

The image shows an aerial photograph of the northeastern coast of Sardinia, Italy. The terrain is a mix of greyish-brown and white, representing different geological or urban features. Overlaid on this is a dense grid of small, multi-colored squares (red, green, blue, yellow, purple) that represent ground vertical displacements. The displacements are most prominent along the coast and in some inland areas, showing a clear pattern of movement.

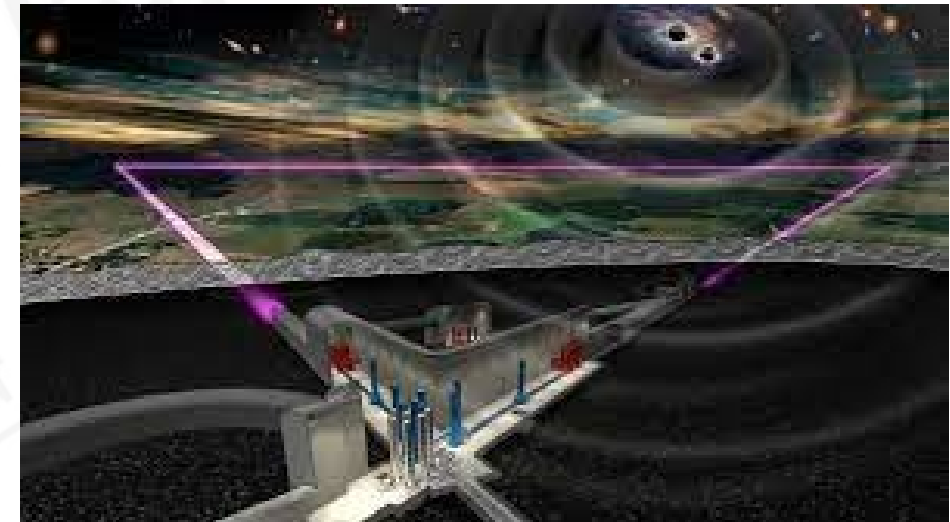
Ground Vertical Displacements Of NE Sardinia

Dott. Francesco Dessì, PhD – University of Cagliari

Project scenario

The Einstein Telescope (ET) is a proposed underground infrastructure to host a third-generation, gravitational-wave observatory. Currently, two European candidate-sites are competing to host it: one is located in the area of Sos Enattos in Northern Sardinia (Italy), the second is in the Meuse-Rhine Euregion. The choice of the most suitable site to host this unique research infrastructure will be decided by an international commission. The site-characterization analyses are under way and the final decision is expected by the end of 2024.

The present study is part of the geological characterization of the site of Sos Enattos, and is focused on the evaluation of the surface deformations of its area by means of Synthetic Aperture Radar (SAR) data. In this framework, the PSI (Persistent Scattered Interferometry) technique with SAR data provided by Sentinel-1 mission is the proposed approach for the analysis of a long time-series imagery.



Study area



Abstract

- Scopework: Measure ground deformation in SOS ENATTOS area with Remote Sensing data – SAR
- Overview of StaMPS PSI processing chain
- Methodology application: issues and workarounds
- First results and developments

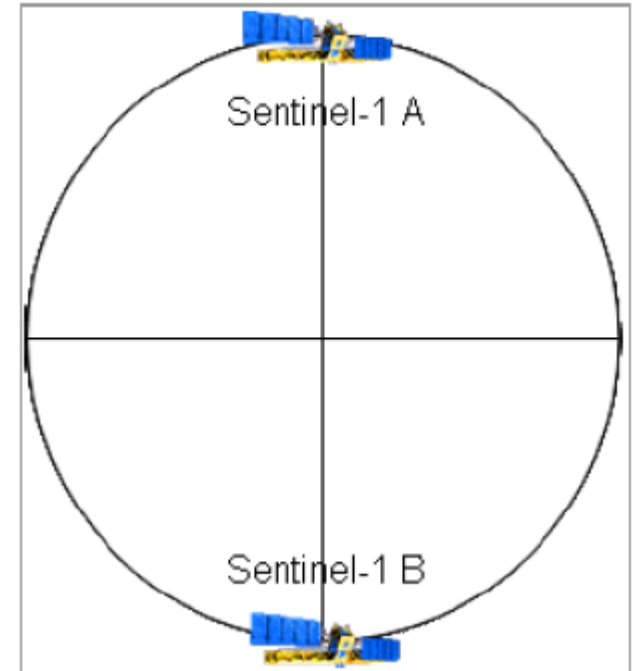
Sentinel 1 ESA

- The constellation covers the entire world's land masses on a bi-weekly basis, sea-ice zones, Europe's coastal zones and shipping routes on a daily basis and open ocean continuously.
- The Sentinel-1 mission is based on a constellation of two satellites (A and B units). Sentinel-1 carries a C-band Synthetic Aperture Radar (SAR), and provides continuity of ERS and ENVISAT SAR types of missions. It allows all-weather and day/night imaging capability.



Sentinel 1 orbit

- SENTINEL-1 is in a near-polar, sun-synchronous orbit with a 12 day repeat cycle and 175 orbits per cycle for a single satellite. Both SENTINEL-1A and SENTINEL-1B share the same orbit plane with a 180° orbital phasing difference. With both satellites operating, the repeat cycle is 6 days.



Sentinel 1 operational modes

- Main modes:

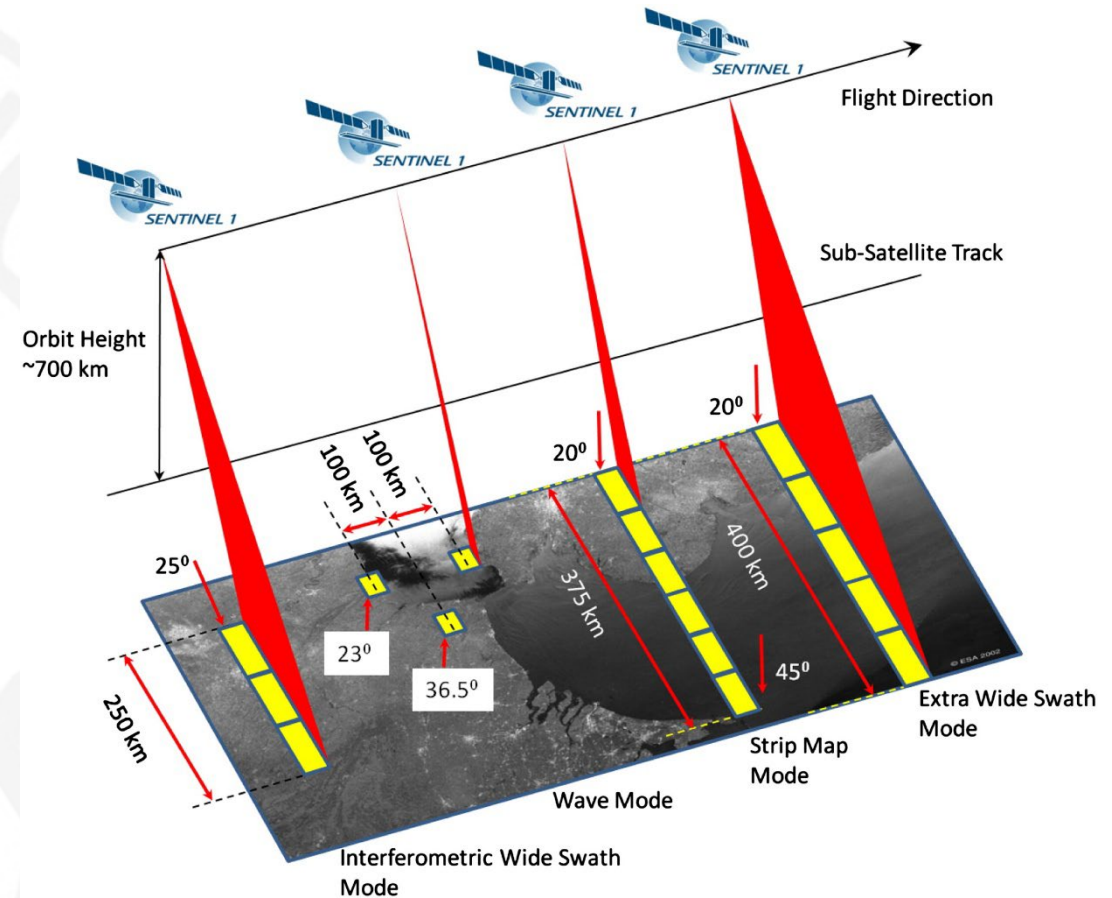
- 1) Interferometric wide-swath mode at 250 km and 5×20 m spatial resolution

- 2) Wave-mode images of 20×20 km and 5×5 m spatial resolution (at 100 km intervals)

- Additional modes:

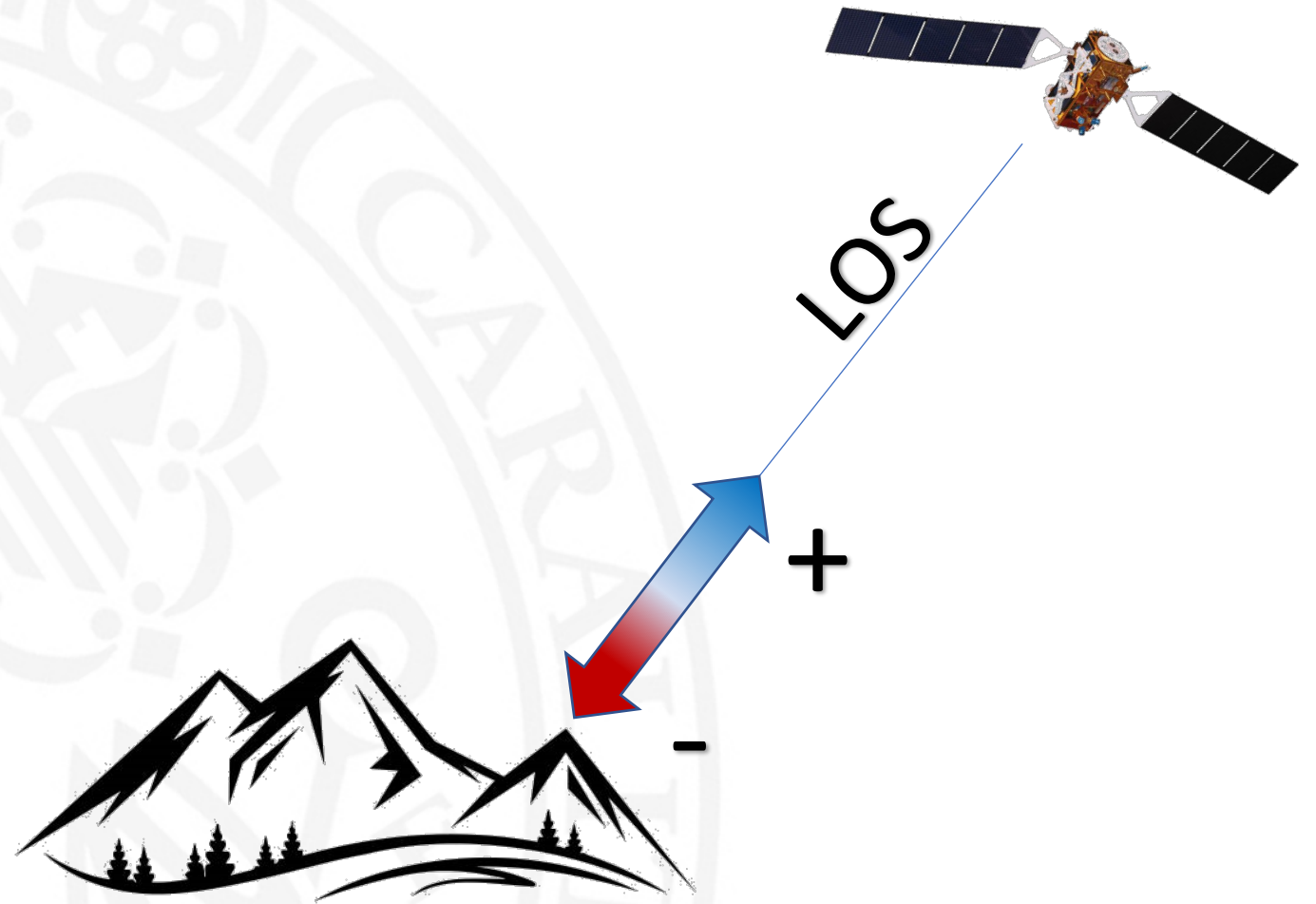
- Strip map mode at 80 km swath and 5×5 m spatial resolution

- Extra wide-swath mode of 400 km and 20×40 m spatial resolution



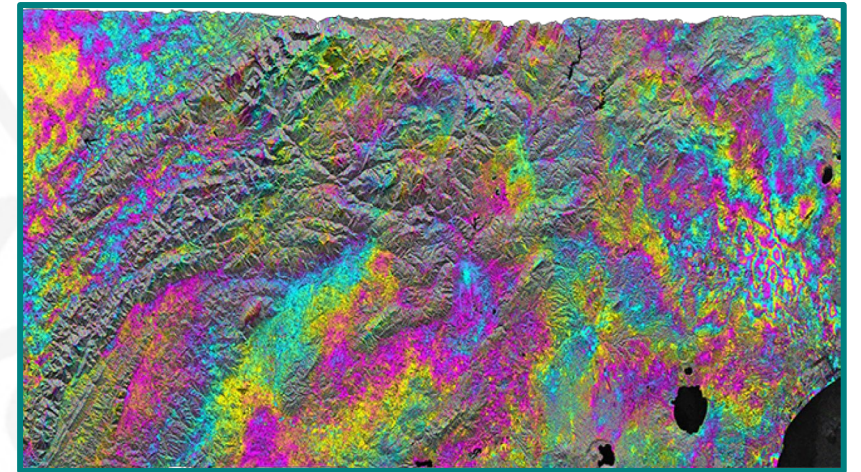
Some basics

- SAR does not see things from directly on top, or nadir, like we do with most optical sensors.
- We view things from an angle on the side, also known as line of sight, or LOS.



Some basics

- SAR can be used to monitor and track displacement by using the phase that is collected alongside its amplitude.
- The phase change shows minor shifts on the ground surface related to when a specific part of the wave hits the ground at what time.
- The change in time can be tracked in between images and used to find ground surface change!



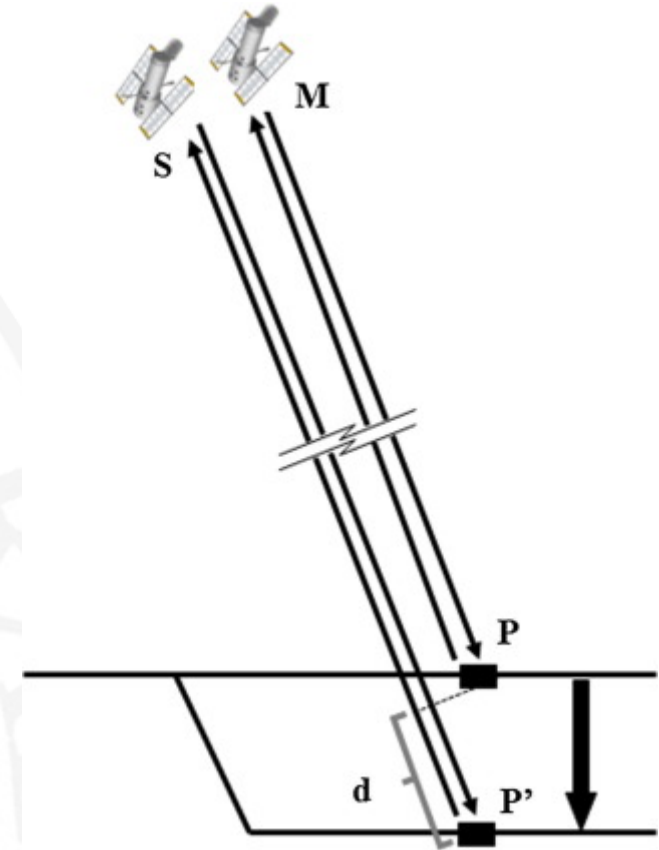
Sentinel-1 Interferogram

InSAR = Interferometric SAR

PSI – Persistent Scatterer Interferometry

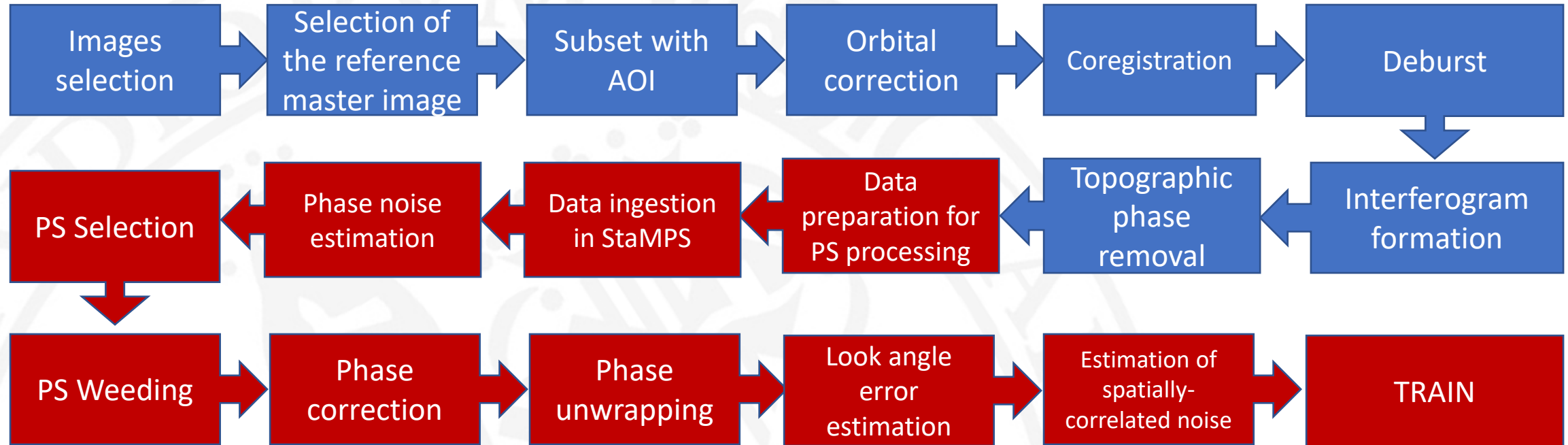
- Persistent Scatterer Interferometric technique involves the observation of radar phase changes measured for repeat acquisitions. Large numbers of permanent scatterers are analyzed to determine velocity of movement along sight. The method allows to measure terrain movements with an error of 1.2 mm/year.

StaMPS (Stanford Method for Persistent Scatterers) is a software package that implements an InSAR persistent scatterer (PS) method



Processing workflow

Interferogram generation



PSI processing



First test

- A first test has been carried out with a dedicated workstation: a Linux environment with all softwares, libraries, scripts (Matlab license, Python,...)
- A small area (250 square kilometers) in Sos Enattos surroundings has been processed in order to get Vertical Velocities from Sentinel 1 data.
- For the first performance test has been utilized 46 images acquired by descending orbit and 48 images acquired by ascending orbit
- Time span is from January 2021 to July 2022

Some issues..

- SAR data is heavy (around 4 GB for each input image)
- Even with a relatively powerful workstation (multi core CPUs, RAM, SSD disks) processing time takes a **lot of hours or days**



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SNAPPING PSI Full: PSI measurements at full resolution on the GEP

The first service for generating ground motion time series at full resolution on the GEP has now been released! It will be open soon to the GEP community.

[Learn more](#)



Apps

Access points to data processing capabilities



Communities

Membership providing access to resources



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Discussion forum and FAQs

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Step-by-step guidances for data processing




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NoR Discovery Portal

The NoR Discovery Portal can help user discover an ever increasing portfolio of innovative operational platform and cloud services operated by actors from participating countries available through the NoR.

SNAPPING service

geohazards tep **SNAPPING - Surface motion mAPPING** EO Data Interferogram stacks Interferogram stacks monitoring fdessi

Free Text Search **earth observation** others

Features basket

- basket errors Remove all Save
- S1A SLC IW_DP L1 88 Sat, 29 Oct 2022 17:22:07 GMT
- S1A SLC IW_DP L1 88 Wed, 05 Oct 2022 17:22:07 GMT
- S1A SLC IW_DP L1 88 Sun, 11 Sep 2022 17:22:07 GMT
- S1A SLC IW_DP L1 88 Thu, 18 Aug 2022 17:22:05 GMT
- S1A SLC IW_DP L1 88 Fri, 15 May 2015 19:21:22 GMT
- S1A SLC IW_DP L1 88 Mon, 31 Aug 2015 19:21:30 GMT
- S1A SLC IW_DP L1 88 Sat, 12 Sep 2015 19:21:30 GMT
- S1A SLC IW_DP L1 88 Thu, 24 Sep 2015 19:21:30 GMT
- S1A SLC IW_DP L1 88 Tue, 06 Oct 2015 19:21:31 GMT
- S1A SLC IW_DP L1 88 Sat, 05 Dec 2015 18:21:17 GMT
- S1A SLC IW_DP L1 88 Thu, 17 Dec 2015 18:21:29 GMT
- S1A SLC IW_DP L1 88 Wed, 03 Feb 2016 18:21:28 GMT
- S1A SLC IW_DP L1 88 Mon, 25 Jul 2022 17:22:04 GMT
- S1A SLC IW_DP L1 88 Fri, 01 Jul 2022 17:22:02 GMT

Total results: 256 1 2 3 ... 6 »

Processing Services

SNAPPING IFG

id: e4b1eccf-31e8-4e0f-a07f-57a3d5f133c7
publisher: esa-gep-apps-deployer-hetzner-c4 (pc-terradue)
version: 2.0.5

Generation of Sentinel-1 interferometric stack for PSI processing

Tutorial

Import params Export params

Job title *

SNAPPING IFG

Input Sentinel-1 SLC * clear

Interferometric Stack *

Area of Interest *

Input DEM *
SRTM 1Sec HGT

Sentinel-1 Polarisation *
VV

AOI-based Coregistration *

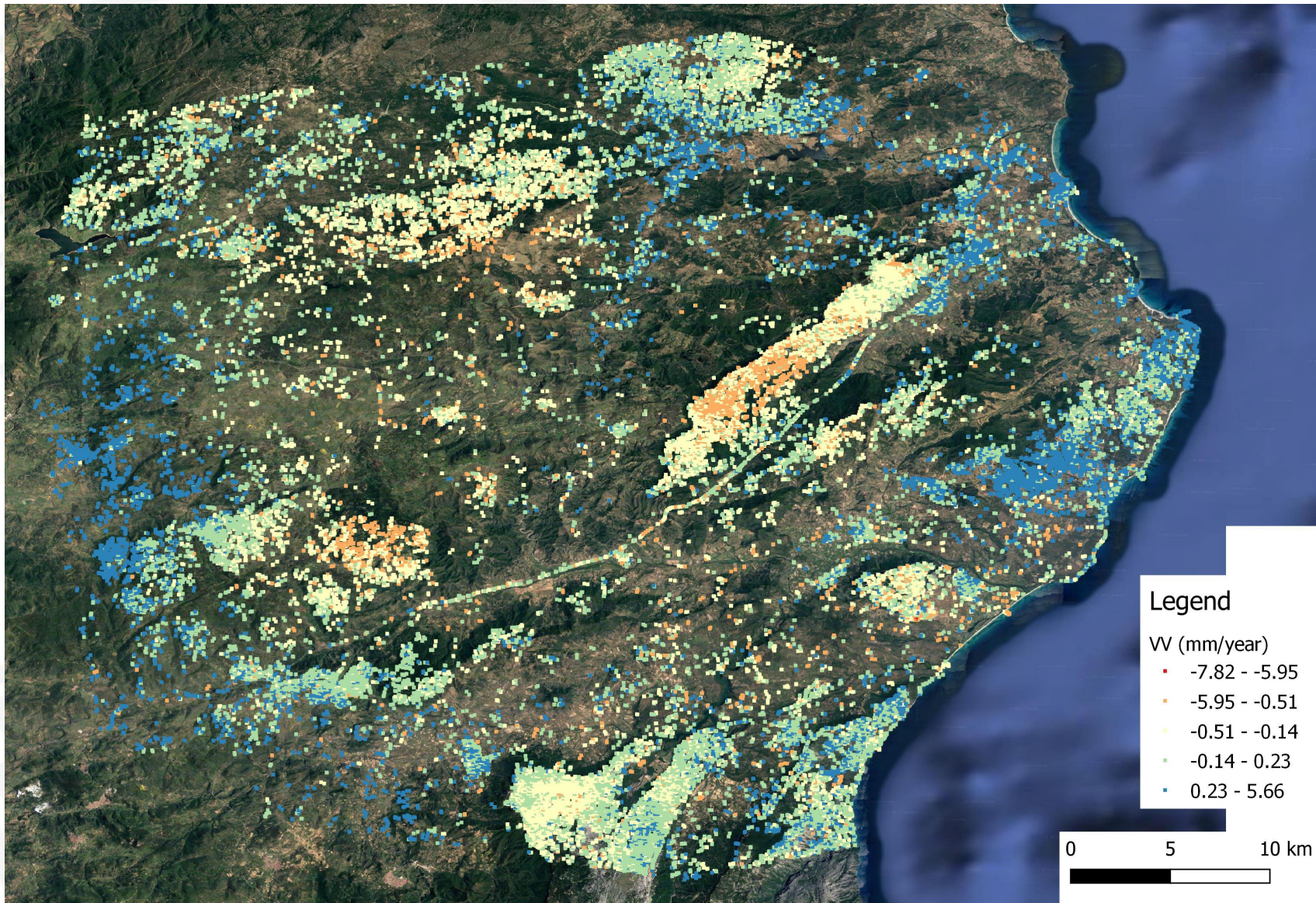
A good improvement!

- More than 2400 square kilometers as investigated area
- Around 8 years of acquisitions from May 2015 to October 2022
- More than 400 images
- Faster processing time (only 8 hours for PSI calculation related to Descending orbit)

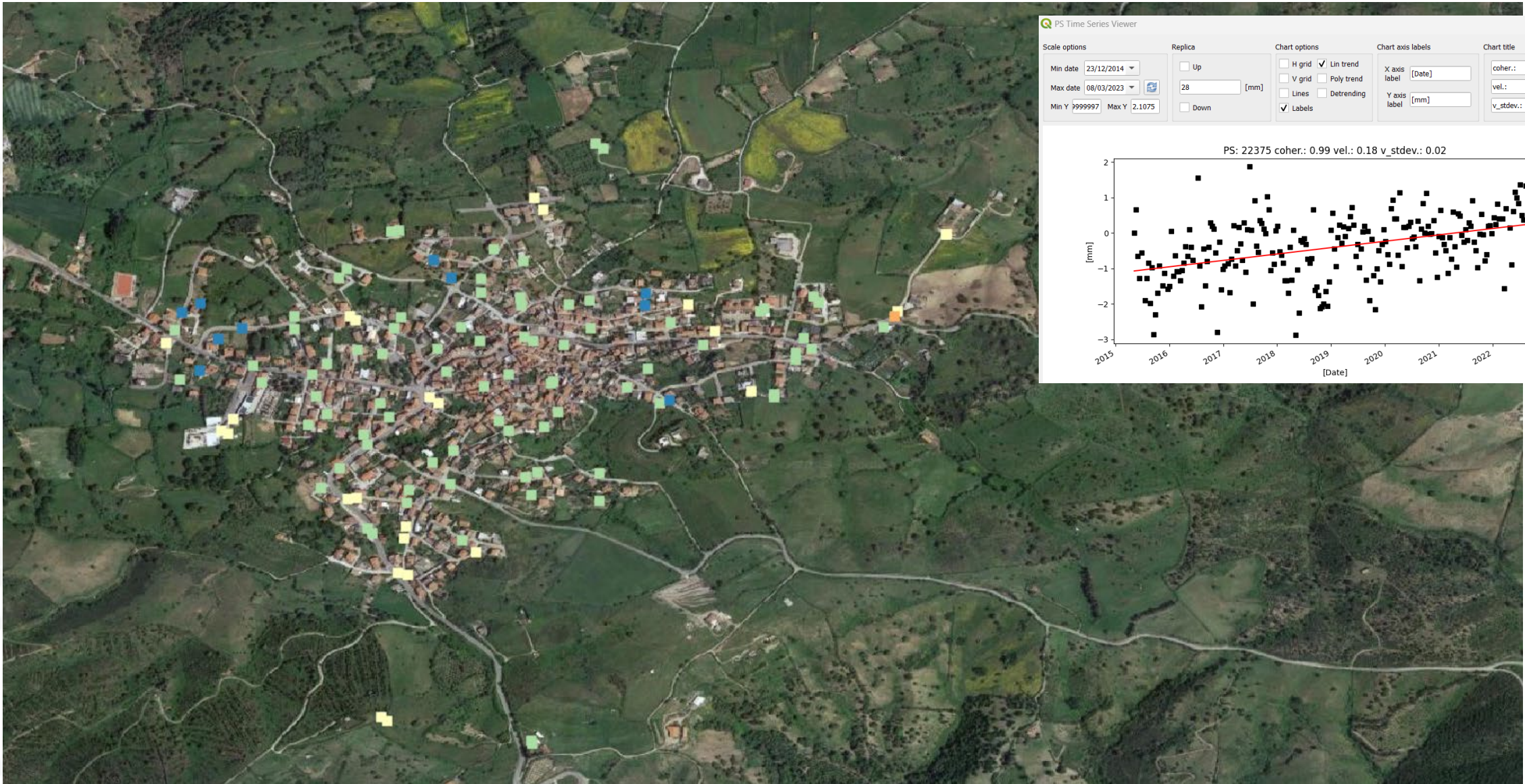
LOS Velocities – Descending orbit



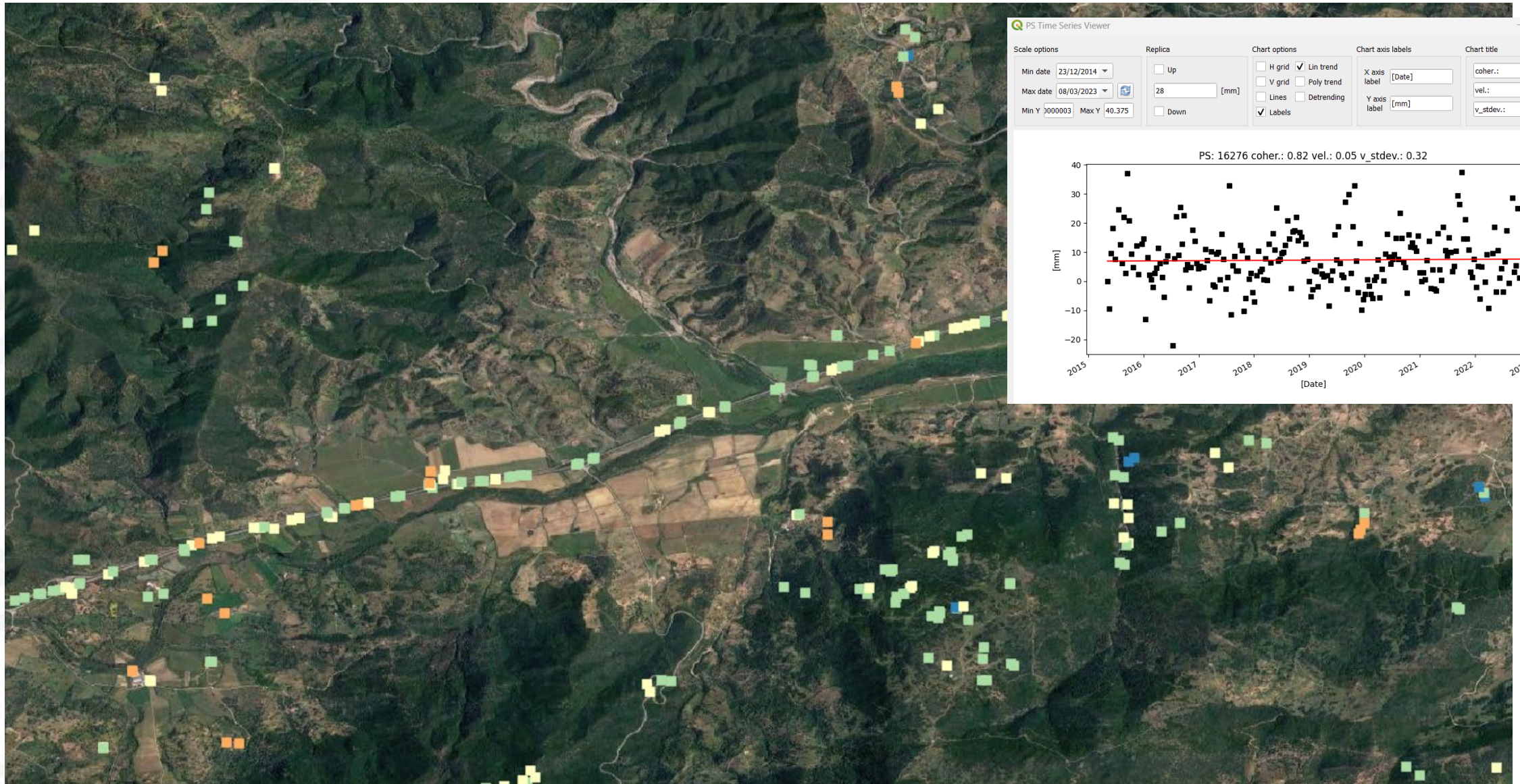
Vector decomposition – GIS – Vertical velocities



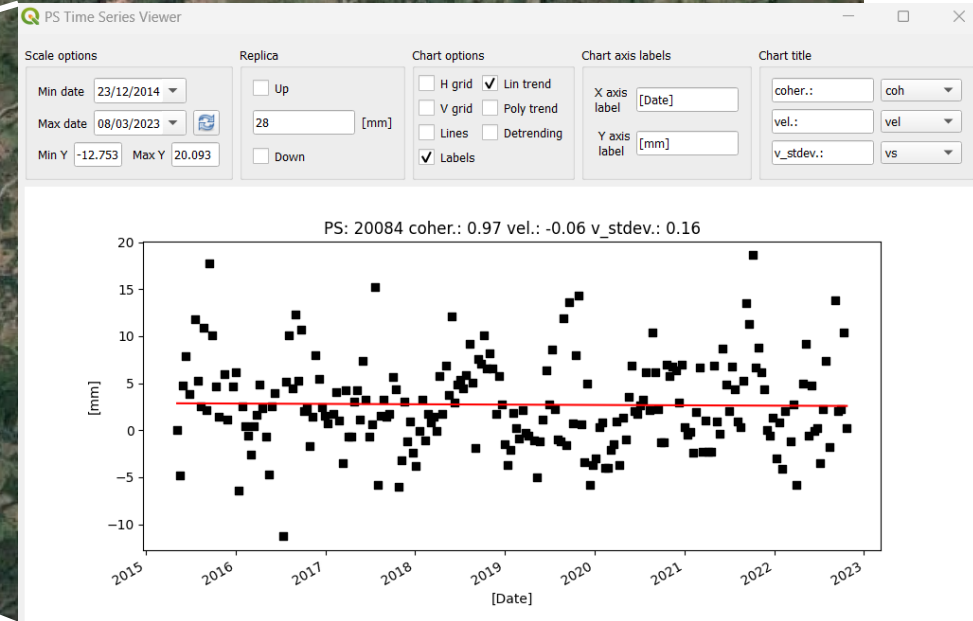
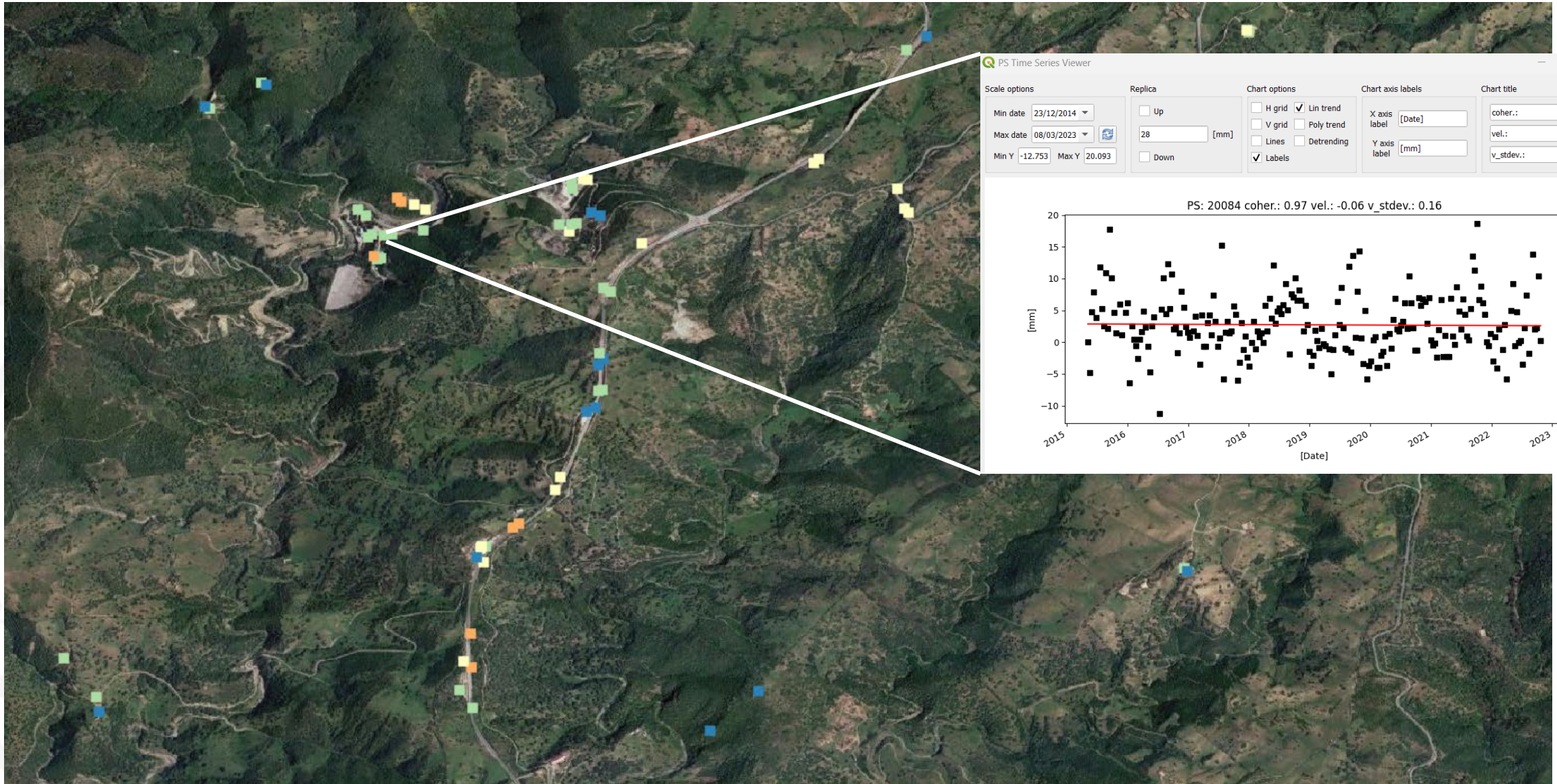
Time series – Lula town



Time series – Roads



Time series – Sos Enattos mining site



- It is possible to extend this procedure to next months acquisitions in order to get a continuous monitoring system
- It is possible to apply decomposition formulas in order to get W-E displacement

Scientific Publications

- First results has been presented as a poster at EGU General Assembly in Vienna

<https://doi.org/10.5194/egusphere-egu23-14807>

- A scientific article with title «**Measuring land deformation through PSI technique in NE Sardinia (Italy): Roads to Einstein Telescope**» has been submitted and is currently under review at Springer Nature editor (Open Access)