WP7 Geosphere and Landsurface

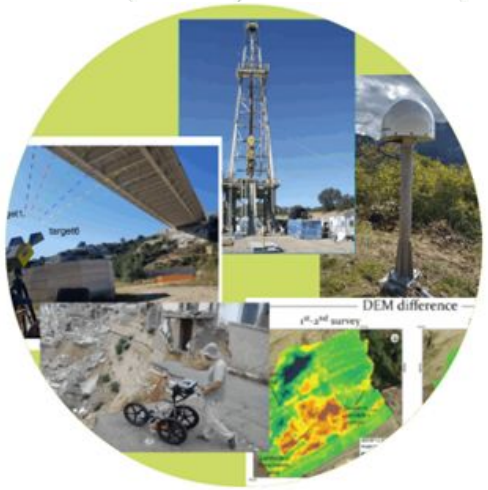
Giuliana Rossi, Ilaria Catapano, Valeria Giampaolo, Giovanni Gigli and all the WP7's staff

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"

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani

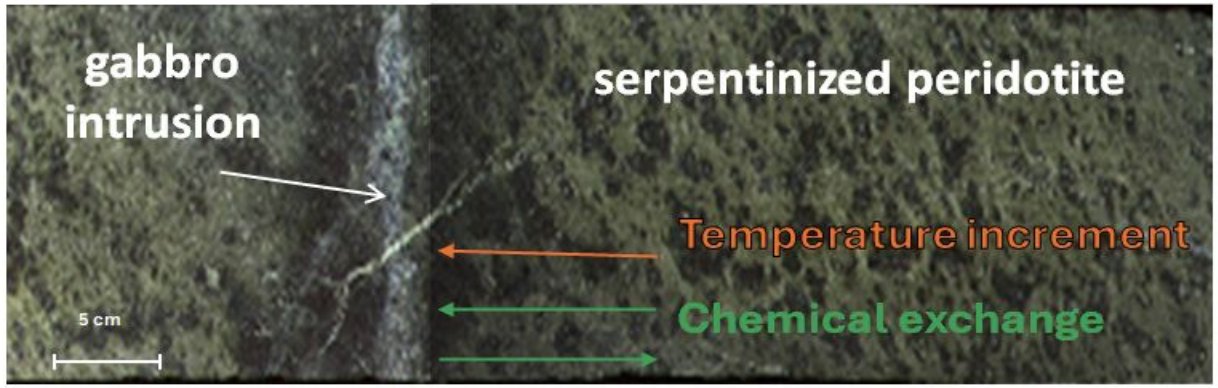
Environmental observations on Geosphere and Landsurface

Integrating key Research Infrastructure capabilities & related datasets including: SMINO, ATLaS, ECORD-ICDP, & EUFAR



Testing cutting-edge technologies in three pilot sites: the Friuli Venezia Giulia region, Tito and Potenza in the Basilicata region

7.1- Improving the access to the ECORD infrastructure and enabling scientific drilling micro-analysis, geochemical and site survey data sharing



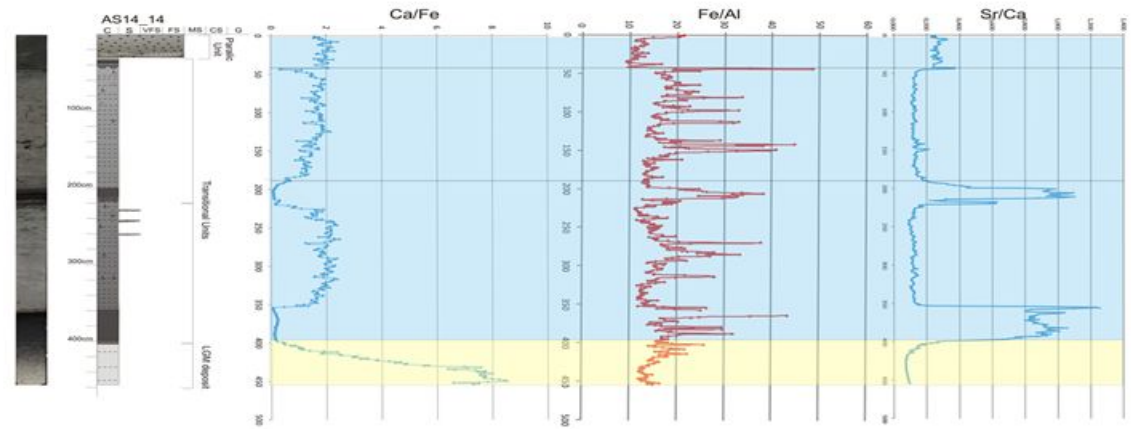
Serpentinization and gabbro intrusions: temperature and chemical exchange in leg 209 (ODP) and 357 (IODP)

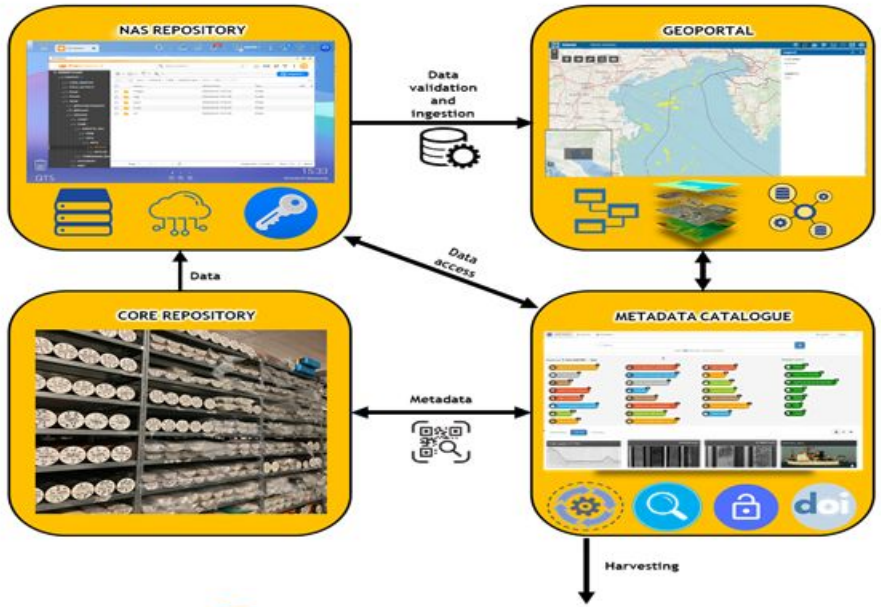
- → Oxygen isotopes thermometry: Fluorination line at IGG-CNR Pisa
- → Elemental and isotopic variations:
  - Sr, Nd, Hf isotopes (Uni-Köln, Germany)
  - In situ Si isotopes (GFZ-Potsdam, Germany)
  - Zr isotopes (CUG Wuhan, China)

POSTER – sessione 8, codice 102, schermo 5

XRF core scanning technique as a too for high-resolution stratigraphy.

Data derived from non-destructive analysis of a vibracore collected on the northern Adriatic: stratigraphic log, XRF-CS analysis, and magnetic susceptibility.



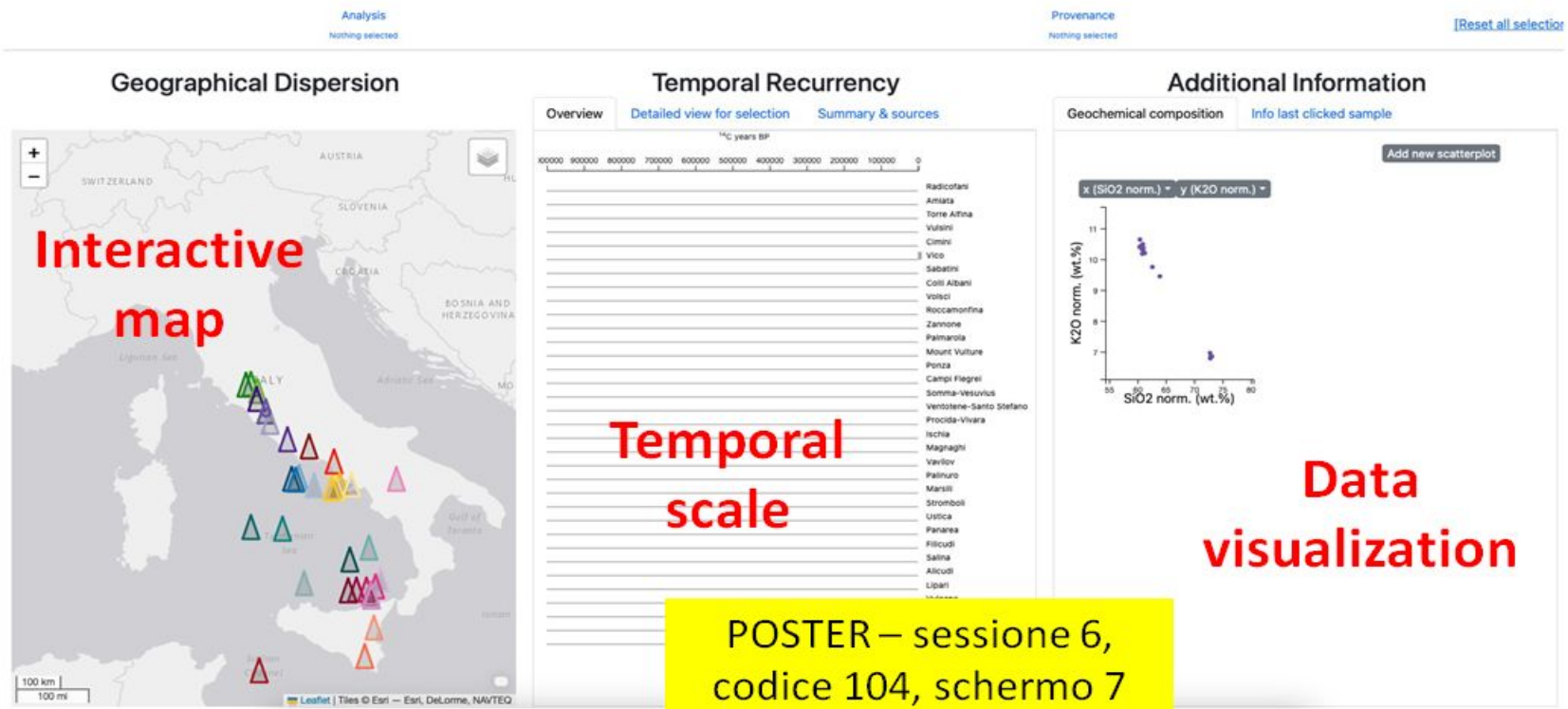


Data Flow - Cores are described and managed through the GeoNetwork metadata catalogue making them findable, accessible, and interoperable with the ITINERIS data HUB. The geoportal shows their distribution and provides some information about origin, type, overview. Data are stored in a NAS repository and are accessible through the catalogue.

POSTER – sessione 6, codice 103, schermo 6

Stratigraphic, geochemical, and geochronological data of pyroclastic units from Quaternary Italian volcanoes.

Prototype online version of the database displaying the main features: an interactive map with location of the volcanic centres and outcropes/cores (left); a temporal scale (from 1.5 Ma to present; front); bi-plots diagrams showing major, minor and trace element data (right).



POSTER – sessione 6, codice 104, schermo 7

7.3 Improving the access to IODP scientific borehole geophysics, subsurface structural data, and stratigraphic/lithologic samples-data sharing.

Stratigraphic/lithologic samples-data (**Earth Science Department, University of Milano**)

Physical catalogue completed of 8 stratigraphic wells, in progress on additional 34 wells

- 4162 samples
- 4046 smear slides
- 2459 re-usable residues from Nannofossil analyses
- 2384 re-usable residues from Foraminifera analyses
- 359 thin sections

Petrographic samples-data (**Department of Earth Science, University of Pavia**)

Physical catalogue completed of 2 IODP Wells and 1 ICDP well.

- Rock samples
- Thins sections

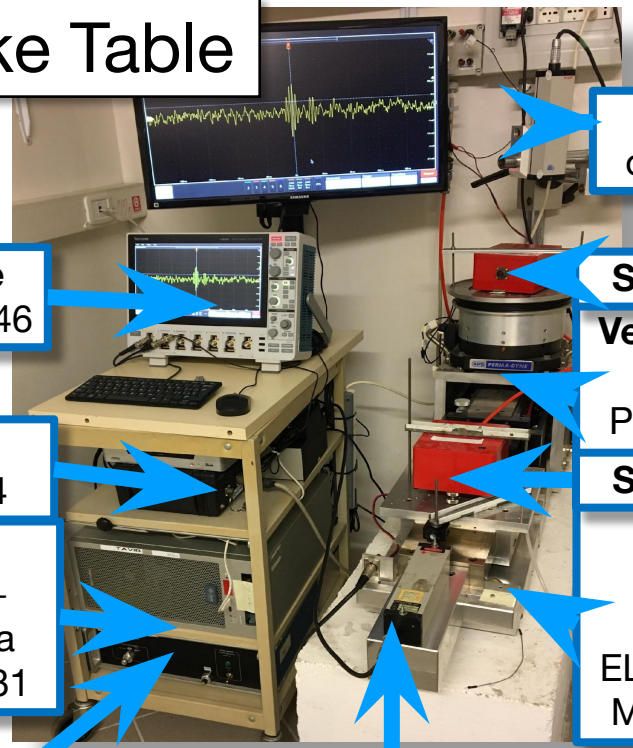
Catalogue includes bibliographic references of published data

Digital data temporarily stored in Excel files before using the **Mobile Drilling Information System (m-DIS)**

7.7 Integrated facility for the access to SMINO observations

The SPEKTRA Q-Leap CS Vibration Table is a system for calibrating seismometers (velocimeters and accelerometers) that uses an absolute position reference system with sample measurement from a laser device.

Shake Table



Laser sensor
optodyne L-109

Oscilloscope
Tektronix MSO46

Seismometer

Vertical shaker
APS
PERMA-DYNE

Data logger
Lennartz M24

Seismometer

PC
PICMG 1.0 +
Sigma – Delta
Crystal CS4231

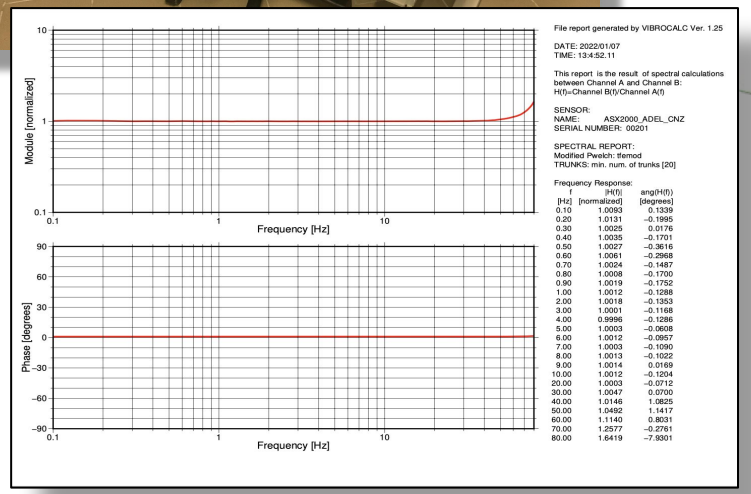
Horizontal shaker
APS
ELECTRO-SEIS
Model 113-AB

Amplifier
APS DYNAMICS
Model 124

Laser sensor
optodyne L-109

Calibration laboratory

Calibration repor

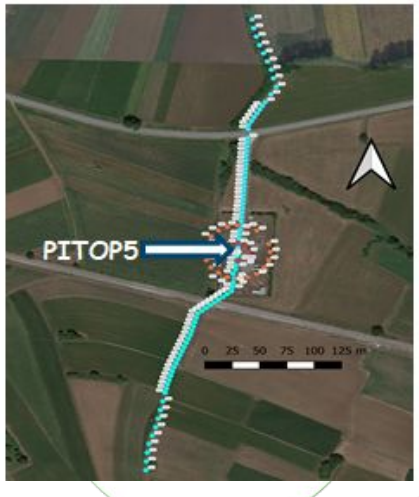


Acquired, base prepared, to be activated in the next weeks.

7.8 Data integrated facility for the access to geophysical observations on the subsurface

PITOP FACILITY IN TRAVESIO (PN, ITALY)

Deployment of surface geophones during the drilling of PITOP5 well



NuSeis Geophones (mono and three components):

- Long battery life: providing up to 45 days of continuous operation.
- Wireless recording units
- GNSS and BLE comms: easy deployment and retrieval.
- SEG standard data formats: compatible with processing softwares.

New seismic nodes 1C and 3C, acquired and tested while drilling the new borehole.

7.7 Integrated facility for the access to SMINO observations

Fiber interrogators: acquired, waiting for the delivery

Ocean Bottom seismograph: acquired, waiting for the installation at the MEDA (coordination with WP5).

7.8 Data integrated facility for the access to geophysical observations on the subsurface

Fiber cable and interrogators: acquired, waiting for the delivery

7.9 Integrated facility for accessible airborne geophysical observations.

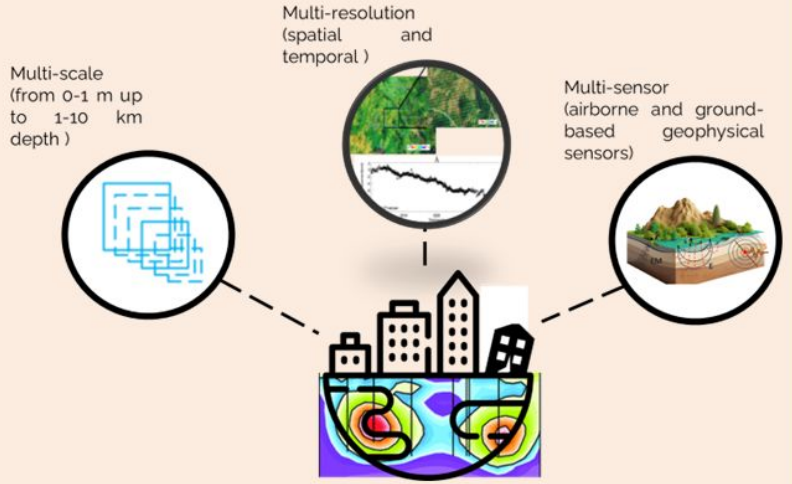
Very high resolution magnetic and GPR drones: acquired: to be tested on Marmolada Glacier (Dolomites, Italy) in July;

Magnetic sensors for aero-magnetic surveys; gamma-ray sensors; strapdown gravity system: tender opened.

7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

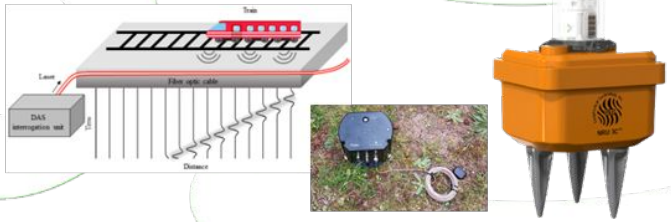
SCIENTIFIC GOALS

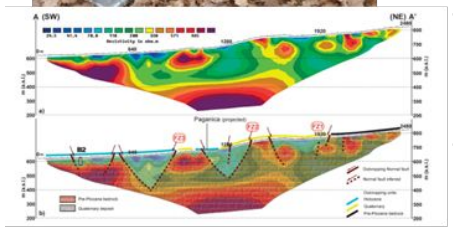
Development of an integrated approach for surface, subsurface and built-up characterization in urban areas and monitoring of civil infrastructure of strategic interest to mitigate the effects of natural and man-made hazards



Airborne Hyperspectral Imaging Systems (VNIR-SWIR)

- Continuous spectral coverage from 400nm to 2500nm
- Spatial resolution of about 30/40 cm in the VNIR and about 1m in the SWIR





New electrical resistivity tomography system

- Different spatial e temporal resolution by using 2D and 3D tomographic methods,
- investigation depth (from 0-1 m up to 1-10 km depth time-lapse acquisition,
- ML data analysis techniques

New GB-SAR and GB-RAR

- monitoring surface deformation
- studying the static and dynamic behavior of strategic infrastructure
- Spatial resolution of at least 0.75 m

Seimic data from new sesimic sensors and fiber optic interrogator

- Nodal systems consisting into velocimeter and accelerometers,
- DAS maximum interrogation range ≥ 50 km
- ML data analysis techniques

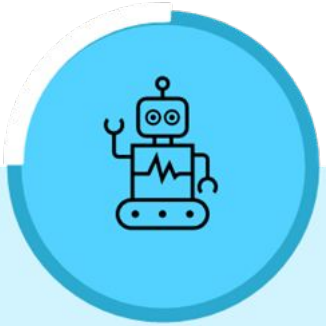
7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

Next-generation researchers and technologists

100%

Engagement of new personnel dedicated to these topics:

- 1 researcher,
- 1 technologist,
- 2 Phd students.



Cutting-edge equipment

50%

Cutting-edge geophysical equipment for the subsoil investigation within the depth range 0-10 km and the analysis of near-surface-soil-infrastructure dynamical interactions.

Sensors operating in short-wave infrared (SWIR) spectral range for land surface monitoring.

Pilot sites: Potenza and Tito urban areas

30%

Areas affected by high seismic and hydrogeological risk. Furthermore, the industrial area of Tito is heavily polluted and is classified as national interest site (SIN).

FAIR data access In synergy with Activity 7.5 and WP2

30%

Integration with SMINO and ATLaS IR.

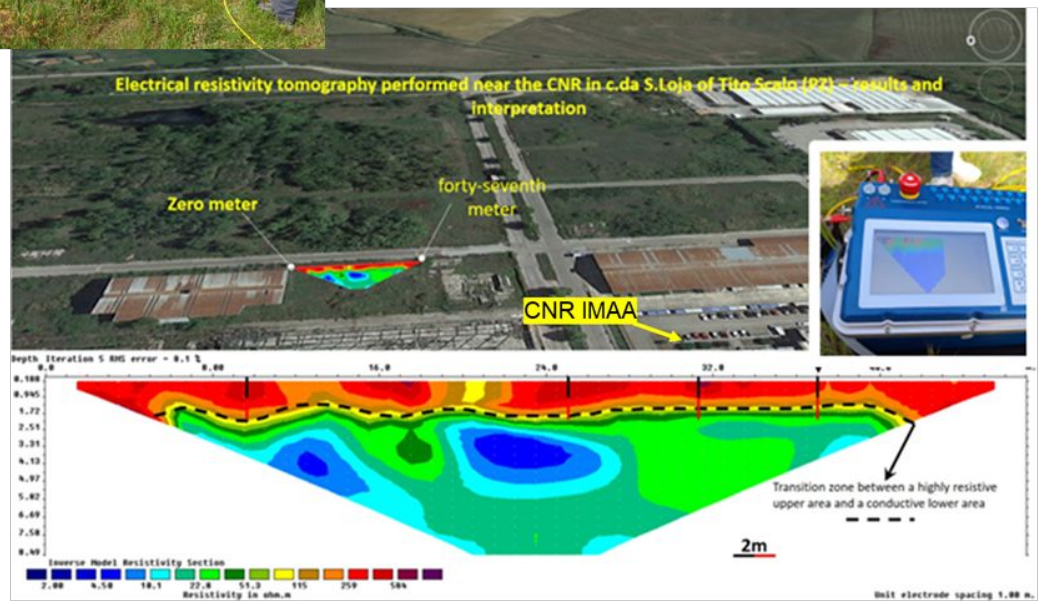
Webgis tool: it will include, for the first time, also raw datasets from on land geophysical surveys, airborne data, and the newly generated fiber optical strain measurements.

7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

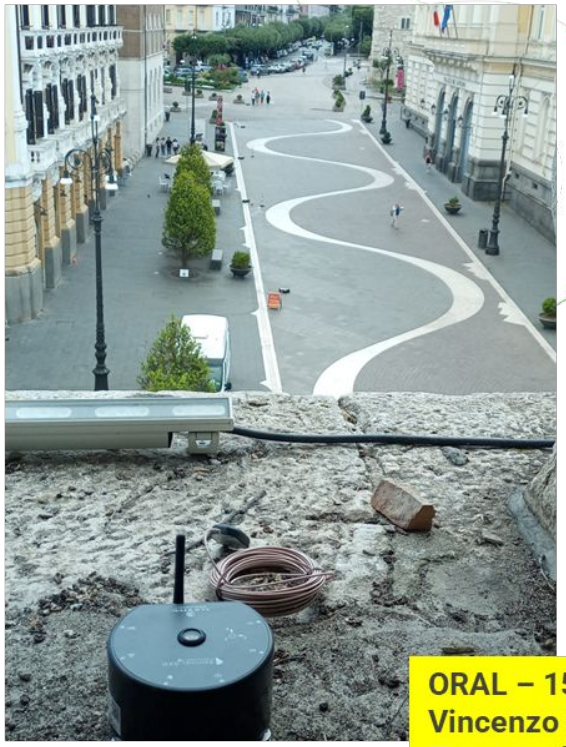
FIRST TESTS OF GEOPHYSICAL EQUIPMENT

POSTER – session 6
Code 105, screen 8

Syscal Terra (IRIS Instruments) for mapping the groundwater table at the industrial site of Tito affected by groundwater pollution



Electrical resistivity and seismic noise measurements in the historic center of Benevento town for seismic protection of historical buildings



Structural monitoring using SENTINEL GEO (LUNITEK)

3D ERT using Syscal Terra (IRIS Instruments)

ORAL – 15:10 - 15:17
Vincenzo Serlenga
Tests and applications of seismic arrays in different urban contexts

7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

FIRST ACTIVITIES AT PILOT SITES

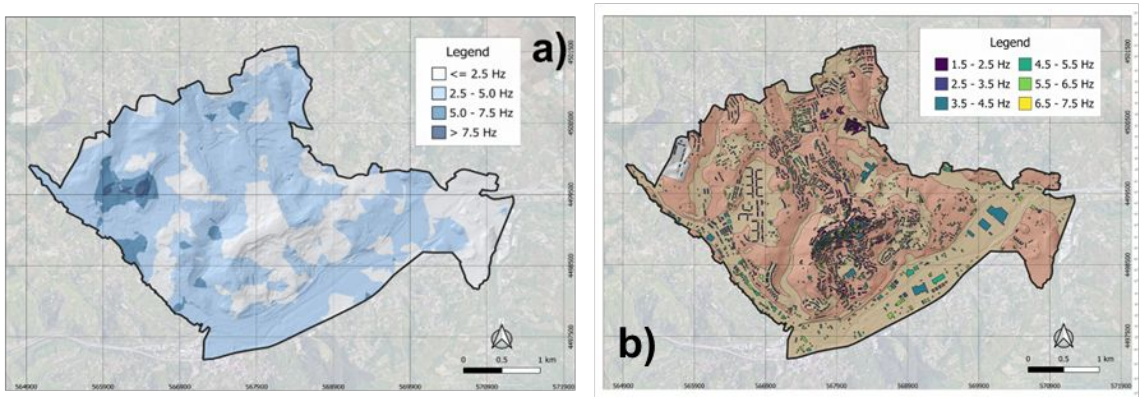
One of the pilot sites of WP7 is the city of Potenza in Basilicata region (southern Italy), a predominantly mountainous zone affected by high seismic and hydrogeological risks.

(rights reserved to Gianluca Labella)

ORAL – 16:46 - 16:53
Giovanni Gangone (PhD student)
Soil-building resonance effect in the urban area of the city of Potenza (Southern Italy)

SOIL-BUILDING RESONANCE EFFECTS OF THE CITY OF POTENZA

- To estimate the fundamental resonance frequency of the soils of the city of Potenza, we acquired 300 microtremor signals.
- 153 buildings of the city of Potenza were monitored by microtremors acquisitions. Their selection was performed by taking into account different characteristics (i.e. height of the building, area in plan of the building, construction type, tipology of outcropping soils).



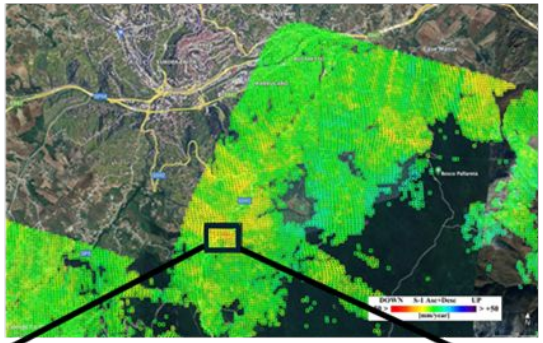
a) Iso-frequency map of the soil of the city of Potenza,
b) Iso-frequency map of the buildings of Potenza.

7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

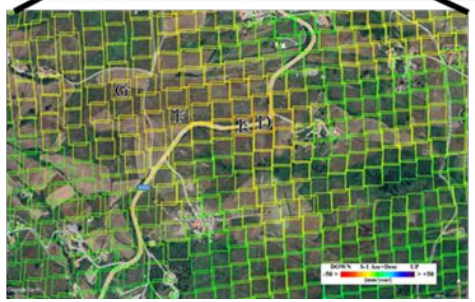
FIRST ACTIVITIES AT PILOT SITES

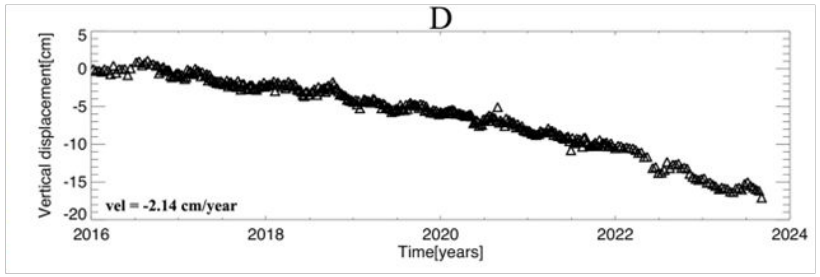
InSAR Vertical displacement of POTENZA and TITO in therm of soil deformation for the identification of test area affected by landslides

In Basilicata, hydrogeological instability is widespread and is an extremely serious and important issue because urban settlements are involved in many cases.



Urban and periurban area of POTENZA

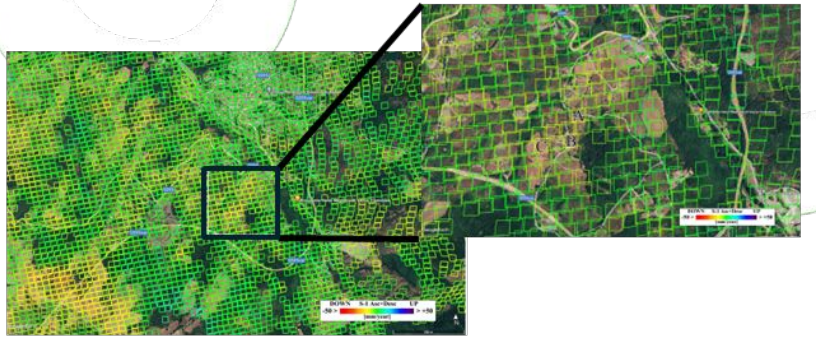


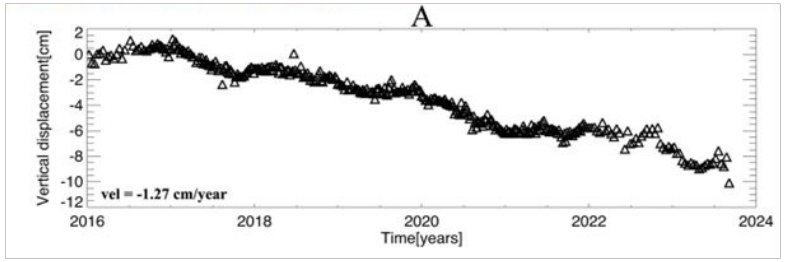


STAKEHOLDERS INVOLVEMENT

The landslide has been attended to by the mayor of the municipality of Tito and is part of the **118 landslides project** of the Basilicata order of geologists.

Urban and periurban area of TITO





7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)

ON GOING and FUTURE RESEARCH ACTIVITIES

Instrumentation of the selected slope affected by landslides for geophysical monitoring

Machine learning techniques applications to link geophysical and subsoil properties

Multi-parameter, multi-scale and multi-resolution experiment in the test areas and demonstration to stakeholders
in collaboration with OGS, CNR IREA all interested partner of WP7

Transfer of the integrated approach developed into ITINERIS project to other activities such as the microzonation of Campi Flegrei for the Italian Civil Protection

7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

Exploitation and optimization of technologies for the Soil-Subsoil System (SSS) observation by using two technological assets:

AIRBORNE SYNTHETIC APERTURE RADAR

The system aims at improving the multi-parameter observation of the surface processes, f.i., mass movements, subsidence and ground deformations. It will be mounted on-board an aircraft and include a compact, multi-capability radar system allowing different data acquisition modes (i.e. single-pass interferometry and polarimetry); a Flight Management System, for planning flight missions and navigating the aircraft for precise SAR data acquisitions; a GNSS/IMU system providing both real-time position and attitude information to the radar; computing resources for raw data storing and subsequent post-processing on ground.

Advantages:

- high operational flexibility
- suitable for reaching inaccessible areas
- short revisiting time

GROUND-BASED INSTRUMENTATIONS

Multi-platform and multi-scale geophysical facility for SSS imaging, electromagnetic characterization (electric contrast and magnetic susceptibility), and measurement of its temperature and strain.
The facility includes proximal and on-site instruments for data acquisition (magnetometers, gradiometer, multi-antenna ground penetrating radar and optical backscatter reflectometer) and will gain of the expertise of IREA researchers in setting-up state of art processing methodologies for 2D and 3D imaging. The facility is useful for urban and structural geology, agronomy, shallow geothermal exploration, terrain instability surveys.

Advantages:

- high resolution imaging of subsoil
- shallow and deep surveys
- synoptic image of the environmental system

7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

AIRBORNE SYNTHETIC APERTURE RADAR

Airborne SAR system infrastructure

Multiband SAR system
(under contract)

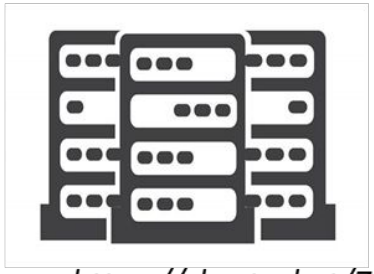
GNSS/INS system PwrPak7D-E2
(acquired)

Source: https://novatel.com

Flight Management System
(acquired)

Source: https://www.topoflight.com

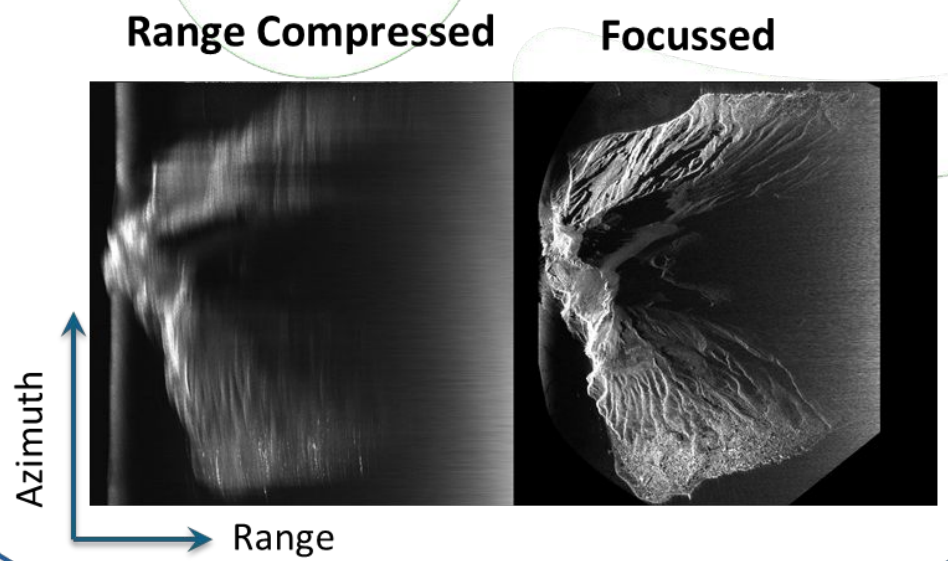
Computing resources
(planned)



Source: https://shorturl.at/7lKoV

Developed activities :

- Review and training on the new softwares Novatel and Flight Management System TopoFlight.
- Adaptation of focusing algorithms for processing data collected by the new instrumentation.



7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

GROUND-BASED INSTRUMENTATIONS

(purchase at the final steps – testing and payment)

Magnetometer: system for the total magnetic field and its vertical gradient measurement equipped with 2 QuSpin Gen-2 sensors, which guarantee data acquisition with 200 – 1000 Hz sampling rate and 0.003 nT sensitivity.

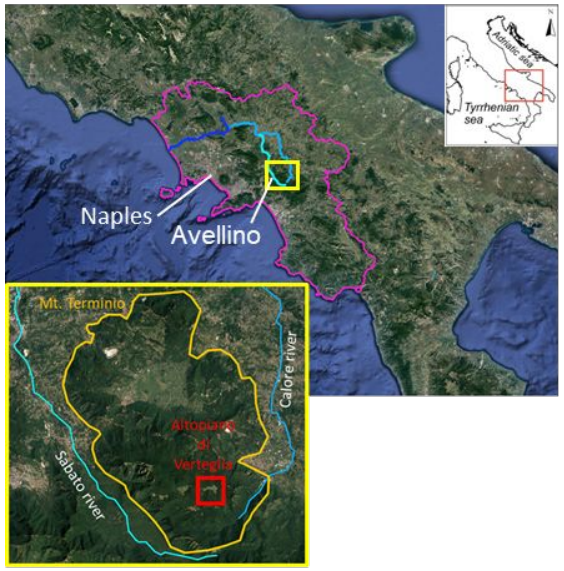
Zond Aero LF: drone based ultralight ground penetrating radar system equipped with 3 unshielded dipole antennas working at 3 different central frequencies: 100 MHz, 150 MHz, 300 MHz.

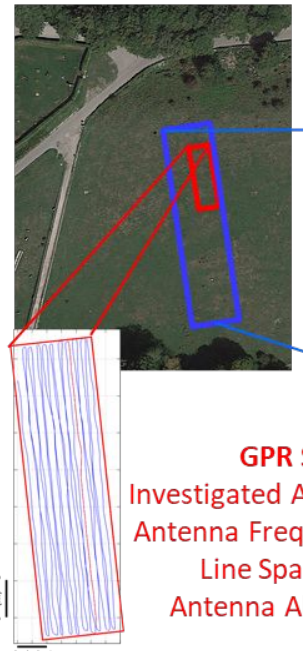
Geoscope MklV equipped with the array ground coupled G0908: multi-channel multi-frequency ground penetrating radar (GPR) for high-density 3D data capturing. Thanks to the step-frequency technology, the system enables optimal penetration and highest resolution simultaneously by sweeping through a wide frequency range (40 MHz – 3GHz) with only one single antenna array.

OBR 4600 Optical Backscatter Reflectometer: device for fiber optic distributed strain and temperature sensing, which is able to measure strain and temperature over 2 km distance range with no dead zone, with high spatial resolution (few mm) and high speed (3Hz).

7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

GROUND-BASED INSTRUMENTATIONS – FIRST ON FIELD TRIALS

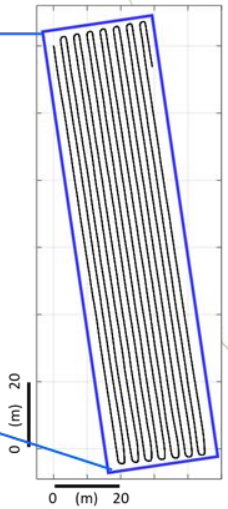


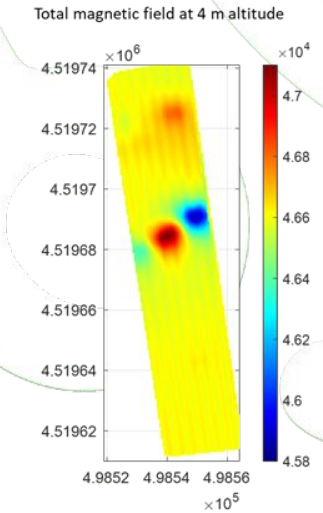


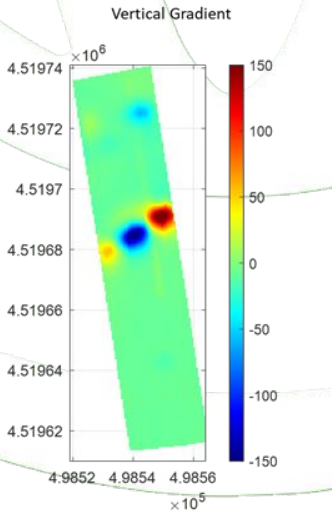
MAGNETOMETRIC SURVEY
Investigated Area ~ 30 x 120 m^2
Line Spacing: 2 m
Sensors Altitude: 4 and 5.7 m

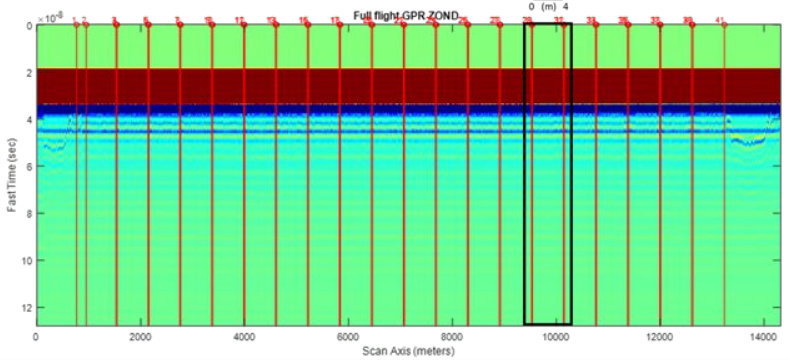
GPR SURVEY
Investigated Area ~ 10 x 40 m^2
Antenna Frequency: 300 MHz
Line Spacing: 0.5 m
Antenna Altitude: 1.5 m

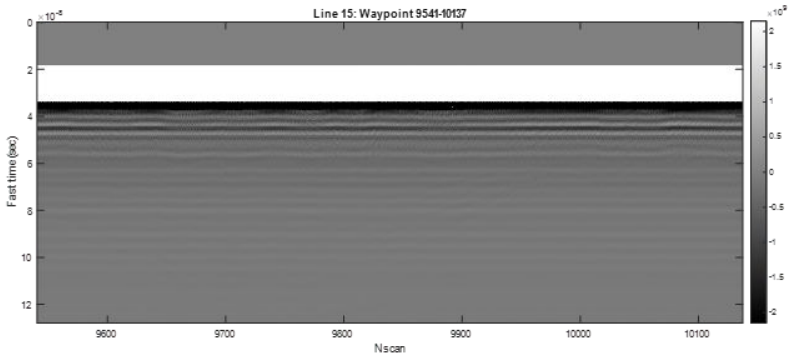
Measurement campaign at Piano di Verteglia (AV)

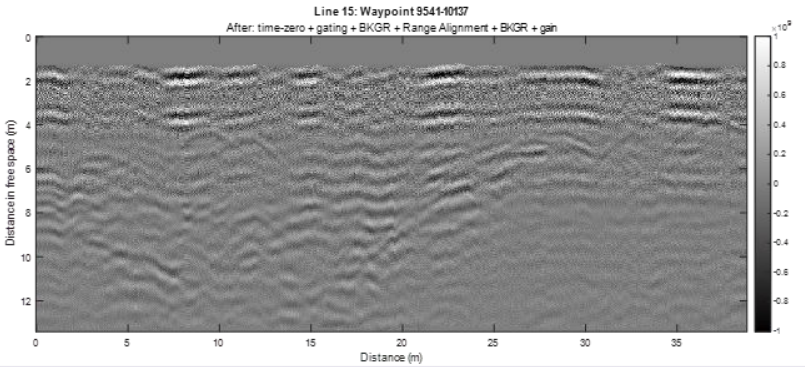










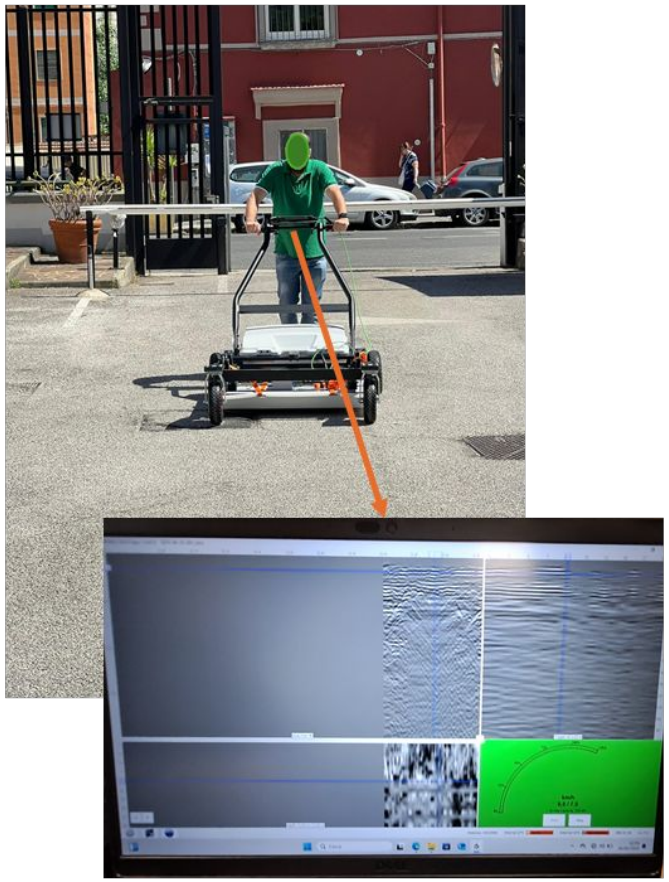


7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

GROUND-BASED INSTRUMENTATIONS – PRELIMINARY TEST & RESEARCH ACTIVITIES

Multi-channel multi-frequency ground penetrating radar (GPR)

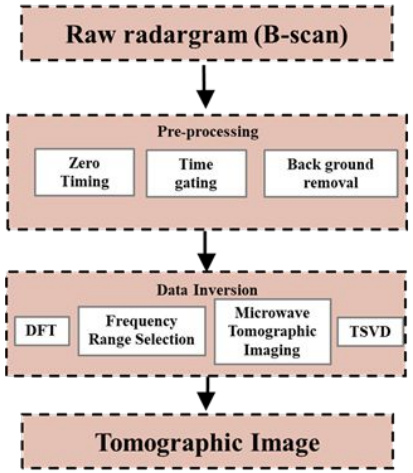
Preliminary test @CNR-IREA

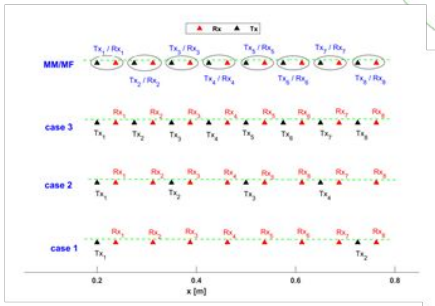


Research activities

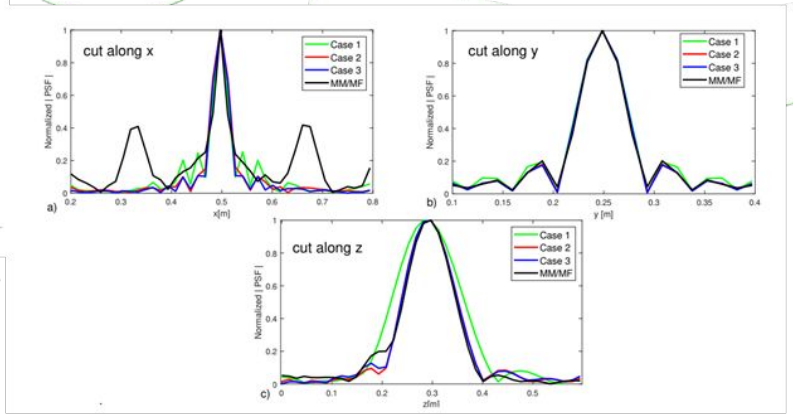
A data processing strategy specifically designed to handle multi-view and multi-static GPR data has been designed and a study devoted to establish the relationship among the number of transmitting antennas and the imaging capabilities has been presented at EGU 2024 [1] and in a paper under review [2]

Data processing flow chart





Considered measurement configurations



Comparison of the PSF cuts related to a point-like target placed at (0.5, 0.25, 0.3) m

[1] F. Soldovieri, G. Gennarelli, G. Esposito, G. Ludeno, I. Catapano, Non-destructive surveys via microwave tomography enhanced multichannel GPR, EGU General Assembly 2024

[2] M. Masoodi, G. Gennarelli, F. Soldovieri, I. Catapano, Multiview Multistatic vs Multimonostatic 3D GPR imaging: a comparison, submitted to Remote Sensing

7.5 - Earth Observation infrastructure based on airborne X/L Band SAR and in-situ geophysical data (CNR-IREA)

ON GOING RESEARCH ACTIVITIES

vs an optimized use of Airborne SAR system infrastructure

Adaptation of the interferometric SAR calculation chain for data processing collected by the new instrumentation

vs an integrated use of electromagnetic methodologies for subsoils investigations

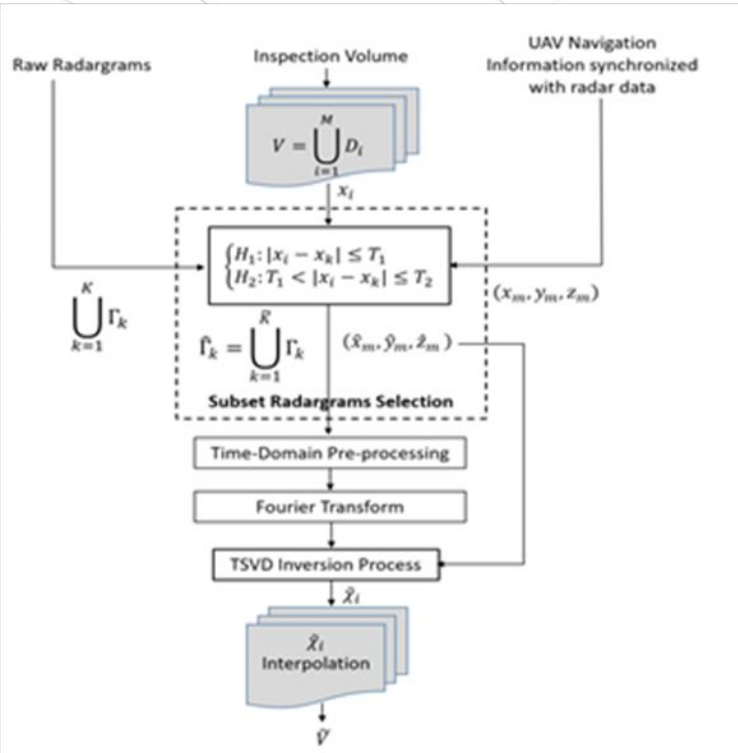
WP7 Poster "Development of an integrated electromagnetic sensing system for environment characterization"
Francesco Mercogliano - 10/07/2024 Session 8 16:40 - 17:00 (Poster code: 106 - Monitor: 9)

vs an optimized use of drone based Ground Penetrating Radar

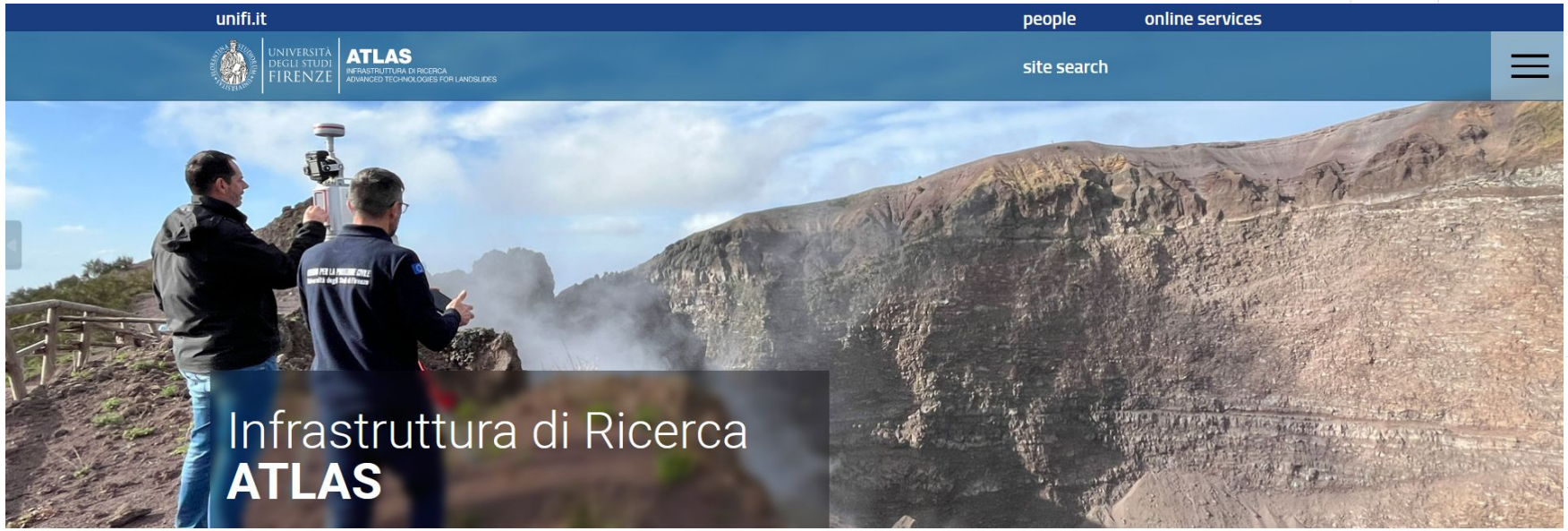
Design, Implementation and validation of data processing approaches accounting for flight positioning information (Microwave Tomography Imaging approaches compensating platform deviations from the nominal flight trajectory)

vs an optimized use of multi-channel Ground Penetrating Radar

Design, Implementation and validation of advanced data processing approaches exploiting the increased amount of gathered data for improving the imaging performances



7.6 Integrated platform for surface movements monitoring



Developing an integrated platform to distribute data for the observation and the forecasting of ground deformations, including the output from advanced monitoring and hazard forecasting models in a multi-scale perspective

ATLAS - Advanced Technologies for Landslides

ATLaS (Advanced Technologies for Landslides) is a research infrastructure established aiming to develop leading-edge methodologies (Mission) for the prevention and management of ground instabilities. The objective of reducing the hydrogeological risk is pursued conducting innovative research activities in which the use of state-of-the-art instruments plays a pivotal role.

Research Activities

Projects

Instruments

ATLAS Research Infrastructure includes:

- The Civil Protection Center
- The UNESCO Chair for Prevention and Sustainable Management of Geohydrological Hazards
- The Department of Earth Sciences

7.6 Scientific Instrumentation

3D printer

Fixed-wing UAV

UAV LiDAR

UAV Hyperspectral cameras

Mobile Slam Lidar

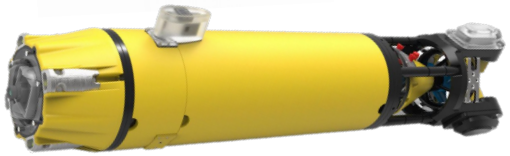
Long Range TLS

Thermal camera and sensors

Hi-Res spectroradiometer

Wireless Sensor Network

GB InSAR

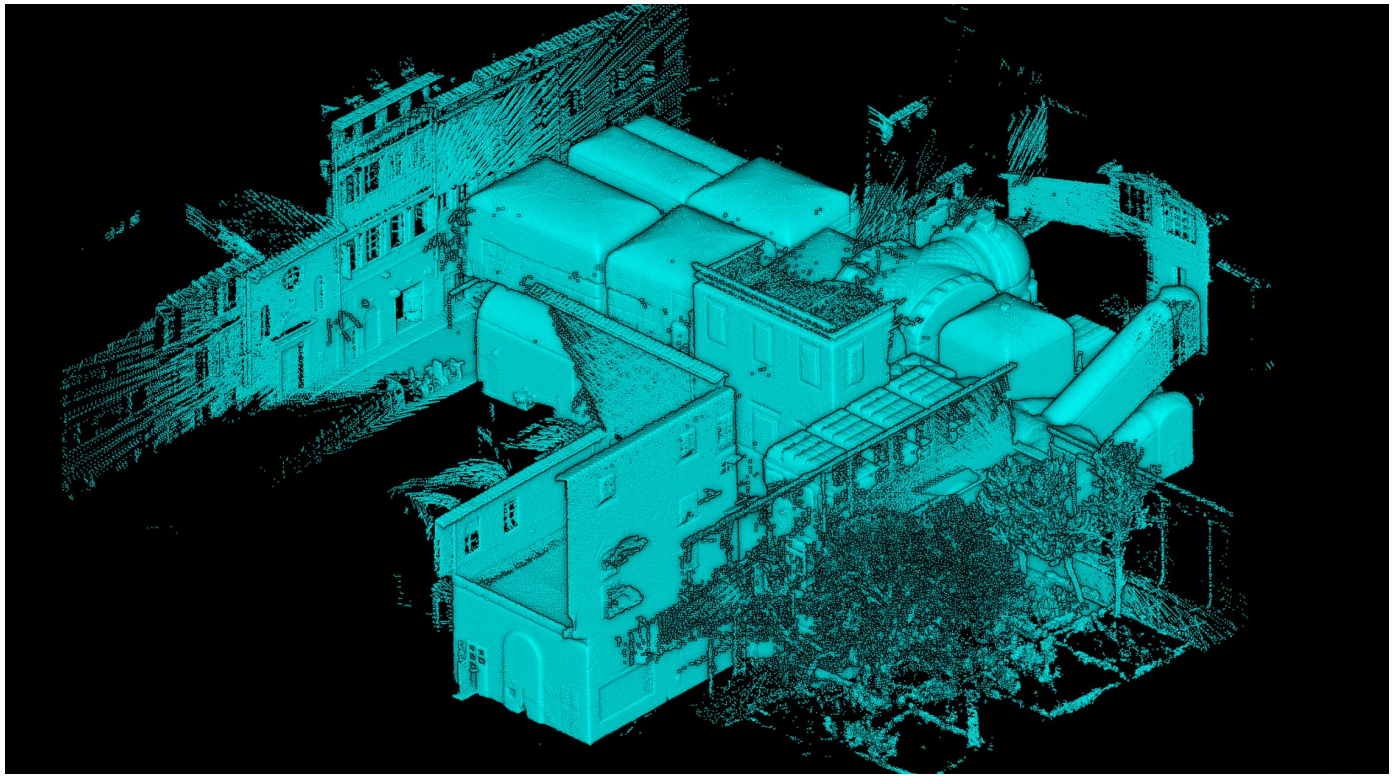


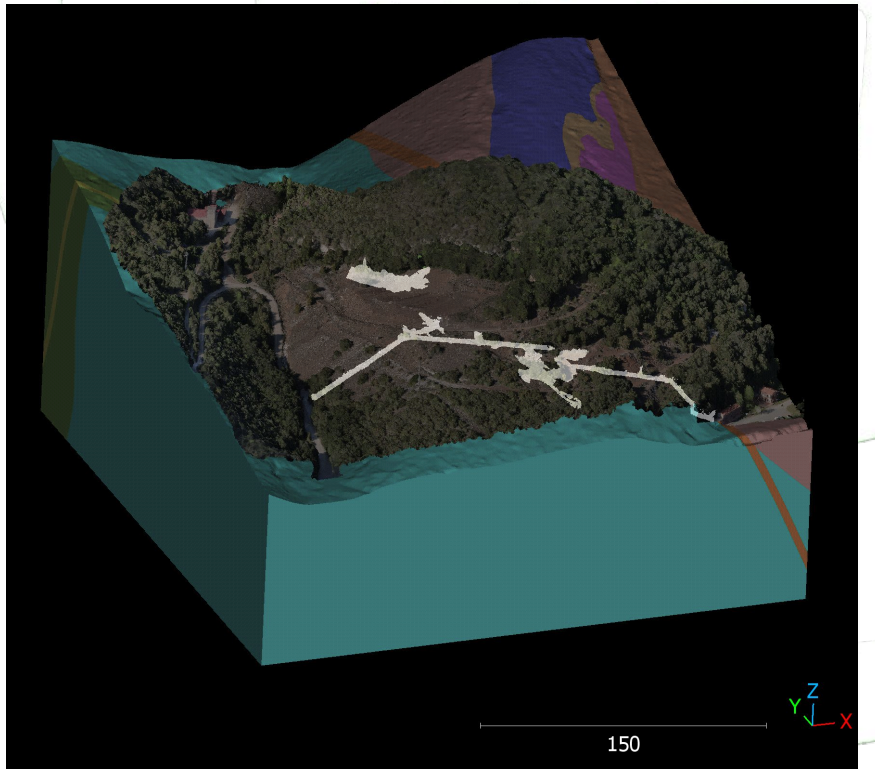
Underwater ROV

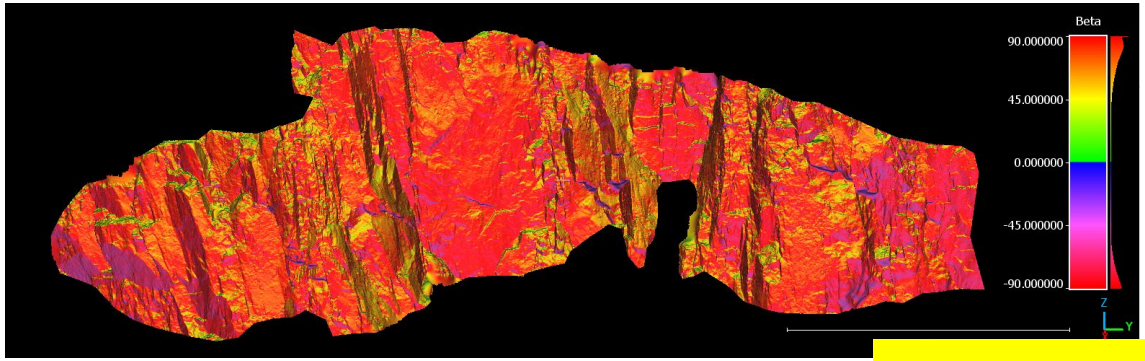
Mobile Unit

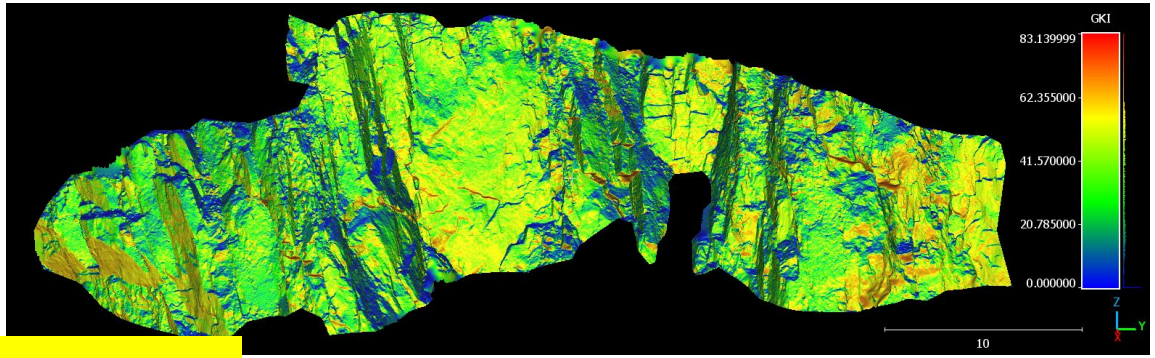
Doppler Radar

7.6 Training and experimental campaigns



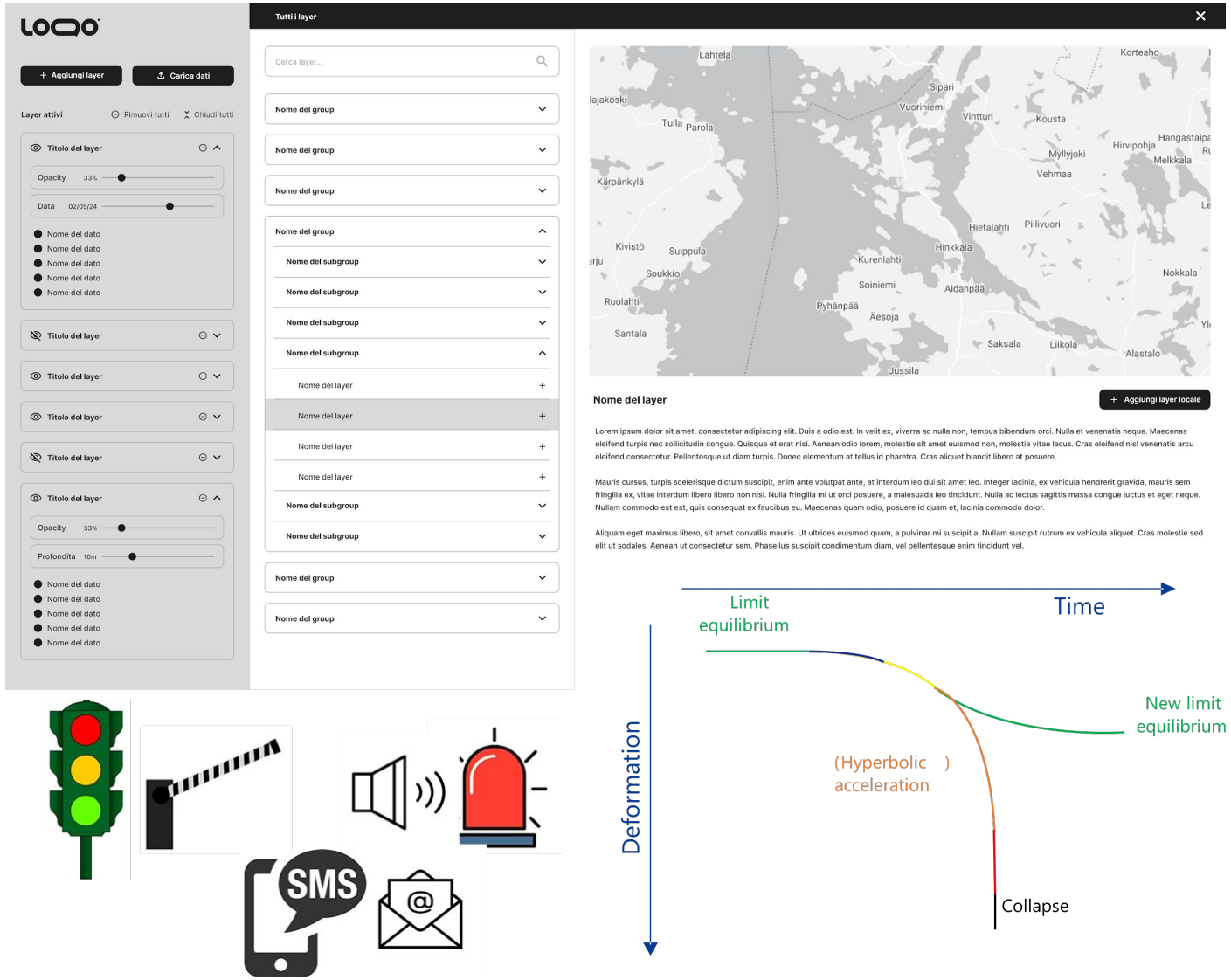






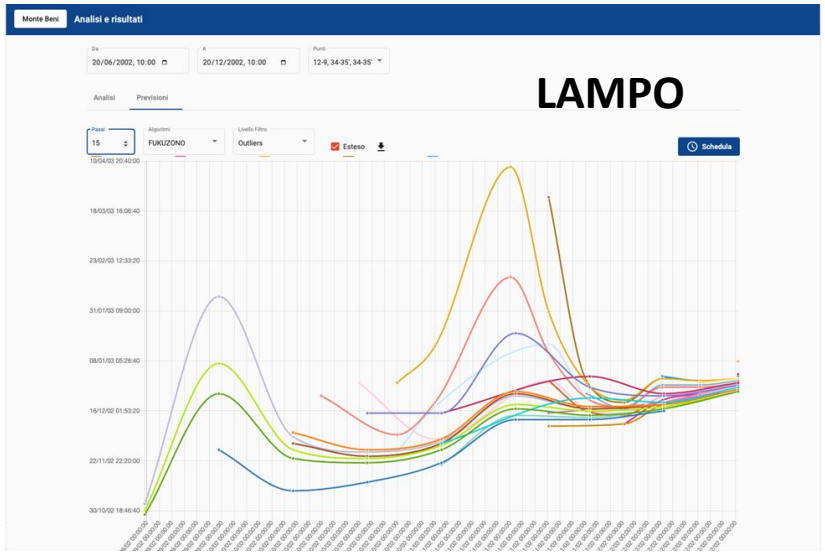
POSTER - Sessione 8
Codice 108, Schermo 11

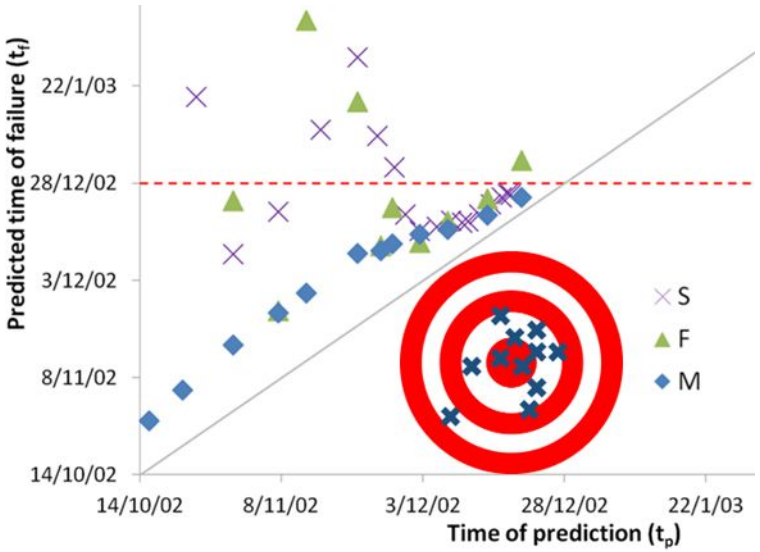
7.6 Data Sharing and Early Warning Platform

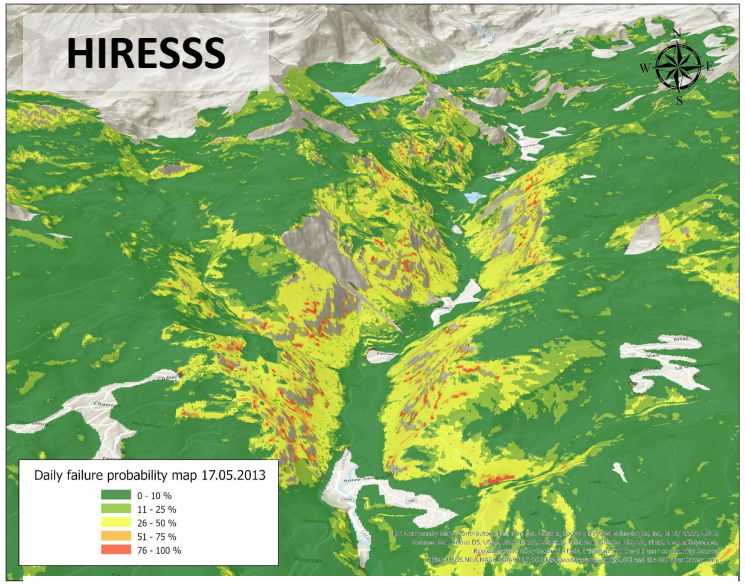


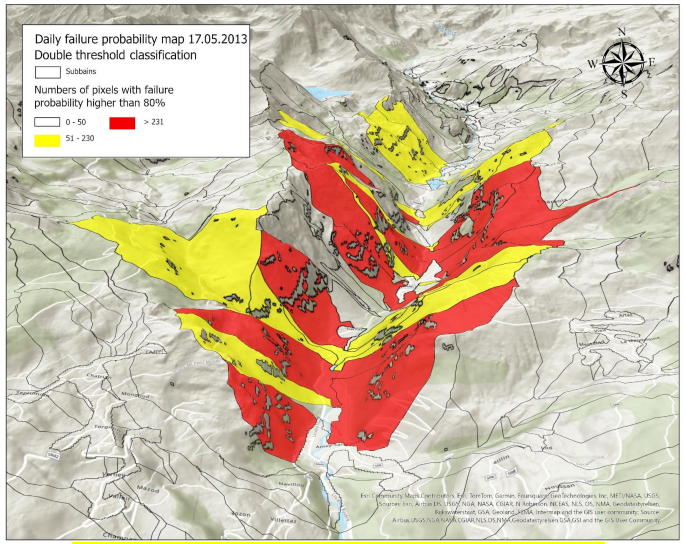
- Display and share planimetric and 3D data
- Real-time monitoring data
- Customised diagrams
- Dashboard for emergency management
- Tools for quickly defining risk scenarios
- Real-time forecasting algorithms
- Definition of alarm thresholds
- Threshold exceeding notifications

7.6 Forecasting Models







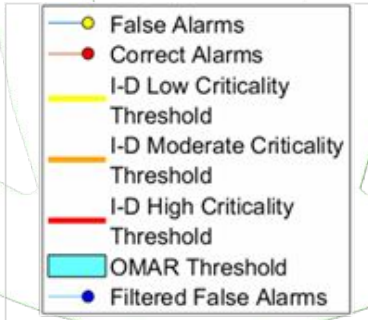


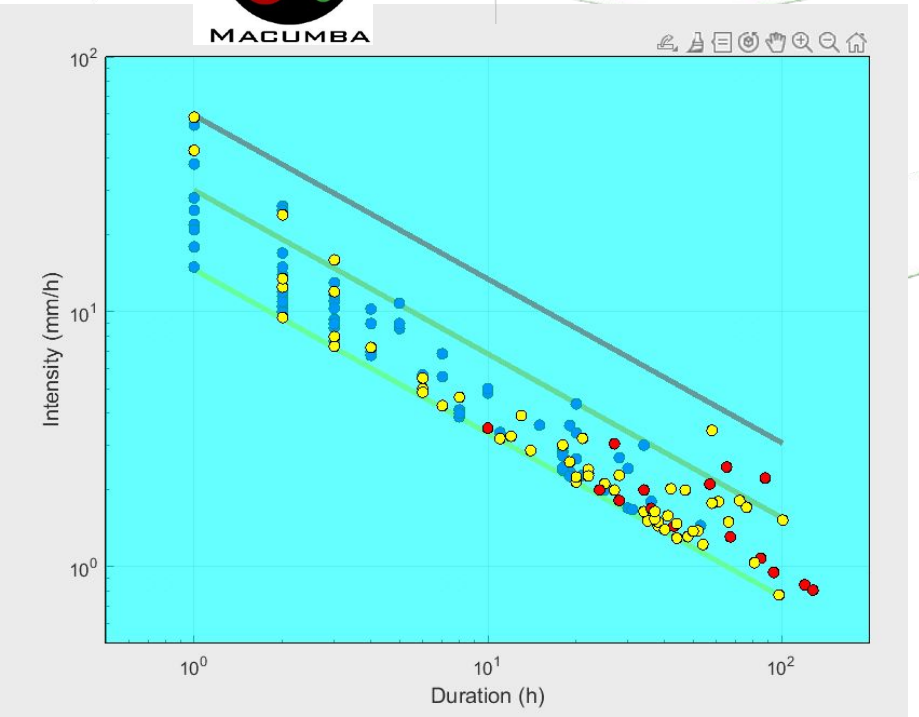
POSTER - Sessione 8
Codice 109, Schermo 12

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

ITINERIS

MACUMBA

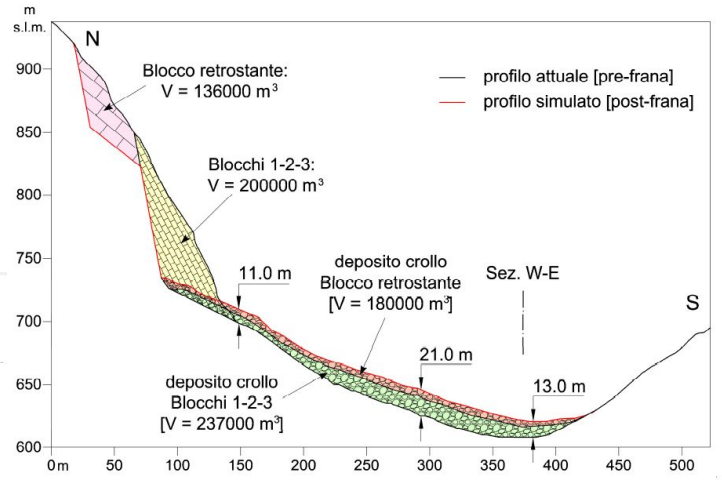




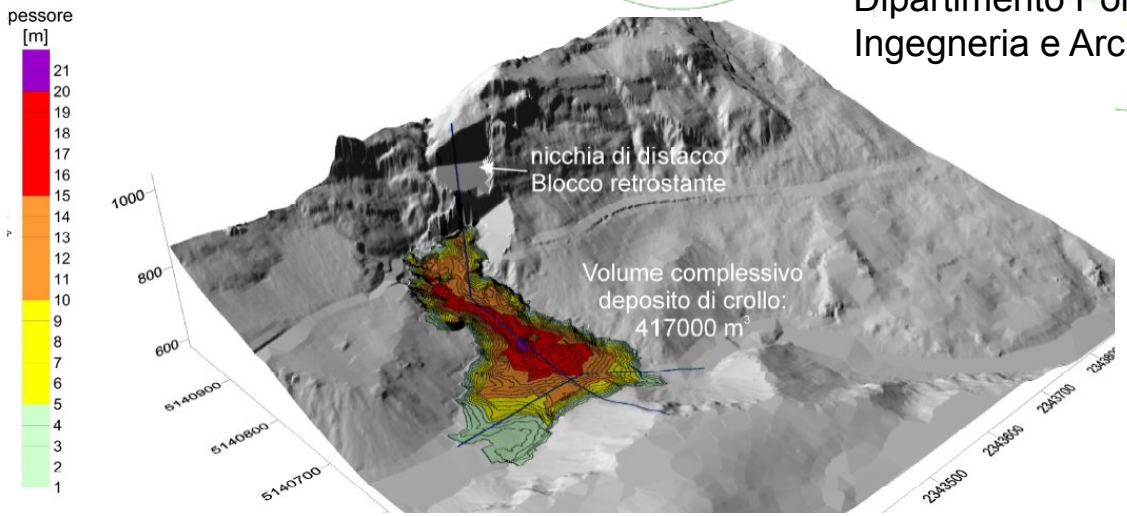
7.6 Selected Test Site

REGIONE AUTONOMA FRIULI VENEZIA GIULIA

ITINERIS



Università degli studi di Udine
Dipartimento Politecnico
Ingegneria e Architettura, 2018



THANKS!

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(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
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