GeoSciencesIR

GeoSciences IR @ 6th World Landslide Forum
New technologies for landslide monitoring and mapping

Update landslide inventories by addressing related criticalities

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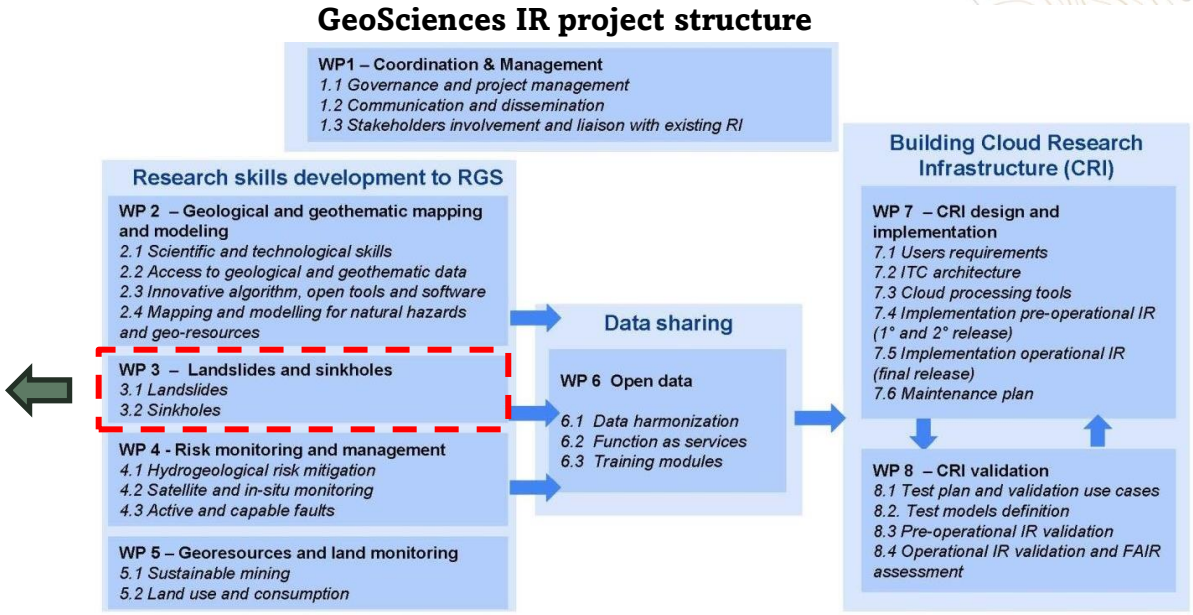
INTRODUCTION

New technologies, facilities, data and services for the research communities to conduct research, foster innovation and achieve scientific excellence in the field of landslides and sinkholes to support policies and actions of risk reduction.



Activity 3.1 Landslides

The IdroGEO open-access national web platform of the Italian Landslide Inventory – IFFI (https://idrogeo.isprambiente.it) will be enhanced with new tools and services for researchers and technicians of the Regional Geological Surveys (RGSs) to support landslide mapping.

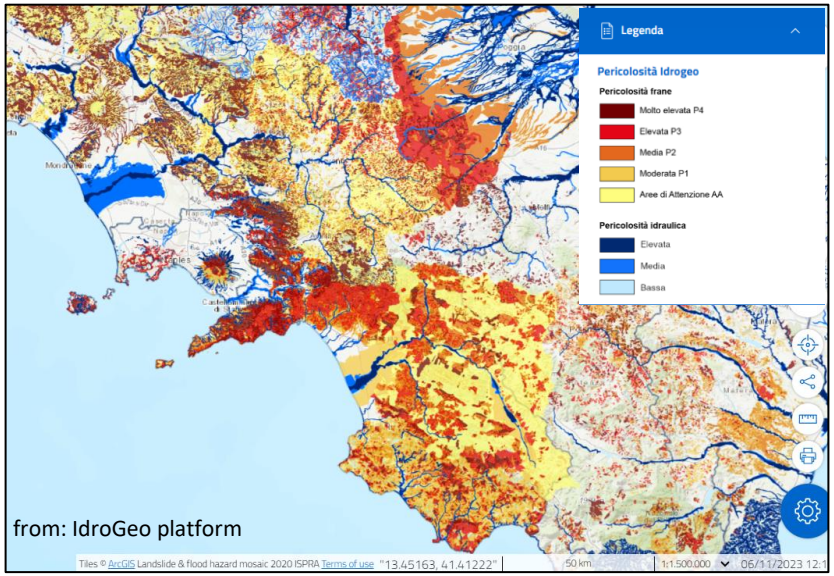
(…)

The IdroGEO platform will guarantee over time data and interoperable mapping services on landslides, according to FAIR data principles, for the GeoSciences IR. The review, upgrading/updating in terms of quality, resolution, and completeness of **landslide inventories in Campania**, Sicily and Sardinia region (Southern Italy) will be implemented in the IdroGEO platform.

INVENTORY UPDATING

As for the Piemonte (SIFRAP - webgis.arpa.piemonte.it/Geoviewer2D) and Emilia Romagna regions (ambiente.regione.emilia-romagna.it/), also for the Campania region an attempt to homogenize the existing landslide records derived from multiple sources has been implemented in a unique regional landslide inventory.

The Campania region is one of the Italian regions with the highest percentage of area that is prone to landslides (approximately 60%) and with the highest number of people exposed to landslide hazards (~302.783; Trigila et al., 2018). Despite this, a unique public and homogeneous landslide inventory covering the entire Campanian territory is not available.



WORKFLOW

Data acquisition

- Southern Apennine Hydrological District (SAHD)
- Italian Landslide Inventory (IFFI)
- Published articles and reports.

Records processing

- Structure of available inventories including records type, landslide classifications and details, were analyzed before merging
- Checking records details after merging
- Processing of records for possible overlaying or errors

Implementing of the new inventory

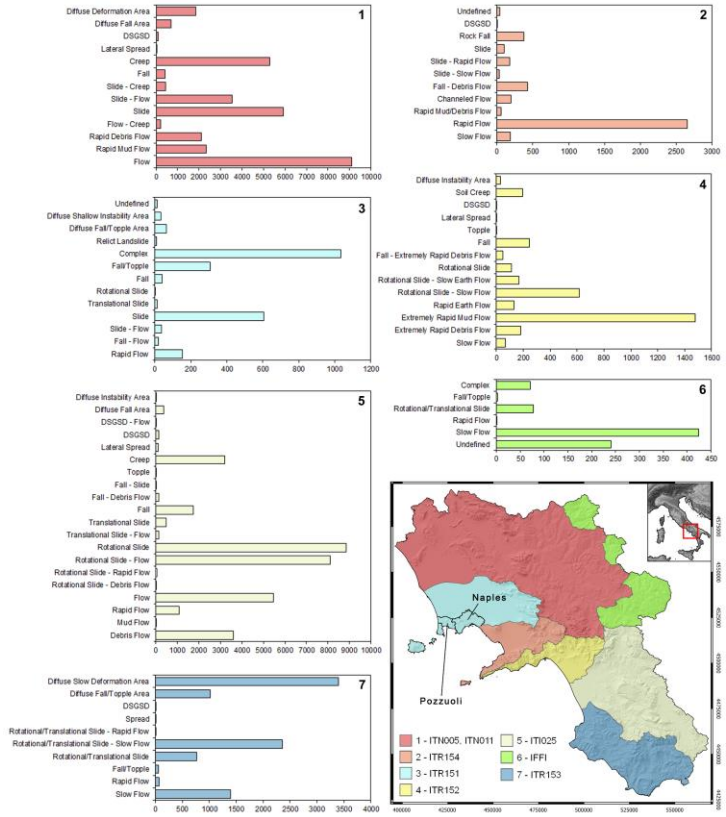
- Defining of a unique format for the new inventory structure
- Processing of terminology and codes
- Reclassifying of several landslides
- Implementing of landslide details

DATA SOURCES

- **Southern Apennine Hydrological District** (SAHD) landslide inventories by the seven former **Unit of Managements** (UoMs) covering 92% of the Campania region;
- **IFFI inventory** was considered for the remaining areas of the Campania territory (8%), where no records from SAHD inventories were available;
- **Technical reports and published scientific articles** (i.e.; a very small areas of the Campania region within the UoM ITR151 administrative boundary).

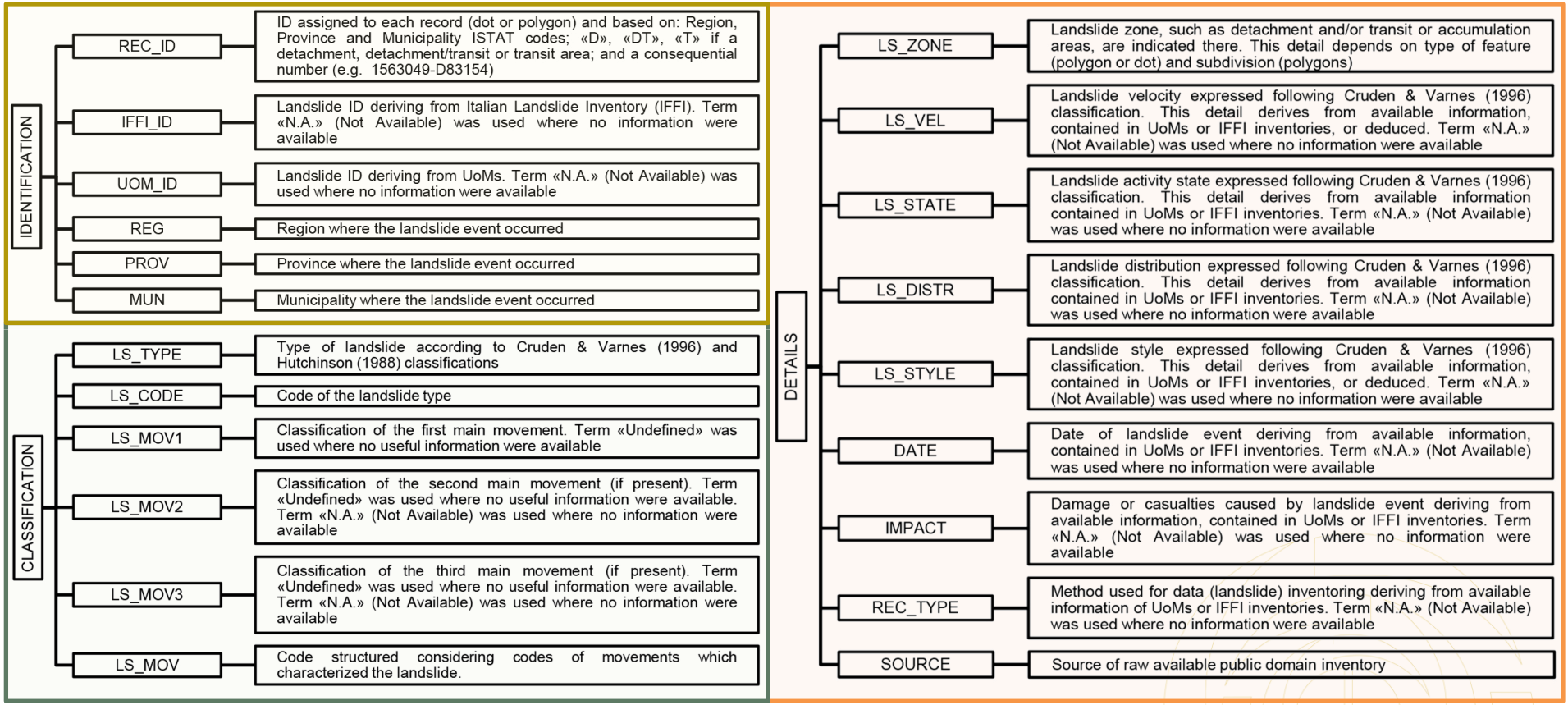
All the considered geodatabases were recognized as having different structures for landslide feature types and details and considering differentiated classification criteria: (1) landslide classification; (2) type and quantity of details considered for the landslide event; and (3) possibility to specify the detachment/source, transit, and accumulation landslide areas.

	Classification		Details			Zoning		
Inventory ID	Single	Mixed	Low	Medium	High	Low	Medium	High
ITN05-11		×	×					×
ITR151	×			×		×		
ITR154	×		×				×	
ITR152		×			×	×		
ITR153		×		×				×
ITI025	×				×	×		
IFFI		×	×			×		
Publ. data	×			×			×	



1 - UoM Volturno (ITN011); 1 - UoM Liri-Garigliano (ITN005); 2 - UoM Sarno (ITR154); 3 - UoM Campania Nord Occidentale (ITR151); 4 - UoM Destra Sele (ITR152); 5 - UoM Interregionale Sele (ITI025); 6 – IFFI; 7 - UoM Sinistra Sele (ITR153). Records from ITN005 and ITN011 are dated to 2011 and mapped at a scale of 1:25,000, while all the other records are dated to 2016, with a scale of 1:5,000.

THE STRUCTURE OF THE GEODATABASE



COVERAGE AND REPRESENTATIVENESS

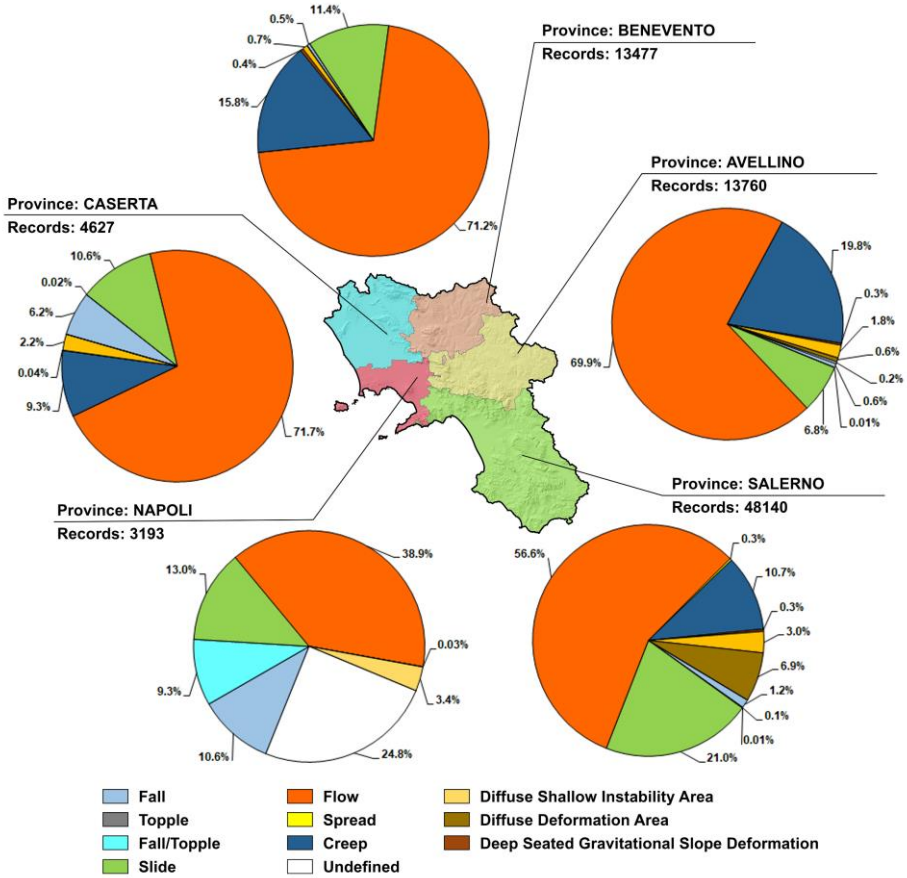
- 51.155 landslides for the whole Campania region (~23.500 from IFFI):
  - 3,4 events/km^2 (1,7 from IFFI project);
  - involved area of ≈141.911 ha (96.806 ha from IFFI);
  - 160 municipalities (35% of total) affected when considering the new geodatabase (296, 65% of total, from IFFI);
  - ≈1% detachment, ≈42% detachment/transit, and 57% transit/accumulation, were indicated.

The geodatabase includes also a number of landslides not comprised in the SAHD and IFFI inventories because more recent.

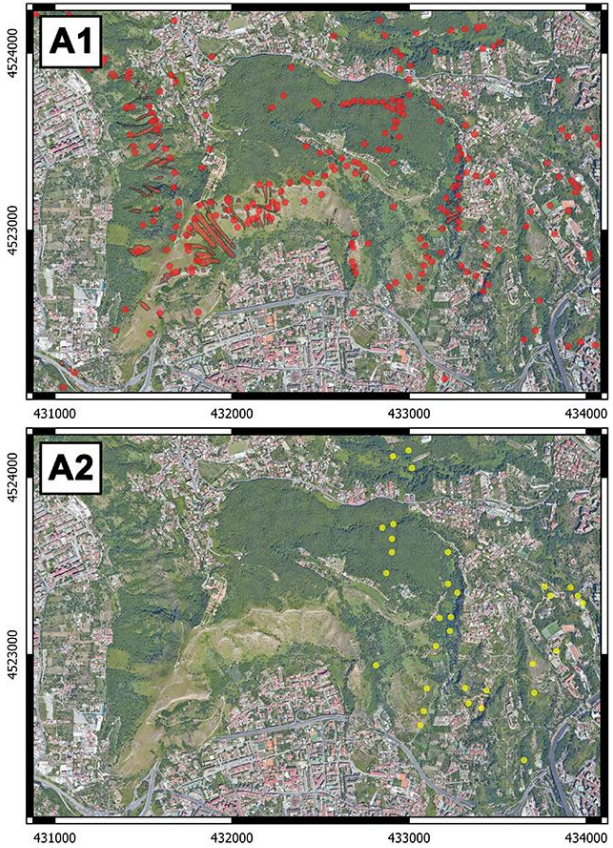
CAMPANIA REGION

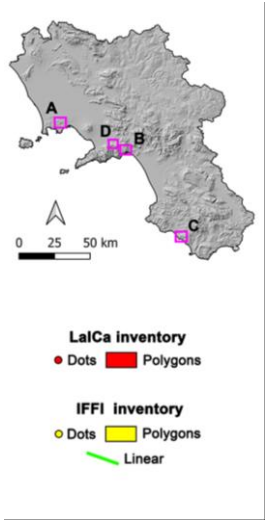
Class type	D - D/T (n°)	T (n°)	D - D/T (%)	T (%)
Fall	1017	329	1.22%	0.39%
Topple	3	-	0.004%	-
Fall/Topple	347	-	0.42%	-
Slide	7366	6130	8.84%	7.35%
Flow	28609	22458	34.32%	26.94%
Spread	123	6	0.15%	0.01%
Creep	7821	2597	9.38%	3.12%
Undefined	827	-	0.99%	-
Deep Seated Gravit. Slope Def.	115	132	0.14%	0.16%
Diffuse Shallow Instability Area	1530	559	1.84%	0.67%
Diffuse Deformation Area	3397	1	4.07%	0.001%
Total	**51155**	**32212**	**61%**	**39%**

D) detachment; D/T) detachment/transit; T) transit



ACCURACY EVALUATION (1) – Number of events





Landslides described in scientific publications and/or governmental reports were considered for **comparison** with those reported in the IFFI geodatabase.

The case of the Camaldoli Hill area (Municipality of Naples), shows a major accuracy and completeness in terms of number of inventoried records and geometric representation of records.

434 total records (32 for the IFFI geodatabase)

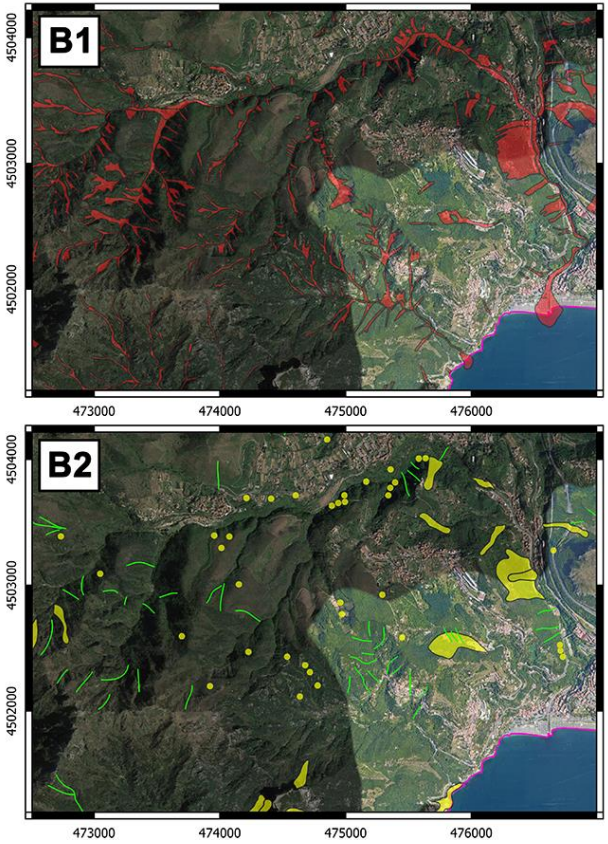
This significant change is due also to the occurrence of many landslides after 2006, which were considered in the updated inventory.

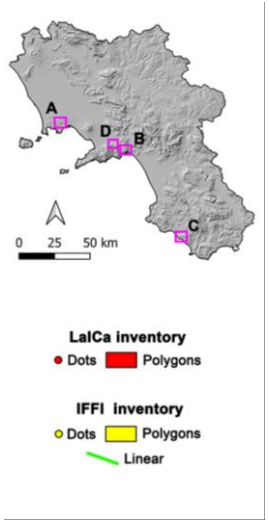
Carratù, M. T., Di Martire, D., Finicelli, G. F. & Calcaterra, D. Comparison of bivariate and multivariate analyses for landslide susceptibility mapping in the Phlegraean district: the case study of Camaldoli hill (Napoli, Italy). *Rend. Online Soc. Geol. It.* **35**, 50–53 (2015).

Finicelli, G. F., Confuorto, P., Carratù, M. T. & Martire, D. D. Multivariate Statistical approach vs. Deterministic physically based model for landslide susceptibility assessment. *Rend. Online Soc. Geol. It.* **41** https://doi.org/10.3301/ROL.2016.116 (2016).

Miele, P. *et al.* SAR data and field surveys combination to update rainfall-induced shallow landslide inventory. *Remote Sensing Applications: Society and Environment* **26**, 100755, https://doi.org/10.1016/j.rsase.2022.100755 (2022).

ACCURACY EVALUATION (2) – Geometric representation





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The case of landslides occurred in October 1954 in a sector of the Lattari Mts., including Cava de' Tirreni, Vietri and Cetara municipalities (Province of Salerno). Also in this case, there is a greater accuracy in terms of number of inventoried records.

230 total records (97 for the IFFI geodatabase)

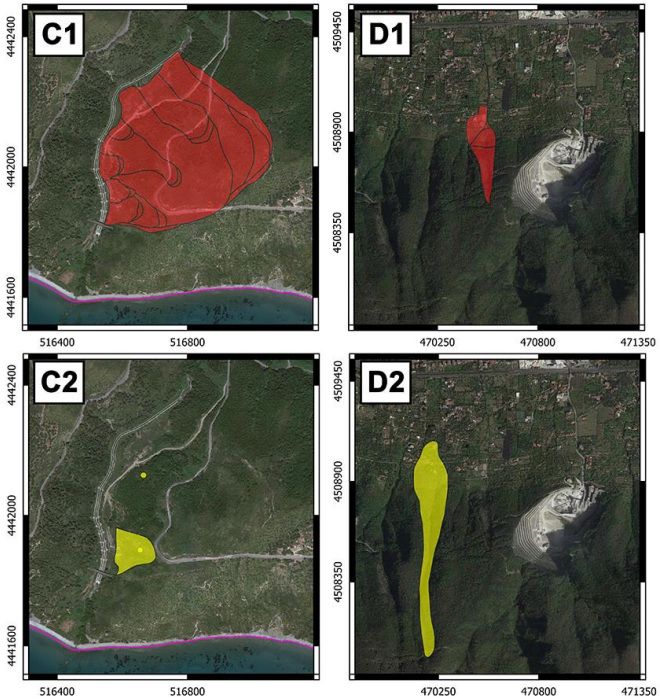
Moreover, landslides inventoried by the IFFI project were mainly represented by dots or lines instead of polygons. This aspect indicates the major accuracy of the updated inventory in estimating areas affected by landslides.

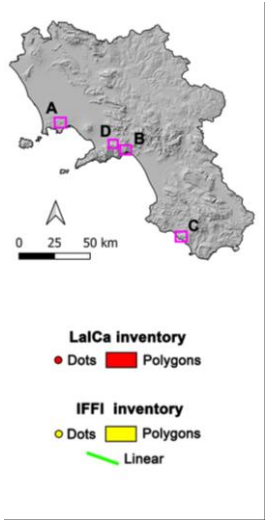
184 ha (25,5 ha for the IFFI geodatabase)

De Vita, P. & Smaldone, P. Spatial distribution and hydrological threshold of the October 1954 high magnitude debris flow event occurred in the Amalfi coast (southern Italy). Geophysical Research Abstracts 13, EGU2011–4402, 2011. EGU General Assembly (2011).

Fiorillo, F. et al. Inventory of Vietri-Maiori landslides induced by the storm of October 1954 (southern Italy). Journal of Maps 15, 530–537, https://doi.org/10.1080/17445647.2019.1626777 (2019).

ACCURACY EVALUATION (3) – Positioning and shape





Landslides described in scientific publications and/or governmental reports were considered for **comparison** with those reported in the IFFI geodatabase.

The cases of the Rizzico (C) and the Nocera Inferiore (D) landslides, both occurred in Salerno Province, demonstrate the accuracy of records in terms of the **positioning** and **shape** of geometries.

De Vita, P., Carratù, M. T., La Barbera, G. & Santoro, S. Kinematics and geological constraints of the slow-moving Pisciotta rock slide (southern Italy). Geomorphology. 201, 415–429, https://doi.org/10.1016/j.geomorph.2013.07.015 (2013).

Revellino, P. et al. Initiation and propagation of the 2005 debris avalanche at Nocera Inferiore (Southern Italy). Italian Journal of Geosciences. 132, 366–379, https://doi.org/10.3301/IJG.2013.02 (2013).

CONCLUSIONS

The revised landslide inventory developed for the Campania region results from processing of multiple existing landslide inventories, with the aim to:

1. provide a new geodatabase able to overcome issues derived from the coexistence of multiple inventories;
2. provide a methodological paradigm able to support the reorganization of existing official inventories.

Some technical limitations result from processing different preexisting landslide inventories, such as:

1. records gathered on different dates (2006 for IFFI, 2016 for UoMs and 2020 for scientific articles and reports);
2. inventory not homogeneously updated over the Campania region due to issues when merging several IFFI records which do not overlap SAHD ones (however, records were processed based on landslide classification and detailing, adopting a unique and uniform criterion);
3. no geometries (dots or polygons) modified in terms of extension, shape and/or positioning to preserve the integrity of raw records and replicability of the analyses (cases of errors in the geometric representation were inevitably accepted);
4. in the case of two events inventoried in the same location, the latest event prevails over the first one and the same landslide area is not counted twice (such as for deep-seated gravitational slope deformations or diffuse deformation areas);
5. lack of information affecting some fields of the landslide database.

Further elaborations will concern the implementation in the landslide inventory of landslides not belonging to the IFFI and Southern Apennine Hydrological District (SAHD) landslide inventories (≈1700 geometries identified), to be detected through field surveys.

Link to the paper by Fusco et al. (2023): https://doi.org/10.1038/s41597-023-02155-6

Thanks for the attention

https://geosciences-ir.it

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