Continuous monitoring of ground deformational scenario of Veneto region (Italy) through Sentinel-1 data

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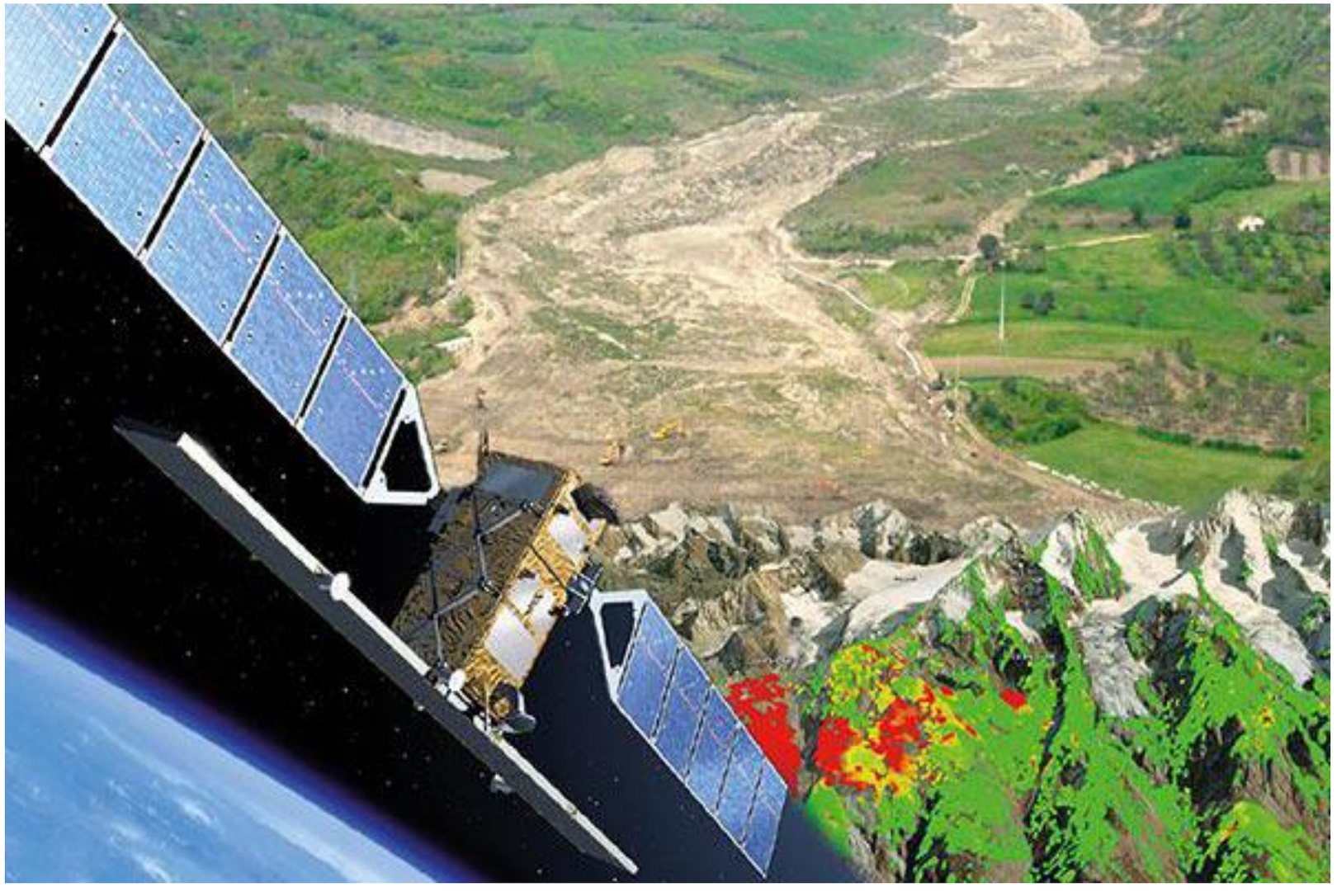
Question

Why nowadays is it possible to make a continuous and systematic satellite-based monitoring service of ground deformation at a regional scale?



The answers

All the technologies essential to continuously survey the territory are nowadays available

Sentinel-1 (ESA) is designed to regularly acquire continuous deformation data on a national and regional scale

InSAR technology is exhaustive and Italy is one of the most InSAR-advanced countries

More and more automatized and complex **processing chains**

Increase of the **computational capacities** (parallel processings, cloud computing)

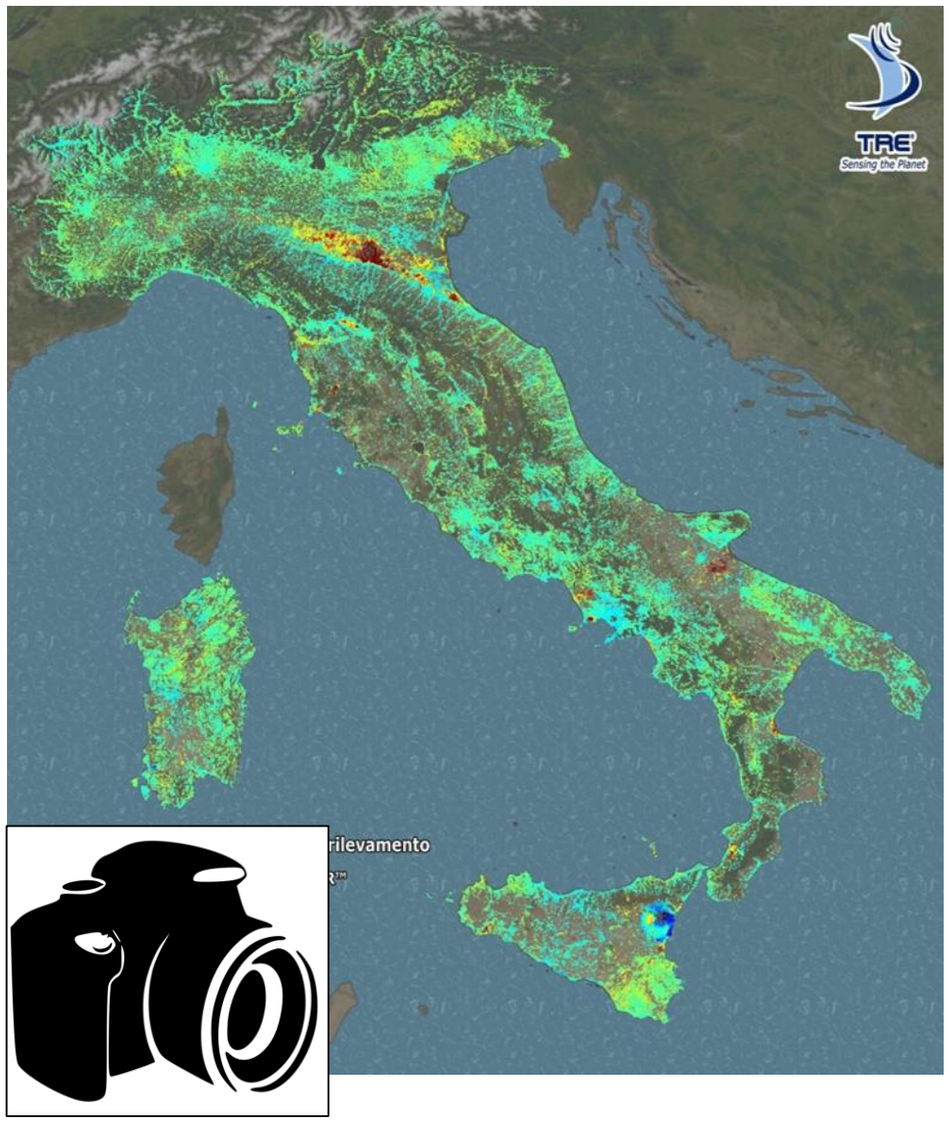
Sentinel-1A e -1B

- Two-satellites constellation(1A e 1B)
- C-Band SAR (λ=56 mm)
- Revisiting time: 6 days

Monitoring Project

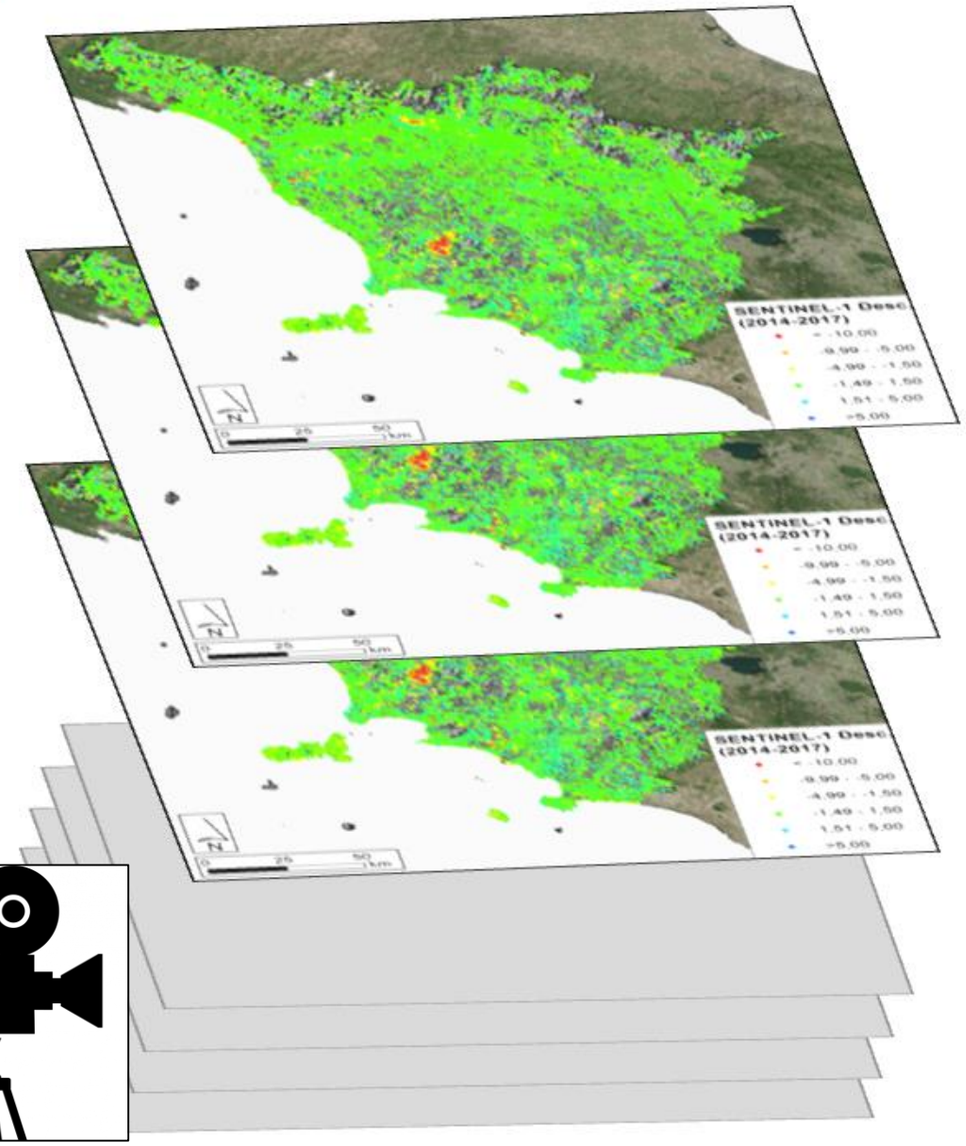
PS Continuous streaming at a regional scale

ERS1/2 & ENVISAT esa



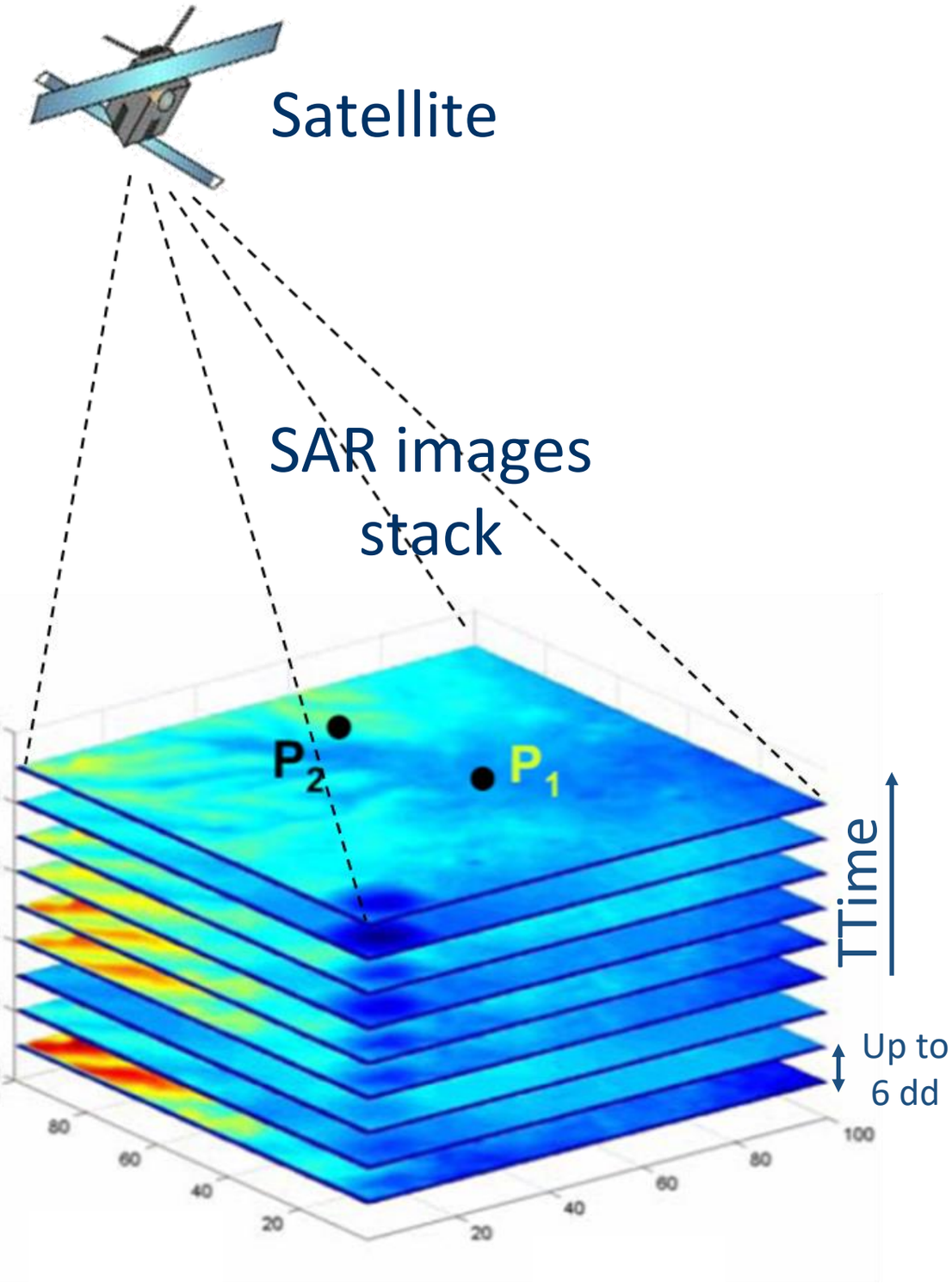
Revisiting time: 35 days

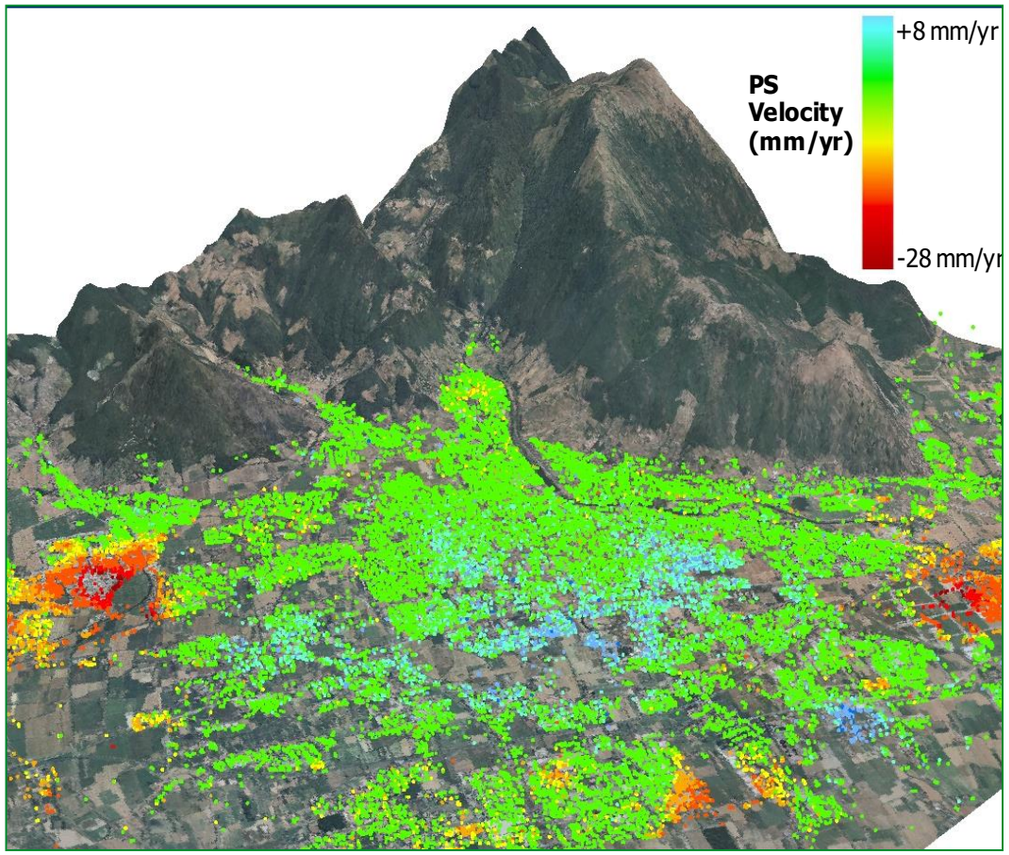
sentinel esa



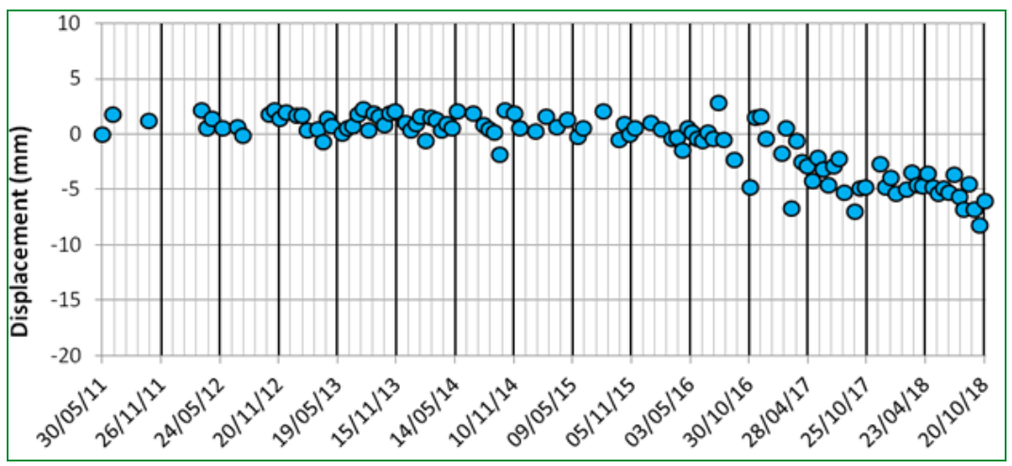
Revisiting time: 6-12 days

Spaceborne Radar Interferometry





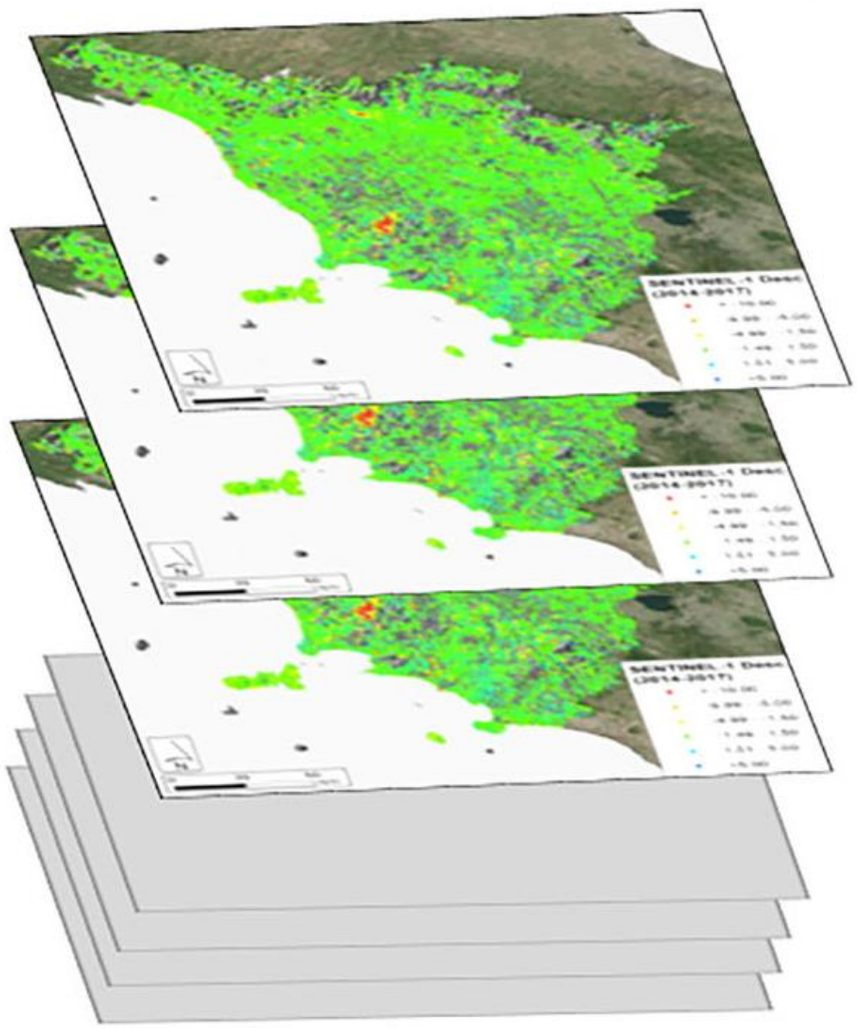
Average annual velocity along the LOS (precision~ ±1 mm/anno)



Time series of displacement (precision ~ ±1-5 mm)

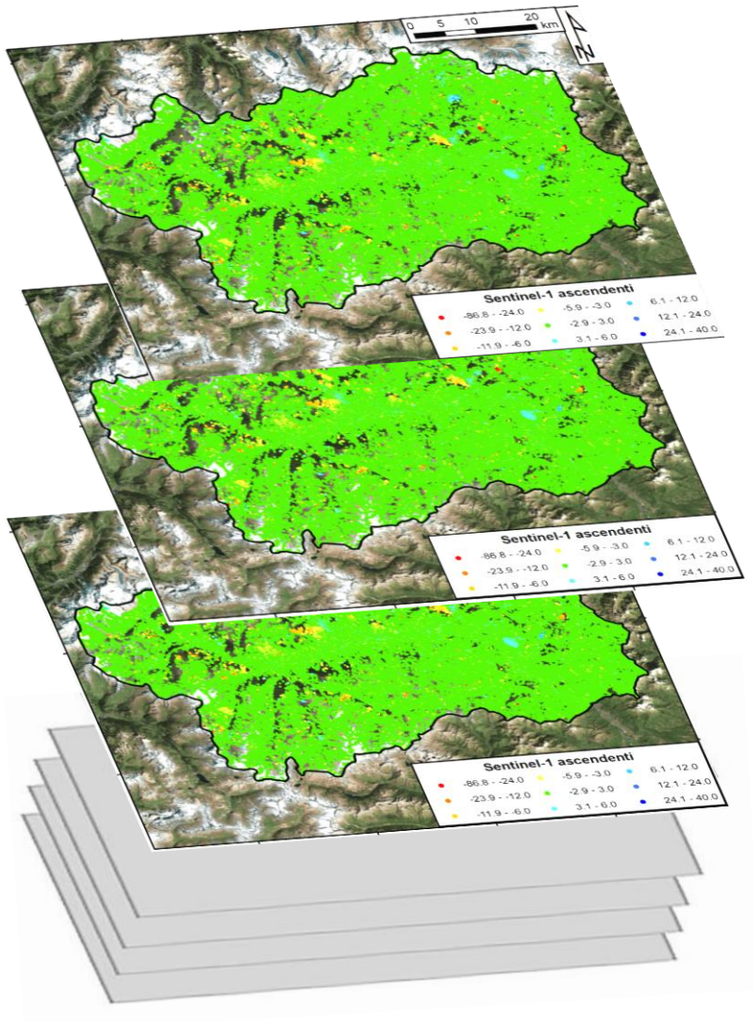
Continuous radar monitoring at a regional scale

Tuscany region



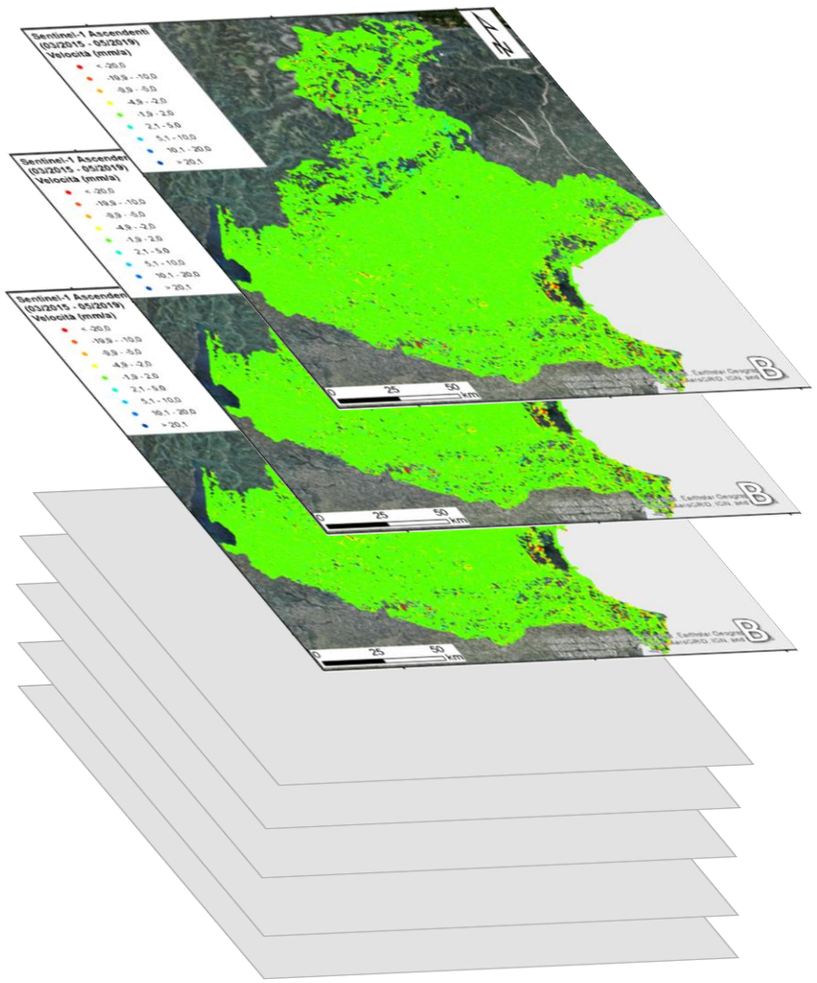
≈ 2.000.000 PSs

Valle d'Aosta region



≈ 700.000 PSs

Veneto region



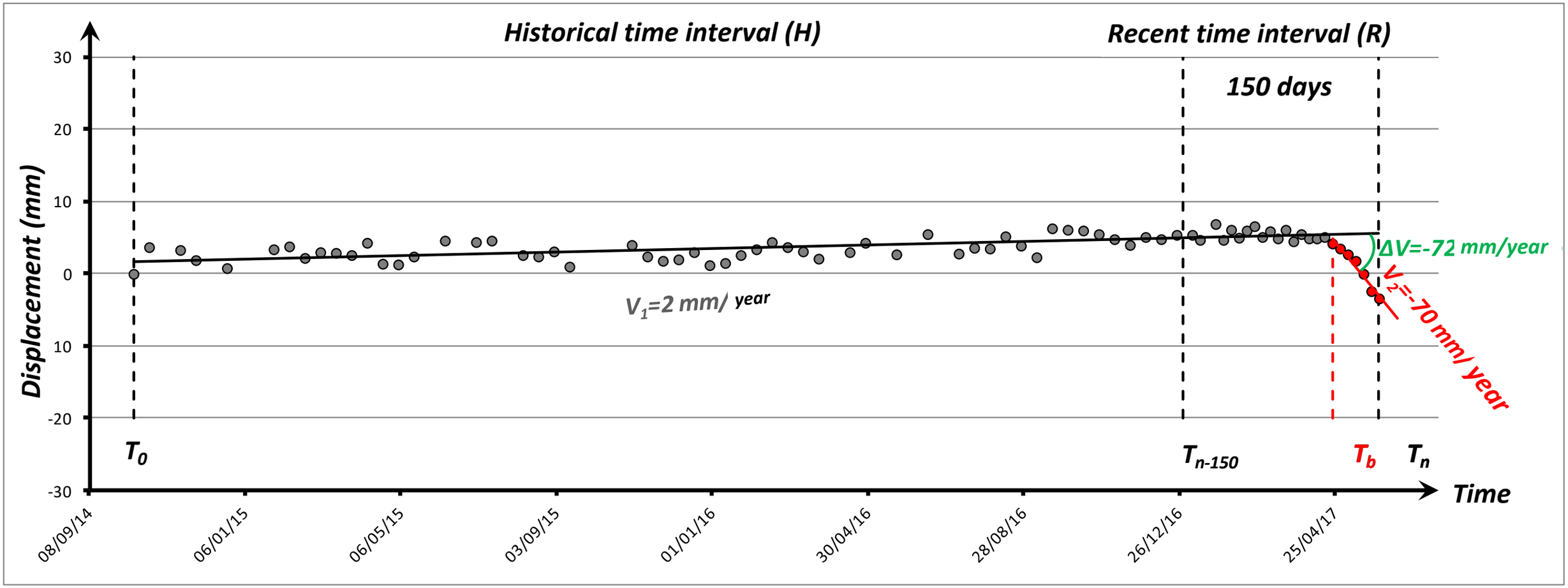
≈ 3.000.000 PSs

Activities

	PS Mapping	*PS Monitoring*
Type	Product	Service
Time	«deferred»	«real»
Update	1 year	12 days
Aim	Planning/Update of landslide inventories	Operational alert system/monitoring

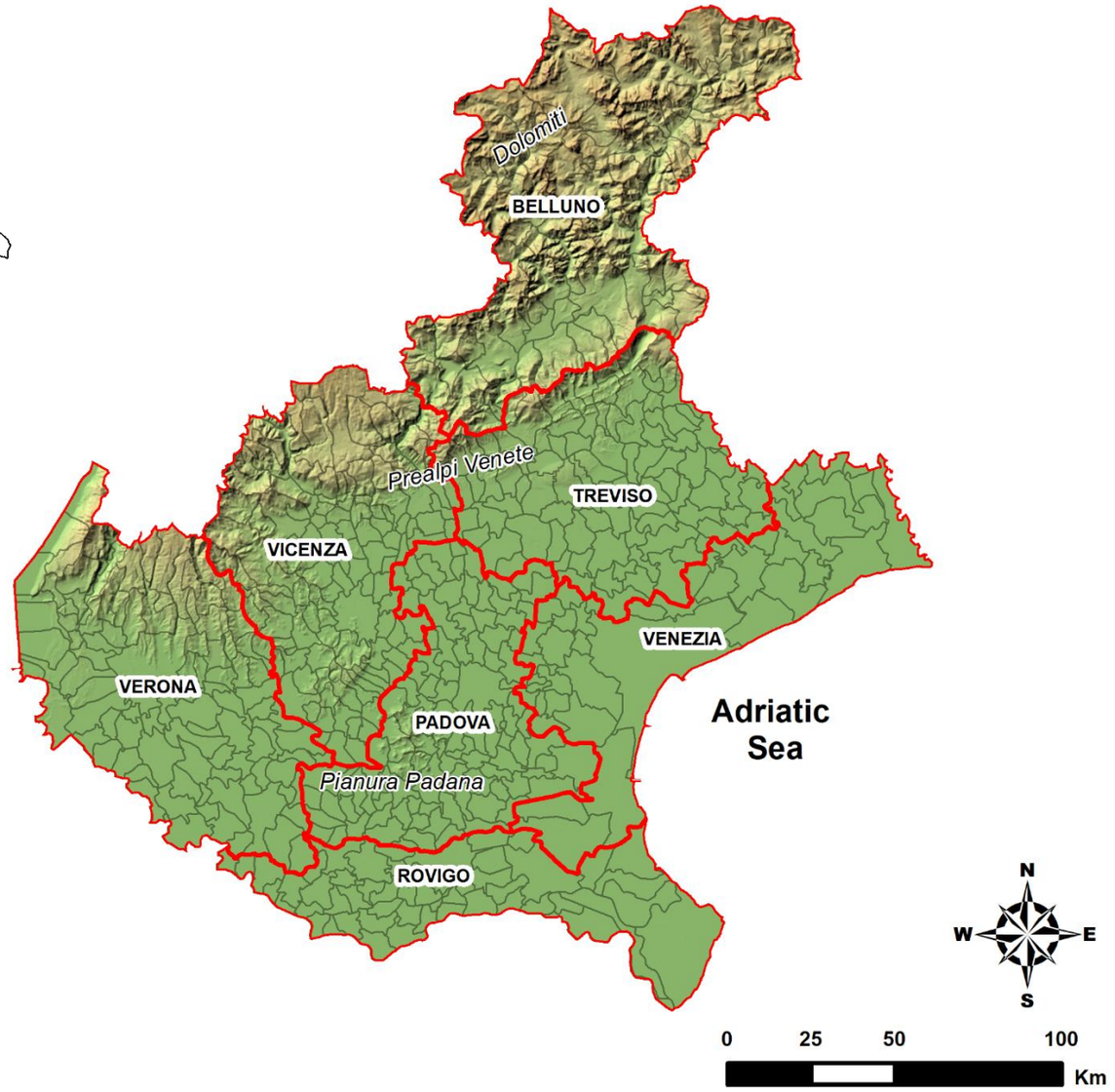
PS monitoring: real time monitoring (Dir. PCM 27/02/2004)

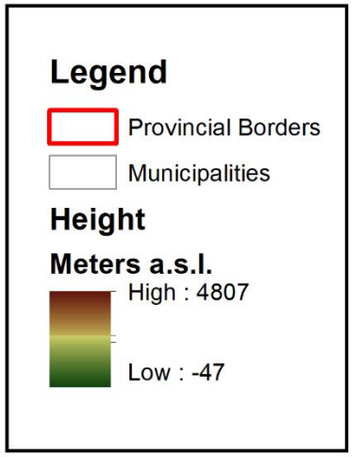
Updated analysis of time series of deformation



Anomaly: Variation of velocity ΔV > 10 mm/yr in a recent time interval R

Veneto region





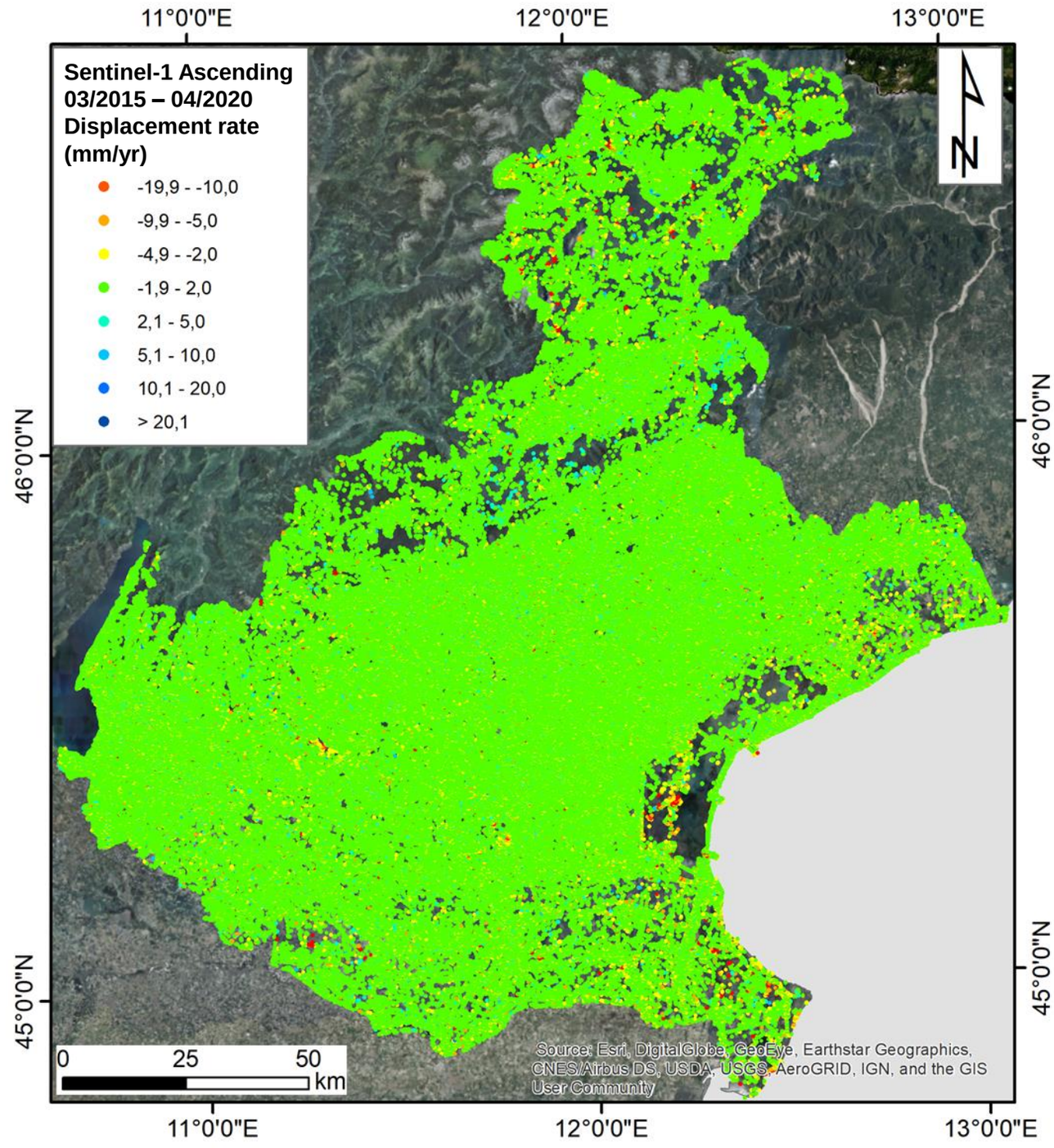
Tessina landslide

Mt. Rotolon landslide

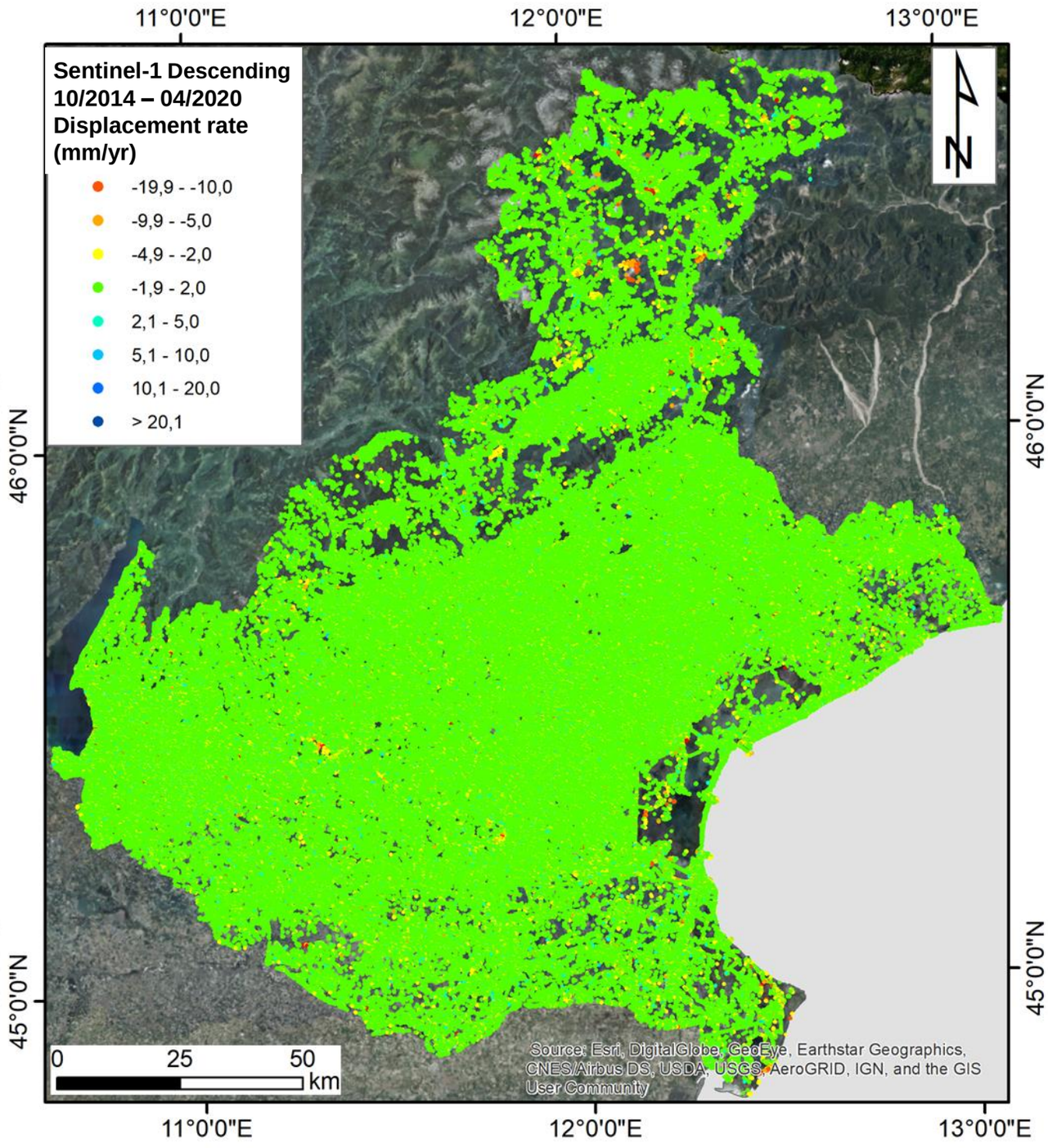
- About 4400 mapped landslides (IFFI)
- Extensive subsidence areas
- Karst landscape

Slides, flows, complex landslides, DSGSDs

Sentinel-1 data

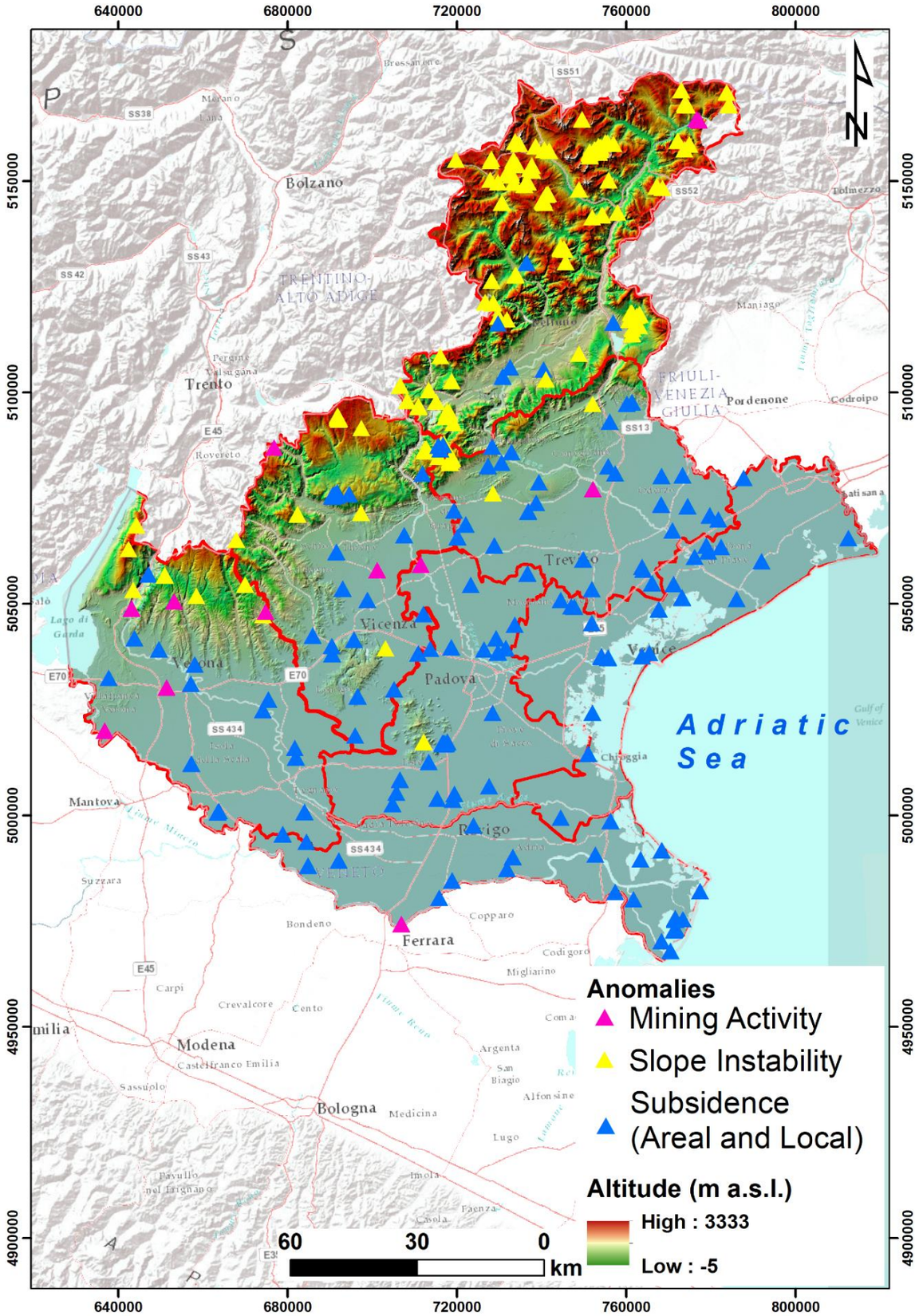


Ascending geometry
03/2015 – 04/2020

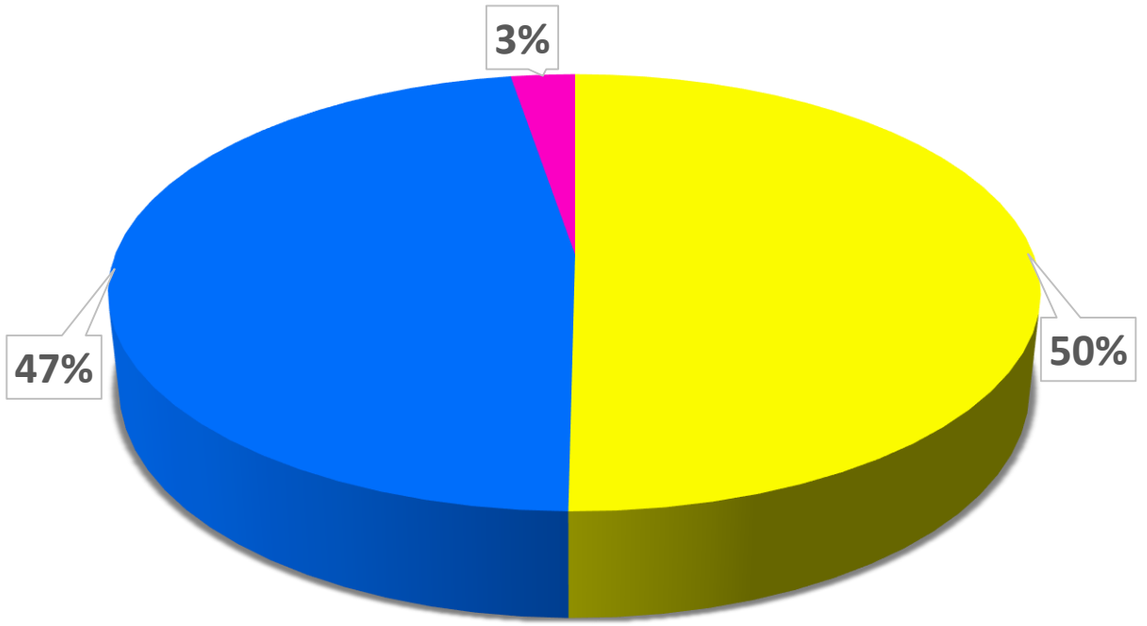


Descending geometry
10/2014 – 04/2020

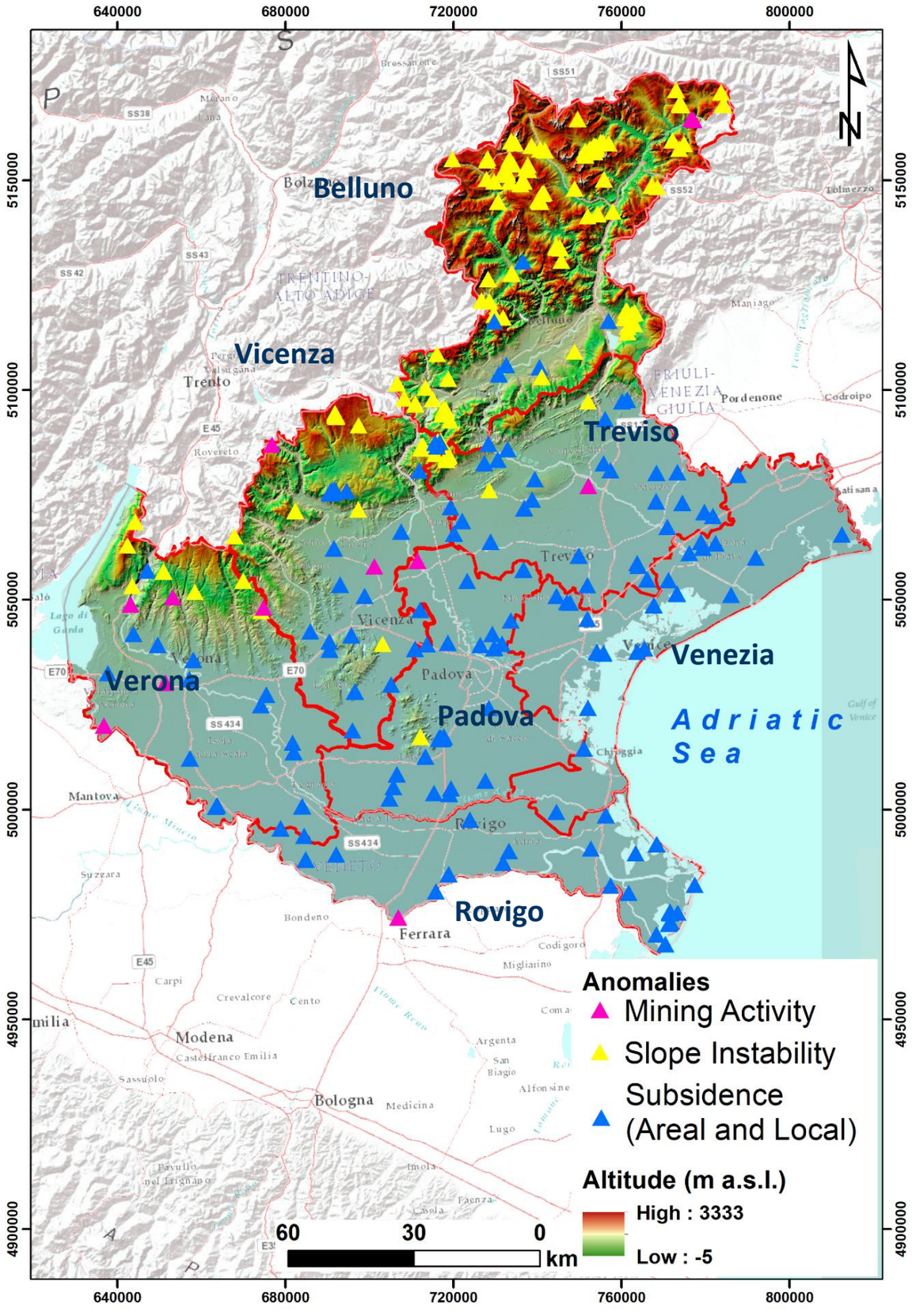
PS monitoring – Anomalies



Cause	n.
Mining Activity	68
Slope Instability	1299
Subsidence (Areal and Local)	1221

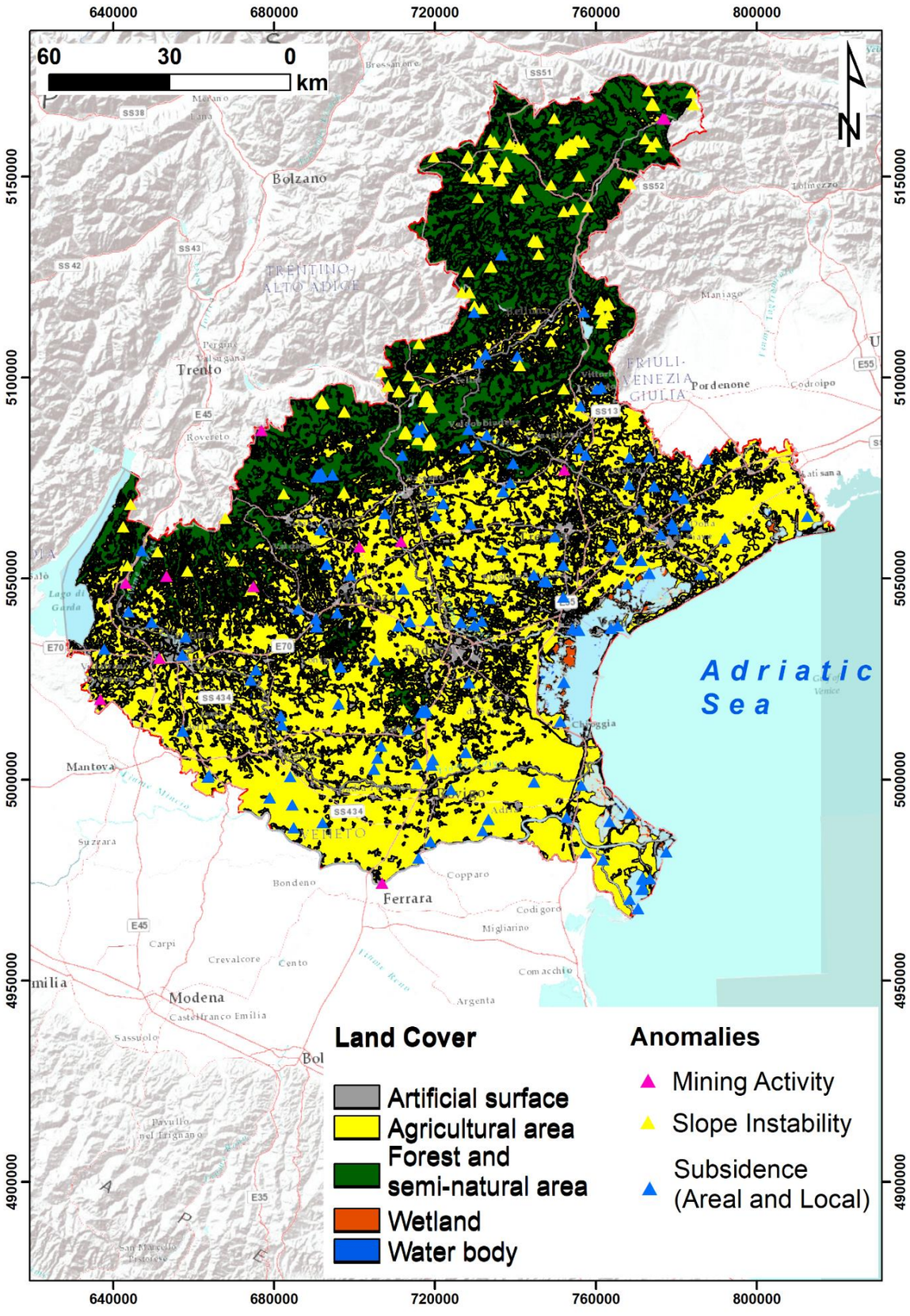


PS monitoring – Anomalies



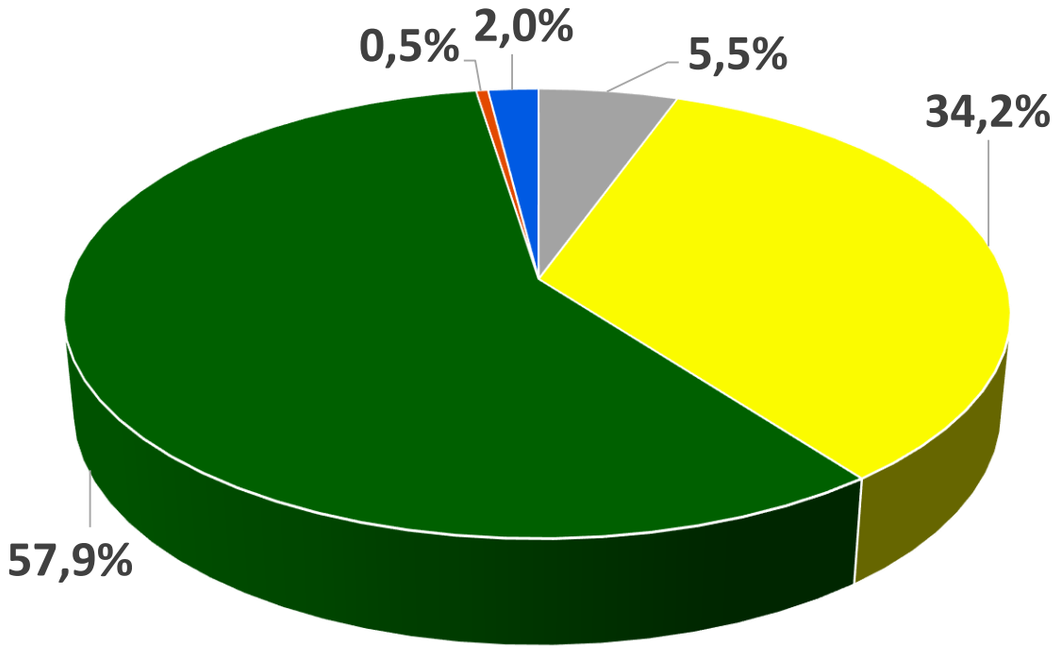
Province	SI	S	MA
Belluno	94%	4%	2%
Vicenza	26%	72%	2%
Treviso	21%	77%	2%
Verona	21%	62%	17%
Padova	13%	85%	2%
Venezia	0%	100%	0%
Rovigo	0%	98%	2%

PS monitoring – Anomalies

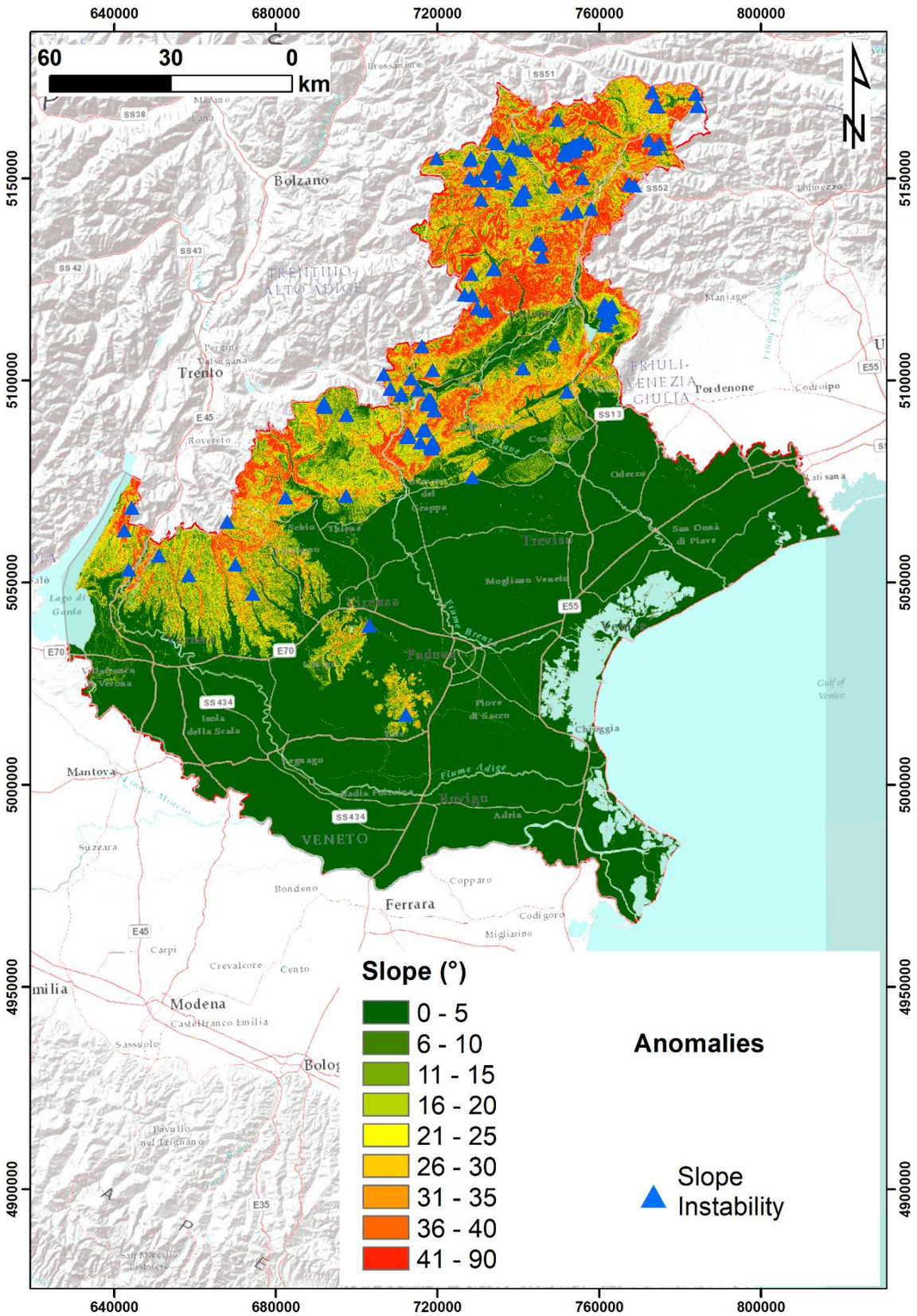


Land cover distribution

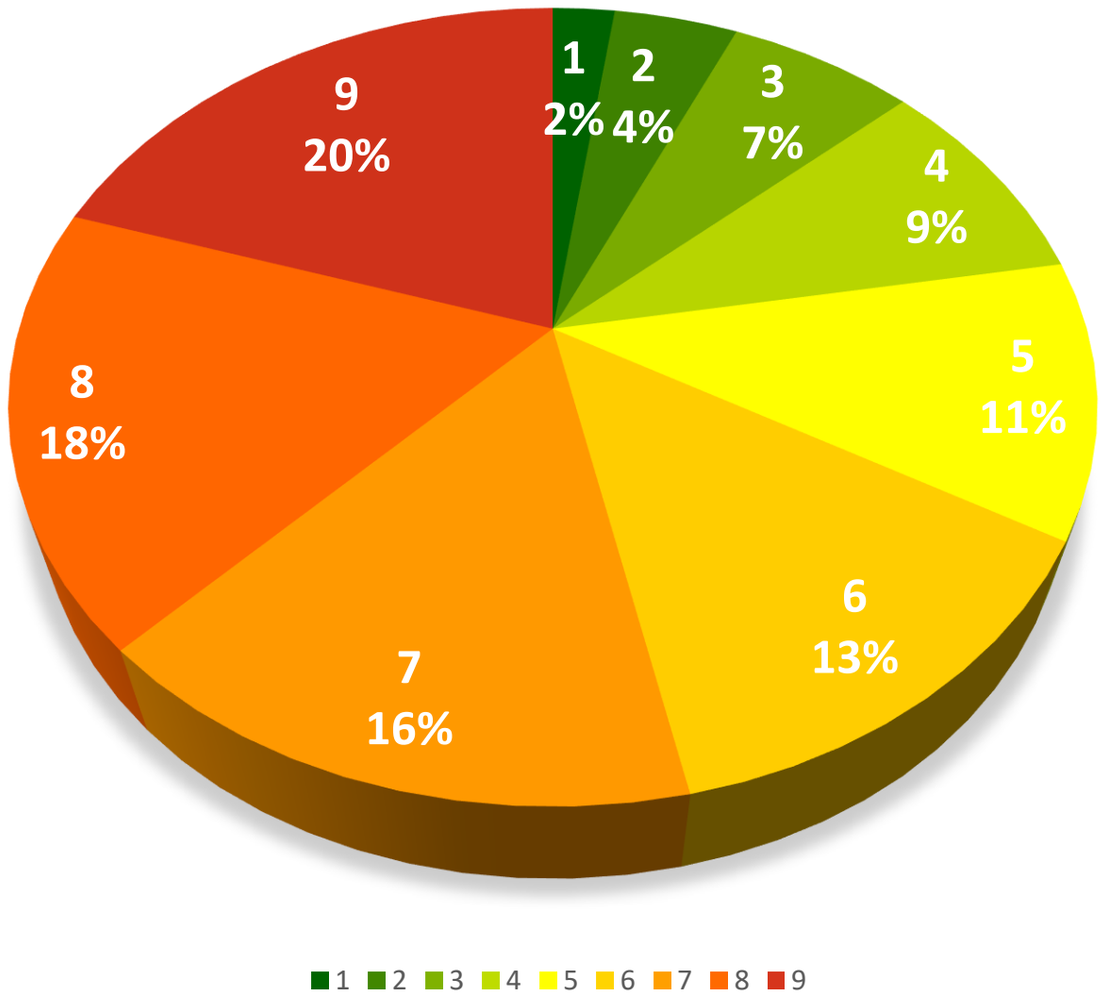
Cause	n.
Artificial surface	141
Agricultural area	877
Forest and semi-natural area	1484
Wetland	12
Water body	51



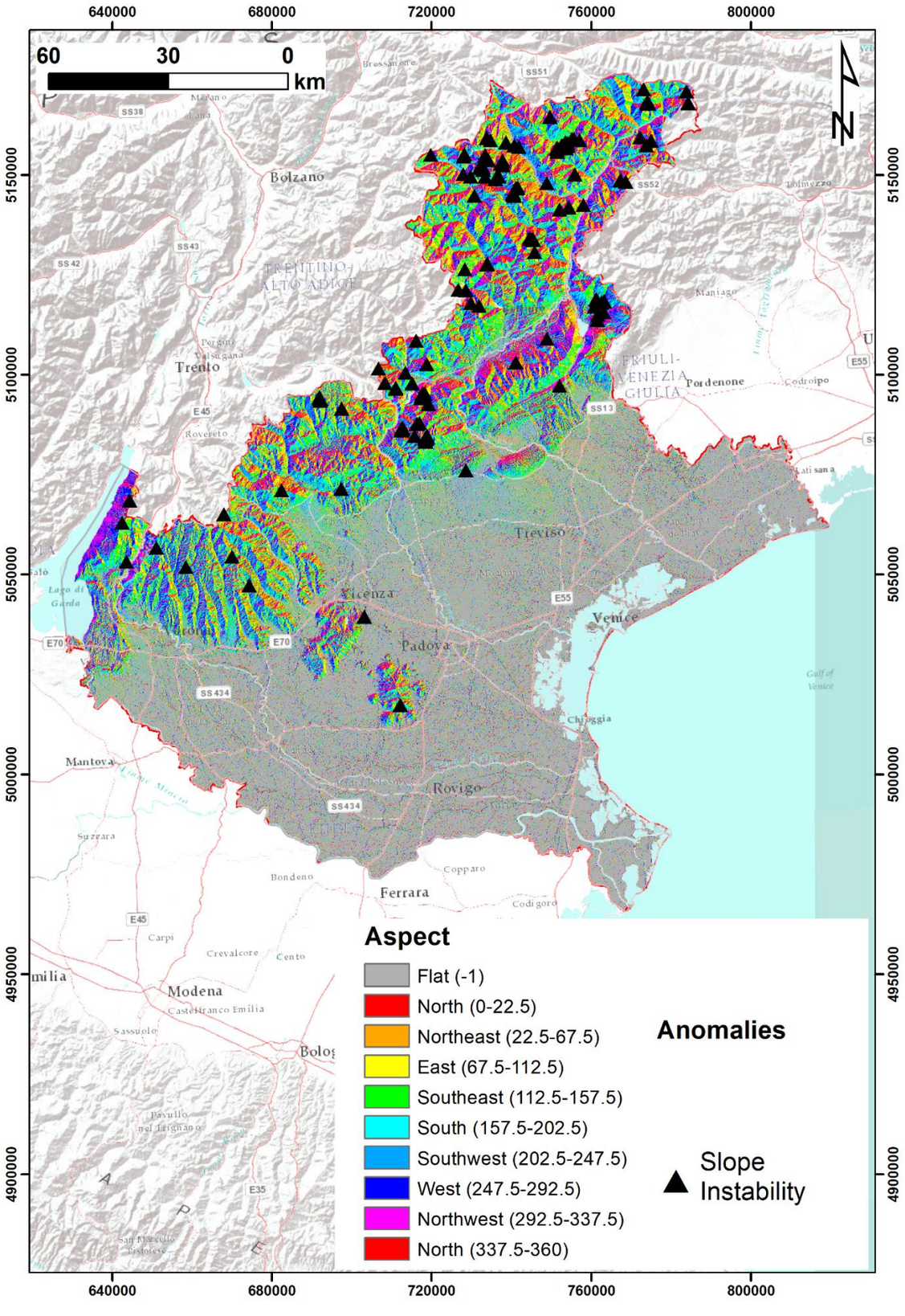
PS monitoring – Anomalies



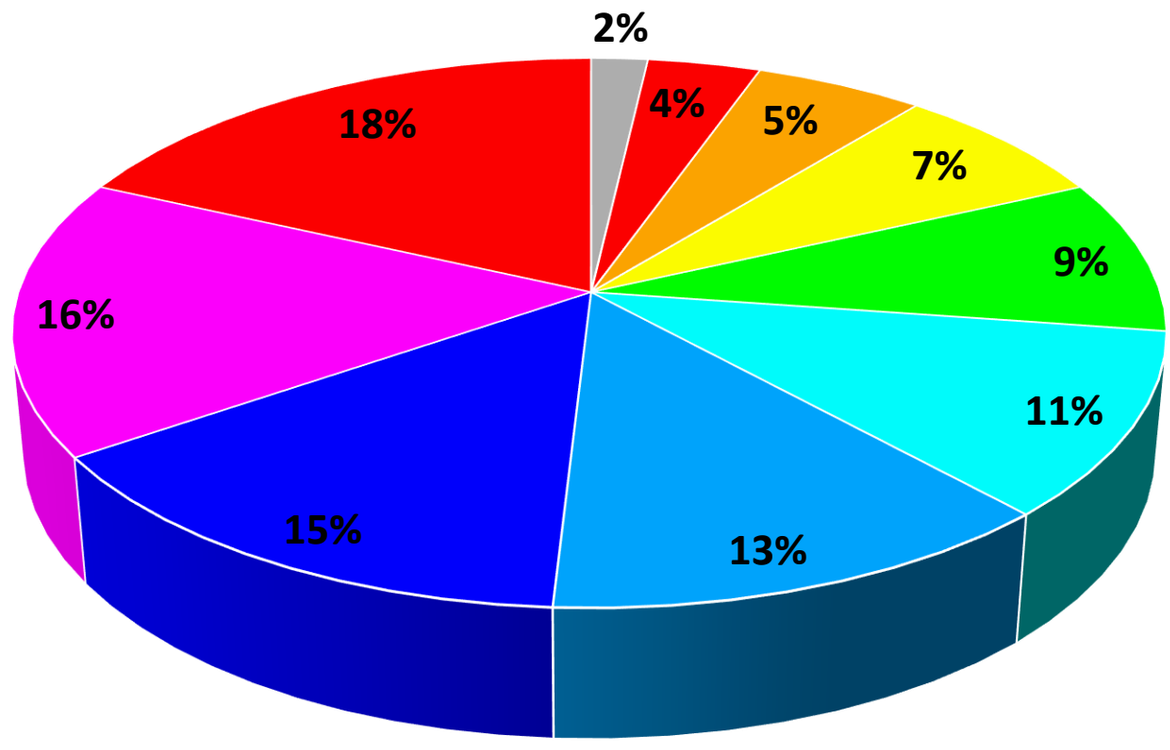
Slope angle distribution



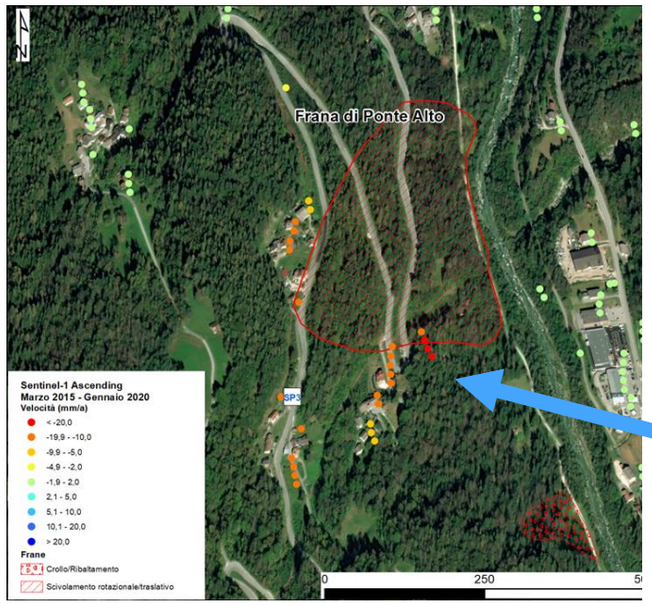
PS monitoring – Anomalies



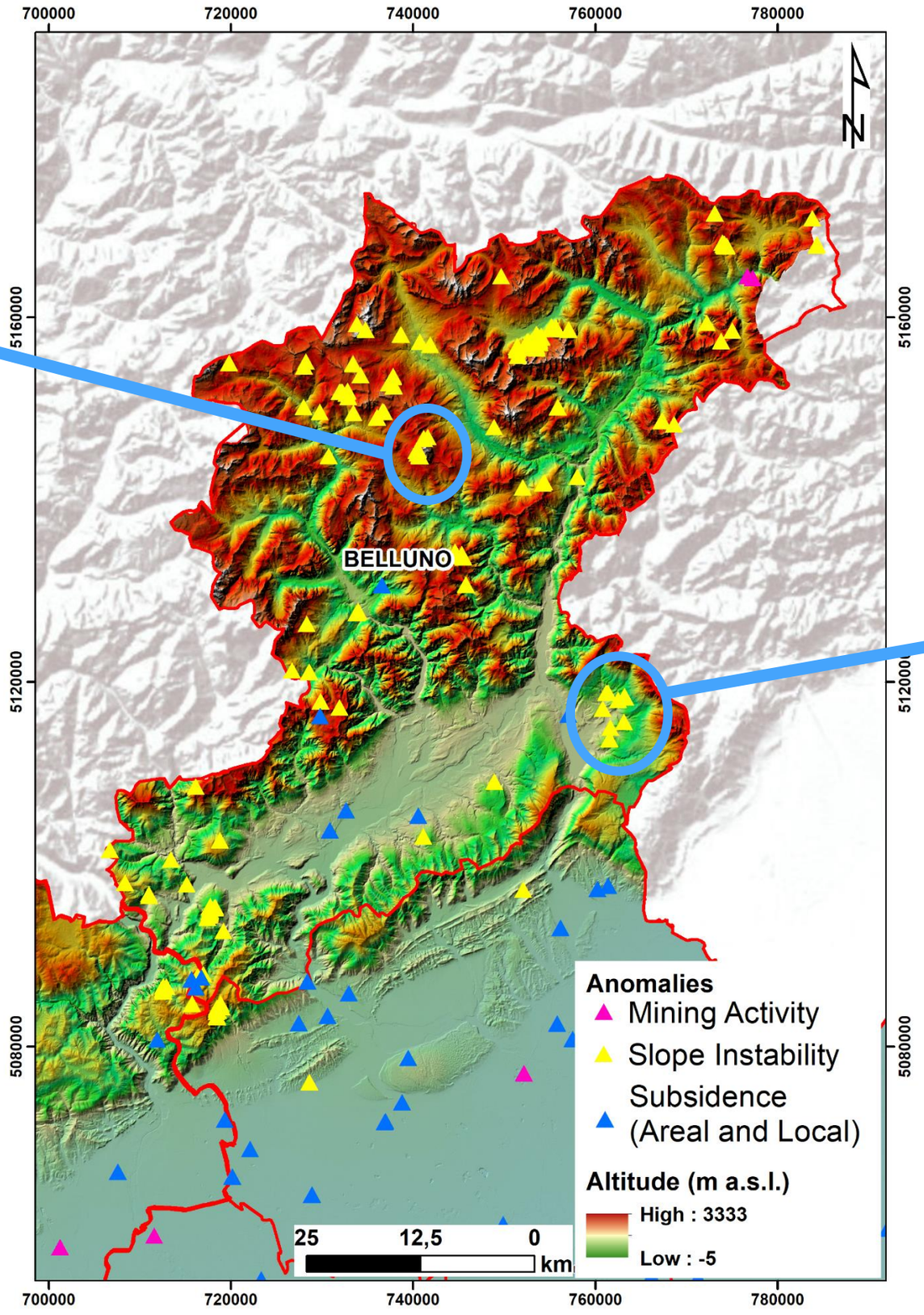
Aspect angle distribution

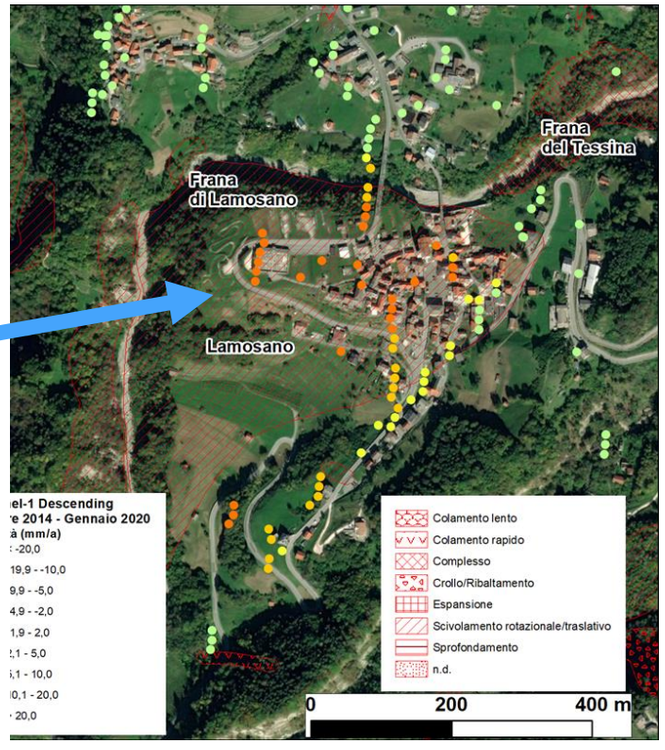


PS monitoring – Alerts



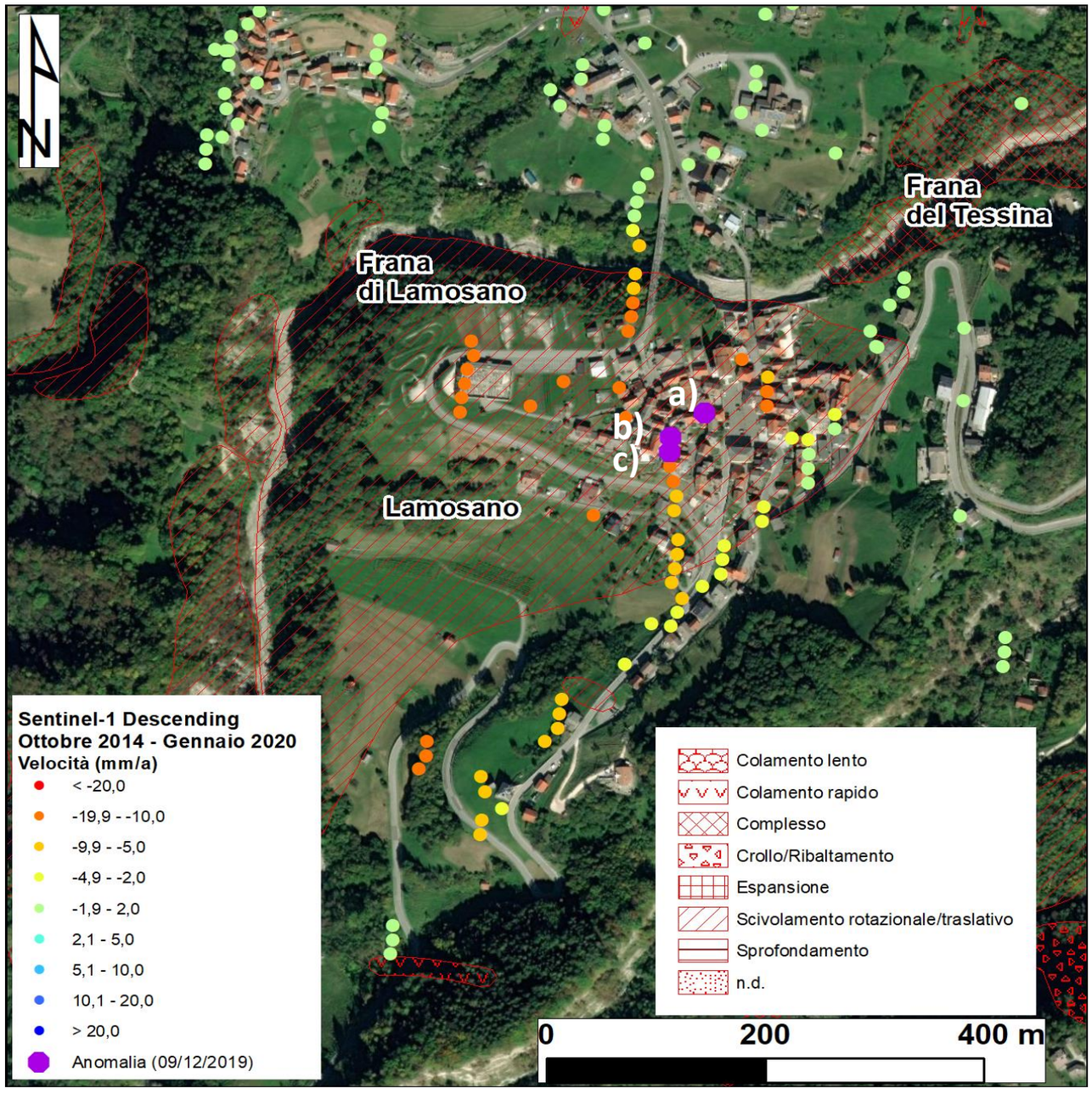
Rivamonte Agordino

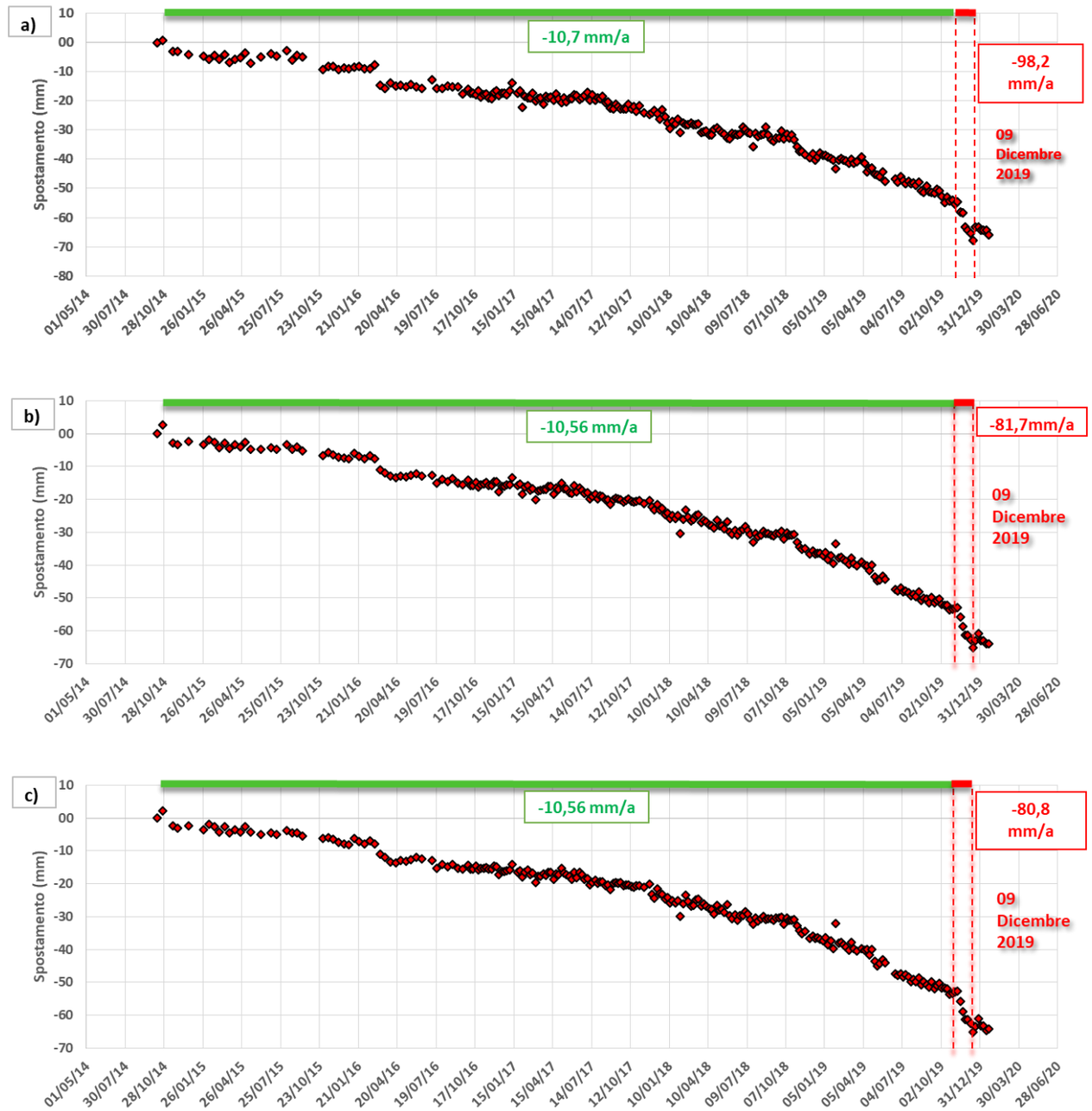




Lamosano

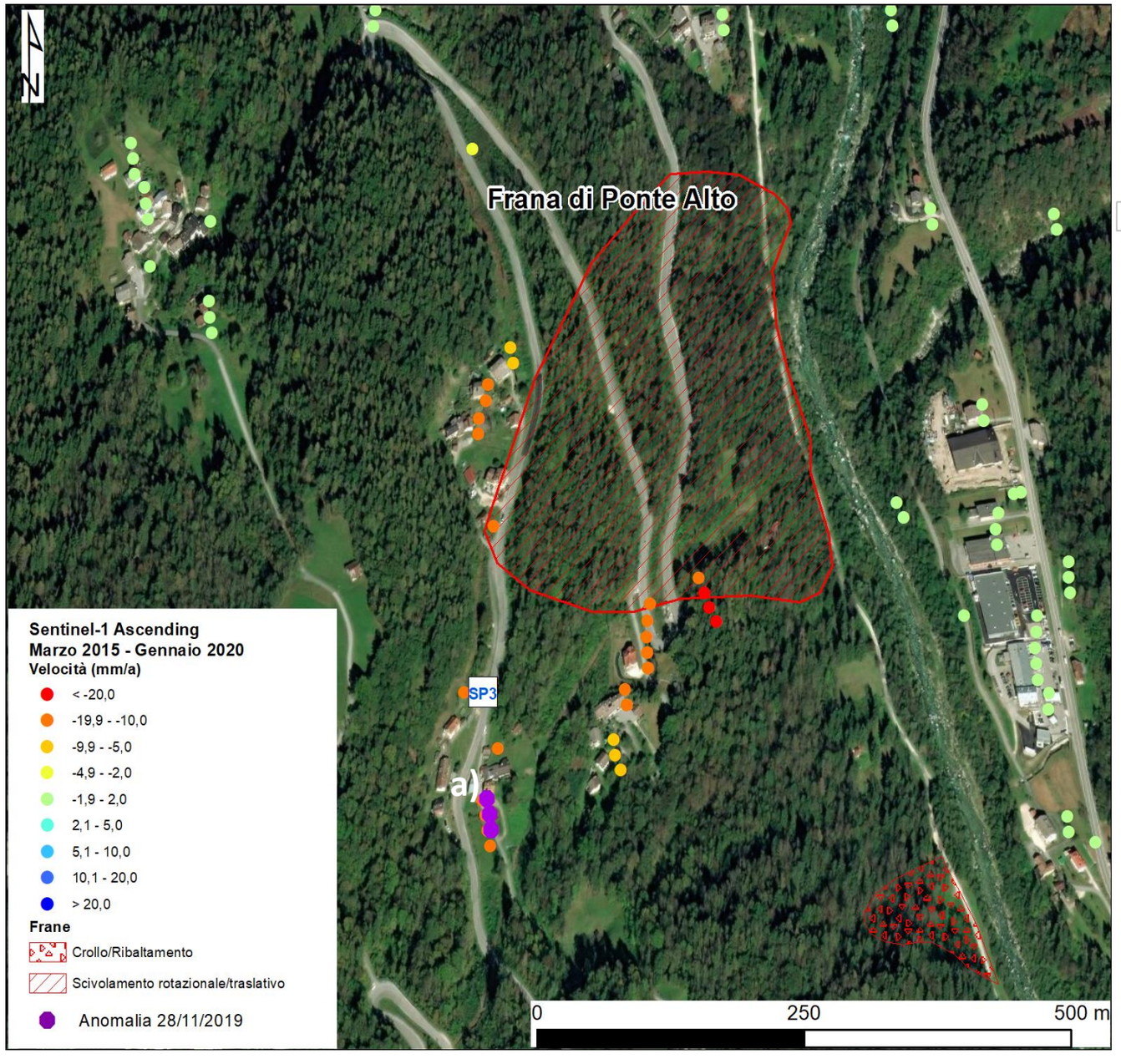
PS monitoring – Alerts

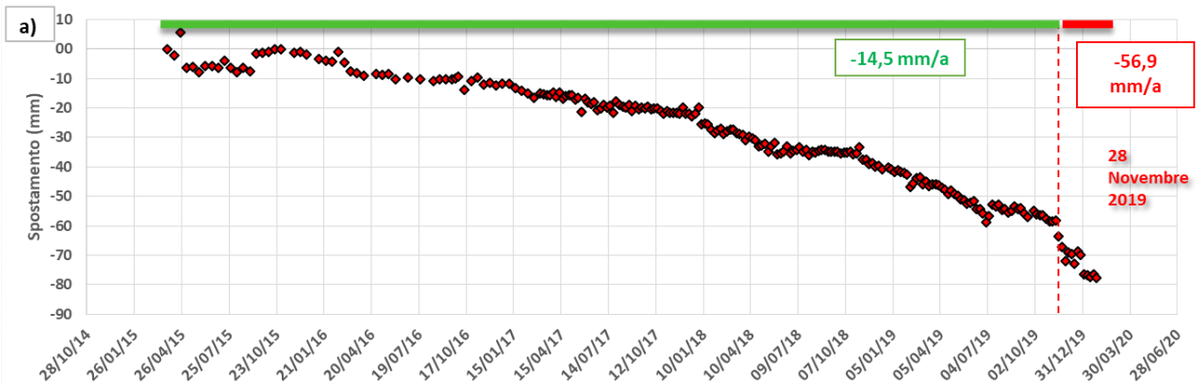




Lamosano

PS monitoring – Alerts





Rivamonte Agordino

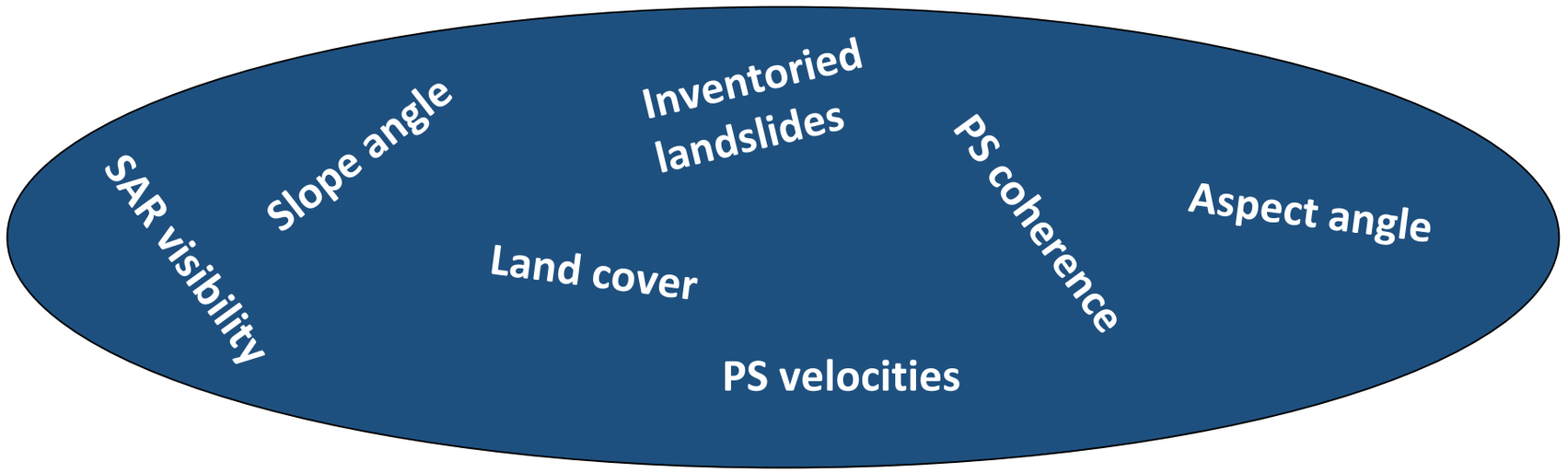
Conclusions

- Time-series analysis is a valuable tool to promptly detect the so-called anomalies of movement, i.e. those areas showing a trend variation (e.g. acceleration), needing further on-site investigations.

- The monitoring system is a «real time» operational tool capable of providing the continuous update and warning of critical issues, giving useful indications to territorial planning and risk management activities.

Future perspective

Analysis of anomalies distribution



Spatial forecasting of anomalies occurrence?