

**ACTION 2020-2-21:
COPERNICUS
FOR CULTURAL HERITAGE**

IdroGEO and EGMS for Cultural Heritage

Carla Iadanza, Alessandro Trigila

ISPRA

13-16.06.2023

PARCO REGIONALE DELL'APPIA ANTICA
Ex Cartiera Latina - Via Appia Antica, 42

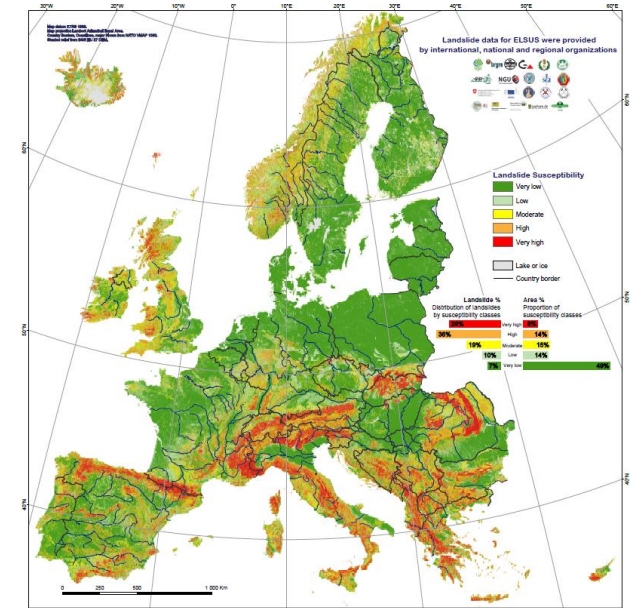
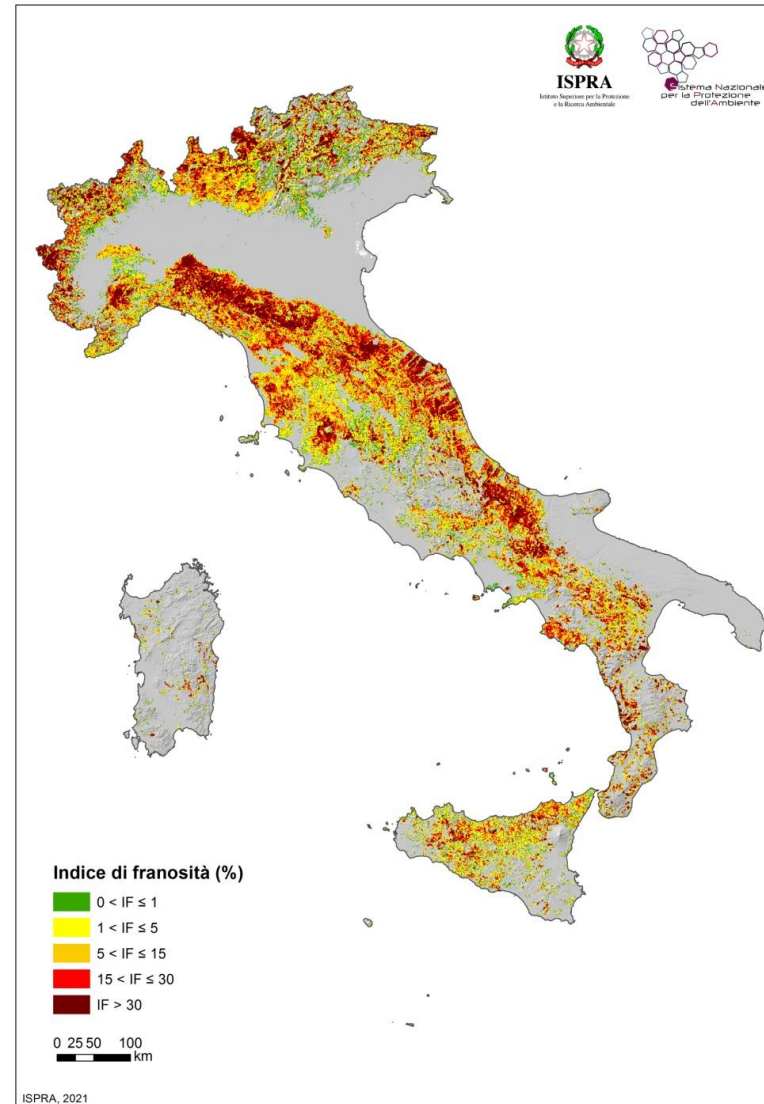
CONTENTS

- Italian Landslide Inventory
- National landslide hazard map and risk indicators
- IdroGEO web platform
- Satellite radar data for Cultural Heritage
- European Ground Motion Service – EGMS



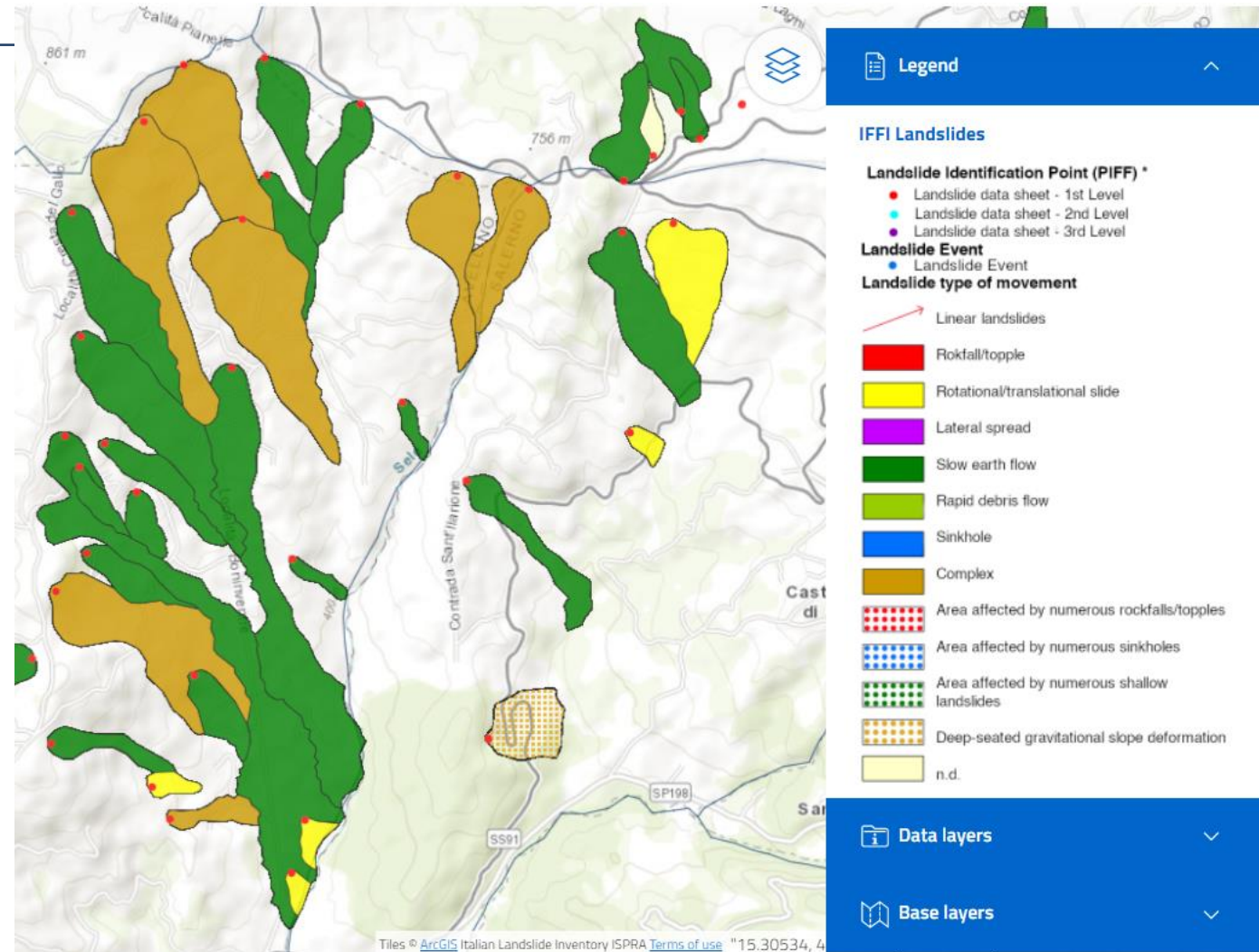
ITALIAN LANDSLIDE INVENTORY - IFFI

- **Over 621,000** landslides recorded in Italy
- **2/3** of the **900,000** European landslides
- Inventory carried out by ISPRA and by the Regions and Autonomous Provinces. **ISPRA** has the task of coordinating and controlling the activities, management of the national geo-database and web map application, data dissemination. **Regions and Autonomous Provinces** are in charge to collect and map landslides.

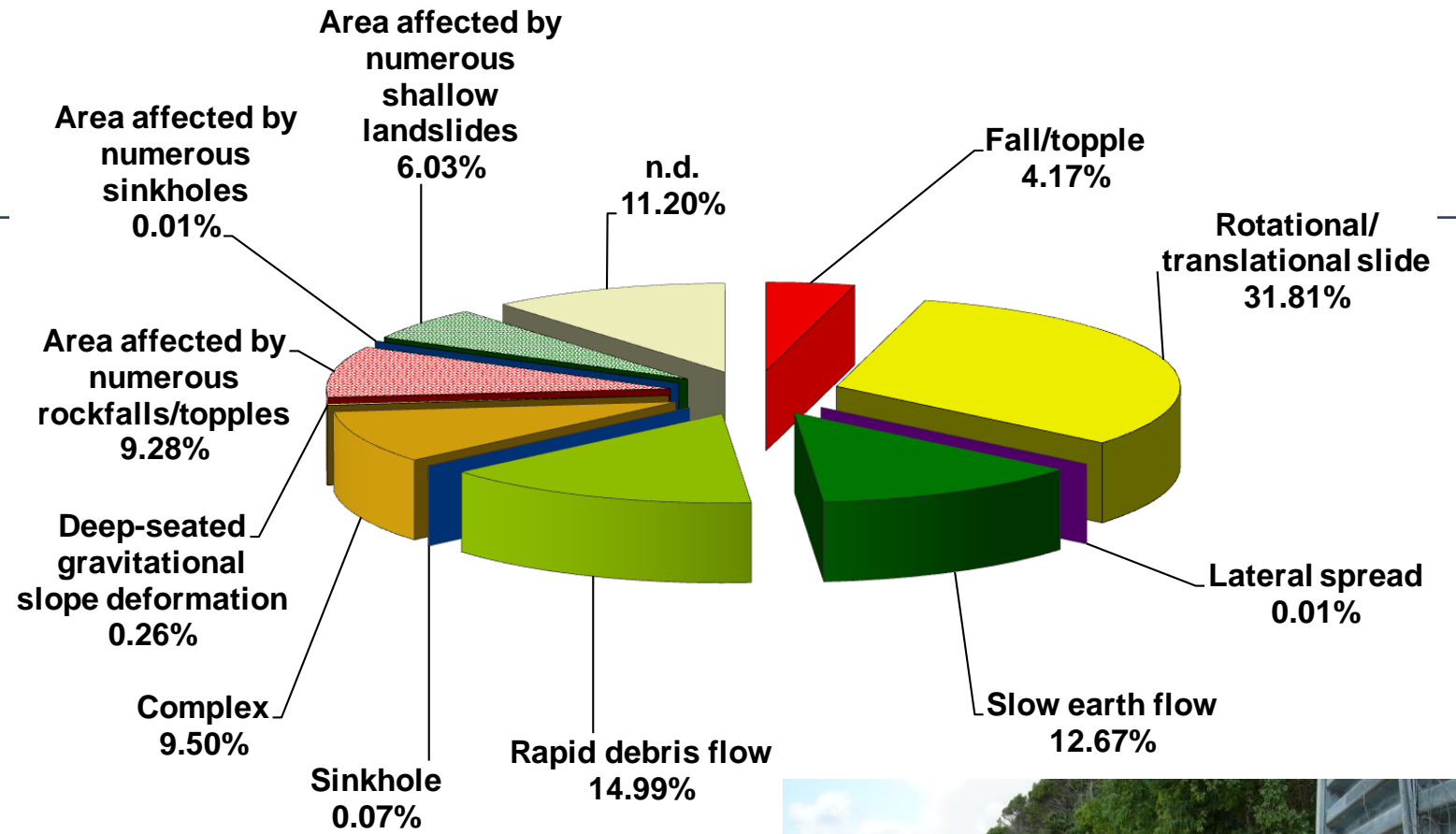


IFFI INVENTORY METHODOLOGY

- ✓ the **methodology** is based on the collection of historical documents and archive data, aerial photo-interpretation, field surveys;
- ✓ **IFFI landslides are represented by a point**, located at the highest point of the crown; a polygon or a line when the width is very narrow, as in the case of debris flows;
- ✓ information on each landslide has been collected using the **IFFI Landslide data sheet** (up to 144 fields: type of movement, state of activity, lithology, geotechnical properties, causes, investigations, date of occurrence or remedial measures for risk reduction, etc.).

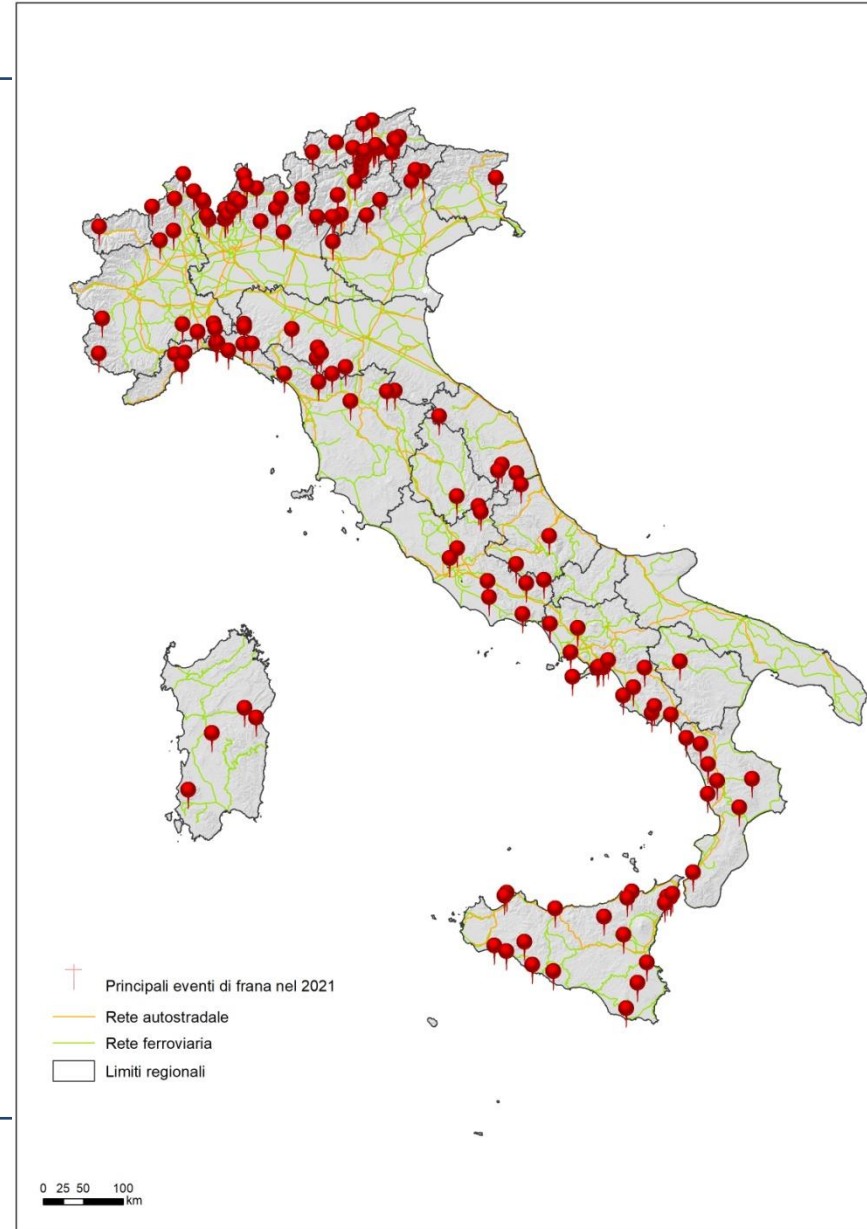


TYPE OF MOVEMENT



HOW MANY LANDSLIDES EVERY YEAR?

- Every year a few thousand of landslides occur on the national territory
- **a few hundred** cause deads, injured, evacuated people and damage to buildings, cultural heritage, and primary transportation infrastructures

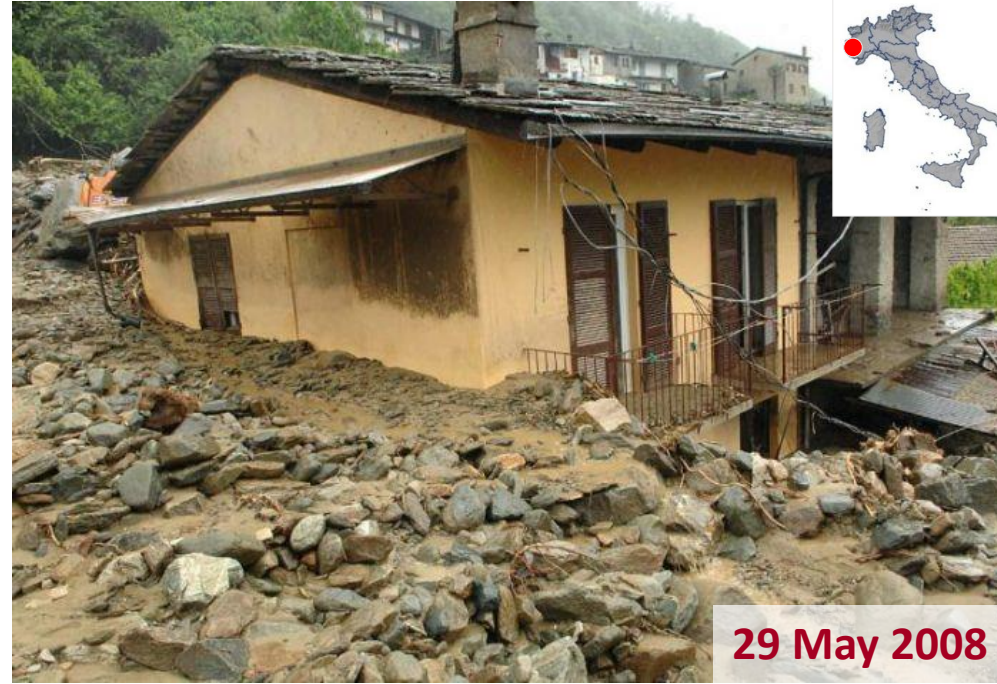


Pomarico (MT) - 29 gennaio 2019



*Autostrada Torino-Savona
Madonna del Monte (SV)
29 novembre 2019*

WHAT IS THE IMPORTANCE OF LANDSLIDE INVENTORY?



Villar Pellice (TO)

The IFFI Inventory is an **important base-knowledge tool** for:

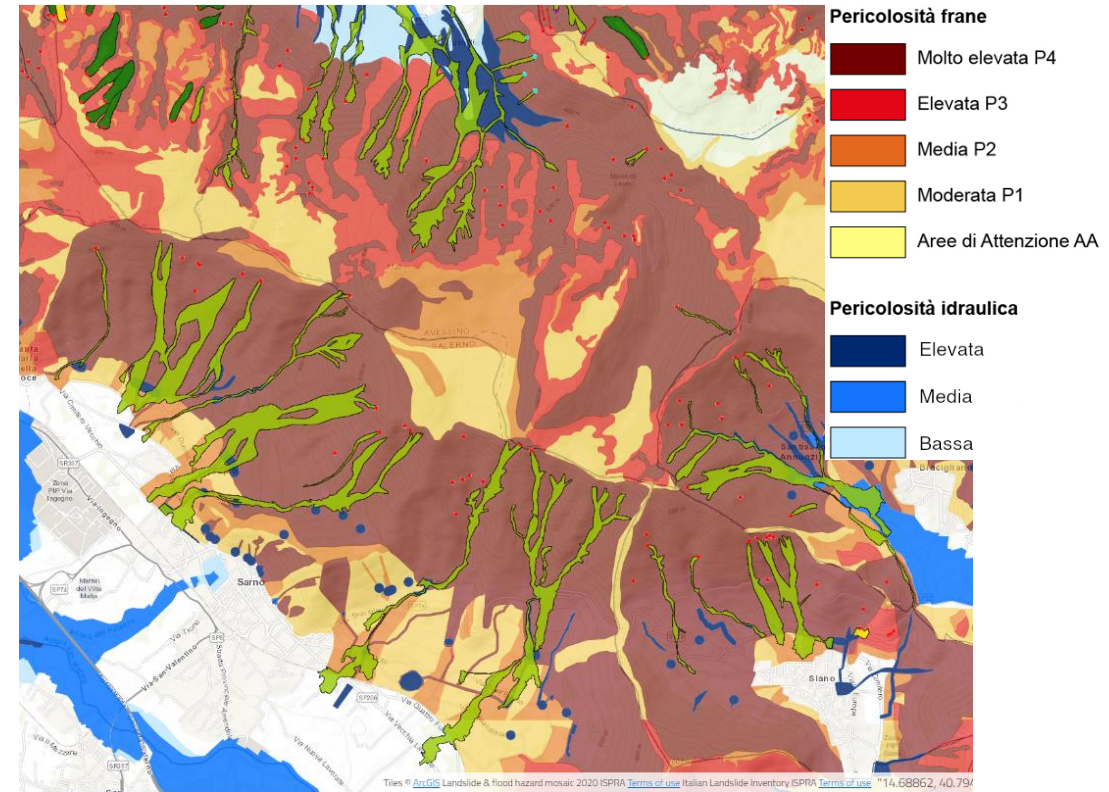
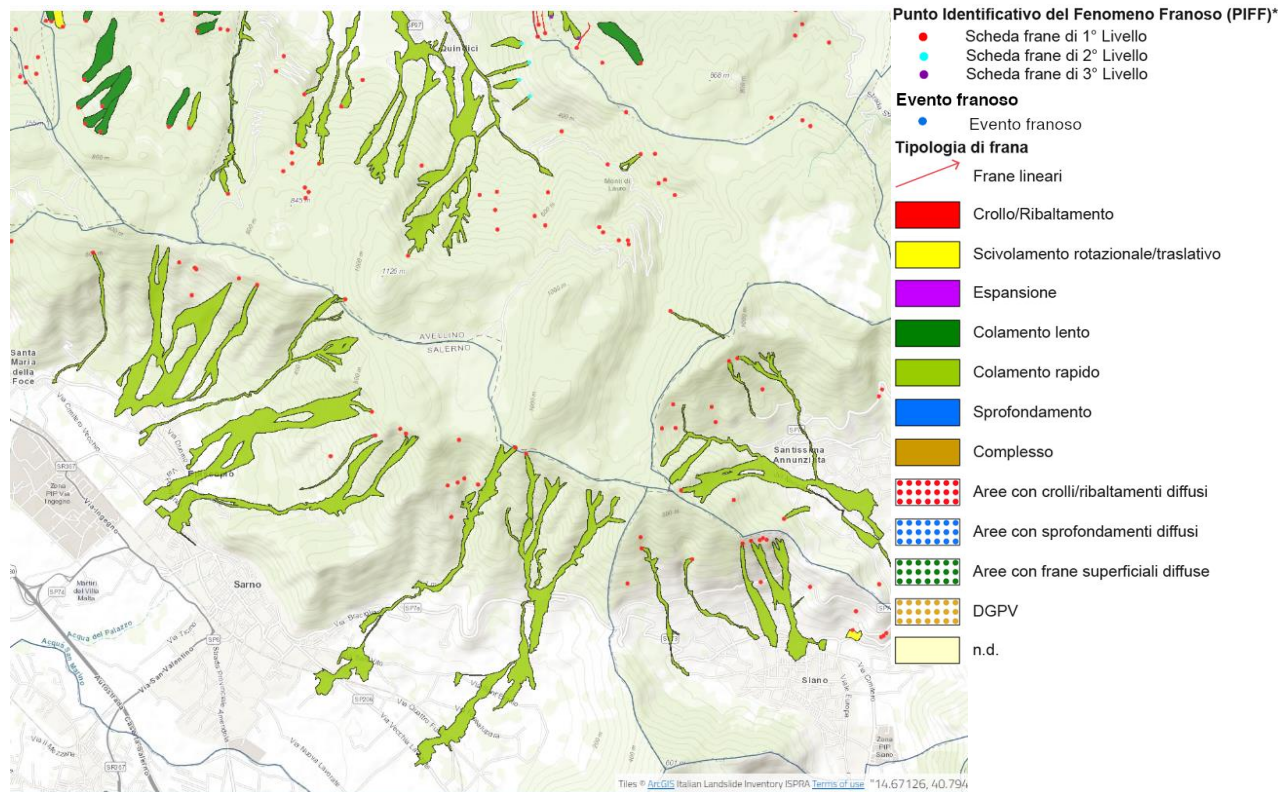
- land use planning (landslide hazard map of River Basin Plans - PAI);
- preliminary design of landslide mitigation works and infrastructures;
- management of Civil Protection Emergencies.

Knowledge of past landslides helps predict future risk:

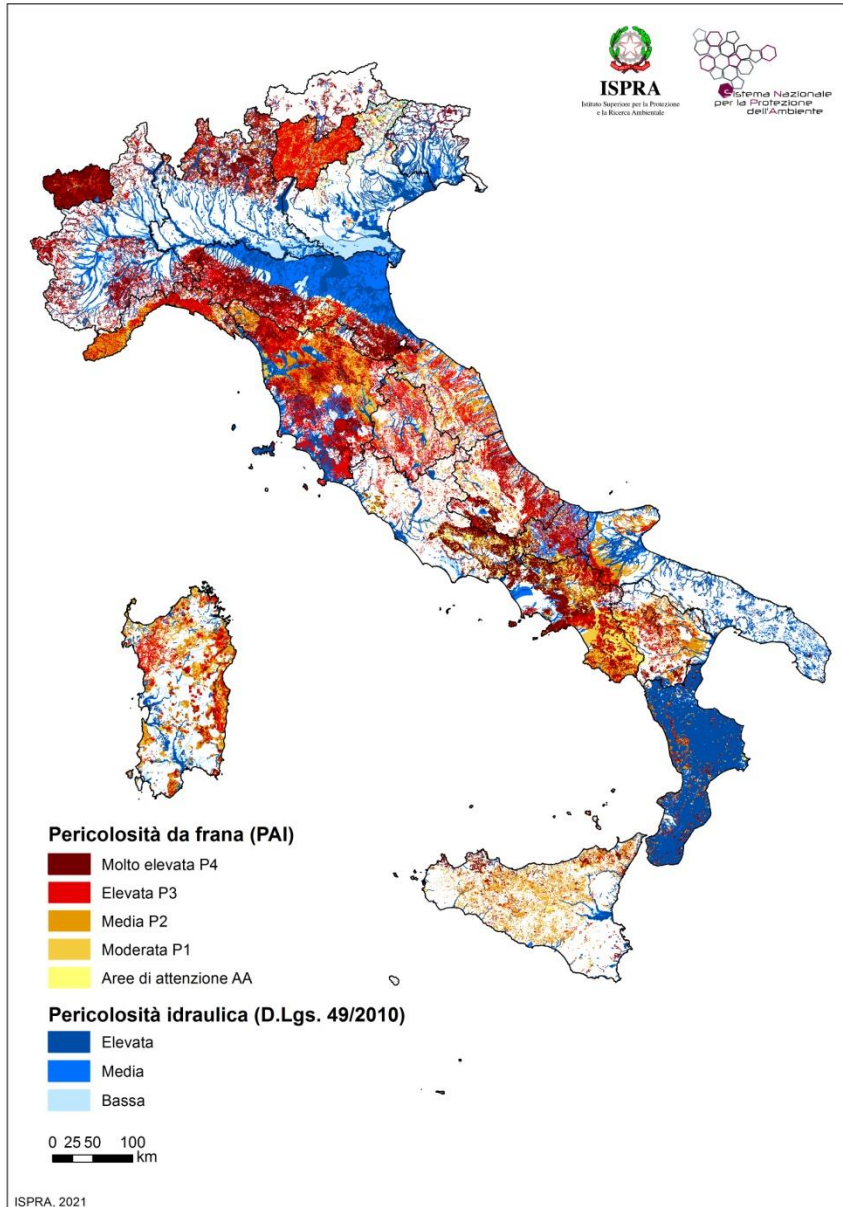
landslides are likely to occur in areas that have previously experienced a failure

FROM LANDSLIDE INVENTORY TO HAZARD ZONES

- ✓ realized by **River Basin Authorities** (now River Basin District Authorities);
- ✓ **landslide hazard zones** include areas of possible evolution of existing landslides and areas where new landslides potentially may occur, in addition to occurred landslides;
- ✓ application of **land use restrictions and regulations** for hazard zones.



NATIONAL MOSAIC OF LANDSLIDE AND FLOOD HAZARD ZONES



Landslide Hazard	Area (km ²)	% Italy
Very high P4	9,495	3.1%
High P3	16,891	5.6%
Medium P2	14,551	4.8%
Moderate P1	12,556	4.2%
Attention zones AA	6,988	2.3%
Italy	60,481	20%

Some **mapping inhomogeneities** due to the different methods used by the River Basin District Authorities for landslide hazard assessment

Hazard scenarios - Legislative Decree 49/2010 (Floods Directive 2007/60/EC)	Area (km ²)	% Italy
High probability scenario with return period of 20-50 years (frequent floods)	16,224	5.4%
Medium probability scenario with return period of 100-200 years	30,196	10%
Low probability or extreme event scenario (RP 300 – 500 years)	42,376	14%

NATIONAL RISK INDICATORS

- ✓ Population
- ✓ Families
- ✓ Buildings
- ✓ Industry and services
- ✓ **Cultural heritage**

Goal:

- ✓ to **support national mitigation policies** by identifying intervention priorities, allocation of funds, programming mitigation measures and planning civil protection actions

Methodology:

- ✓ responds to **transparency and repeatability criteria**
- ✓ uses **official data** available across the **national territory**

Exposed elements:

- ✓ 15° Italian **Population Census** ISTAT 2011
- ✓ 9° Italian **Industry and services Census** ISTAT 2011
- ✓ **Cultural Heritage database** (Vincoli in Rete VIR - ICR - Ministry of Cultural Heritage)

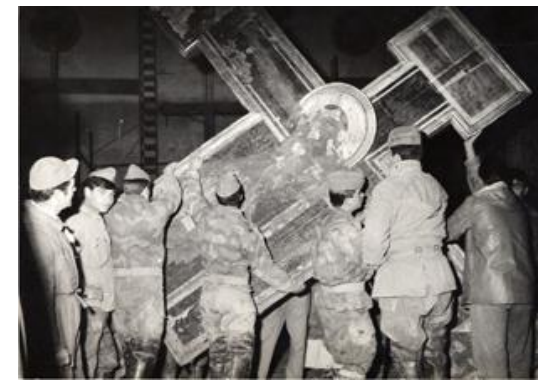
$$R = H \times E \times V$$

R = Risk

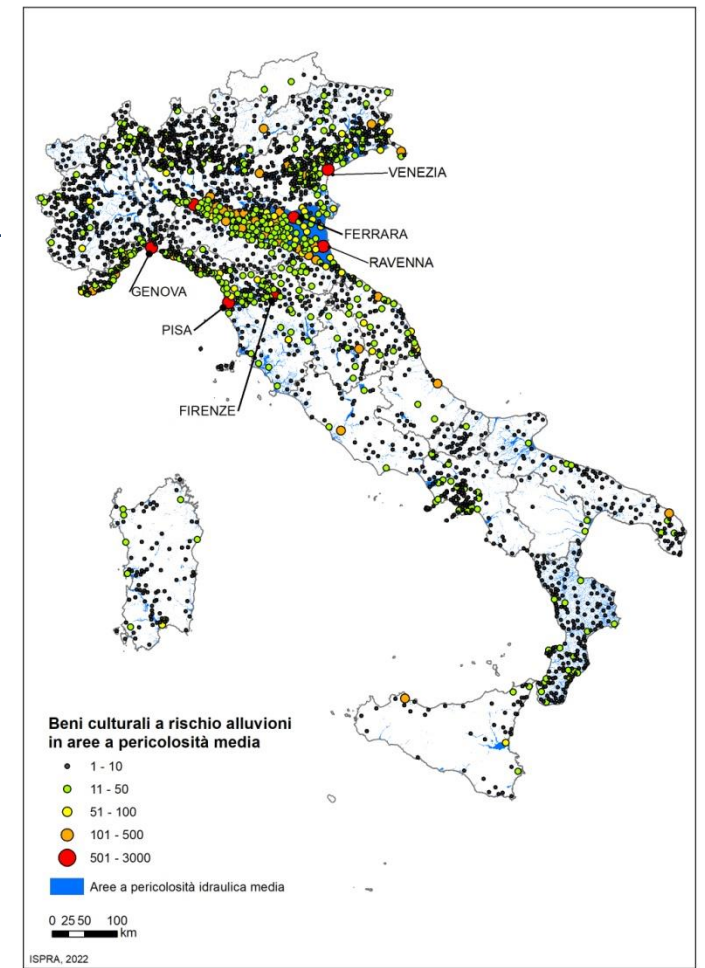
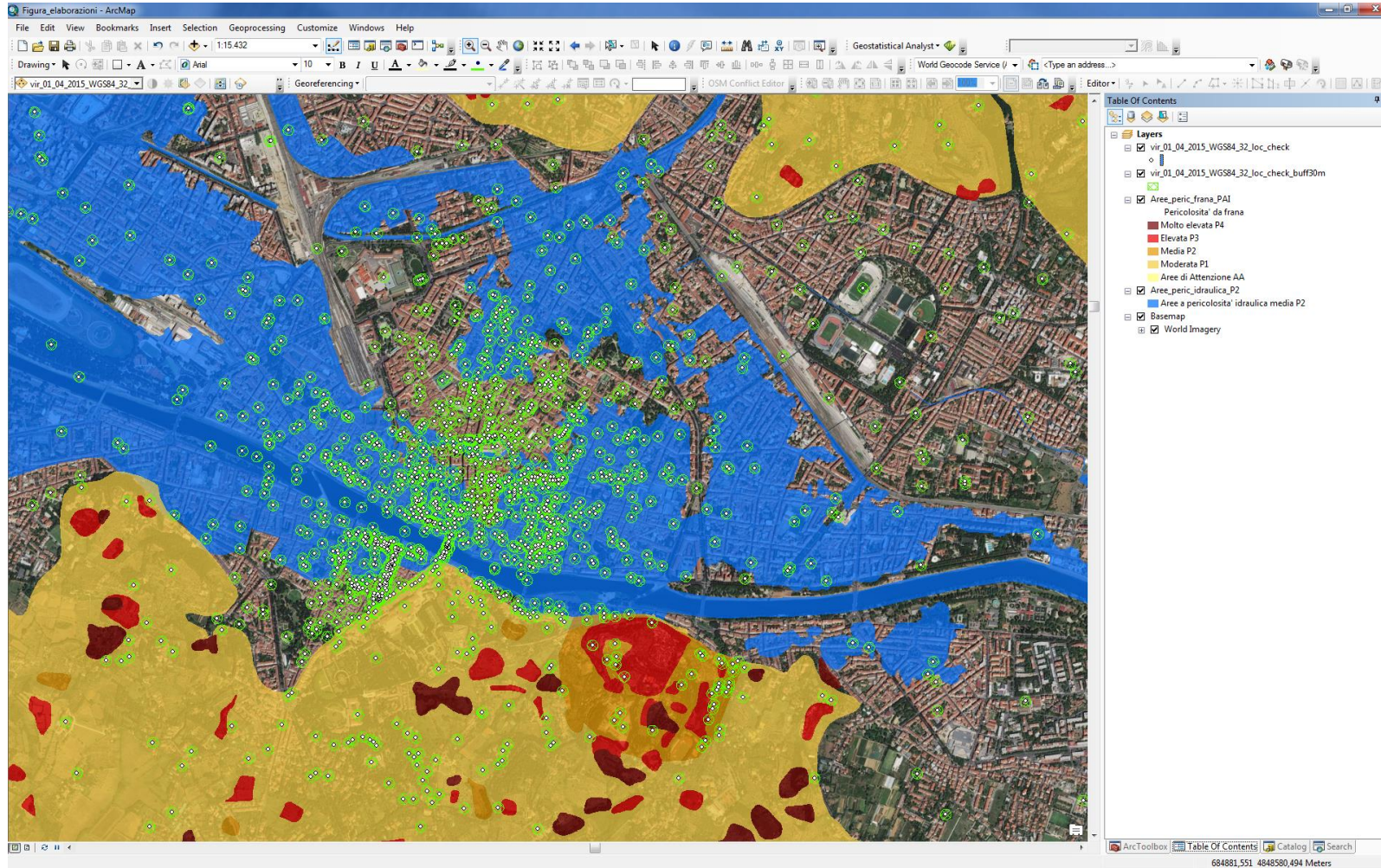
H = Hazard

E = Exposure

V = Vulnerability

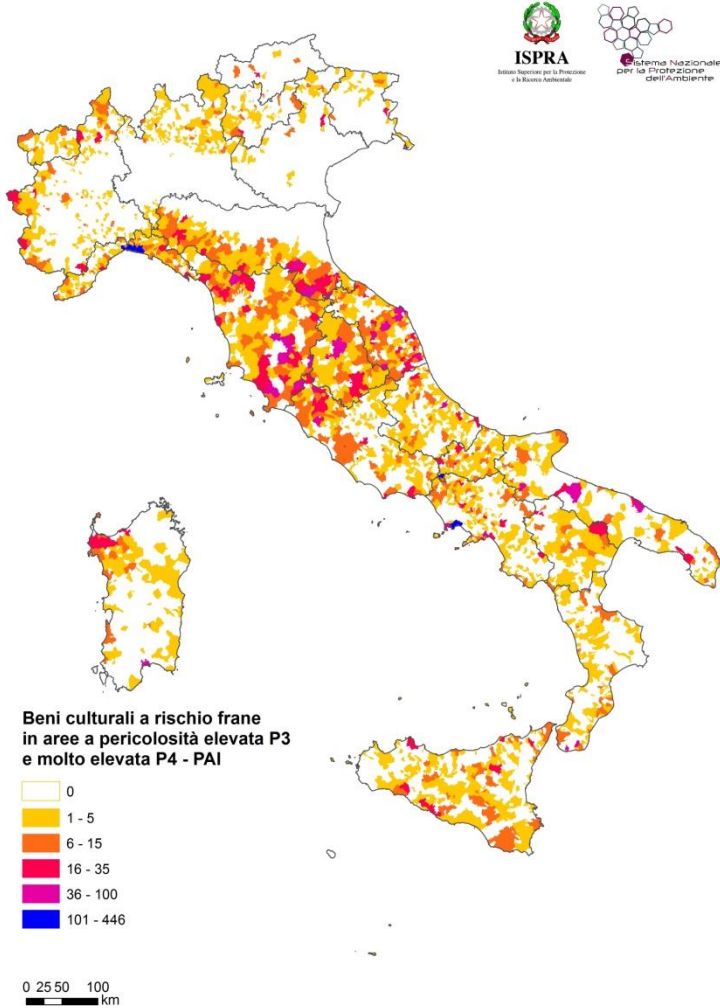


CULTURAL HERITAGE AT RISK



The georeferenced features of cultural heritage have been overlapped with the national mosaics of landslide and flood hazard.

CULTURAL HERITAGE AT RISK



IDROGEO WEB PLATFORM



Contents

- Data and maps of the **Italian Landslide Inventory**
- National landslide and flood **hazard maps** and **risk indicators**

Aims

- **Data dissemination** (ONU Sendai Framework for Disaster Risk Reduction 2015–2030, Sustainable Development Goals - SDGs)
- **Support decisions** in risk mitigation policies



HOME PAGE IDROGEO WEB PLATFORM

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IdroGEO

The Italian web platform on landslides and floods

The IdroGEO platform allows the consultation, download and sharing of data, maps, reports, documents of the Italian Landslide Inventory - IFFI, the national landslide and flood hazard maps and risk indicators

Hazard and risk

Italian Landslide Inventory IFFI

with the contribution of



IDROGEO USER INTERFACE – UI

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Information panel

Italia

Number of landslides: 624,774



624,774
Landslides



1,155
Monitored landslides



568
Landslide Events*



34
Landslide Reports



34,236
Photo



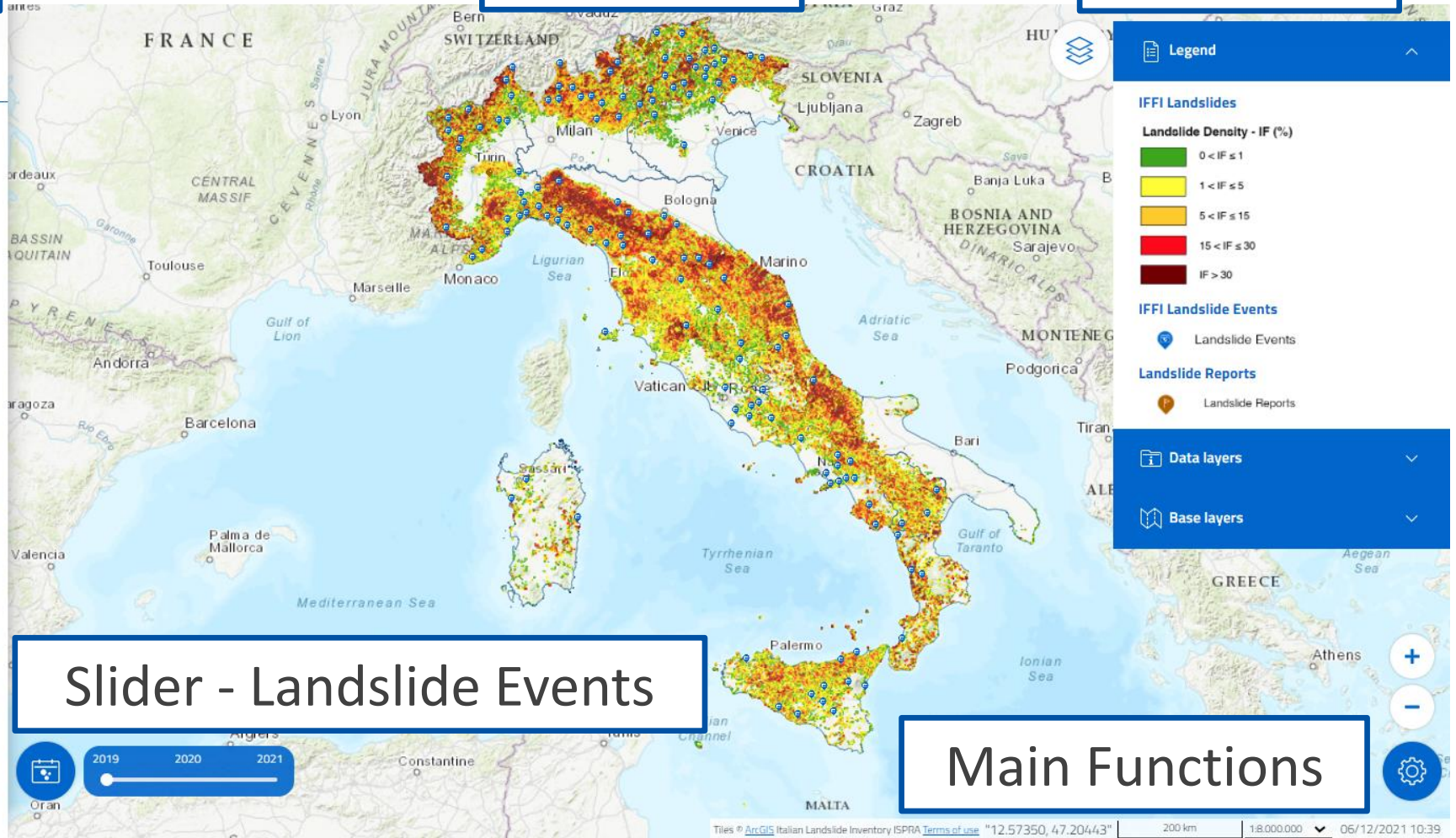
100
Video

Landslides by type of movement

fall/topple	26,078
rotational/translational slide	198,717
lateral spread	80
slow earth flow	79,136
rapid debris flow	93,652
sinkhole	409
complex	59,349
area affected by numerous rockfalls/topples	58,028
area affected by numerous sinkholes	93
area affected by numerous shallow landslides	37,659
deep-seated gravitational slope deformation	1,647
n.d.	69,926

Map

Layers



VIEW A LANDSLIDE

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IdroGEO ISPRa Istituto Superiore per la Protezione e la Ricerca Ambientale

Emilia-Romagna > PR > Corniglio
Landslide
ID: 0340015000 Level: 3

Share Print report

Search

Legend

IFFI Landslides

Landslide Identification Point (PIFF) *

- Landslide data sheet - 1st Level
- Landslide data sheet - 2nd Level
- Landslide data sheet - 3rd Level

Landslide type of movement

- Linear landslides
- Rockfall/topple
- Rotational/translational slide
- Lateral spread
- Slow earth flow
- Rapid debris flow
- Sinkhole
- Complex
- Area affected by numerous rockfalls/topples
- Area affected by numerous sinkholes
- Area affected by numerous shallow landslides
- Deep-seated gravitational slope deformation
- n.d.

IFFI Landslide Events

- Landslide Events

Landslide Reports

- Landslide Reports

Data layers

Base layers

Share **Print Report**

Landslide Info

Region Emilia-Romagna
Province Provincia di Parma
Municipality

Region: Emilia-Romagna
Province: Provincia di Parma
Municipality: Corniglio

Map labels: Roccafererra Superiore, Roccaferrella di Sotto, Galana la Villa, Calfatolo, S. Maria, Bocco, Mossale Inferiore, Sesta Inferiore, Corniglio, S. Maria, Bocco, Mossale Inferiore, Sesta Inferiore, Corniglio, S. Maria, Bocco, Mossale Inferiore, Sesta Inferiore, Corniglio.

Map scale: 1:100,000

Map coordinates: 10.11745, 44.49042

MULTIMEDIA

ISPRA



Nord-Ovest > Lombardia > SO
Valdisotto

Number of landslides: 1.405

- 1.405 Landslides
- 1 Landslide Events*
- 0 Landslide Reports
- 0 Documents
- 11 Photo
- 5 Video

Media list (5)

Type of mov

Video & Photo

- 0:00 / 2:12
- 0:00 / 3:16
- 0:00 / 4:15
- 0:00 / 4:33

Legend

Legend

IFFI Landslides

Punto Identificativo del Fenomeno Franoso (PIFF)*

- Scheda frane di 1° Livello
- Scheda frane di 2° Livello
- Scheda frane di 3° Livello

Tipologia di frana

- Frane lineari
- Crollo/Ribaltamento
- Scivolamento rotazionale/traslattivo
- Espansione
- Colamento lento
- Colamento rapido
- Sprofondamento
- Complesso
- Aree con crolli/ribaltamenti diffusi
- Aree con sprofondamenti diffusi
- Aree con frane superficiali diffuse
- DGPV
- n.d.

Data layers

Base layers

Italian Landslide Inventory ISPRA [Terms of use](#) "10.39026, 46.36712" 500 m 1:25.000 25/05/2021 17:39

MONITORED LANDSLIDES

ISPRA

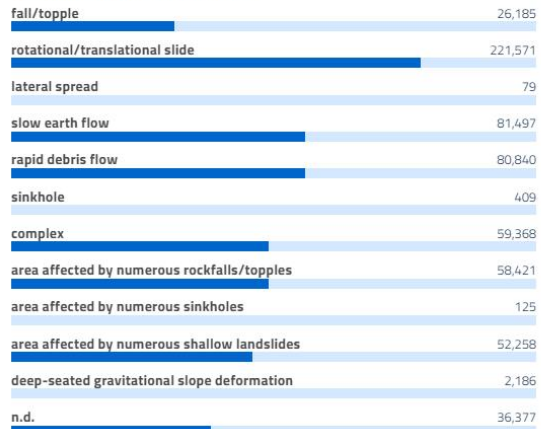


Italia

Number of landslides: 619,316



Landslides by type of movement



ISPRA

IdroGEO ISPRA

Menu > GE > Camogli
Landslide
ID: 0100126200 Level 3

Share Print report

Landslide area
447,897.3 m²

Date of observation
20021212

Date of occurrence
18/04/1963

Cause
adversely oriented structural discontinuities, sheared material, wave erosion of the slope toe

Remedial measures
gabions, ties, anchors, surface drainage, consolidation of buildings

Monitoring
inclinometers, piezometers

Monitoring systems

Code	GEO29
Location	San Rocco Di Camogli
Manager	ARPAL
Installation	2017
Active	attivo
Type	conoscitivo
Acquisition	manuale
Link	link 1

ALLEGATI

- DOCUMENTO 0
- DOCUMENTO 1

Legend

IFFI Landslides

- Landslide Identification Point (PIFF)
 - Landslide data sheet - 1st Level
 - Landslide data sheet - 2nd Level
 - Landslide data sheet - 3rd Level
- Landslide Event
 - Landslide Event
- Landslide type of movement
 - Linear landslides
 - Rockfall/topple
 - Rotational/translational slide
 - Lateral spread
 - Slow earth flow
 - Rapid debris flow
 - Sinkhole
 - Complex
 - Area affected by numerous rockfalls/topples

REMOVED - Rete regionale di monitoraggio dei versanti instabili					
CATASTO STRUMENTAZIONE					
SCHEDA N.	MONOGRAFIA INCLINOMETRO			P3I	
Localizzazione					
Provincia	Genova	CTR n.	Toponimo	S.Rocco-Mortola	
Comune	Camogli	Scala	Coordinate (Gauss Boga)	X 1512619 Y 4909200	
Bacino	Codice sito	1:10.000	Quota (m slm)	210	
Data installazione	Caratteristiche foro		Caratteristiche costruttive		
	Diametro (mm)	Prof. (m)	Lungh. tubo (m)	19.5	Materiale
			Diam. tubo (mm)	50 (2")	ABS (plastica)
Dati amministrativi					Alluminio
Ente attuatore	Proprietà pubblica		Azimut guida	A1-40° N	Capitello in elevazione
Comune di Camogli					(altezza dal p.c. in cm)
					Chiusino carrabile
Lucchetto con chiavi	Si	No	Riferimento Nominativo:		
	X				
CTR			Foto		
Ortofoto			Particolare terminale		
Note. Inclinometro monitorato dal 2003 da privati. Profondità di misura 19m. Lettura di zero					
Data compilazione: 04/10/2016				Redattore: Dott. Geol. Gianluca Beccaris	

HAZARD MAPS & RISK INDICATORS

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Cerca

Italia

Population at risk
Landslides: 1,281,970 ab.

Floods: 6,183,364 ab.

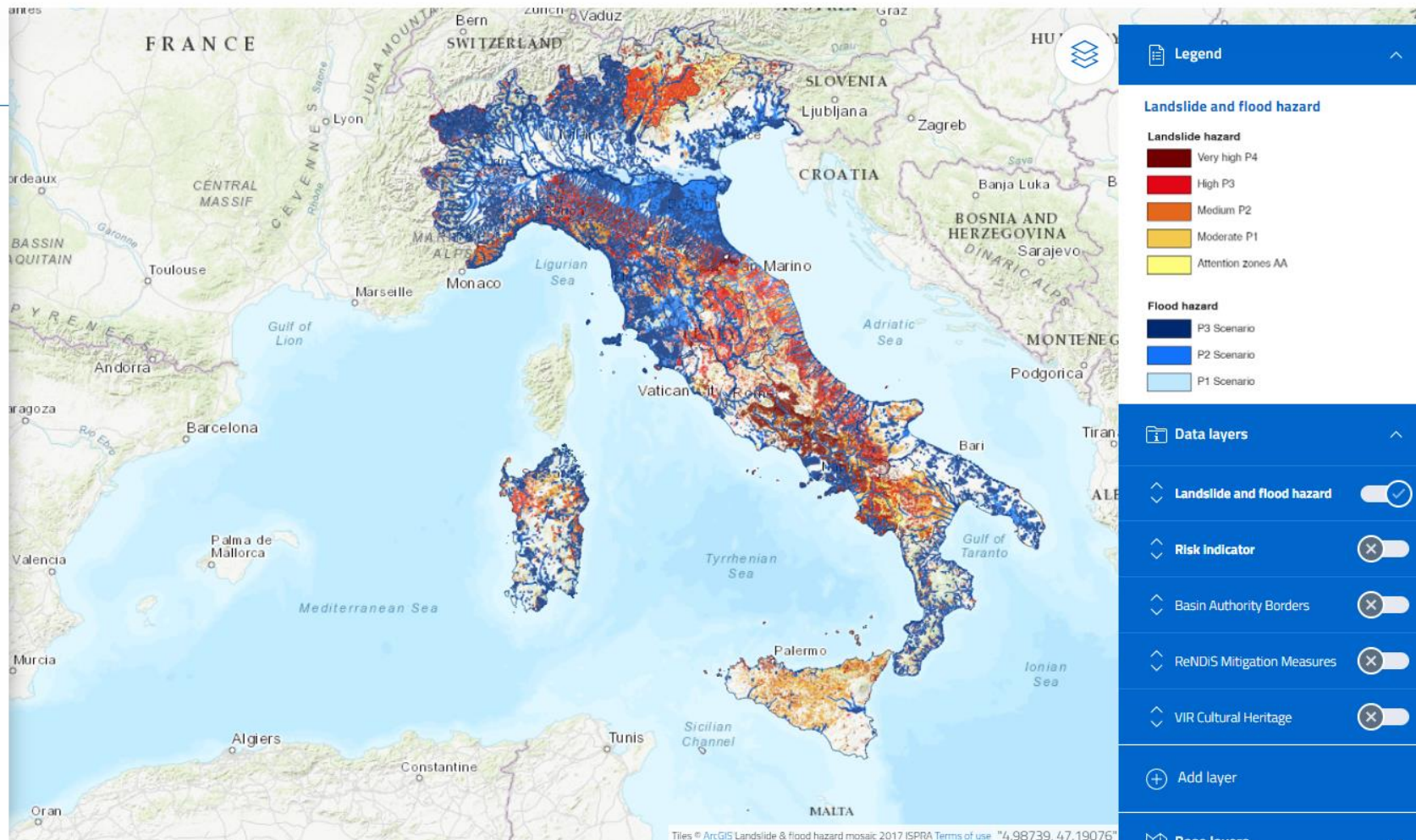
Context Data



Hazard and risk

Landslides	Territory	Population	Families	Buildings	Industries and services	Cultural heritage
Very high P4	9,153.06 (3%)	507,894 (0.9%)	210,452 (0.9%)	227,329 (1.6%)	31,824 (0.7%)	4,741 (2.3%)
High P3	16,256.88 (5.4%)	774,076 (1.3%)	327,582 (1.3%)	323,394 (2.2%)	51,124 (1.1%)	6,971 (3.4%)
Medium P2	13,835.76 (4.6%)	1,685,167 (2.8%)	711,965 (2.9%)	548,500 (3.8%)	123,772 (2.6%)	10,845 (5.3%)
Moderate P1	13,953.47 (4.6%)	2,246,439 (3.8%)	942,992 (3.8%)	599,813 (4.1%)	168,070 (3.5%)	13,267 (6.5%)
Attention zones AA	6,782 (2.2%)	475,887 (0.8%)	191,372 (0.8%)	184,086 (1.3%)	28,929 (0.6%)	2,023 (1%)
P4 + P3	25,409.94 (8.4%)	1,281,970 (2.2%)	538,034 (2.2%)	550,723 (3.8%)	82,948 (1.7%)	11,712 (5.8%)

Floods	Territory	Population	Families	Buildings	Industries and services	Cultural heritage
Scenario P3 Tr. 20-50 years	12,405.23 (4.1%)	2,062,475 (3.5%)	873,832 (3.6%)	487,895 (3.4%)	197,565 (4.1%)	13,865 (6.8%)
Scenario P2 Tr. 100-200 years	25,397.62 (8.4%)	6,183,364 (10.4%)	2,648,499 (10.8%)	1,351,578 (9.3%)	596,254 (12.4%)	31,137 (15.3%)
Scenario P1 Tr.	32,960.92 (10.4%)	9,341,533 (15.6%)	4,001,788 (16.7%)	2,051,126 (14.8%)	884,581 (18.4%)	39,426 (19.3%)



Legend

Landslide and flood hazard

Landslide hazard

- Very high P4
- High P3
- Medium P2
- Moderate P1
- Attention zones AA

Flood hazard

- P3 Scenario
- P2 Scenario
- P1 Scenario

Data layers

- Landslide and flood hazard
- Risk Indicator
- Basin Authority Borders
- ReNDIS Mitigation Measures
- VIR Cultural Heritage
- [Add layer](#)

SCENARIO CALCULATION

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Scenario calculation

Download (CSV) | Download (XLS) | Download metadata

Context Data

- 4,510.85 km² Territory
- 381,179 Buildings
- 1,857,010 Population
- 194,073 Industries and services
- 783,158 Families

Hazard and risk

Landslides	POPOLAZIONE	FAMIGLIE	EDIFICI	IMPRESE
Molto Elevata P4	5,521	2,261	1,617	476
Elevata P3	27,561	11,242	9,015	1,902
Media P2	202,417	80,756	50,870	14,900
Moderata P1	307,641	128,676	83,954	27,092
Aree Attenzione AA	220	110	193	13
P4 + P3	33,081	13,504	10,632	2,377

Floods	POPOLAZIONE	FAMIGLIE	EDIFICI	IMPRESE
Scenario P3 Tr. 20-50 anni	157,753	65,522	33,371	16,428
Scenario P2 Tr. 100-200 anni	678,670	287,682	128,381	76,474
Scenario P1 Tr. 300-500 anni	1,425,664	607,473	268,605	162,003

Scenario calculation

Elaborazione del 30/12/2020 11:01:44 con dati aggiornati al 31/12/2017

IDROGEO & VIR

ISPRRA

IdroGEO ISPRRA

Centro > Lazio > RM
Roma
 Popolazione a rischio Frane: 2.431 ab. Alluvioni: 96.576 ab.

Dati di Contesto

- 1.287,24 km² Territorio
- 176.178 Edifici
- 2.617.175 Popolazione
- 13,4% Giovani (0-14)
- 64,7% Adulti (15-64)
- 21,9% Anziani (65+)
- 259.608 Imprese
- 6.202 Beni culturali
- 1.187.778 Famiglie

Pericolosità e rischio

Frane	Territorio	Popolazione	Famiglie	Edifici	Imprese	Beni culturali
Molto Elevata P4	0,48 (0%)	582	297 (0%)	55 (0%)	78 (0%)	6 (0,1%)
Elevata P3	3,81 (0,3%)	1.840 (0,1%)	874 (0,1%)	145 (0,1%)	152 (0,1%)	8 (0,1%)
Media P2	0,13 (0%)	93 (0%)	43 (0%)	5 (0%)	18 (0%)	4 (0,1%)
Moderata P1	2,01 (0%)	1.308 (0%)	557 (0%)	147 (0%)	131 (0%)	6 (0,1%)

Pericolosità Idrogeo

- Molto elevata P4
- Elevata P3
- Media P2
- Moderata P1
- Aree di Attenzione AA

Pericolosità idraulica

- Elevata
- Media
- Bassa

Beni Culturali VIR

- Archeologi di interesse culturale non verificato
- Archeologi di non interesse culturale
- Archeologi con verifica di interesse culturale in corso
- Archeologi di interesse culturale dichiarato
- Archeologi in area di interesse culturale dichiarato
- Archeologi di non interesse culturale
- Archeologi con verifica di interesse culturale non verificato
- Archeologi di interesse culturale non dichiarato
- Archeologi di interesse culturale dichiarato
- Archeologi in area di interesse culturale dichiarato
- Parchi e giardini di interesse culturale non verificato
- Parchi e giardini di non interesse culturale
- Parchi e giardini con verifica di interesse culturale in corso
- Parchi e giardini di interesse culturale dichiarato
- Parchi e giardini in area di interesse culturale dichiarato

ISPRRA

IdroGEO ISPRRA

Centro > Toscana > FI
Certaldo
 Numero frane: 563

- 563 Frane*
- 0 Eventi**
- 0 Foto
- 0 Frane monitorate
- 0 Segnalazioni
- 0 Video



* Copertura temporale Inventario nazionale: 1116-2022
 ** Copertura temporale degli Eventi IFFI: 2018-2022

Frane IFFI

Punto Identificativo del Fenomeno Franso (PIFF)*

- Scheda frane di 1° Livello
- Scheda frane di 2° Livello
- Scheda frane di 3° Livello

Evento franso

- Evento franso

Tipologia di frane

- Frane lineari
- Crollo/Ribaltamento
- Scivolamento rotazionale/traslato
- Espansione
- Colamento lento
- Colamento rapido
- Sprofondamento
- Complesso
- Aree con crolli/ribaltamenti diffusi
- Aree con sprofondamenti diffusi
- Aree con frane superficiali diffuse
- DGPV
- n.d.

Eventi IFFI

- Eventi franso

Segnalazioni IFFI

- Segnalazioni attive

Beni Culturali VIR

- Archeologi di interesse culturale non verificato
- Archeologi di non interesse culturale
- Archeologi con verifica di interesse culturale in corso
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- Parchi e giardini di interesse culturale dichiarato
- Parchi e giardini in area di interesse culturale dichiarato

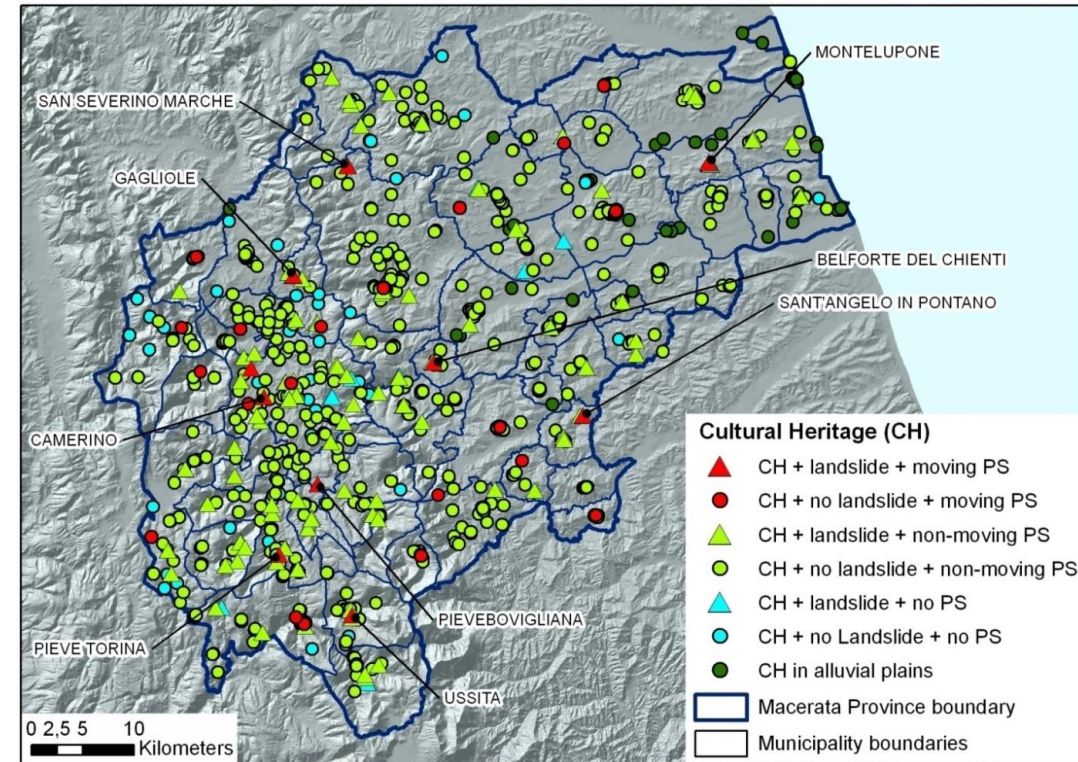
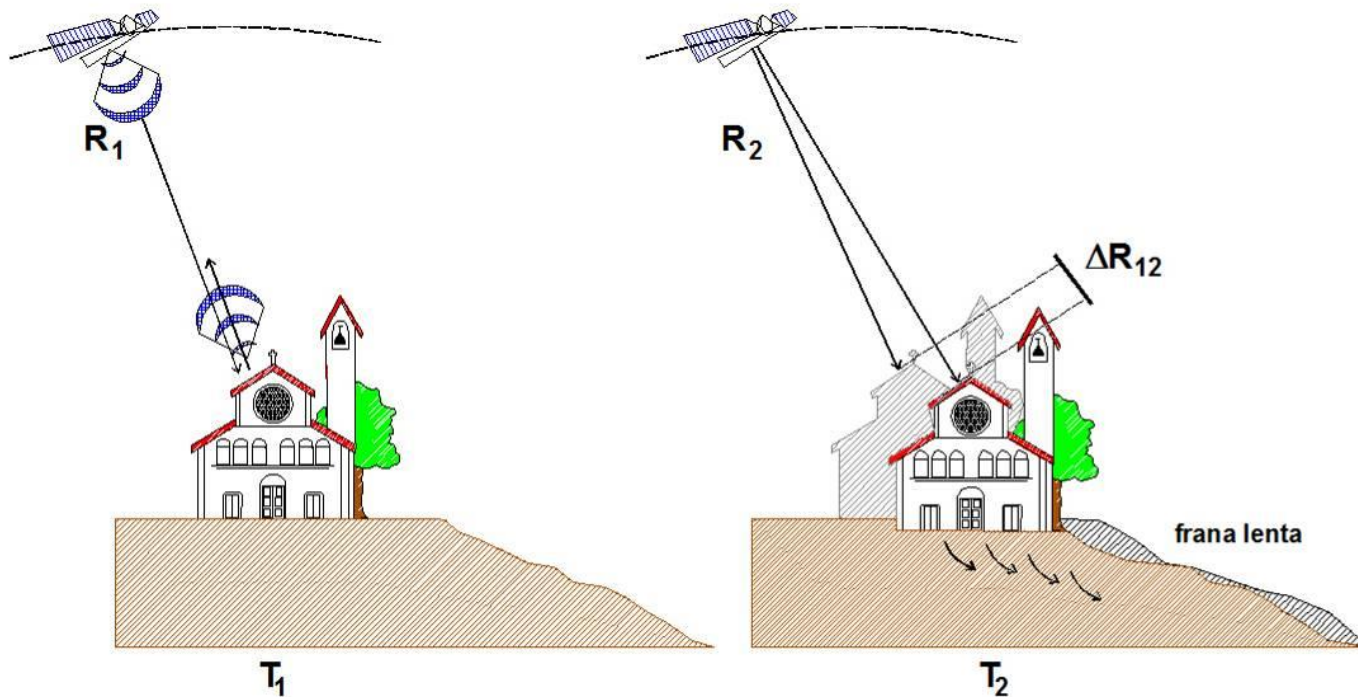


SATELLITE RADAR DATA FOR CULTURAL HERITAGE

Cultural Heritage exposed to very slow/extremely slow mass movements

LARGE AREA APPROACH

SINGLE BUILDING APPROACH



Macerata province: 36 cultural heritage on which, as a priority, field surveys and more detailed analysis have to be performed

SEMIAUTOMATIC DETECTION OF ANOMALIES



Aims:

- To select the most critical situations on the whole area of the archaeological site for predictive and preventive purposes;
- To support the *Soprintendenza* to plan surveys or more detailed studies to verify the real stability conditions

Definition of empirical thresholds:

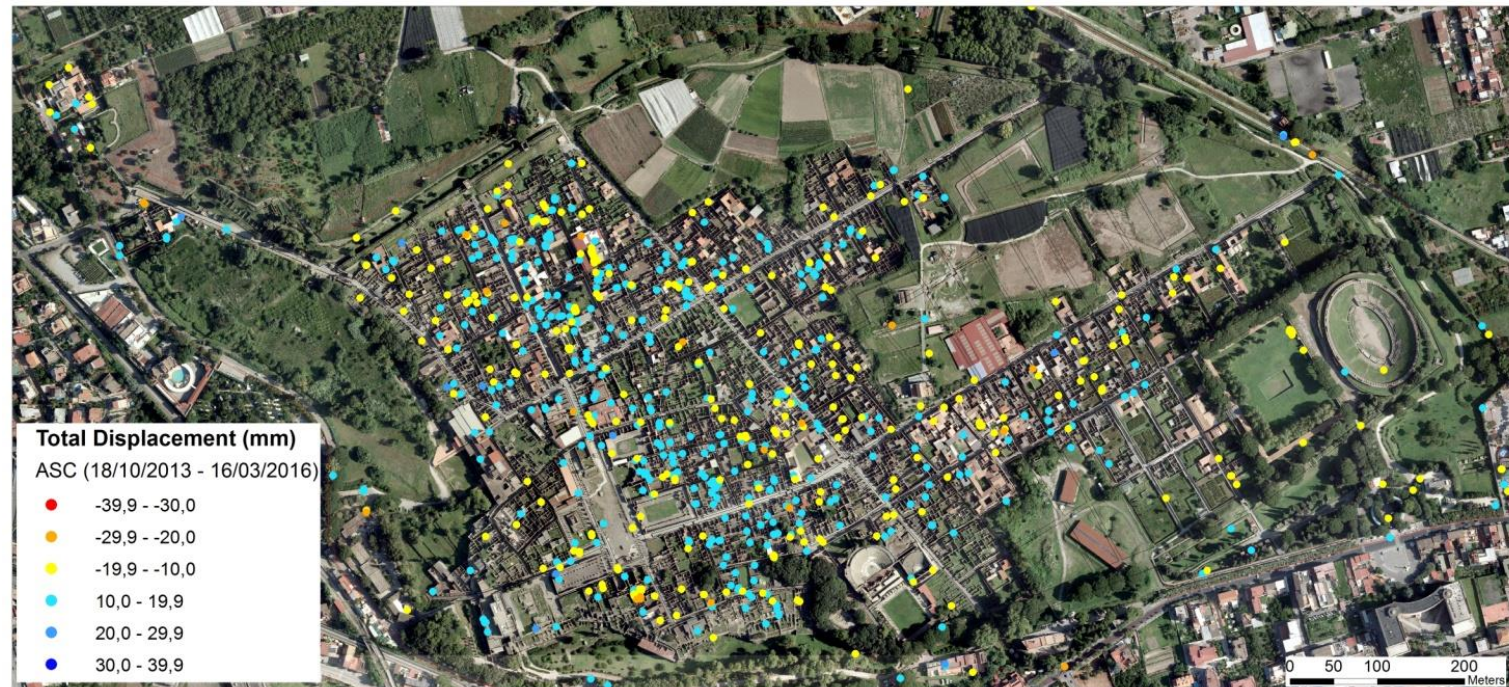
- Average annual velocity threshold
- Cumulative displacement threshold
- Acceleration threshold

Pompeii archeological site (66 ha)

Total number of PS:

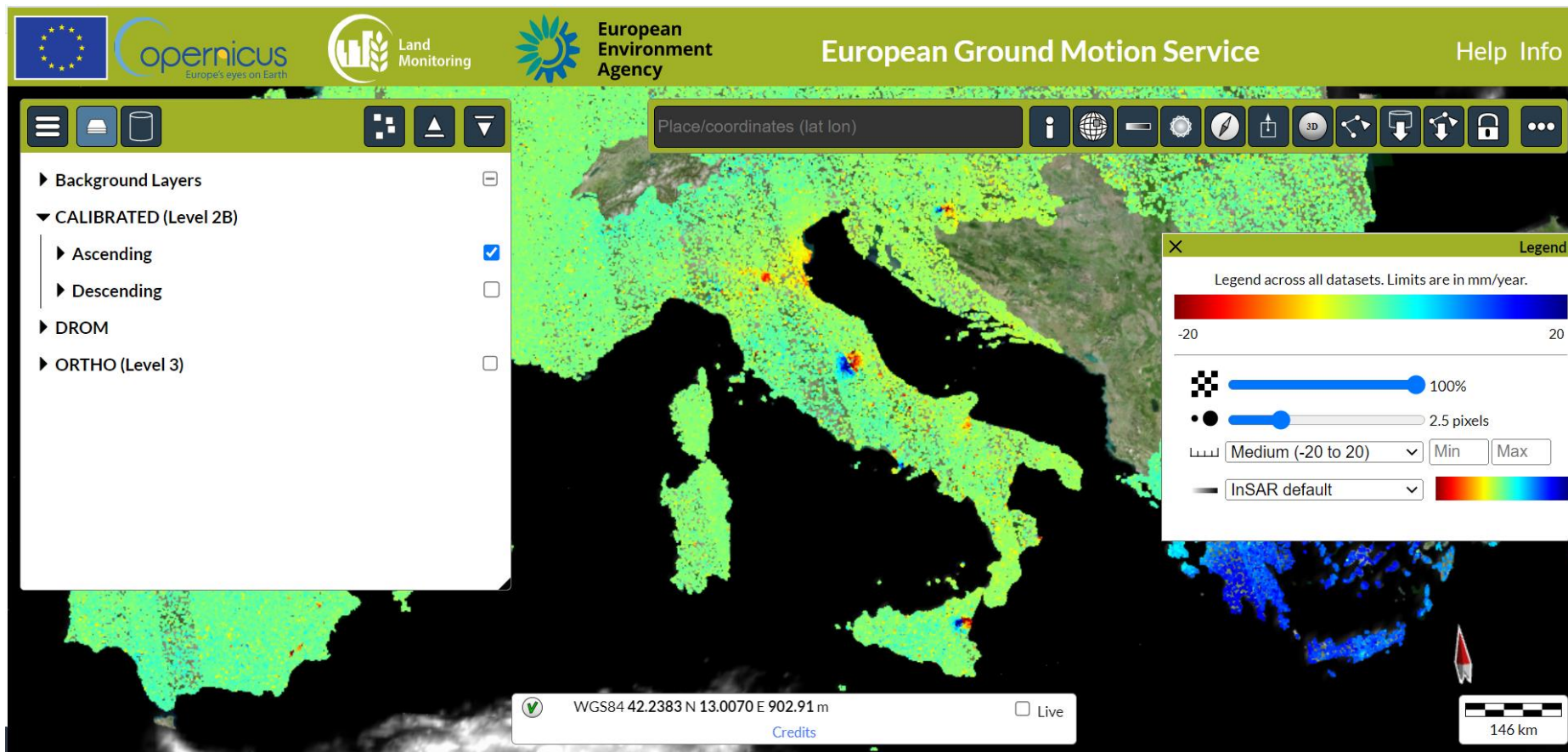
~15.000 PS - Descending geometry (March 2016)

~ 24.000 PS – Ascending geometry (March 2016)



EUROPEAN GROUND MOTION SERVICE - EGMS

- Made from data collected by the Sentinel 1 radar satellite mission;
- Products provide a high density, continental scale map of ground motion (2015-2021);
- EGMS products are free of charge and accessible to everyone.



EGMS PRODUCTS

EGMS BASIC

Ascending orbit geometry
Descending orbit geometry



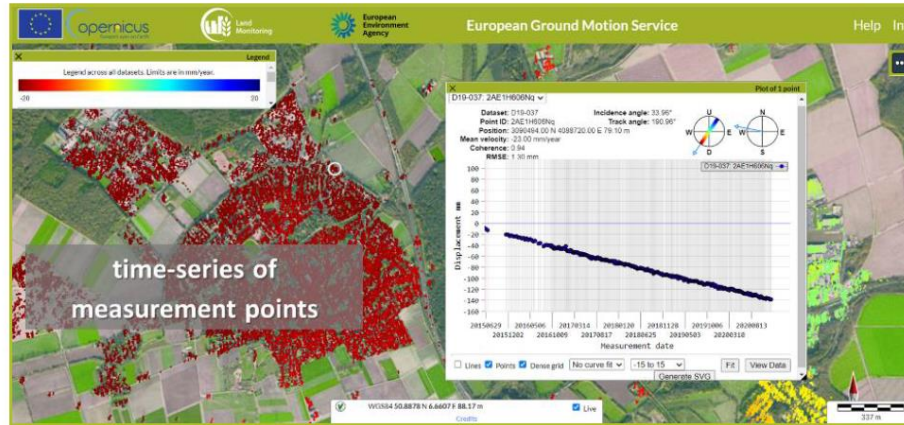
Download only

EGMS CALIBRATED

Ascending orbit geometry
Descending orbit geometry

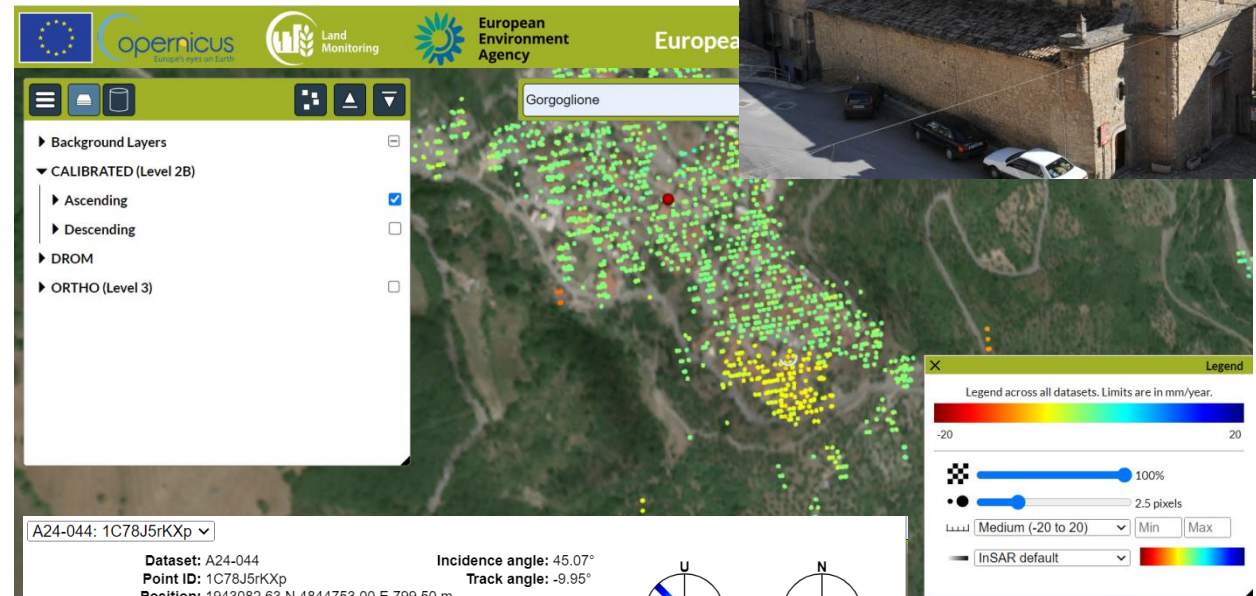
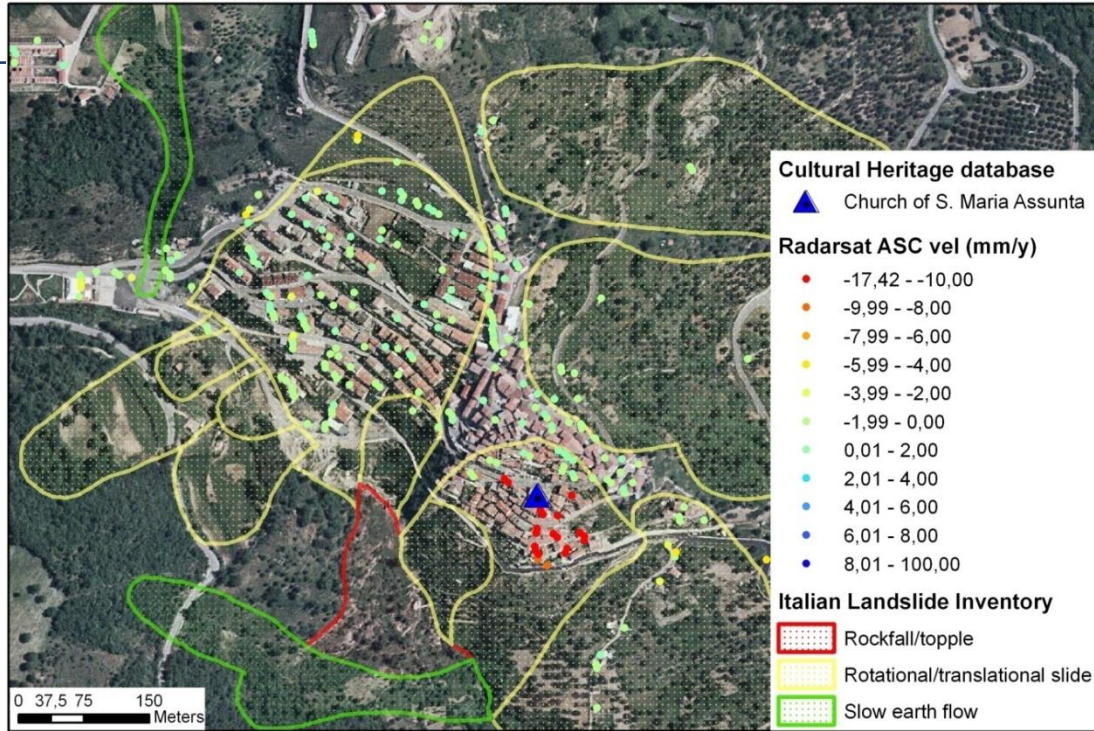
EGMS ORTHO

Vertical
East-west horizontal

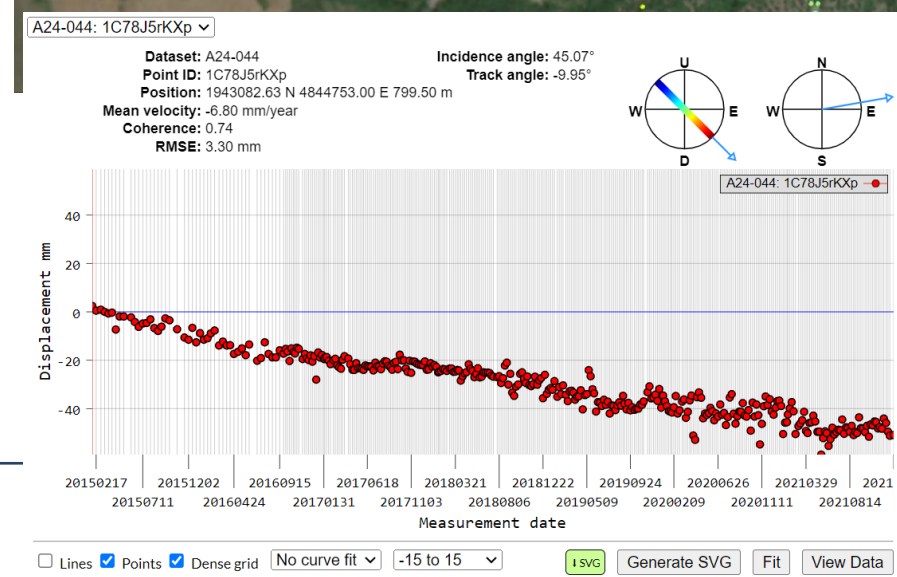


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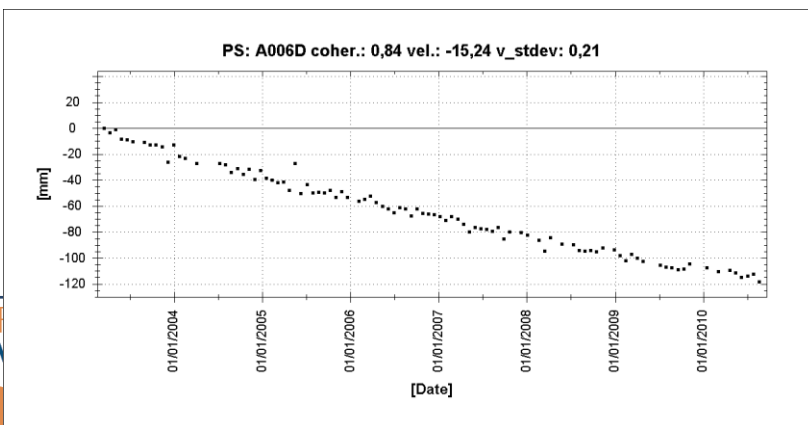
Church of S. Maria Assunta (Gorgoglione, MT)



RADARSAT 2003-2010: $v = 15$ mm/year; $S = 12$ cm



**Sentinel 1 2015-2021:
 $v = 6,8$ mm/year;
 $S = 5$ cm**



Thanks for your attention



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