



Monitoring and safeguarding of cultural heritage: the case of Italian parks and gardens



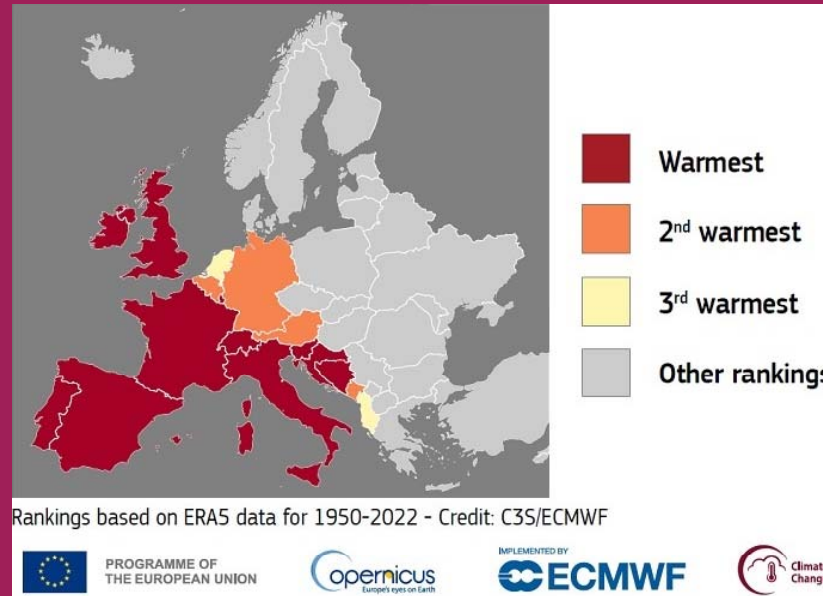
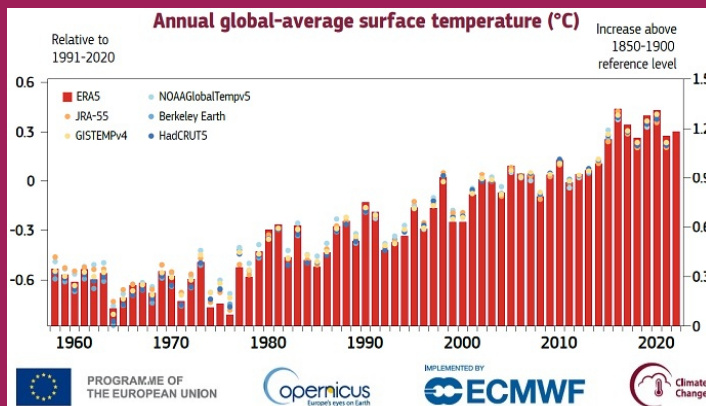
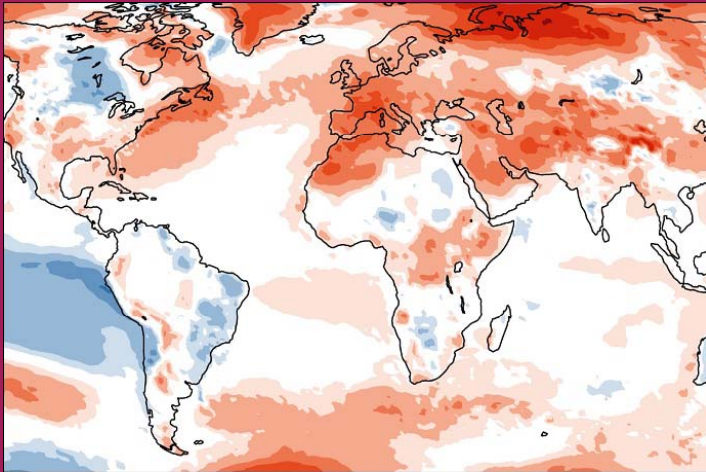
Daniele Spizzichino

Senior Researcher and Scientific Advisor, ISPRA Italian Institute for Environmental Protection and Research, Geological Service Department - GEO

Italian-French Bilateral Cooperation in Heritage Science: “Human-centered approach for cultural heritage in green transition: disciplines talking to each other”

Thursday, 27th April 2023

RATIONALE#1 - The year 2022 was the second warmest on record in Europe – 10 January 2023



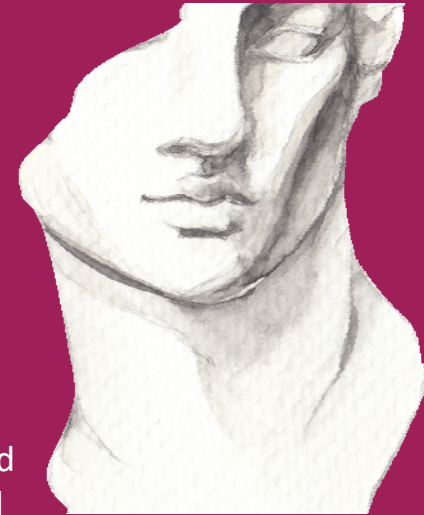
Rankings based on ERA5 data for 1950-2022 - Credit: C3S/ECMWF

Ranking of 2022 surface air temperatures by country over the period since 1950. Data source: ERA5. Credit: Copernicus Climate Change Service/ECMWF.

Second-warmest year in Europe

Temperatures in Europe across the year were the second warmest on record. 2022 was cooler than 2020 by 0.3°C, and marginally warmer – by around 0.1°C – than 2019, 2015 and 2014.

All of Europe, except for Iceland, saw annual temperatures above the 1991–2020 average. Temperatures were most above average in the western part of the continent.



RATIONALE#2 - Rainfall in Europe

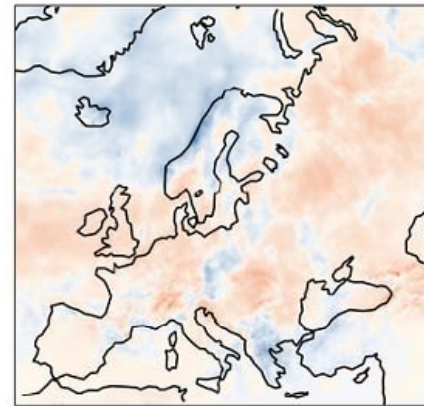
January 10 2023

Rainfall in Europe

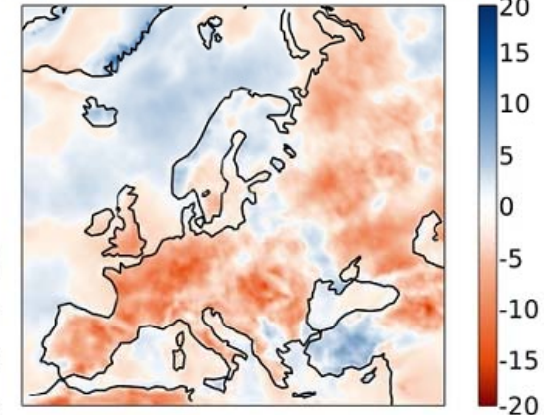
The unusual warmth in late spring and summer in Europe, combined with a lack of rain, clear skies and dry soils, brought drought conditions especially to the southern and central parts of the continent. Many countries reported impacts on agriculture, river transport and energy management. Extremely dry conditions also led to increased fire danger, resulting in unusually high fire activity in south-western Europe, especially France and Spain.



Precipitation (mm/day)



Surface air relative humidity (%)



Data: ERA5. Reference period: 1991-2020. Credit: C3S/ECMWF



PROGRAMME OF
THE EUROPEAN UNION



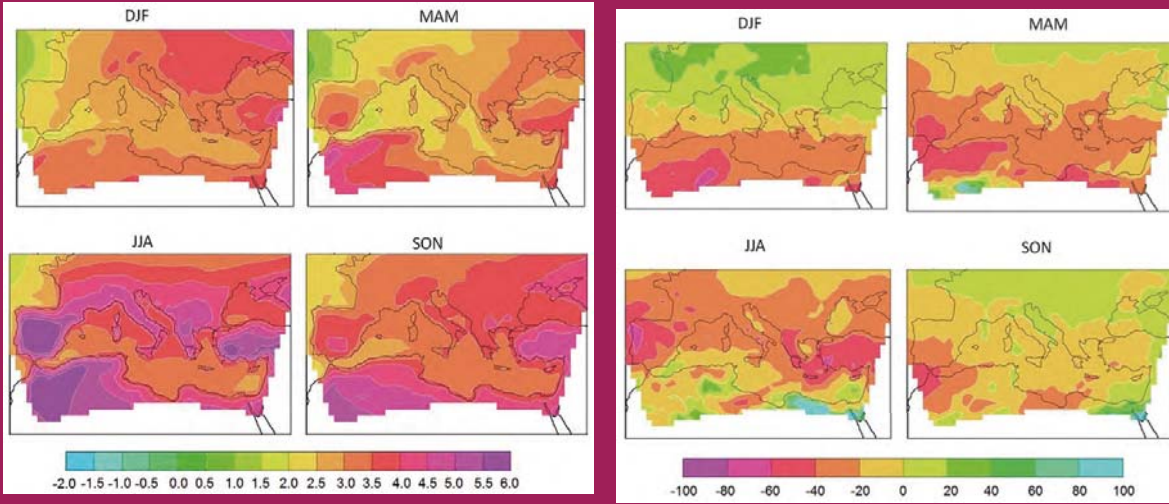
IMPLEMENTED BY

ECMWF

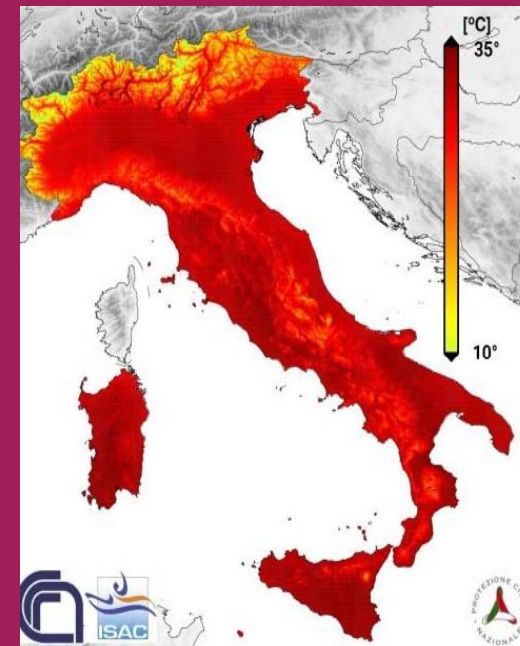
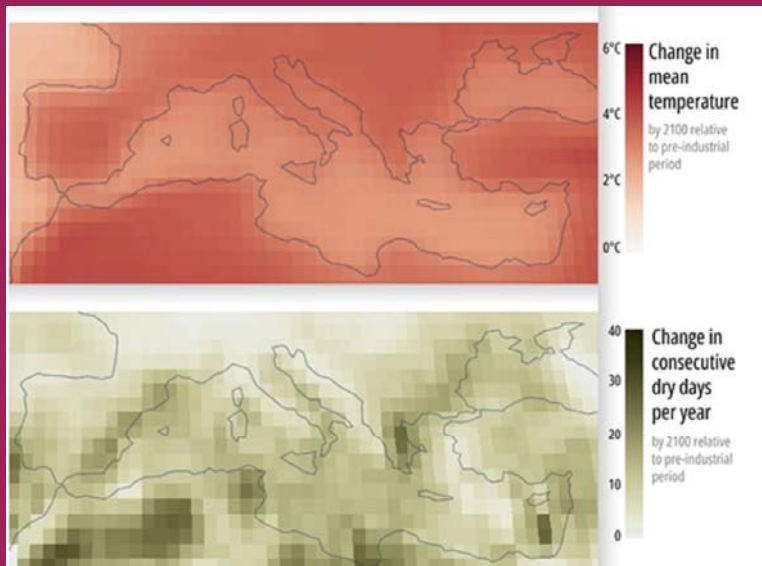


Anomalies in precipitation and the relative humidity of surface air in Europe for the summer of 2022 (June to August) with respect to 1991–2020. Data source: ERA5. Credit: Copernicus Climate Change Service/ECMWF. Originally published in the [August 2022 hydrological bulletin](#).

RATIONALE#3 - Climate Change effects on Euro-Mediterranean Basin



2022 is the hottest (and driest) year ever in Italy: in July 2.26 degrees above average



Direct and indirect impacts of natural and anthropogenic hazard induced by Climate Change on Cultural and Natural Heritage



Hegra - Thermal stress, erosion and geomorphological instability process in KSA © Spizzichino



Blackening - Vittoriano (Roma)



Sea level rise - Venice



Surface recession S. Filippo church (Torino)



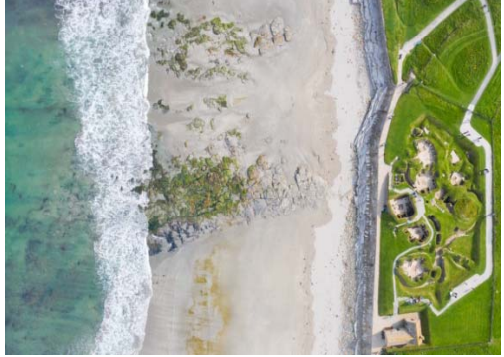
Vegetation Terme di Baia (Naples) © Spizzichino



Rock facade collapse in Petra (Jordan) and in David Gareja Monastery complex (Georgia) © Spizzichino



Erosion in the Akapana pyramid (Bolivia) © Spizzichino



Coastal Erosion Skara Brae © Hist. Env. Scotland

Monitoring and Safeguarding of Cultural Heritage the Italian prospective

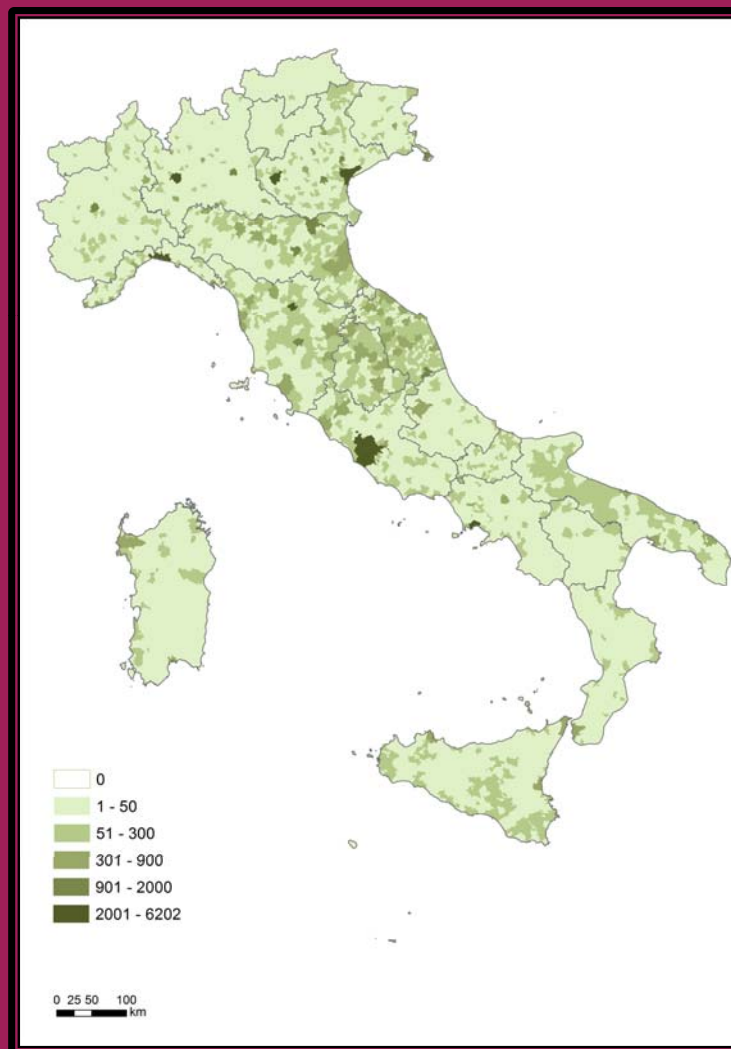


UNESCO WH List



58

Properties inscribed on the World Heritage List



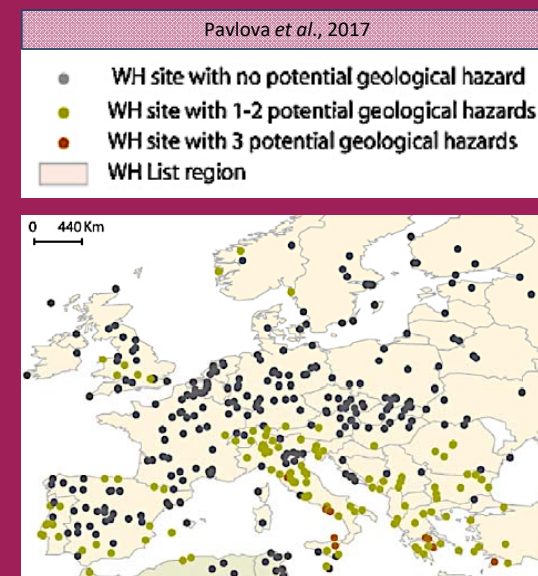
Cultural Heritage of Italian Municipalities Tot. 220.1730

sources:

Dataset VIR e CdR, ISPRA elaboration

References:

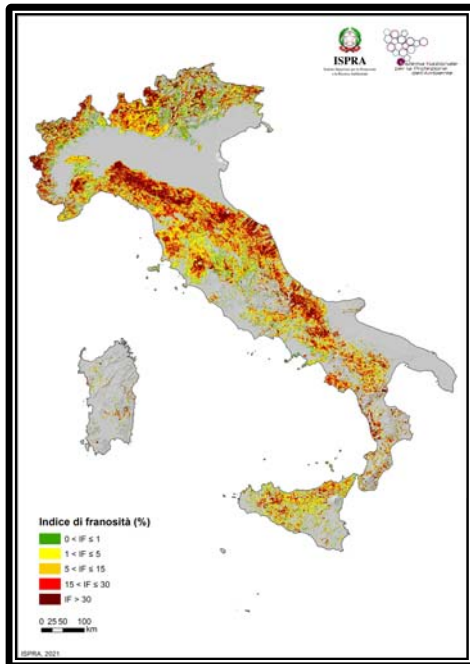
Rapporto ISPRA –2021



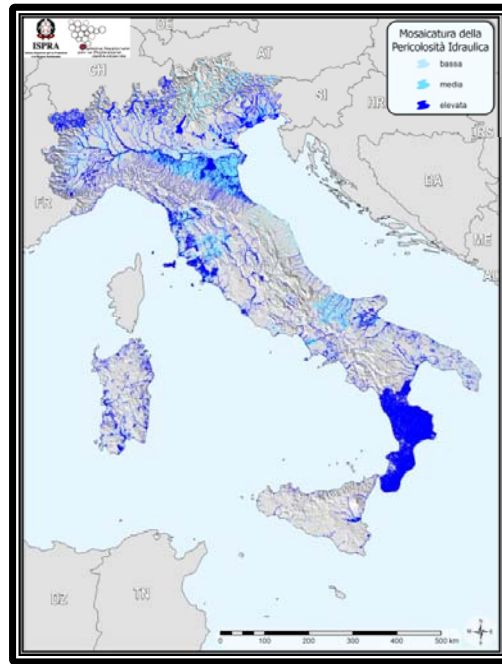
Natural Hazards



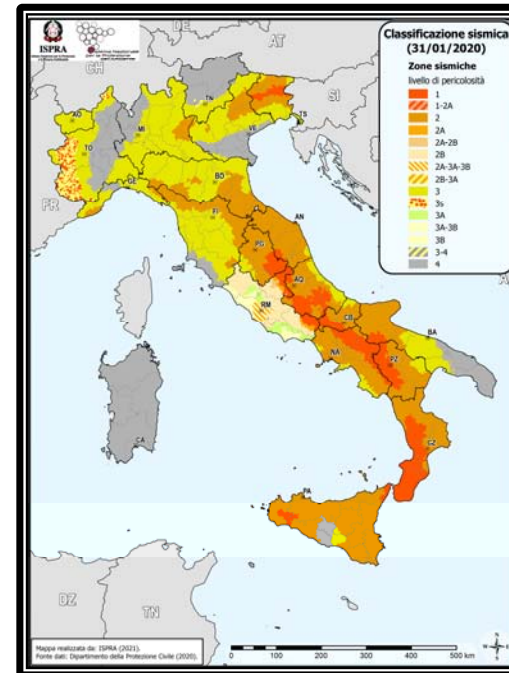
IFFI Project – landslide hazard



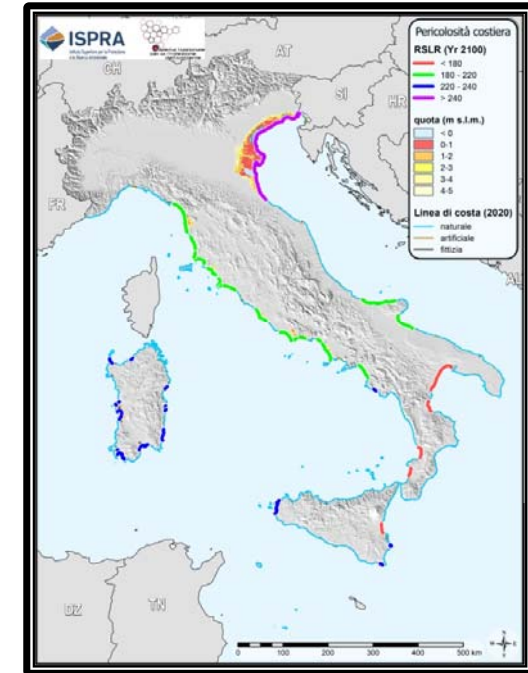
Flood Hazard



Seismic Hazard

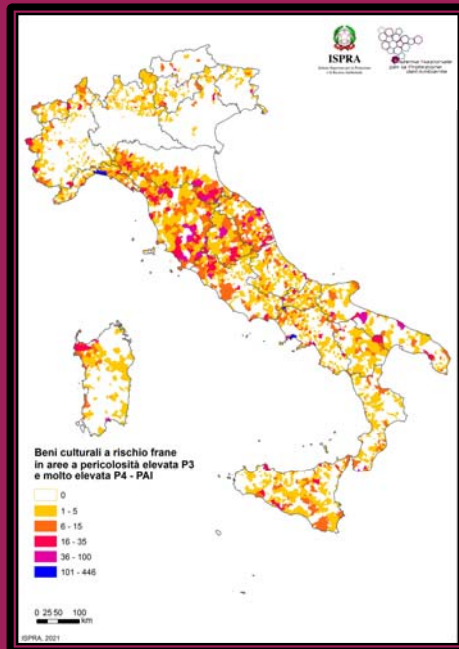


Coastal erosion

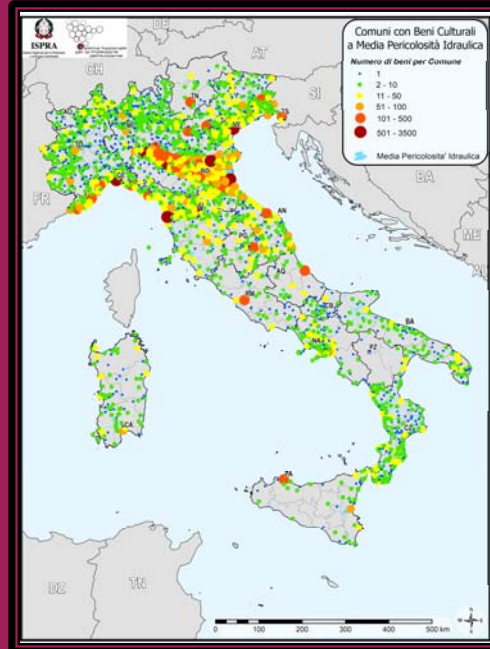


CH & Natural Hazards

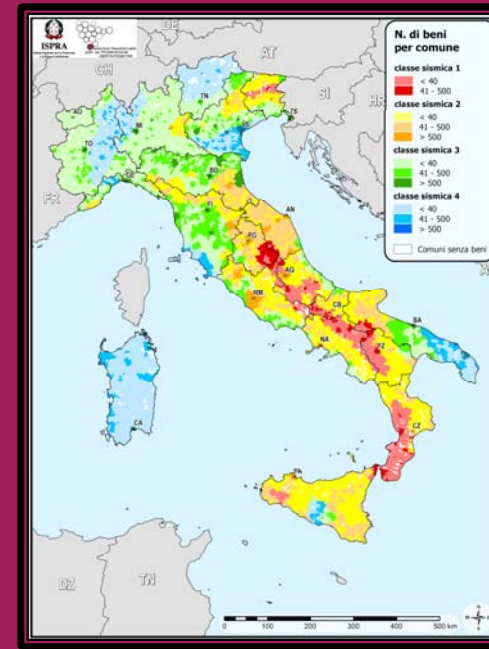
CH Vs Landslide risk in Italy at municipal level



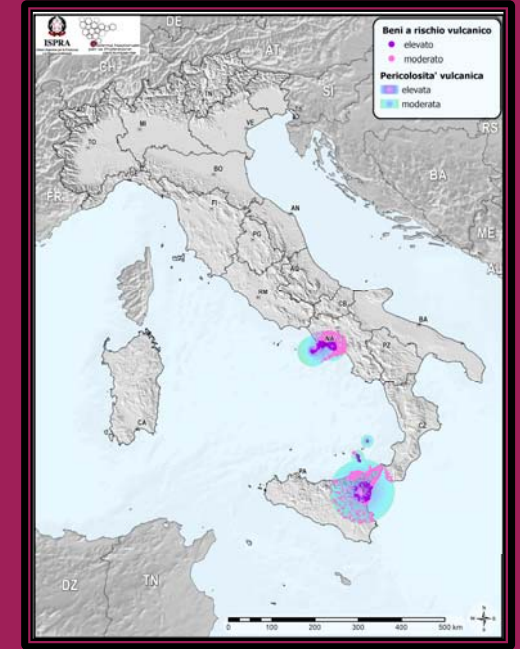
CH Vs Flood risk in Italy at municipal level



CH Vs seismic risk in Italy at municipal level



CH Vs volcanic risk in Italy at municipal level

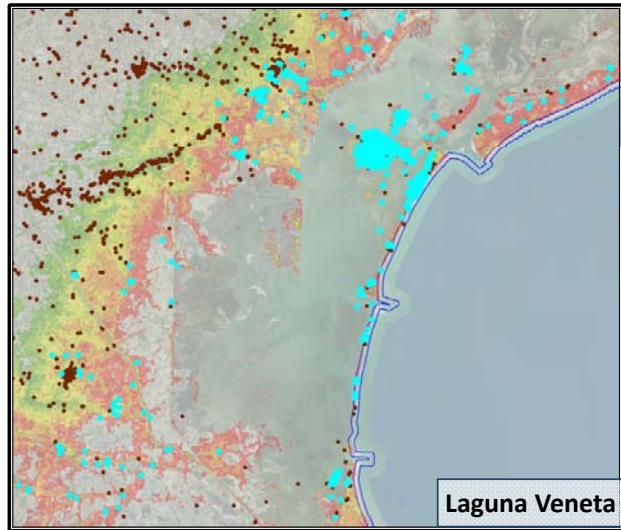
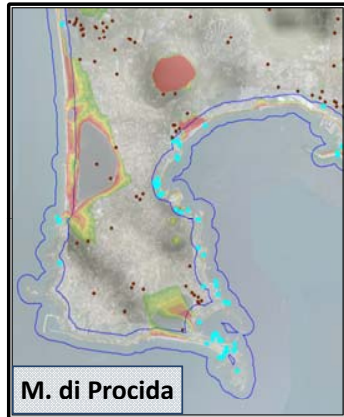


Coastal erosion and *Relative Sea Level Rise*

BBCC in:

- 200 m buffer
 - <1 m s.l.m.
- = 10726 CH (5%)

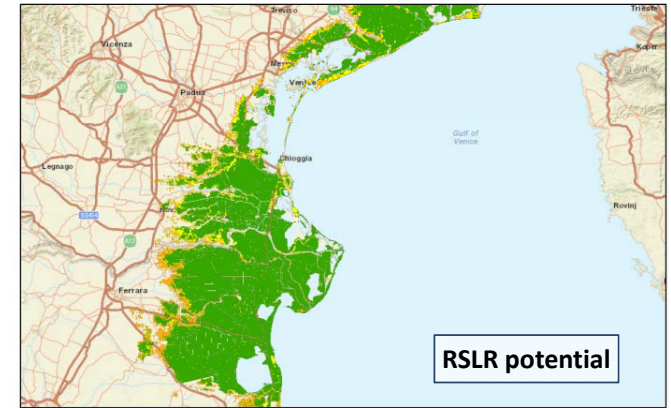
- 200 m Buffer
 - <2 m s.l.m.
- = 12595 CH (6%)



Floodplains under investigation



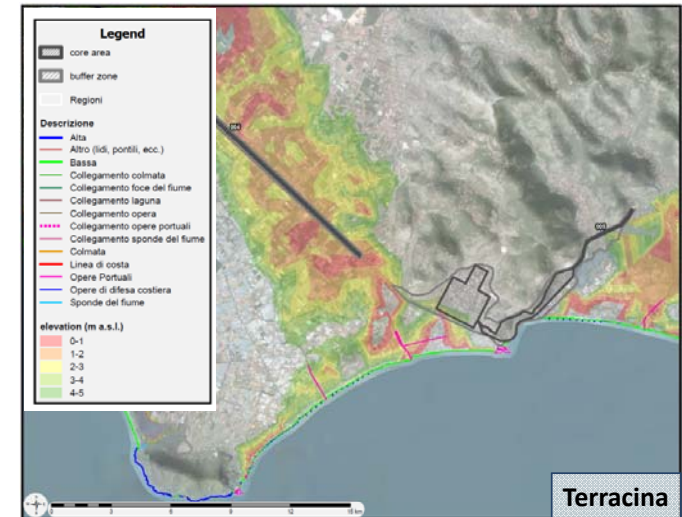
ISPRA-Servizio Geologico d'Italia

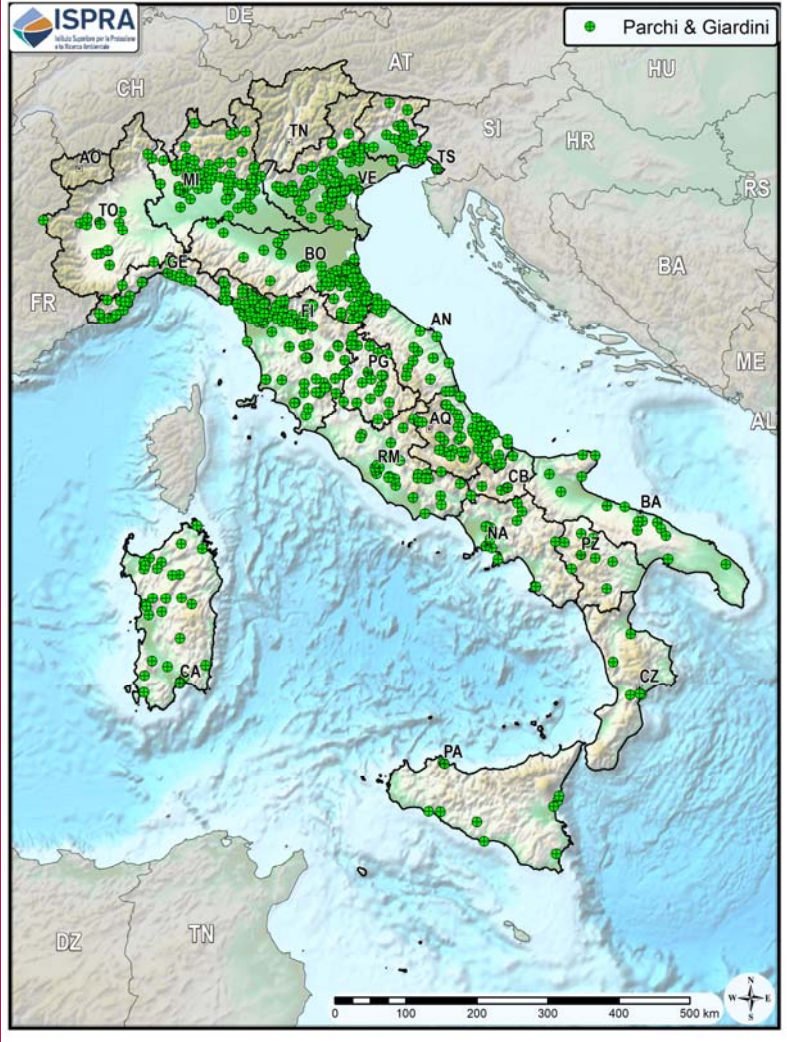


June 27, 2022
 Nord Adriatico
 Scenario 2 (SLR +97cm)
 Scenario 3 (SLR +140cm)
 Scenario 1 (SLR +53cm)

Scale: 1:1,155,581
 0 5 10 20 40 km

Source: ERI, IPIRI, Open, USGS, Inetmap, INCREMENT P, IPIRI, ERI, Japan, MET, ERI, China (Hong Kong), ERI, Korea, ERI, Thailand, ISPRA, ISPRA



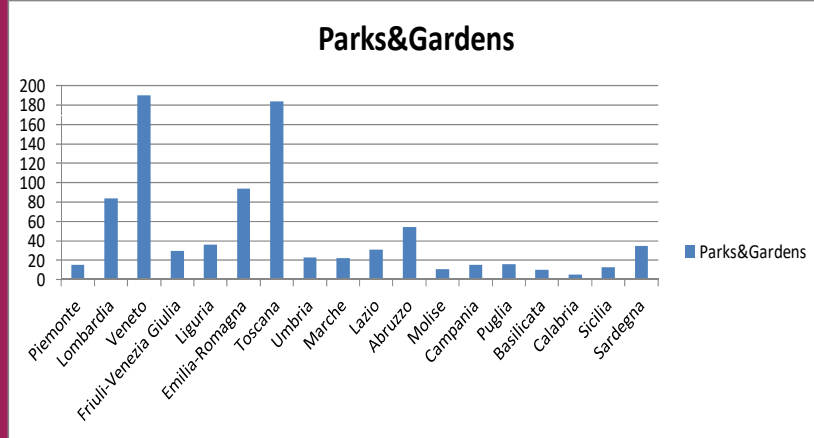


Cultural Heritage of Italian Municipalities Tot. 220.1730

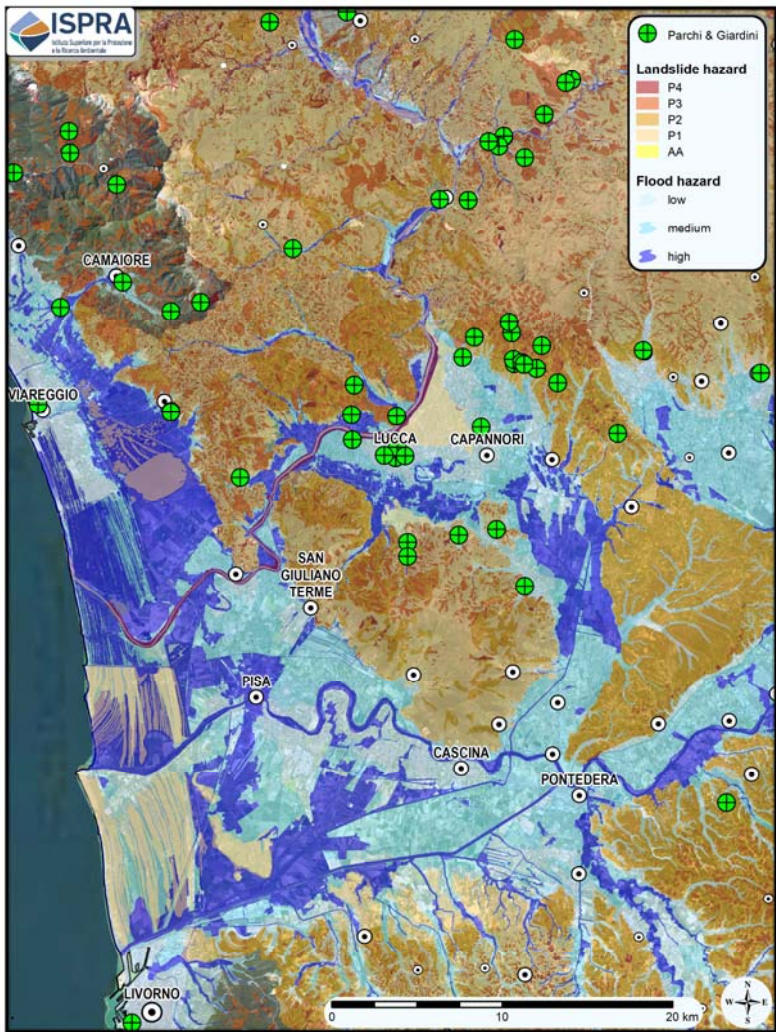
sources:

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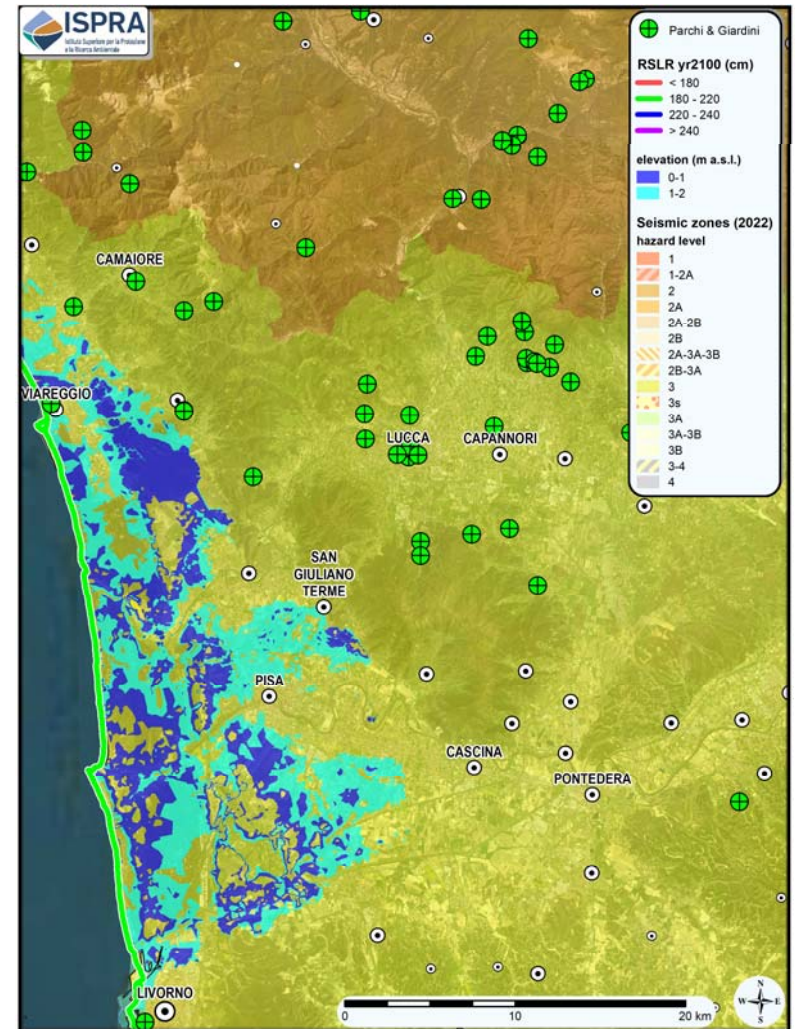
References: Rapporto ISPRa –2021



More than 800 site recorded and collected in Italy

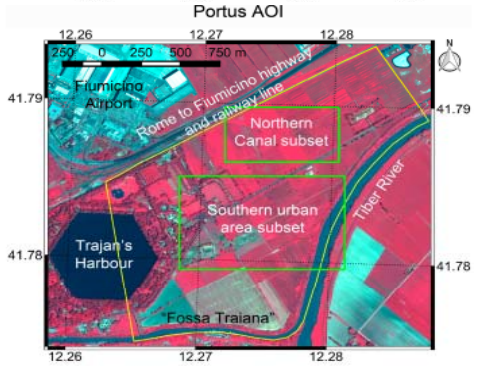
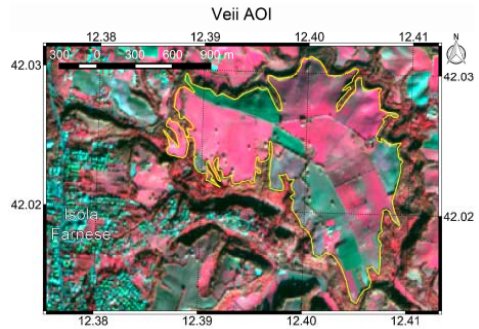


More 330 sites are threaten by seismic hazard (classes 1&2) at national scale

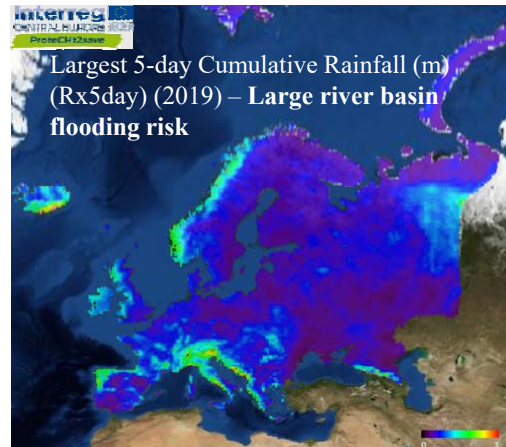
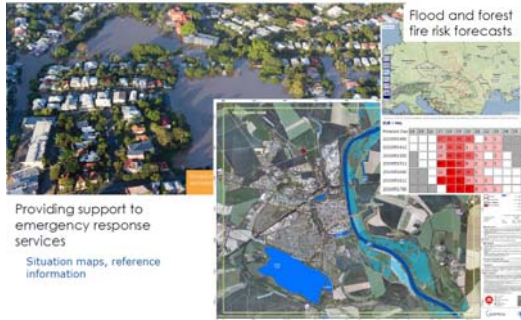


Around 300 sites are threaten by landslide and flood hazard at national scale

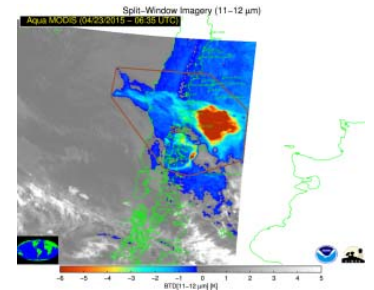
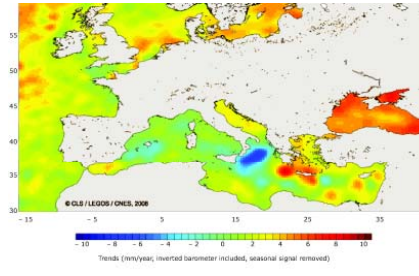
OPTICAL images, from data to downstream services
 (e.g. Multispectral and Hyper spectral analysis)



Land use, change detection and buried sites © ESA - C. Stewart

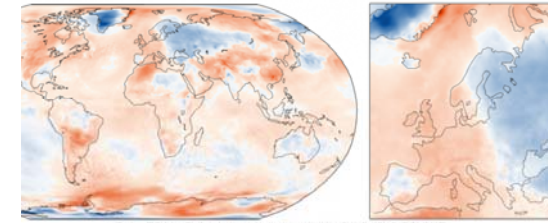


Climate variables and extreme events impact on Cultural Heritage @ ProteCHt2save and STRENCH Projects.



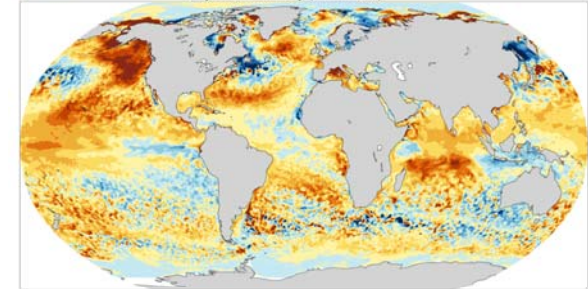
Volcanic Cloud Monitoring website.

Surface air temperature anomaly for September 2021



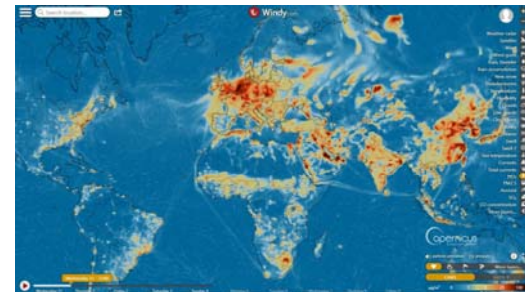
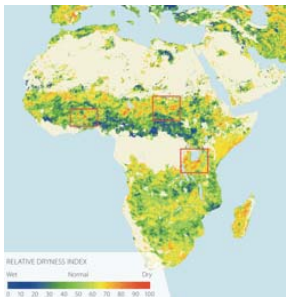
(Data: ERA5, Reference period: 1991-2020. Credit: C3S/ECMWF)
 Copernicus
 ECMWF

Sea Surface Temperature (°C)
 July 2019 anomaly (1993-2016)

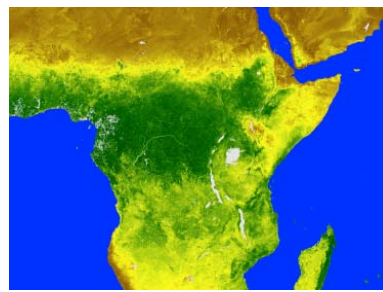


-2 -1.6 -1.2 -0.8 -0.4 0 0.4 0.8 1.2 1.6 2

Ocean Temperature anomaly



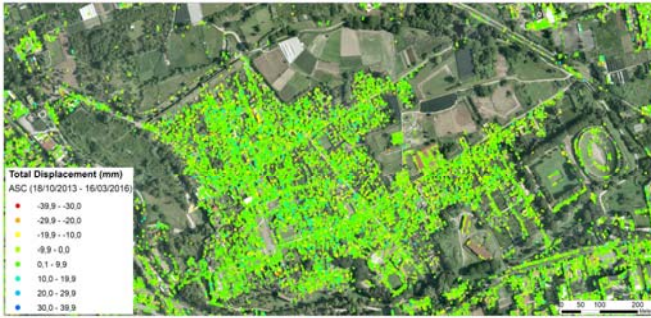
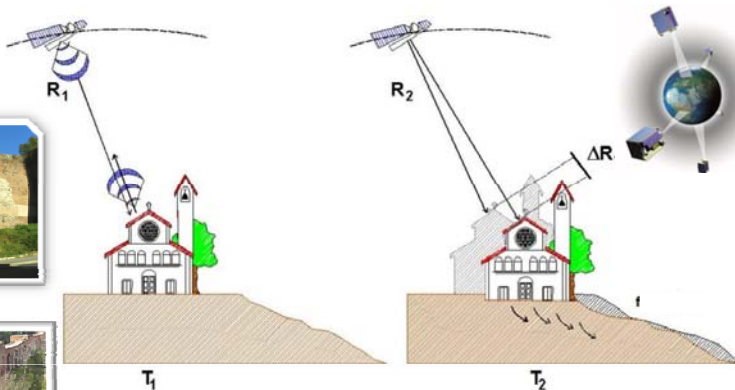
Pollutant concentration © Windy.com



NDVI Vegetation © Copernicus

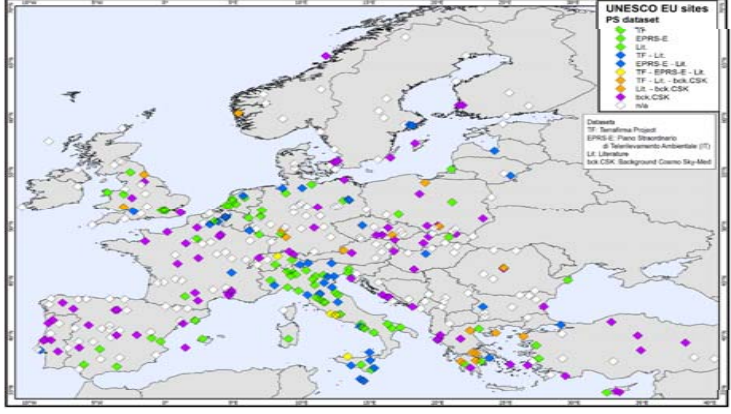
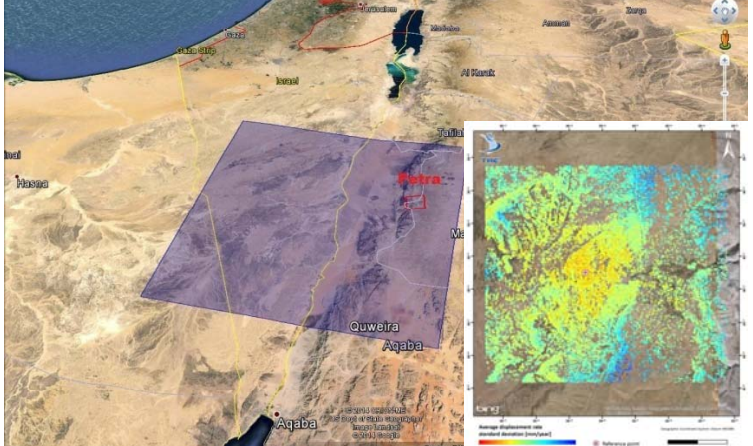
RADAR images, data and products

Differential SAR Interferometry (InSAR or DInSAR)

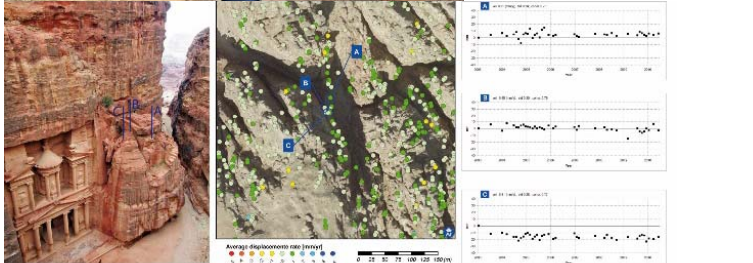
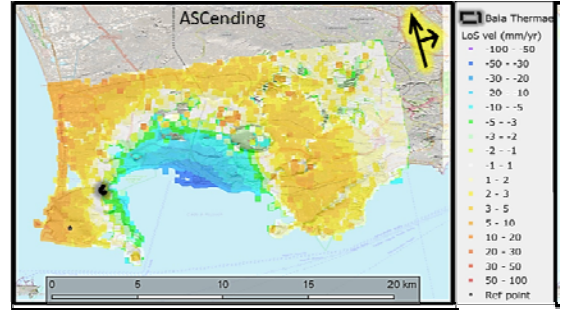


Rome Walls deformation satellite monitoring © Spizzichino

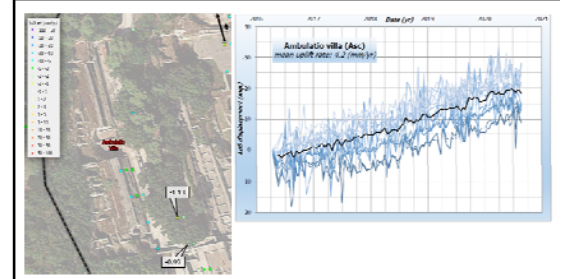
www.prothego.eu collect all the European UNESCO sites where GEO-Hazards and satellite data are already available



Instability processes and SAR data analysis POMPEI



All data after processing, must be calibrated, validate and interpreted by in situ survey in order to be used as support for the mitigation measures



Surface deformation medium-resolution satellite images Petra ©

Subsidence and uplift by satellite analysis PACF Park ©

InSAR ground motion monitoring at national scale

PSTA MITE 1992 - 2014



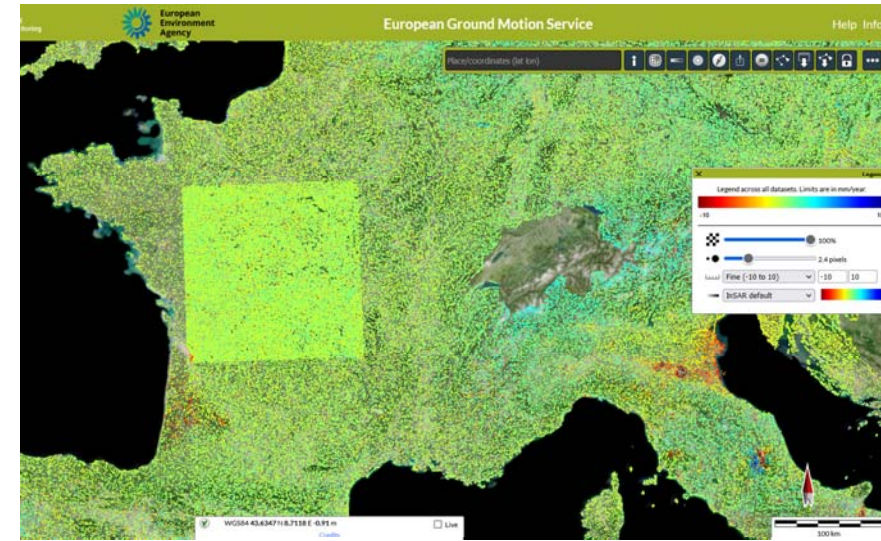
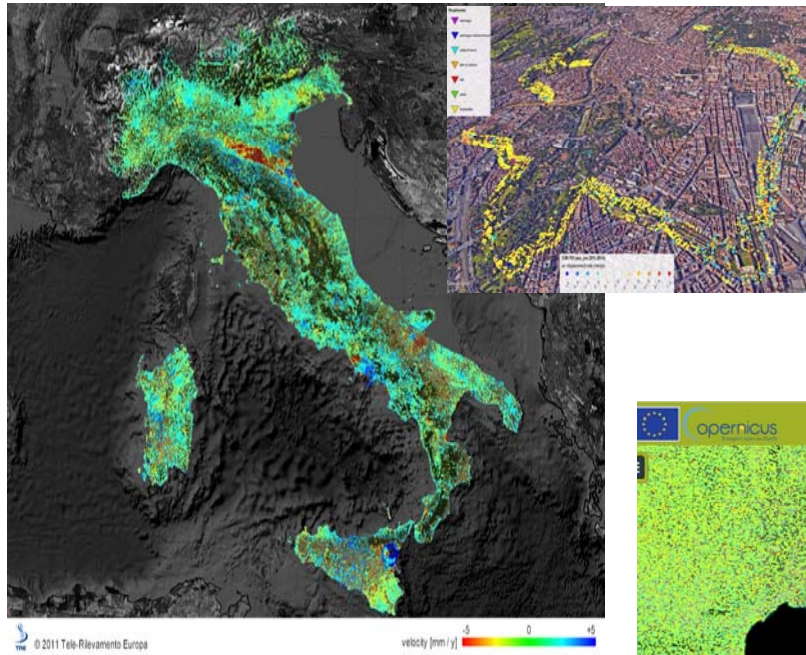
ERS
2008-
-2010



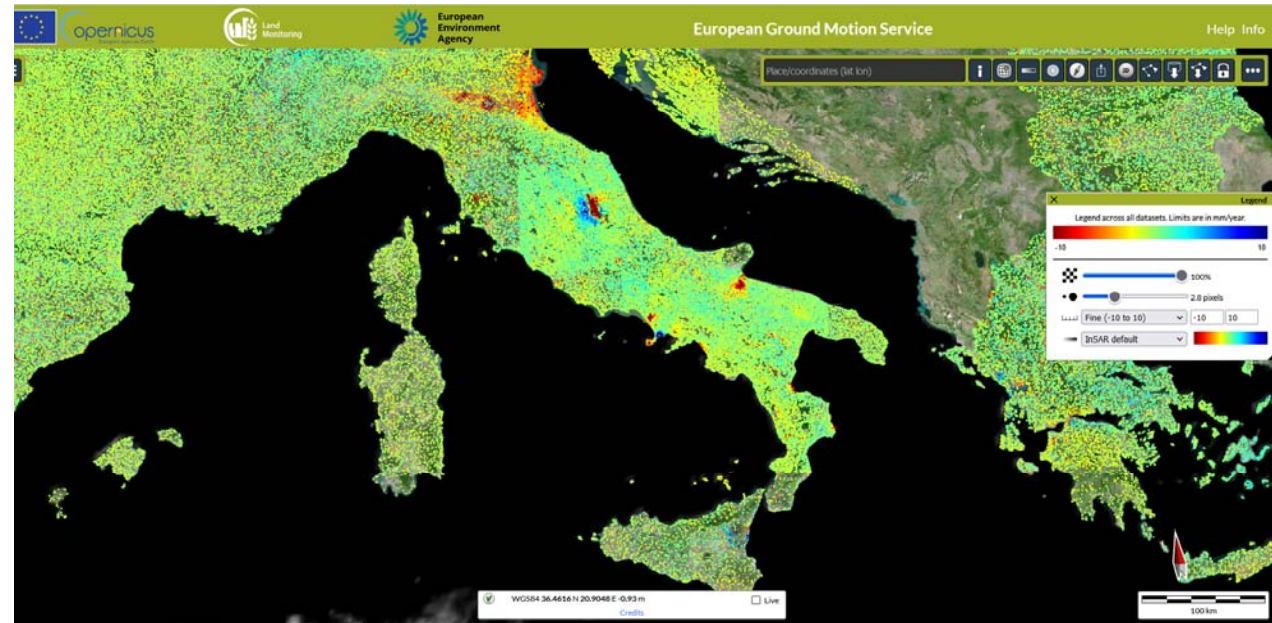
ENVI
2010-
-2012

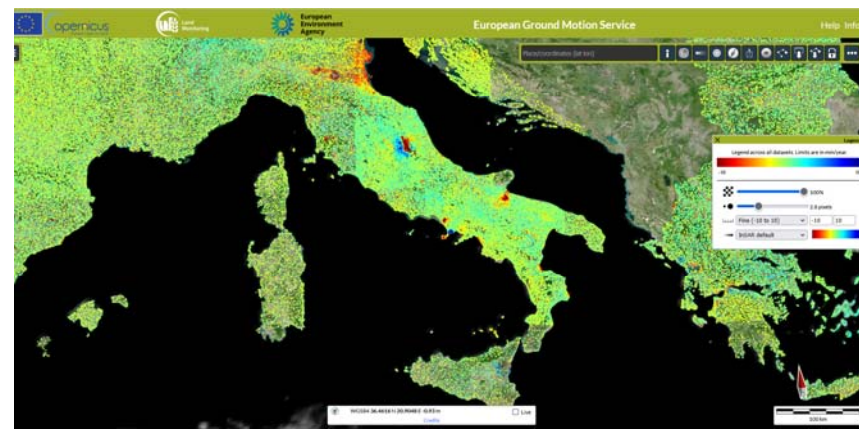
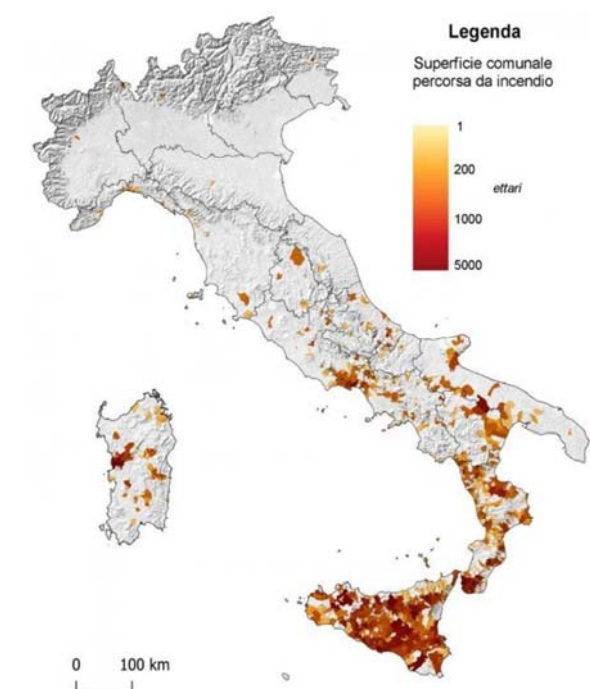
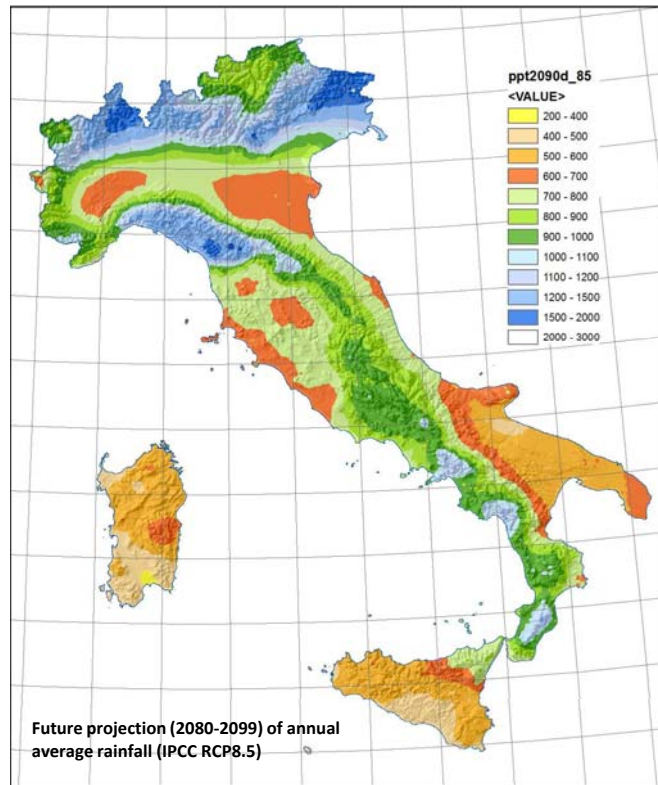
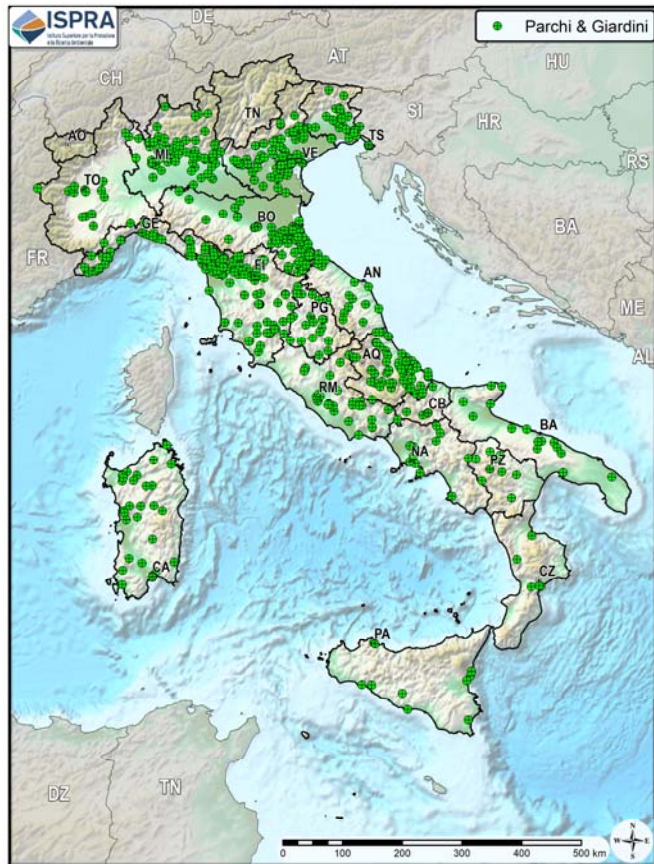


CSK
2011-
-2014



European Ground Motion Service 2022





National PLAN

The Extraordinary Plan for Monitoring and Conservation of Cultural Heritage is aimed at launching AN INTEGRATED SATELLITE-TERRESTRIAL MONITORING SYSTEM that makes it possible to monitor, at different territorial levels, the risk factors and any emergency situations relating to cultural heritage.

TARGET: to assess the CH at greater risk of loss or damage to a monitoring system aimed at allowing the timely start of extraordinary conservation interventions and support the planning and regular maintenance and management

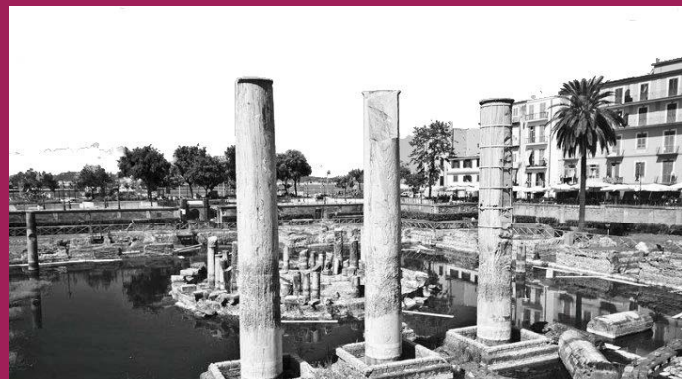
- ✓ Deep Knowledge of CH
- ✓ Maintenance
- ✓ Monitoring and prevention

mitigation
risk

*Conservation and
RESTORATION ACTIVITIES*

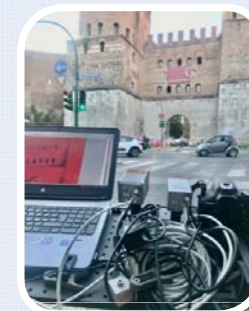
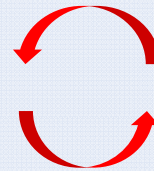
increase
effectiveness

*Residual Risk
Management*



VISION & TARGET

- Carry out an EXPERIMENTAL MONITORING CAMPAIGN of the most vulnerable CH (e.g. towers, bell towers, churches, linear systems, archaeological areas, etc.) INTEGRATING in situ survey and monitoring with EO and SATELLITE MONITORING, possibly also extended to significant surroundings territorial and environmental.



- Prepare **GUIDELINES** and develop INFORMATION AND MANAGEMENT TOOLS, which allow managers or owners of CH (public or private) to ACTIVATE MONITORING, OPERATING PROCEDURES and subsequent CONSERVATIVE and MITIGATION INTERVENTIONS, in relation to the results of the monitoring itself.

STRATEGY

The experimental phase of the **MONITORING** plan will allow to increase the level of **knowledge of the state of conservation of cultural heritage** and of the corresponding exposure factors relating to environmental and anthropogenic hazards, through the acquisition of satellite data, to specific case studies, to define a methodology for elaboration and post-processing of the acquired data.



EO and satellite data
AQUISITION

define

Post processing,
dissemination and
visualisation of data
Downstream service



GENERAL FRAMEWORK AND ROAD MAP

EXPOSE ELEMENTS NATIONAL LEVEL

Digitalisation and geo-localisation of all the site under analysis and investigation (i.e. Parks & Gardens)



HAZARD MAPS NATIONAL LEVEL

FLOOD, LANDSLIDE, SEISMIC, FOREST FIRE, DROUGH, ETC.



RISK MAPS PRODUCTION NATIONAL LEVEL



SATELLITE (EO) AND IN SITU MONITORING NATIONAL PLAN



PROTECTION, SAFEGUARD AND PROTECTION POLICIES (MITIGATION AND ADAPTATION)

Suggestion for the discussion

- Natural and anthropogenic hazards affecting CNH at Euro-Mediterranean due to future climate change;
- Direct and indirect effects;
- Italian Risk maps on CH, their use and application;
- Focus on Parks and Gardens;
- Support on EO and satellite monitoring;
- The Extraordinary Plan for monitoring and conservation of Italian CH



SUMMER SCHOOL WORKSHOP
**ACTION 2020-2-21:
COPERNICUS
FOR CULTURAL HERITAGE**

13-16.06.2023

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

RESPONSABILE SCIENTIFICO:
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SEGRETERIA ORGANIZZATIVA:
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Thanks for your attention!

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