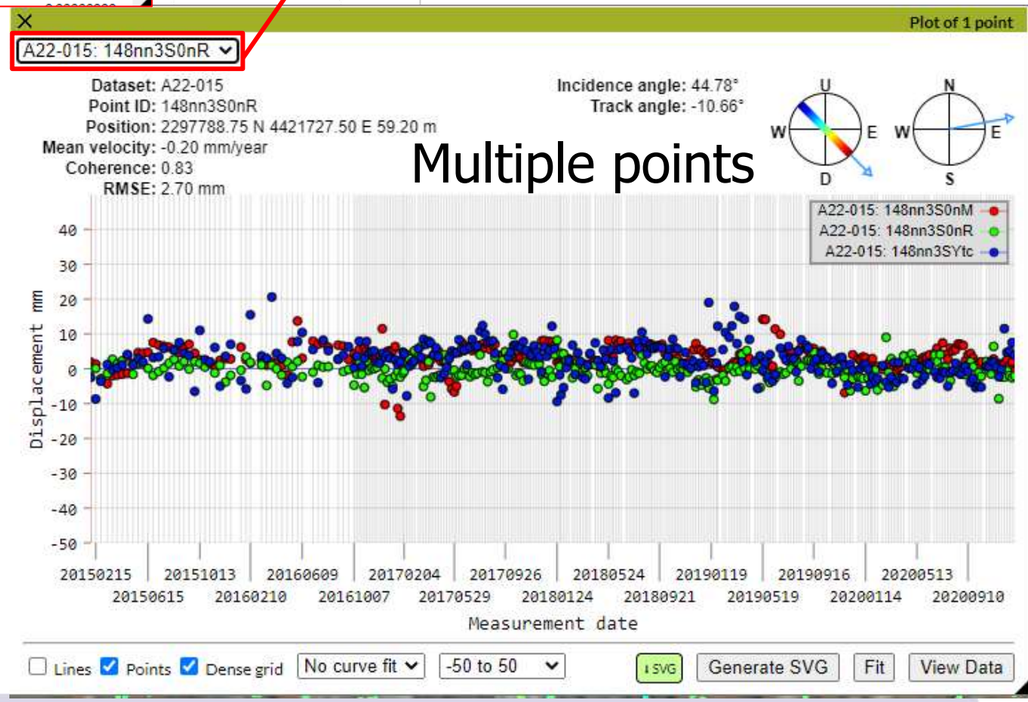
Unique map for each layer

EGMS Explorer - info per point



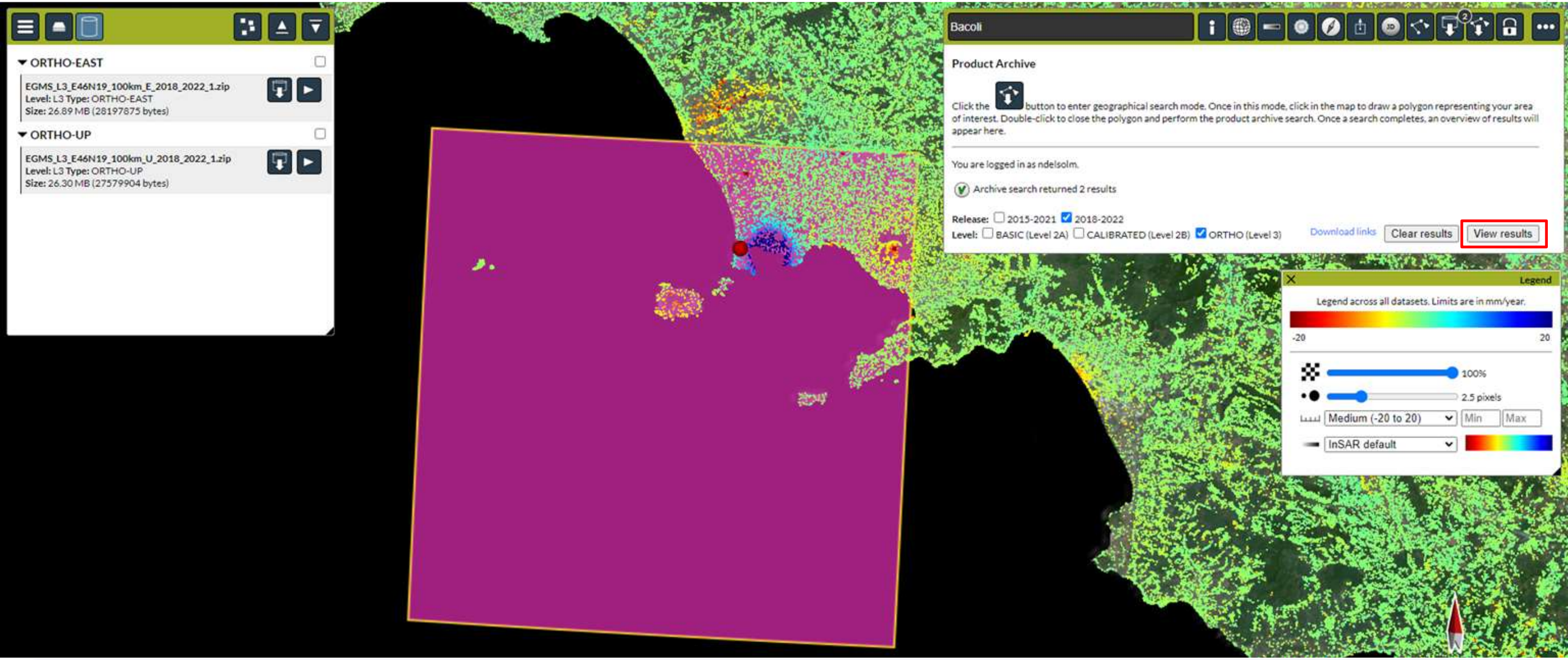


Click here to switch between points



EGMS Explorer - download data

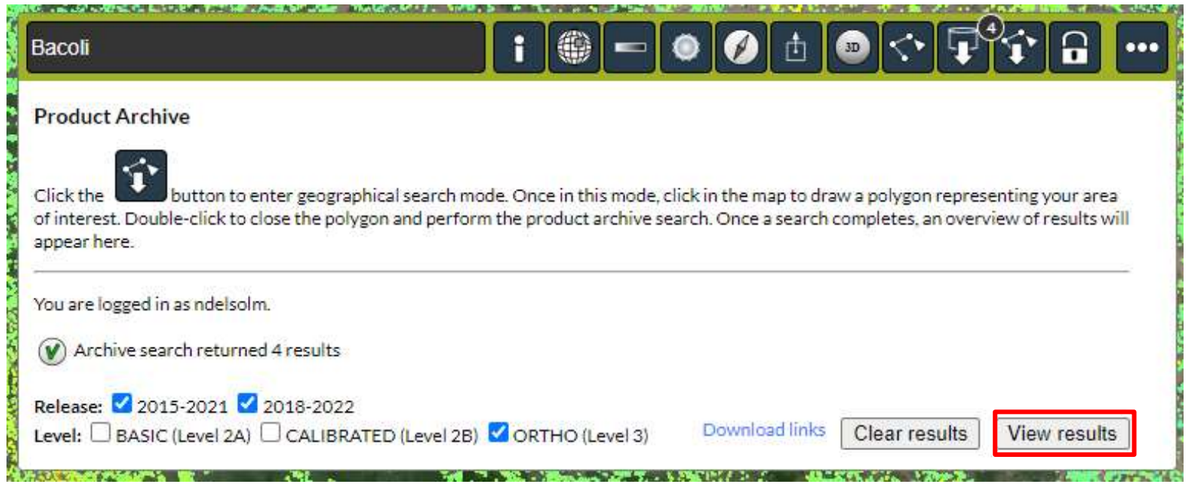
After login to EU Login

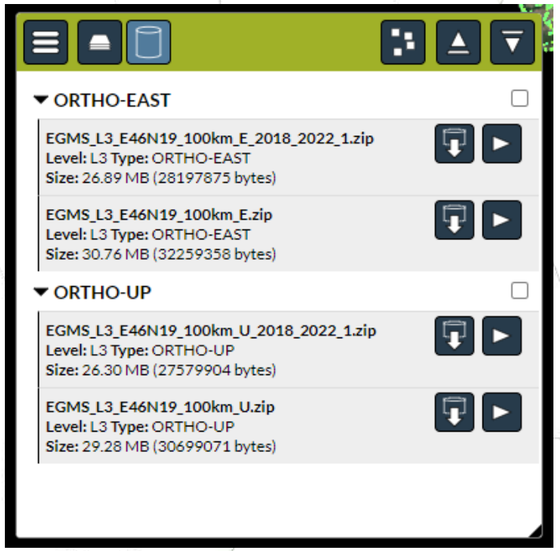


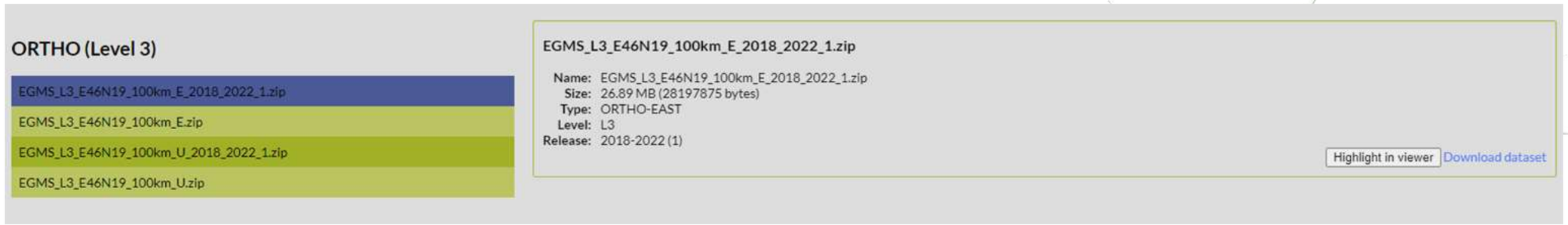
Current data: Sentinel-1 at continental scale

EGMS Explorer - download data

If I wan also the oldest data 2015-2021

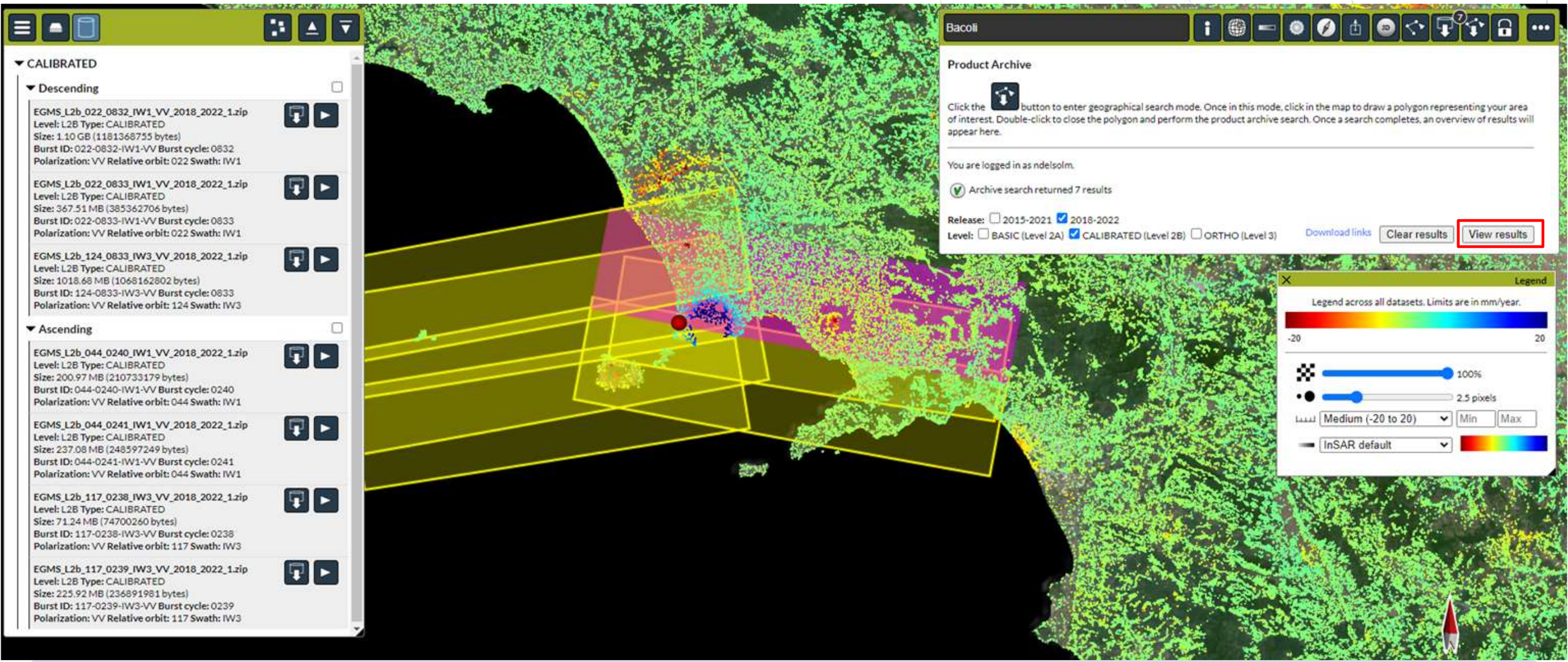






EGMS Explorer - download data

After login to EU Login



Current data: Sentinel-1 at continental scale

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_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

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
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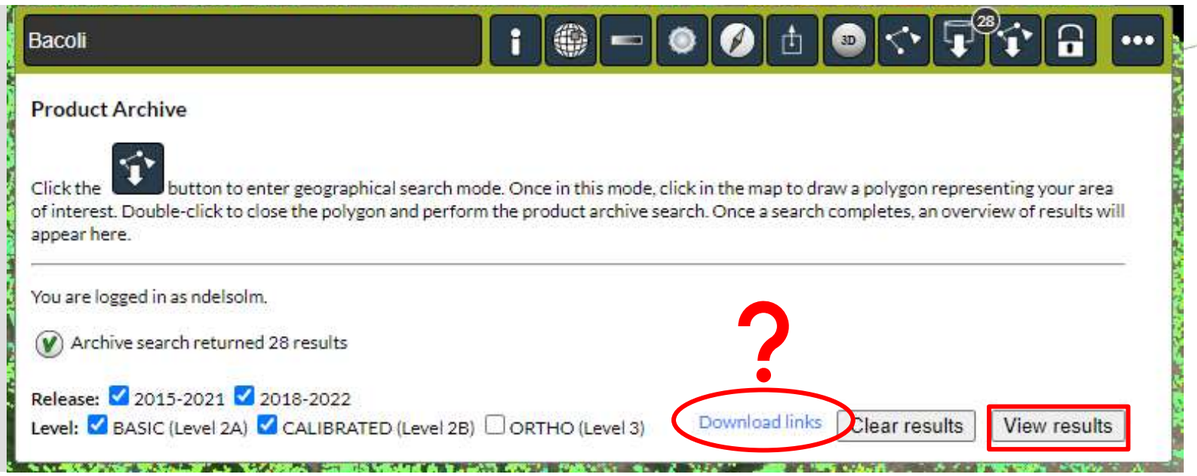
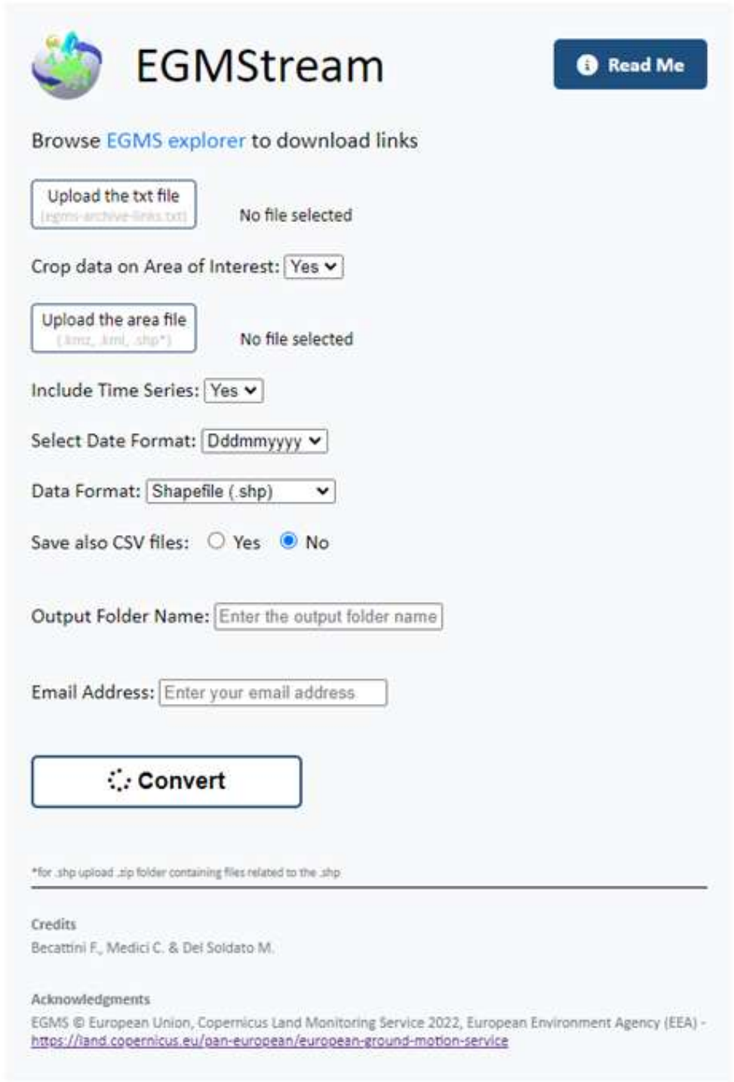


EGMStram webapp



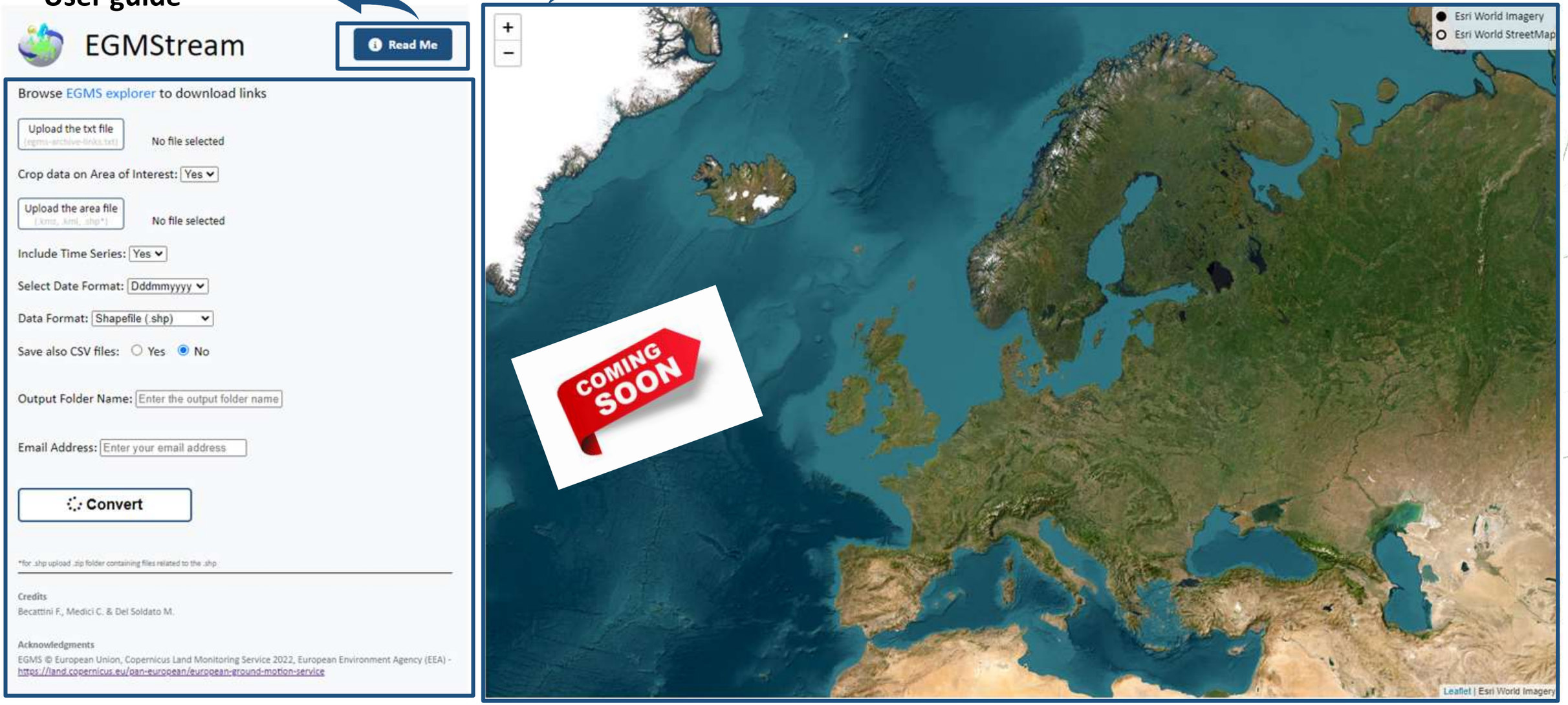
EGMStream App v2.0

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

EGMStram webapp

User guide

Interoperative map



SIDE BAR

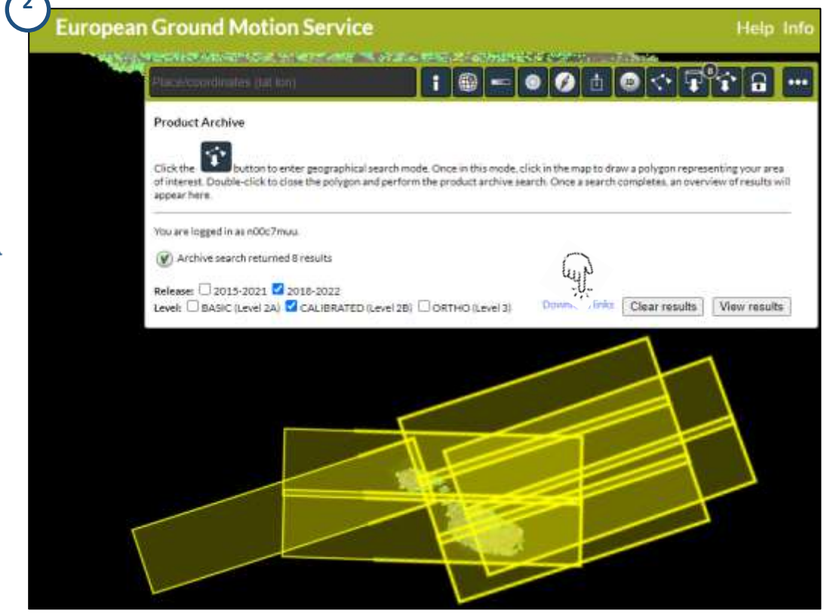
EGMStram webapp

1

EGMStream

Browse EGMS viewer to download links

2



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: Yes

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

Include Time Series: Yes

Select Date Format: Dddmmyyyy

Data Format: Shapefile (.shp)

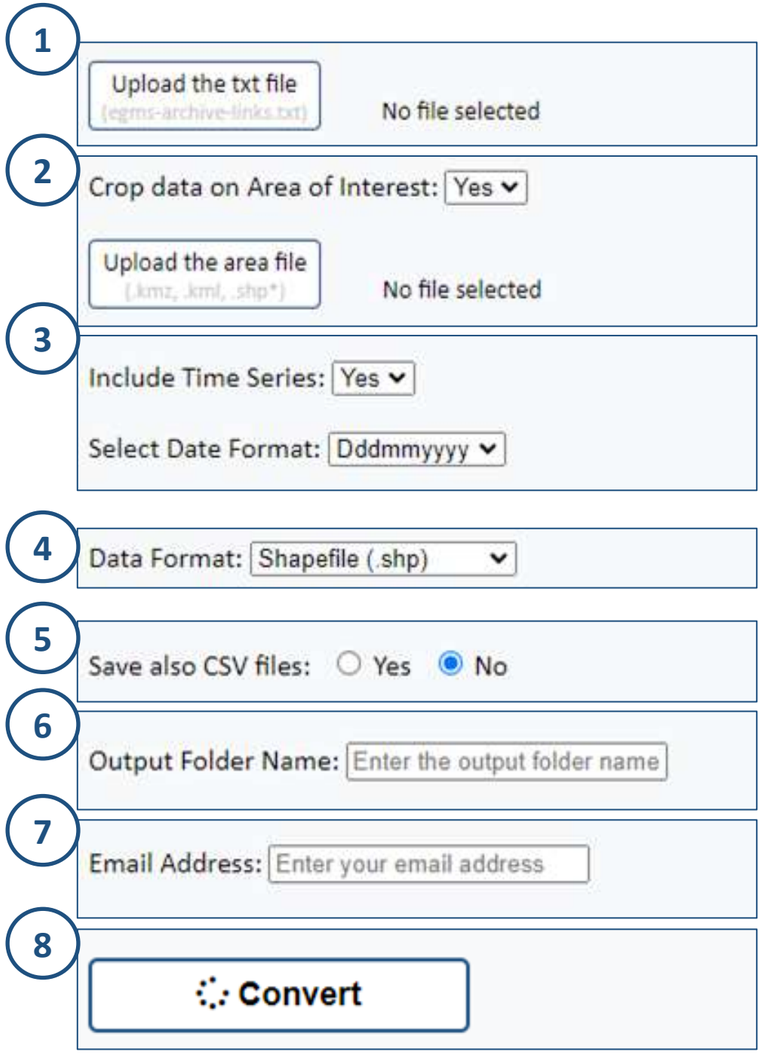
Save also CSV files: Yes No

Output Folder Name: Enter the output folder name

Email Address: Enter your email address

Convert

EGMStram webapp



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 Dddmmyyy 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;

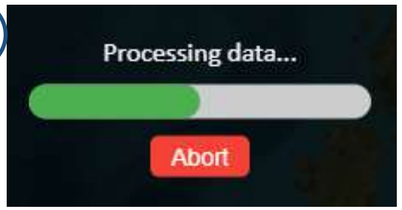
5) Select whether you also want to receive the original .csv files, in addition to the files converted to .shp/.gpkg;

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;

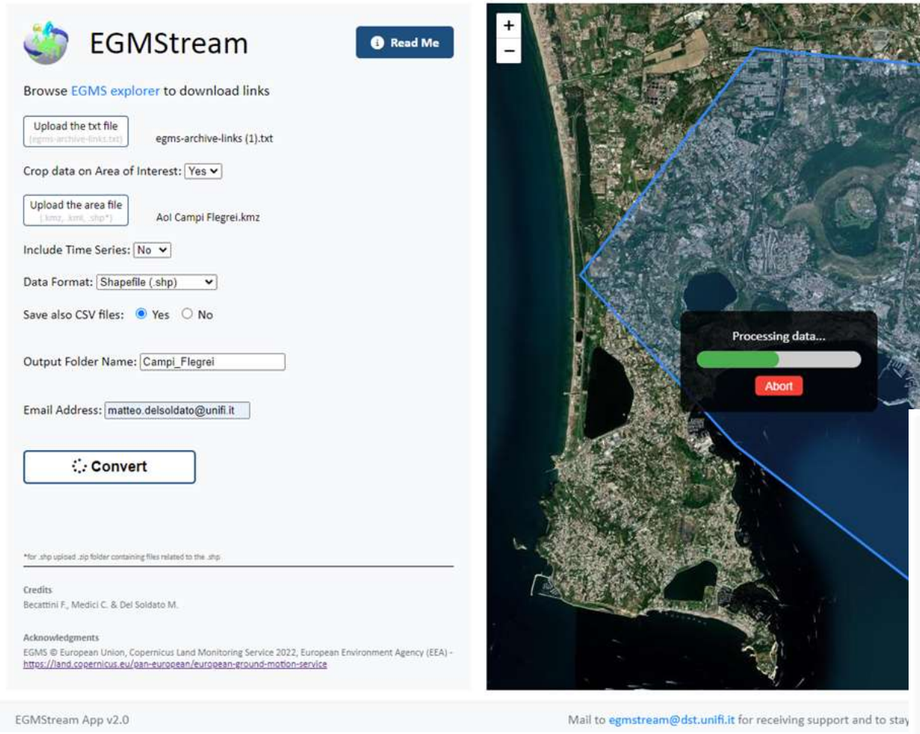
7) Enter the e-mail address to which you want to receive the data at the end of processing;

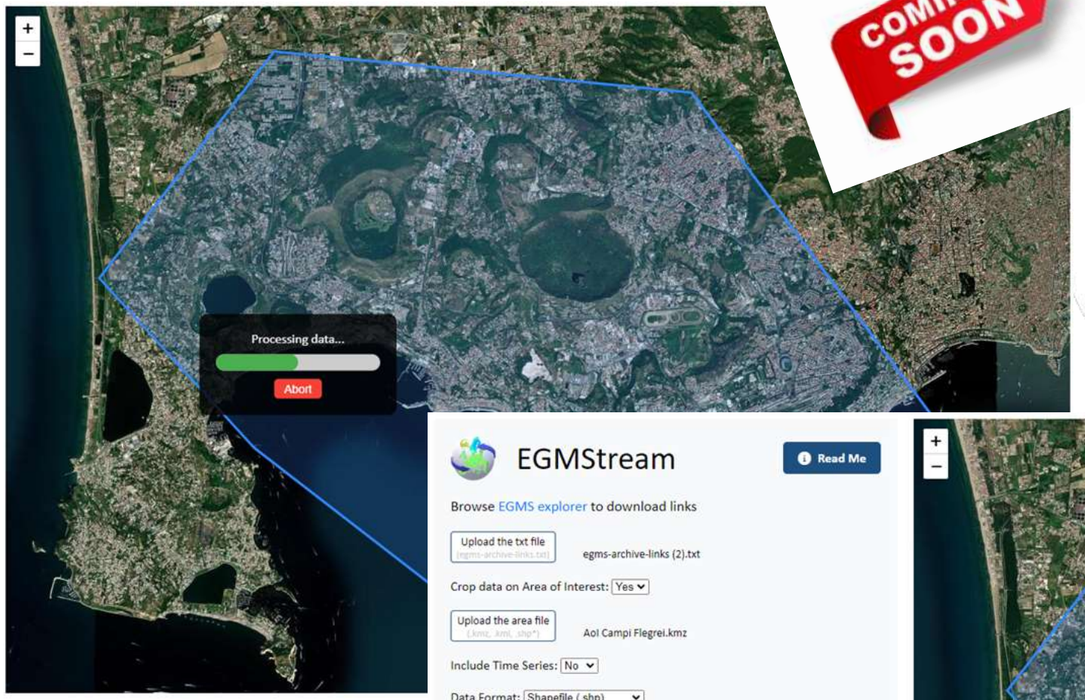
8) Run conversion by triggering the 'Convert' action button;

9

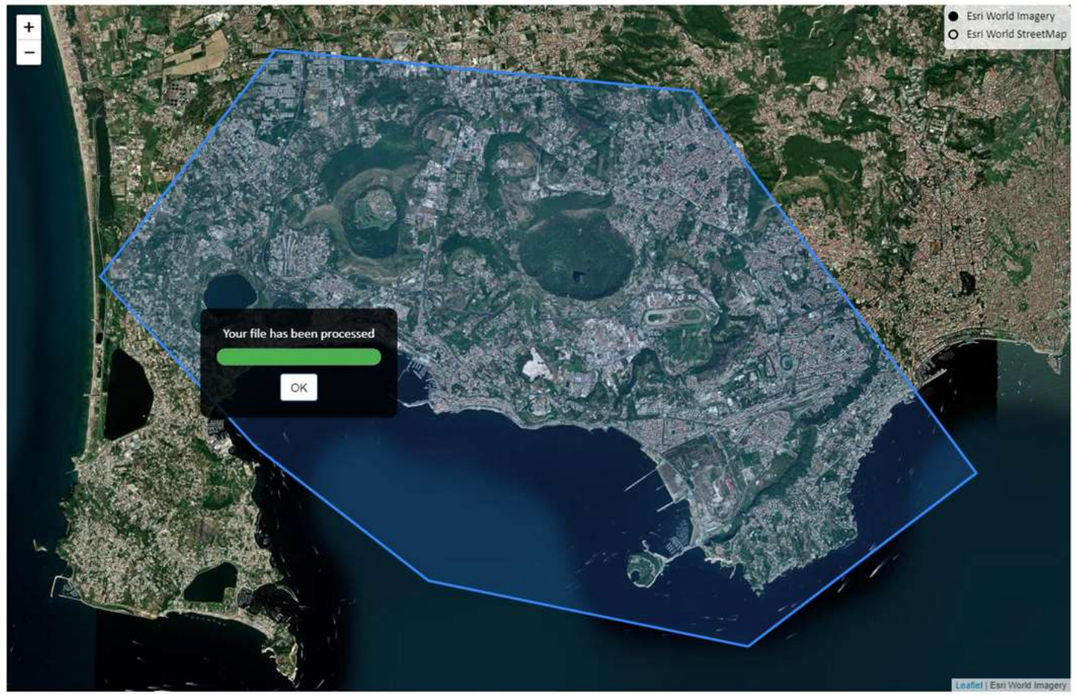


EGMStram webapp





COMING SOON



EGMStram webapp

EGMStram webapp - final reuslts

COMING SOON

EGMS data Posta in arrivo ×

egmstream@dst.unifi.it
a me

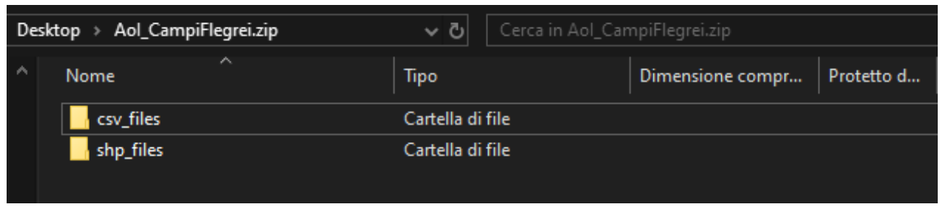
Your files have been processed. You can download it from the following link: http://localhost:5000/download/Campi_Flegrei.zip

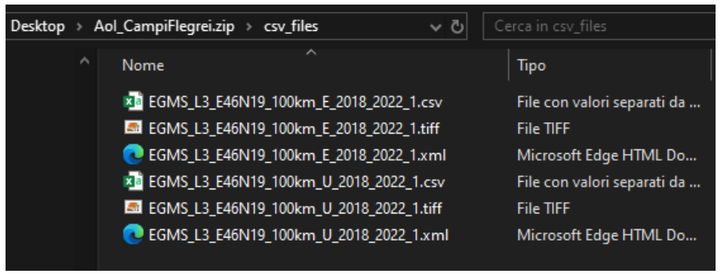
Please consider that the data will expire in 3 days.

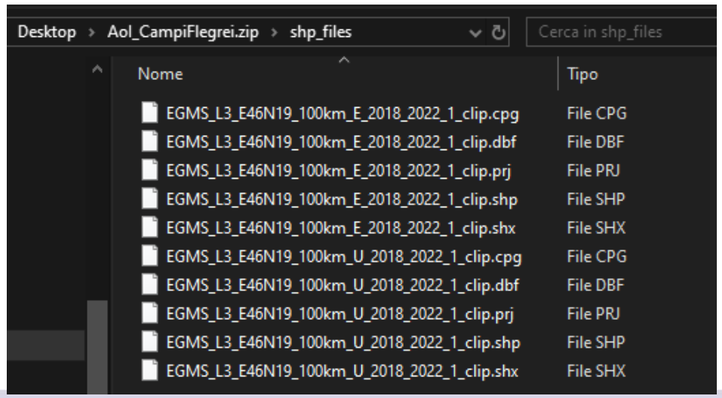
The EGMStream team thank you for using our service.

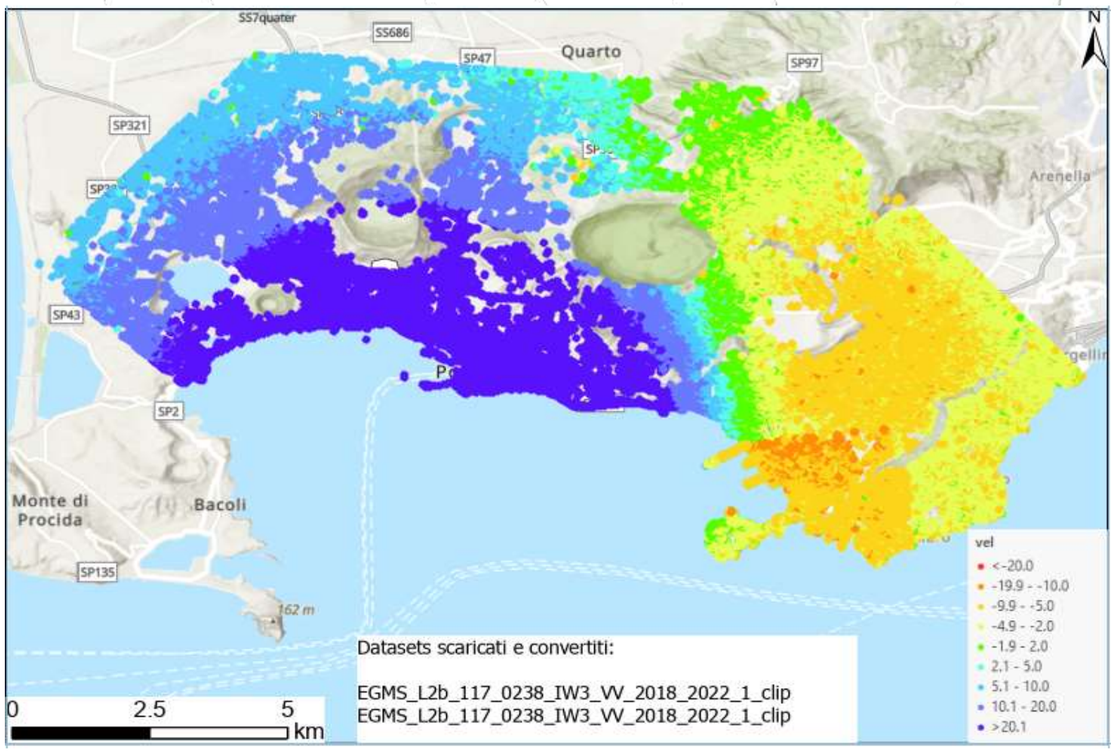
Best regards,

EGMStream team









Data download: a free web application

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”

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Ministero dell’Università e della Ricerca
Italiadomani