

Increasing the number of landslide laboratories through photomonitoring solutions



SAPIENZA
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Friday, November 17th 14.30 - 16.00
PALAFFARI Basement HALL -1, Piazza Adua 1 Florence





WP3.1 Landslides → New Technologies for Landslide Monitoring



GEOSCIENCES IR

Un'Infrastruttura di Ricerca per la Rete Italiana dei Servizi Geologici

Progetto finanziato dal Piano Nazionale di Ripresa e Resilienza –
PNRR

Missione 4, "Istruzione e Ricerca" – Componente 2, "Dalla ricerca
all'impresa" – Linea di investimento 3.1, "Fondo per la realizzazione di
un sistema integrato di infrastrutture di ricerca e innovazione"



- Implementation of a Research Infrastructure for Earth Sciences
- Test of innovative technologies and integration of available inventories
- Enhance the exchange among Universities, ISPRA and Regional Geological Services

Task Photomonitoring



WP3

Landslides and Sinkholes

Research Goal: Support landslides monitoring activities through the testing and development of photomonitoring techniques.

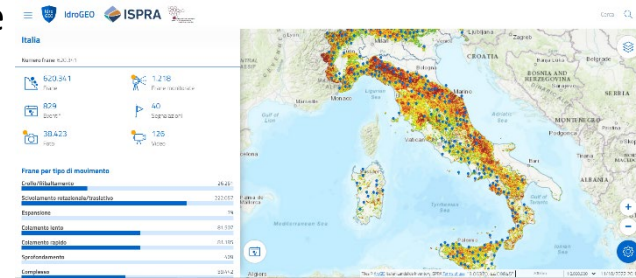
Specific Objectives

- Acquisitions/Installation of experimental stations on 15 sites in Italy;
- Test on different landslides mechanisms and styles;
- Application and improvement image processing techniques;



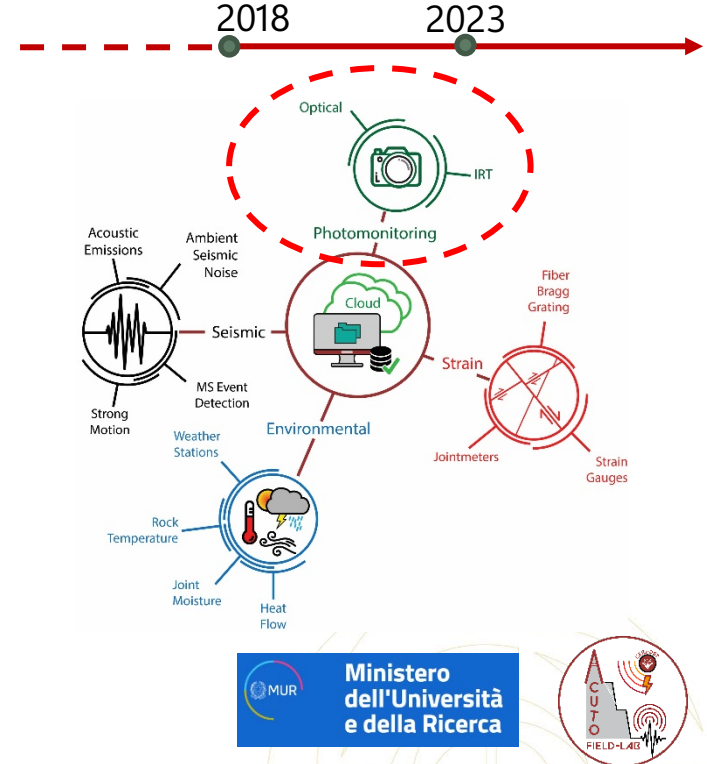
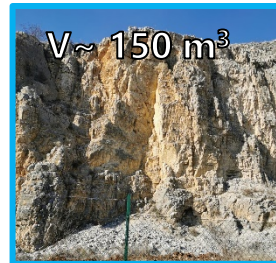
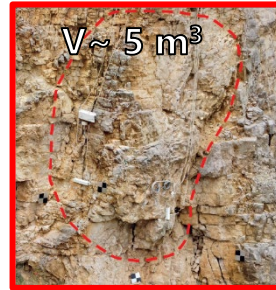
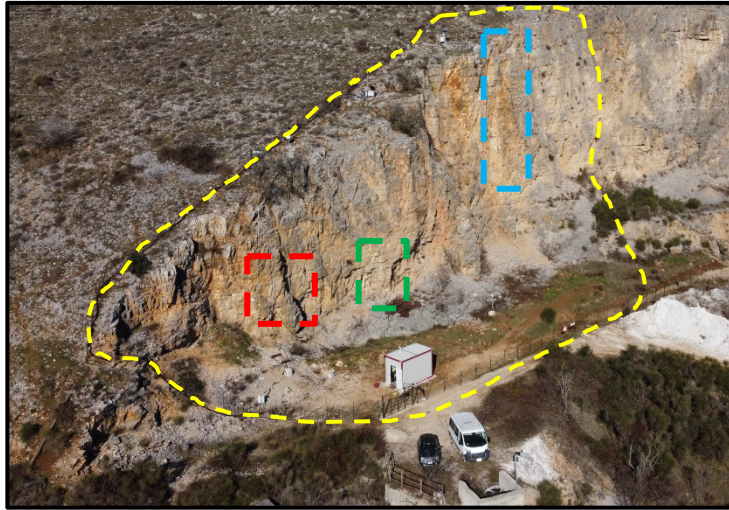
General Objectives

- Increase number of monitored landslide sites in the Italian territory (nowadays ab. 0.2%)
- Verify the efficiency and accuracy of the technique



Natural Field Laboratories: studying processes at their scale

❖ Acuto Field Laboratory



Natural Field Laboratories: studying processes at their scale



❖ Poggio Baldi Landslide

- Remote monitoring of rockfalls;
- Multisensor approach (active and passive);
- Multifrequency (Visible, IR, Microwaves)



| Monitoring time | Volume accumulated [m ³] | Volume loss [m ³] |
|-----------------|--------------------------------------|-------------------------------|
| 2015–2016 | 4475.8 | 2807.5 |
| 2016–2017 | 2985.6 | 2024.7 |
| 2017–2018 | 2809.9 | 2146.6 |

Natural Field Laboratories: studying processes at their scale



- Spreading of optical sensors → Boosting of natural field laboratories (*at least 15*);



- Integration of optical quantitative analysis with other technologies in monitoring sites managed by regional services.



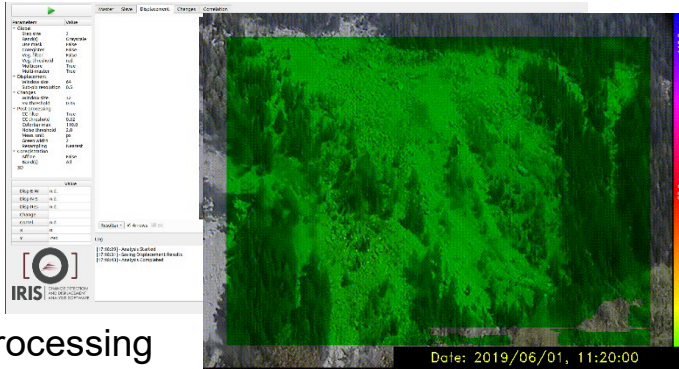
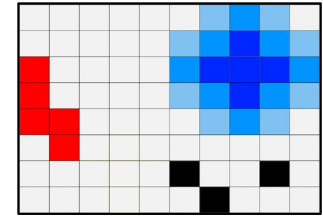
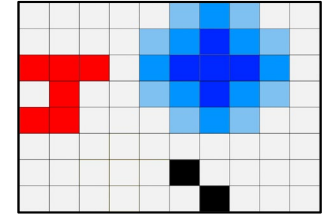
Digital Image Processing: i.e. the *Photomonitoring*

Change detection (CD)

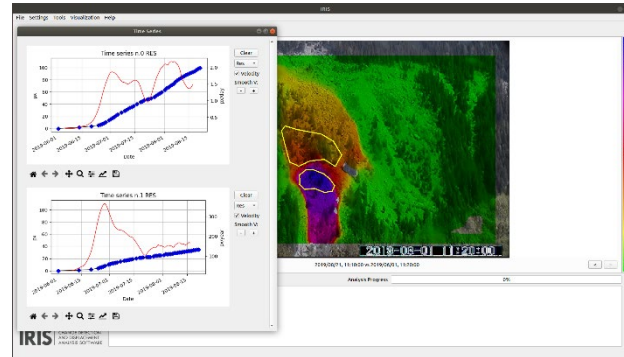
Identification of changes, elements and objects that appear and disappear

Displacement analysis (DIC)

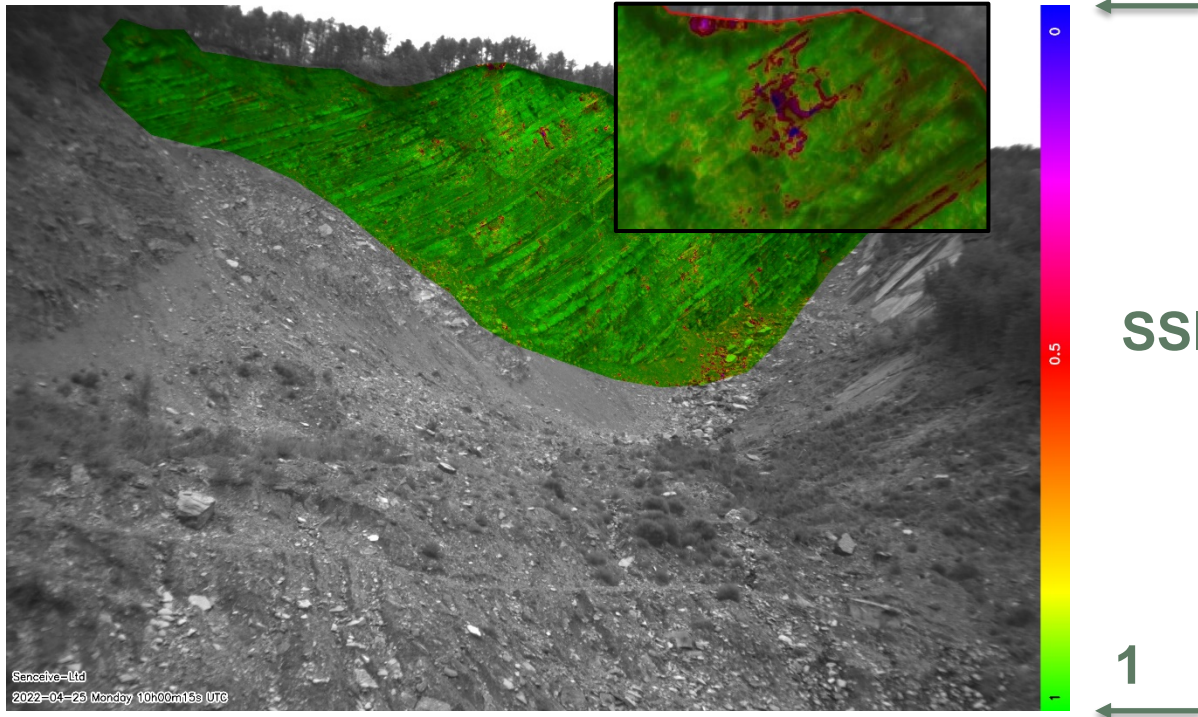
Identification and monitoring of translation, rotation or displacement of image features (variable geometric and temporal resolutions)



DIC processing
(webcam *Ruinon, SO*)



Expected Results: Change Detection



Master image

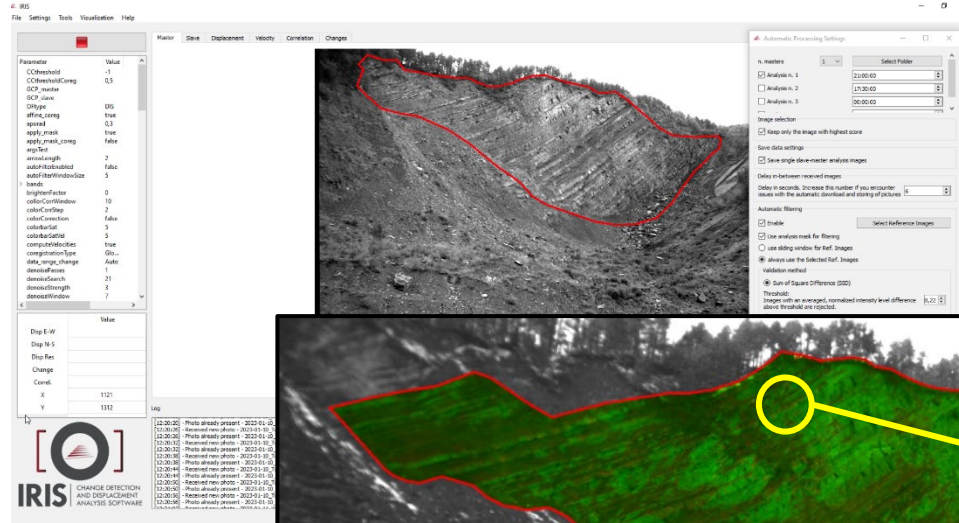


Slave image



CD Analysis 18-19/12/2022

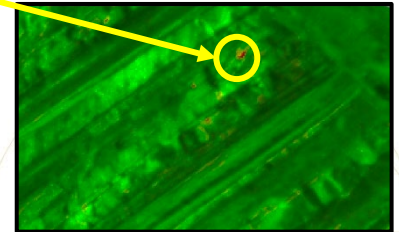
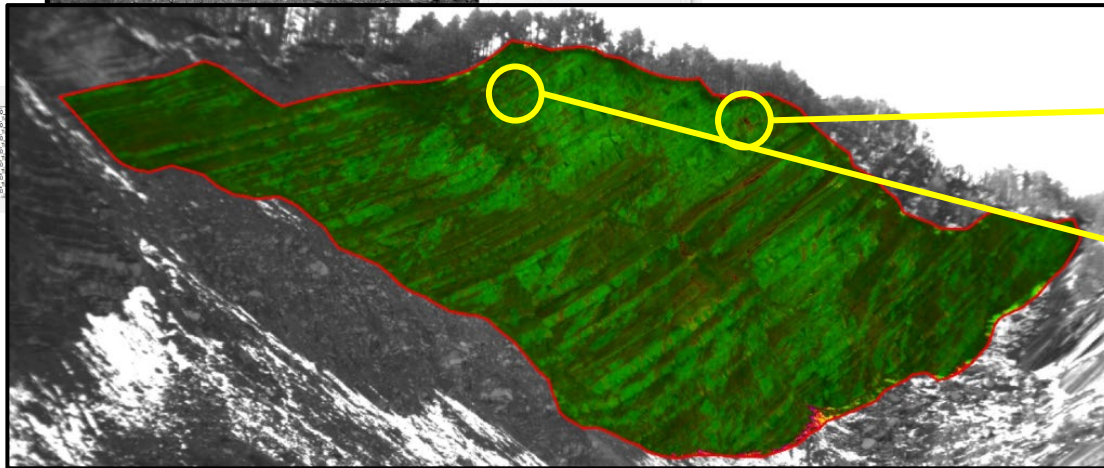
Expected Results: Automatic CD analysis



The screenshot displays the IRIS software interface. On the left, a parameter list is visible with values for various settings. The main window shows a grayscale image of a landslide area with a red outline. A 'Automatic Processing Settings' dialog box is open, showing options for analysis parameters and filters. The 'Automatic Processing Settings' dialog includes the following options:

- n masters: 1
- Analysis n. 1: 21:00:00
- Analysis n. 2: 17:30:00
- Analysis n. 3: 00:00:00
- Image selection: keep only the image with highest score
- Save data settings
- Save single slave-master analysis images
- Delay in between received images
- Delay in seconds. Increase this number if you encounter issues with the automatic download and saving of pictures: 10
- Automatic filtering: enable
- Use analysis mask for filtering
- Use sliding window for ref. images
- Always use the detected surf. images
- Validation method: Sum of Square Difference (SSD)
- Threshold: (largest with an average), normalized intensity level difference about threshold and cropped: 0.22

At the bottom left, the IRIS logo and text are visible: "IRIS CHANGE DETECTION AND DISPLACEMENT ANALYSIS SOFTWARE".



Photomonitoring solutions

- 1) Monitoring with installation of ad-hoc cameras (MR, HR, thermal cameras);
- 2) Periodic monitoring by air or drone or with Gigapan surveys
- 3) Monitoring through images collected by existing webcams
- 4) Collaborative monitoring (smartphone and tablet supports and automatic repositioning systems)

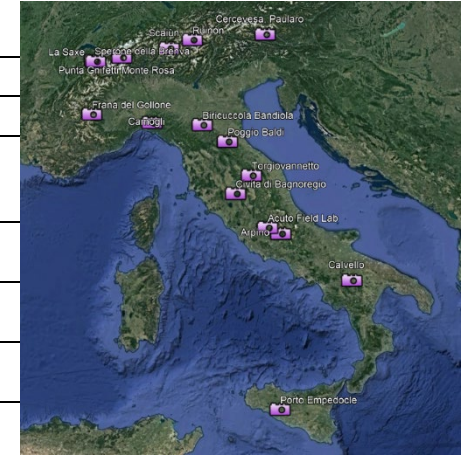


Selected Pilot Sites



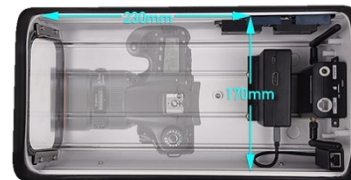
B

| Site | Area, Municipality | Acquisition Platforms | | | | | |
|----------------------------|------------------------------|-----------------------|----------------|--------|----------------|------------------|----------------|
| | | Optical Camera | Thermal Camera | Drones | Gigapixel Cams | Existing Cameras | Mobile Devices |
| Scaiu'n | ValMàsino (Valtellina, SO) | X | | | | | |
| Acuto | Frosinone (FR) | X | X | | | | |
| Poggio Baldi | Santa Sofia (FC) | X | | | X | | |
| Frana Biricuccola/Bandiola | F. Panaro (MO) | X | | | | | |
| Frana Mont de La Saxe | Courmayeur (AO) | | | | | X | |
| Sperone della Brenva | Monte Bianco (AO) | | | | | X | |
| Frana del Gollone | Acceglio (CN) | X | | | X | | |
| Falesia del Castellaro | Camogli (GE) | | | X | | | |
| Punta Gnifetti | Monte Rosa (VB) | | | | X | | |
| Arpino | Frosinone (FR) | | | X | | | X |
| Cercevesa | Paularo, Alpi Carniche, (UD) | X | | X | | | |
| Civita - Lubriano | Bagnoregio (VT) | | | | | | X |
| Torgiovanetto | Assisi (PG) | X | | | | | |
| Ruinon | Valfurva (SO) | | | | | X | |
| Porto Empedocle | Agrigento (AG) | | | | X | | |
| Calvello | Calvello (PZ) | X | | | | | |



Selected Cameras

- Optical cameras (Day and Night);
- Multi-focal cameras;
- DSLR time-lapse camera system
- Gigapan Robotic heads



Operative phases:



Sites: 17

Design: 100%

Purchases: 100%

Survey: 76%

Installation/Acquisition: 35%

First Elaboration: 12%

Processing: 0%

| Site | Area, Municipality | Operative Phases | | | | | |
|------------------------|--------------------|------------------|--------|--------------|-------------|-------------------|------------------|
| | | Design | Survey | Installation | Acquisition | First Elaboration | Image Processing |
| Scaiu'n | Valmàsino (SO) | V | - | - | - | - | - |
| Acuto | Frosinone (FR) | V | V | - | - | - | - |
| Poggio Baldi | Santa Sofia (FC) | V | V | - | V | | |
| Biricuccola | F. Panaro (MO) | V | - | - | - | - | - |
| Mont de La Saxe | Courmayeur (AO) | V | X | X | V | - | - |
| Sperone della Brenva | Monte Bianco (AO) | V | X | X | V | - | - |
| Gollone | Acceglio (CN) | V | V | - | | | |
| Falesia del Castellaro | Camogli (GE) | V | V | X | V | - | - |
| Circo Belvedere | Monte Rosa (VB) | V | V | X | V | V | - |
| Arpino | Frosinone (FR) | V | V | X | - | - | - |
| Ventotene | Ventotene (LT) | V | V | X | V | V | - |
| Cercevesa | Paularo (UD) | V | V | - | - | - | - |
| Civita - Lubriano | Bagnoregio (VT) | V | - | X | - | - | - |
| Torgiovanetto | Assisi (PG) | V | V | - | - | - | - |
| Ruinon | Valfurva (SO) | V | X | X | - | - | - |
| Porto Empedocle | Agrigento (AG) | V | V | X | - | - | - |
| Calvello | Calvello (PZ) | V | - | - | - | - | - |

V: done; -:pending; X:not foreseen

UAV Acquisitions



- **Camogli (GE), Falesia del Castellaro**



- Seasonal drone flights
- Post-wavestorm acquisitions
- Orthophotos extraction
- CD Analysis

UAV Acquisitions

- **Ventotene (LT),
Punta Eolo e Villa di Giulia**



Gigapan Surveys

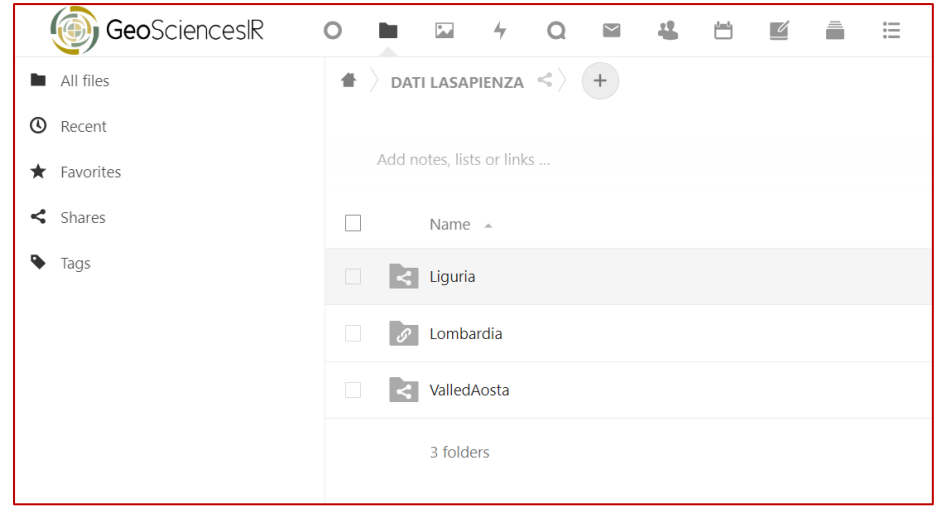
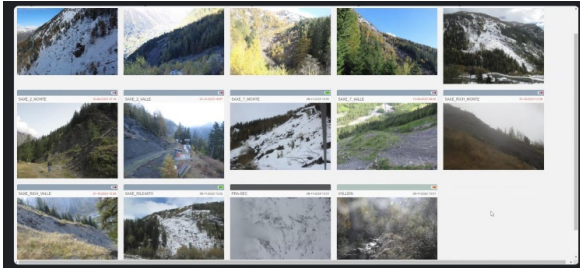
- Wall and cirque: 1512 ph. - 13.5 Gb
- Moraine 546 ph. - 7.39 Gb

- **Monte Rosa e Ghiacciaio Belvedere (27/09/2023)**



Existing WebCAMs

- **Ruinon (SO), La Saxe e Brenva (AO)**
500GB over more than 10 years



1TB Cloud Storage on ISPRA IaaS



Thanks to P. Thuegaz and A. Bertolo

Thanks for your attention!

<https://geosciences-ir.it>

