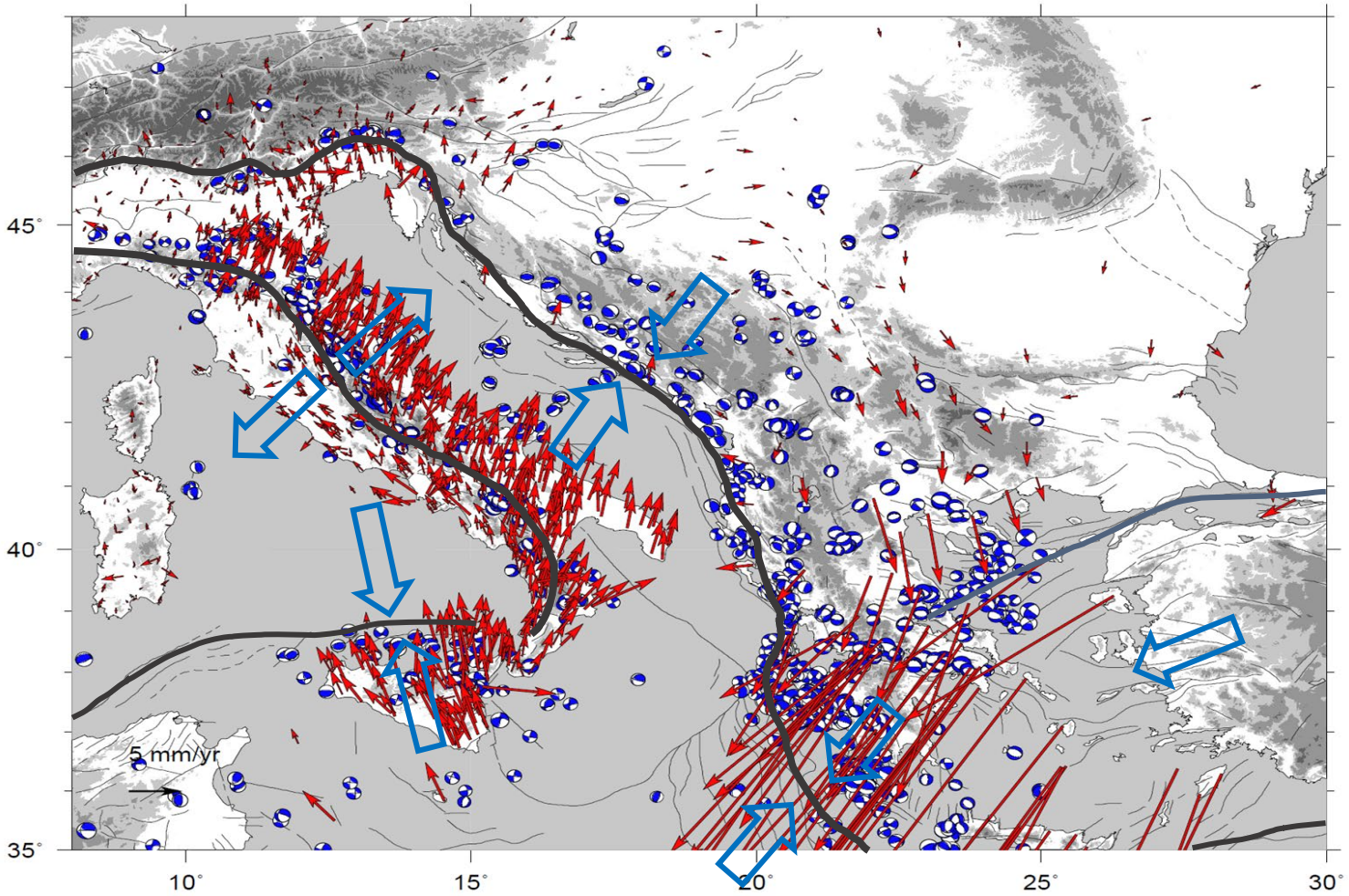
# GNSS archive facility and standard geodetic products

Edited by the GNSS analysis and RING infrastructure team

# • SCIENTIFIC RATIONALE

- Ground deformation monitoring and seismic hazard asessment.
- Ionospheric monitoring.
- Real time applications.

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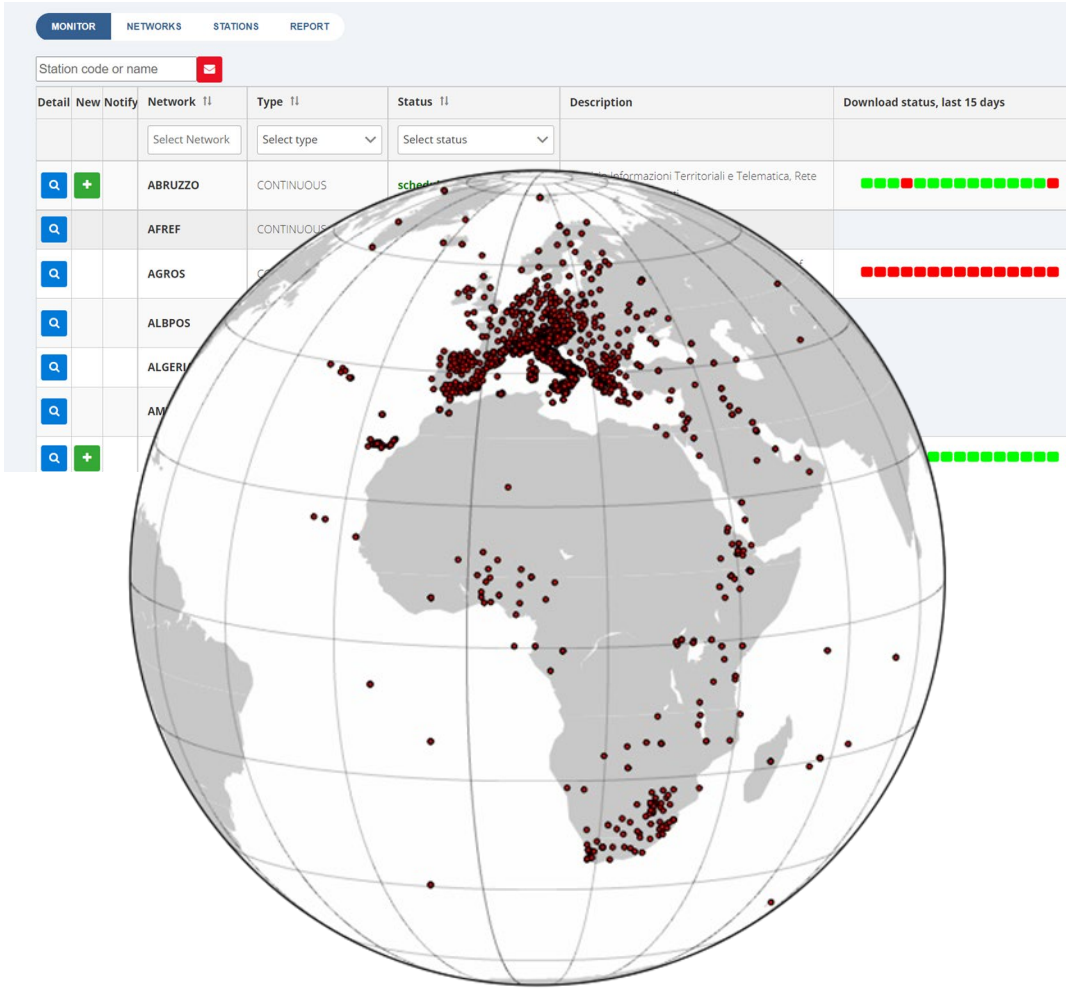
# • Mediterranean GNSS archive (MGA)

All daily GNSS data from permanent stations in Europe - Africa region are archived on MGA. The Monitor allows to get a picture of the data download process, data are logically subdivided into Networks, containing the list of contributing stations.




## MGA in brief:

- Regional archive of daily RINEX files
- 4915 GNSS stations: (RING, Agencies, Public, Private, etc.),
- in Italy 1420 permanent stations
- Mean station interdistance: 15 km
- Quality check and metadata  reconstruction
- Data distribution through anonymous ftp and webservices

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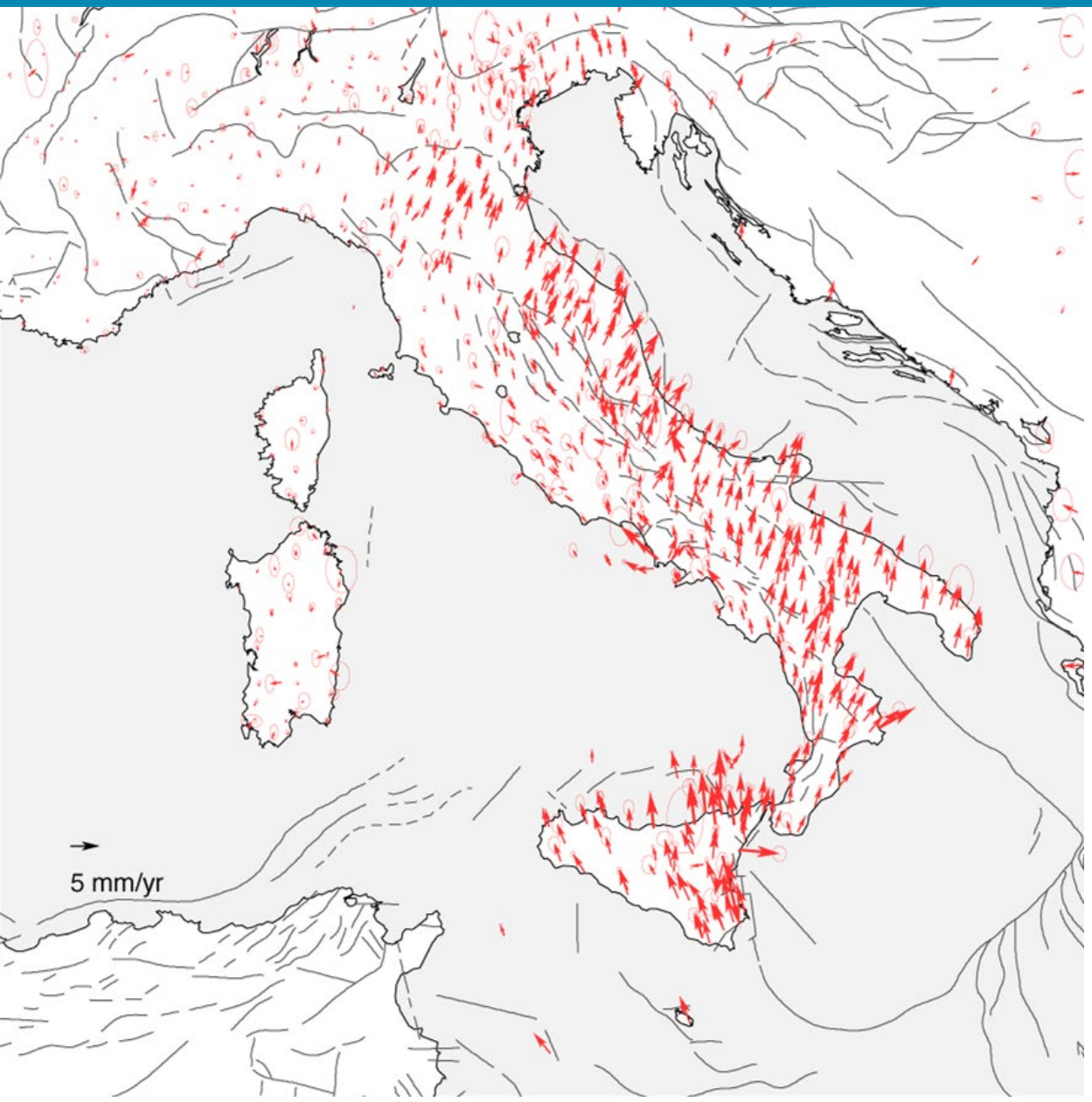
# • INGV Analysis Centers

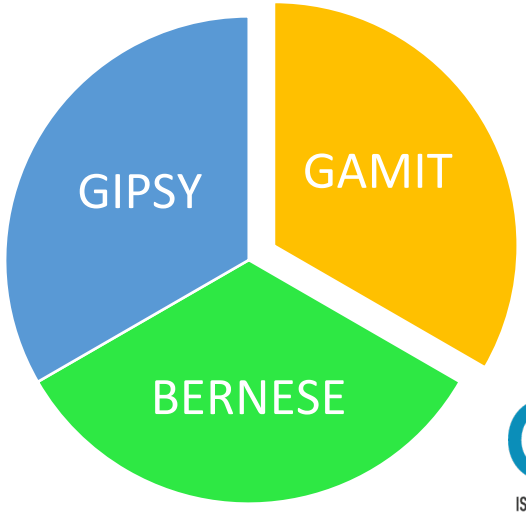



GNSS data analysis

INGV Analysis Centers

- GAMIT solution
- BERNESE solution
- GIPSY solution

Unified velocity field

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# Geodetic scenarios and geophysical modeling

S. ATZORI, A. ANTONIOLI, N. SVIGKAS

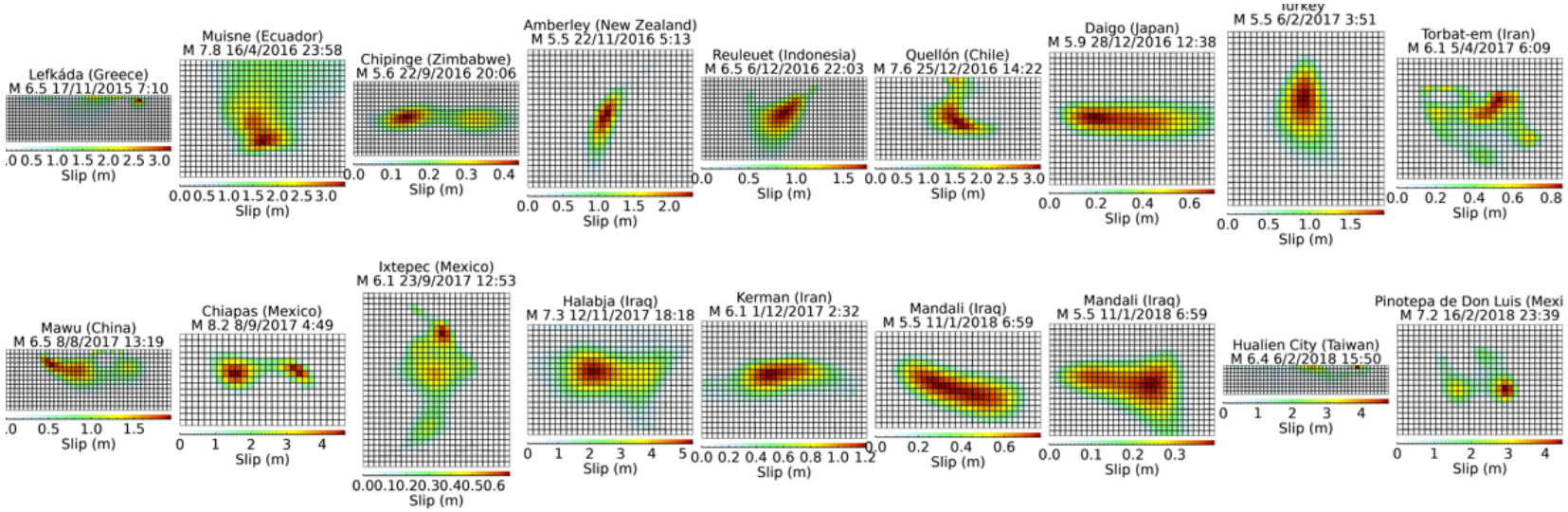
# General Description (Objectives)

Aim of this module is providing information from geodetic, InSAR and GNSS. This module can be activated on demand or automatically triggered at the occurrence of a worldwide seismic event above a predefined threshold. After the availability of a focal mechanism, a finite source is inferred and used to predict the induced permanent deformation. After the availability of any geodetic measurement, this module provides the parameters of the distributed-slip, finite source responsible for the event. Eventually, the modeled source is used to calculate the stress change induced onto surrounding known seismogenic sources.

# Progress Description

In the last year, the algorithm for the automatic modeling of InSAR data has been fully developed and tested over a set of 100 test cases. The implemented algorithm has been submitted to *the International Journal of Applied Earth Observation and Geoinformation*. The service for the scenarios and model provision is already running. Scenarios and modeled sources are available for analysis and download at the page:

http://terremoti.ingv.it/finitesource




# 3D displacement field mapping from geodetic data

F. GUGLIELMINO, A. BONFORTE, G. PUGLISI

# General Description (Objectives)

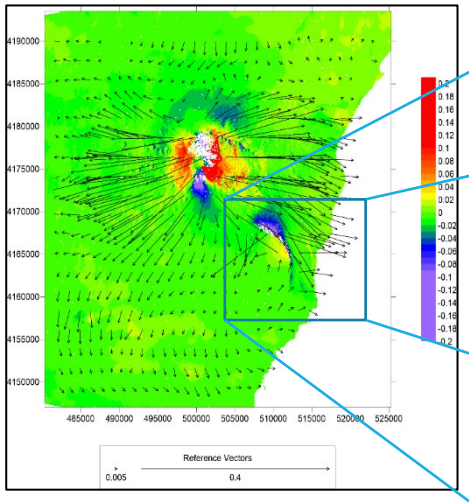
The main objectives of these activities are focused to integrate /validate the EO-SAR data with the ground deformation data (GNSS), using the SISTEM algorithm.

The application fields of such products are the following:

- Volcanic eruptions: volcanoes inflation/deflation movements, volcano-tectonics.
- Seismic cycle investigation: coseismic, postseismic and interseismic phases
- Landslides
- Urban or coastal subsidence

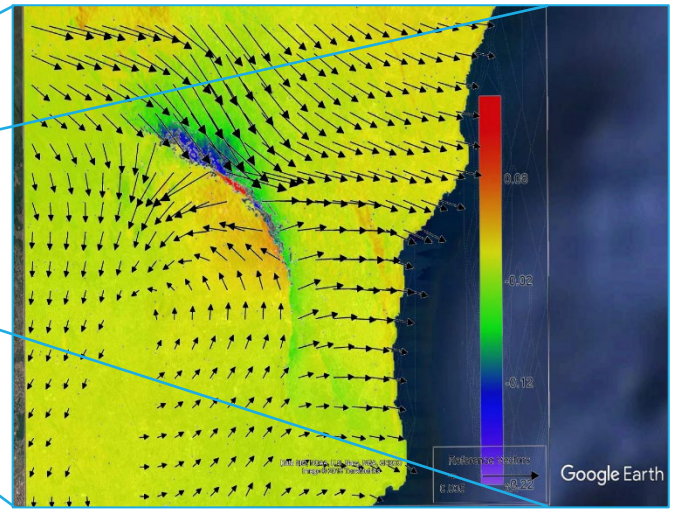
# Progress Description

In the last year, the SISTEM algorithm was update for take in account other kind of geodetic in situ data (Tilt, Levelling, Dilatometer) and the updated version of the SISTEM is actually in test-phase using synthetic and real data.



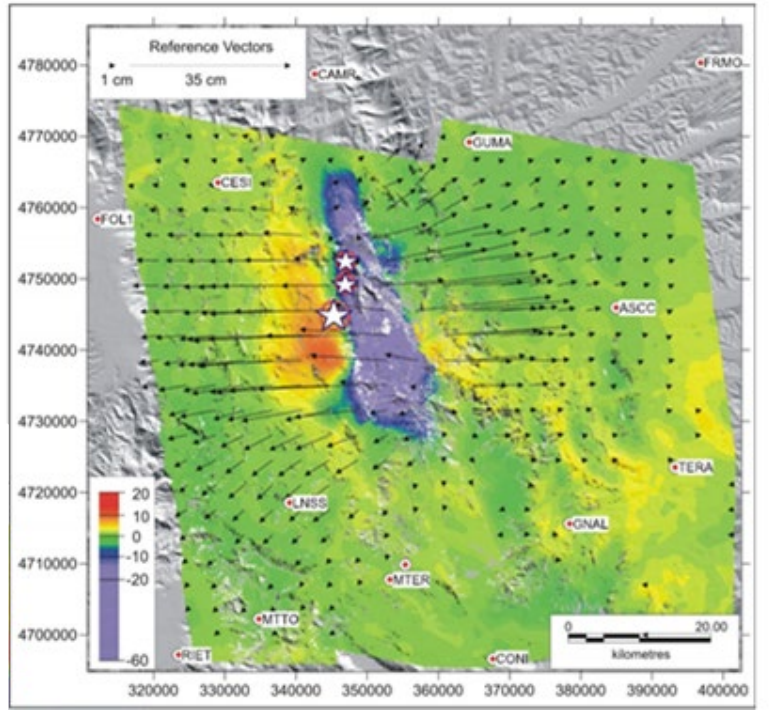

3D Displacement, obtained by integrating the SAR and GNSS data with the SISTEM algorithm

Mt Etna 2018 eruption+earthquake SISTEM data integration




Detail of the 3D displacement map obtained by SISTEM integration of SAR and GNSS data. The elastic rebound towards the top of the structure's footwall can also be seen.

2016 "Visso-Norcia" earthquake sequence



# DAMAGE MAPPING

## Earthquake damage assessment at different spatial scales

Bignami Christian, Piscini Alessandro, Romaniello Vito, ***Emanuele Ferrentino, Gaetana Ganci***

# Earthquake damage assessment at different spatial scales

- ★ The activity concerns the development of algorithms and procedures in order to produce earthquake damage maps.
- ★ Maps are supplied both at single building and block of buildings scale.
- ★ The products can be derived by exploiting different types of satellite data, from SAR images to medium or high spatial resolution optical ones.

The satellite DAMAGE ASSESSMENT is based on change detection methods, capable of identifying the changes of the observed objects on two (or more) scenes acquired at different times (before and after a seismic event). Change features are computed, derived from statistical analysis:

- ★ Kullback-Libler Divergence (KLD)
- ★ Mutual Information (MI)
- ★ Intensity Correlation Difference (ICD) → for SAR data
- ★ Normalised Difference Index (NDI) → for optical EO data
- ★ ***SAR polarimetric features + InSAR phase coherence***
- ★ ***PCA metrics for Optical data***

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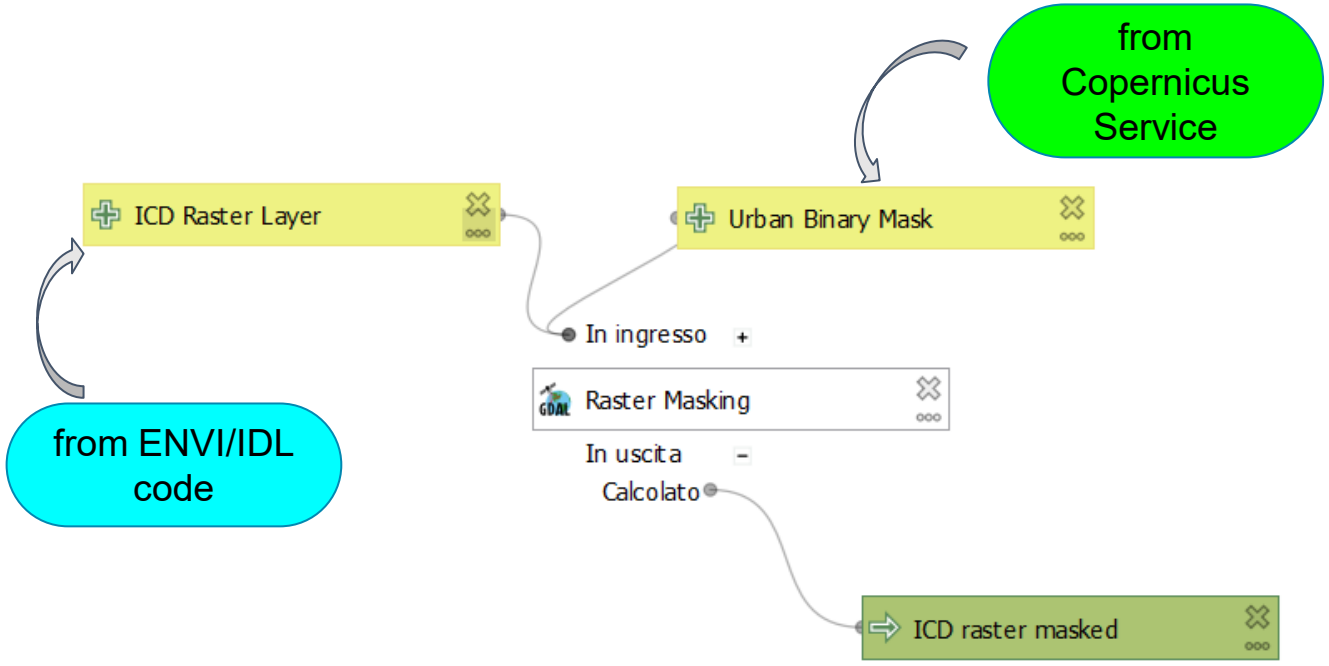
# • ALGORITHMS & TOOLS

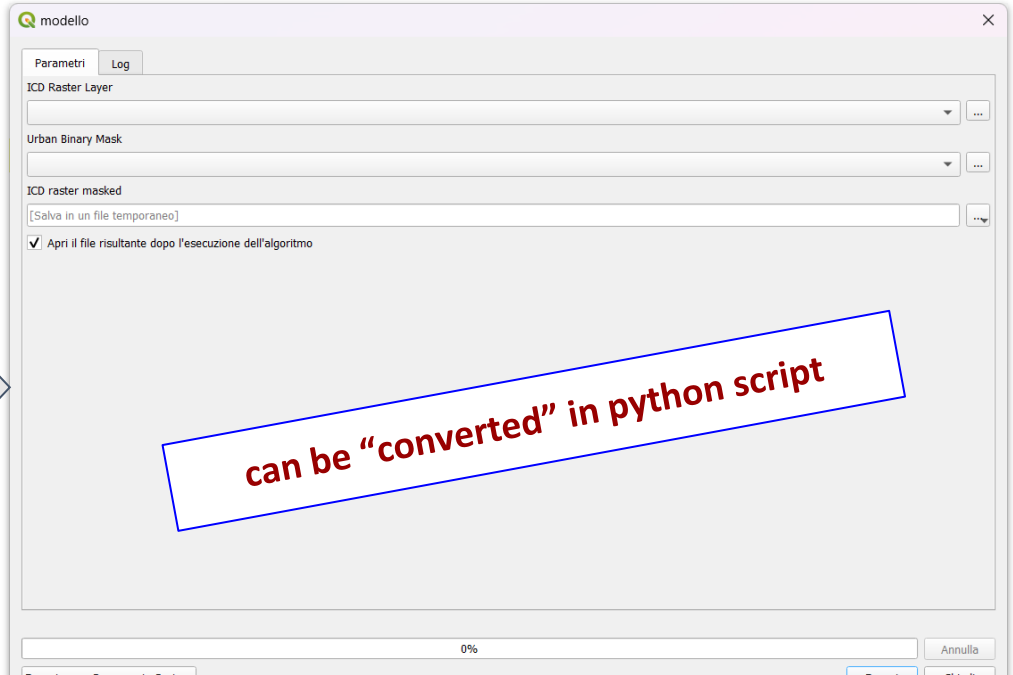
There are two main *damage assessment* algorithms for data fusion:

1) FST (*Feature Stepwise Thresholding*)
2) NN-CD (*Neural Network - Change Detection*)

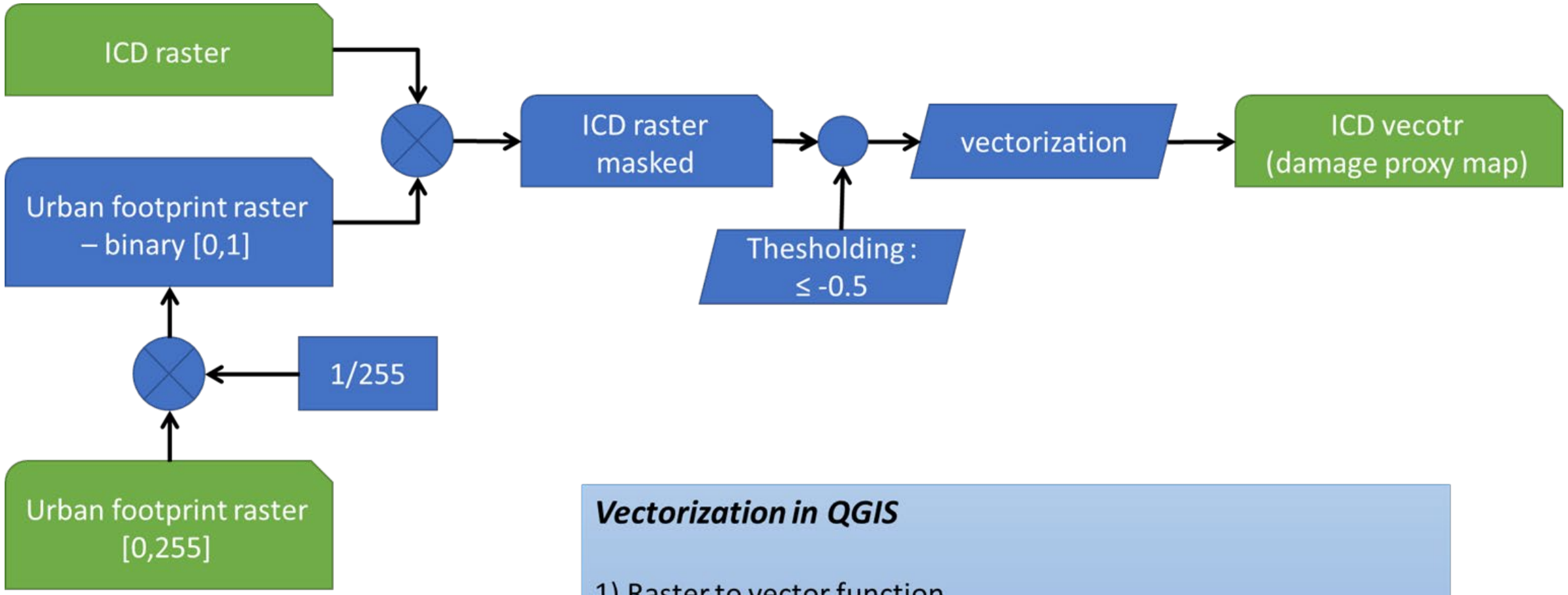
Unsupervised method in *our kitchen* to be tested on Turkiye case study

GIS procedure for ICD damage proxy in Turkije (introduced urban footprint from Copernicus-DLR products):



# • ALGORITHMS & QGIS




***Vectorization in QGIS***

1) Raster to vector function
2) Selection of elements with DN=1 and export of selected elements to new shapefile

# • RECENT ACHIEVEMENTS

Publications:

- ❏ Ferrentino, E., Nunziata, F., Bignami, C., Graziani, L., Maramai, A., Migliaccio, M., 2021. **Multi-polarization C-band SAR imagery to quantify damage levels due to the Central Italy earthquake**. International Journal of Remote Sensing 42, 5971–5986.
- ❏ Ferrentino, E., Nunziata, F., Bignami, C., Graziani, L., Maramai, A., Migliaccio, M., Stramondo, S., 2022. **On the Combination of Dual-Polarization Sentinel-1 Ascending/Descending Orbiting Passes to Estimate Damage Due to the 2016 Central Italy Earthquake**. IEEE J. Sel. Top. Appl. Earth Observations Remote Sensing 15, 9509–9518.

❏ ASI news

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