

# Post-disaster Landslide Evaluation and Risk Assessment by using Copernicus Emergency Management Service (CEMS)

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Emergency  
Management

Planetek Hellas



# Earth Observation & Space Systems

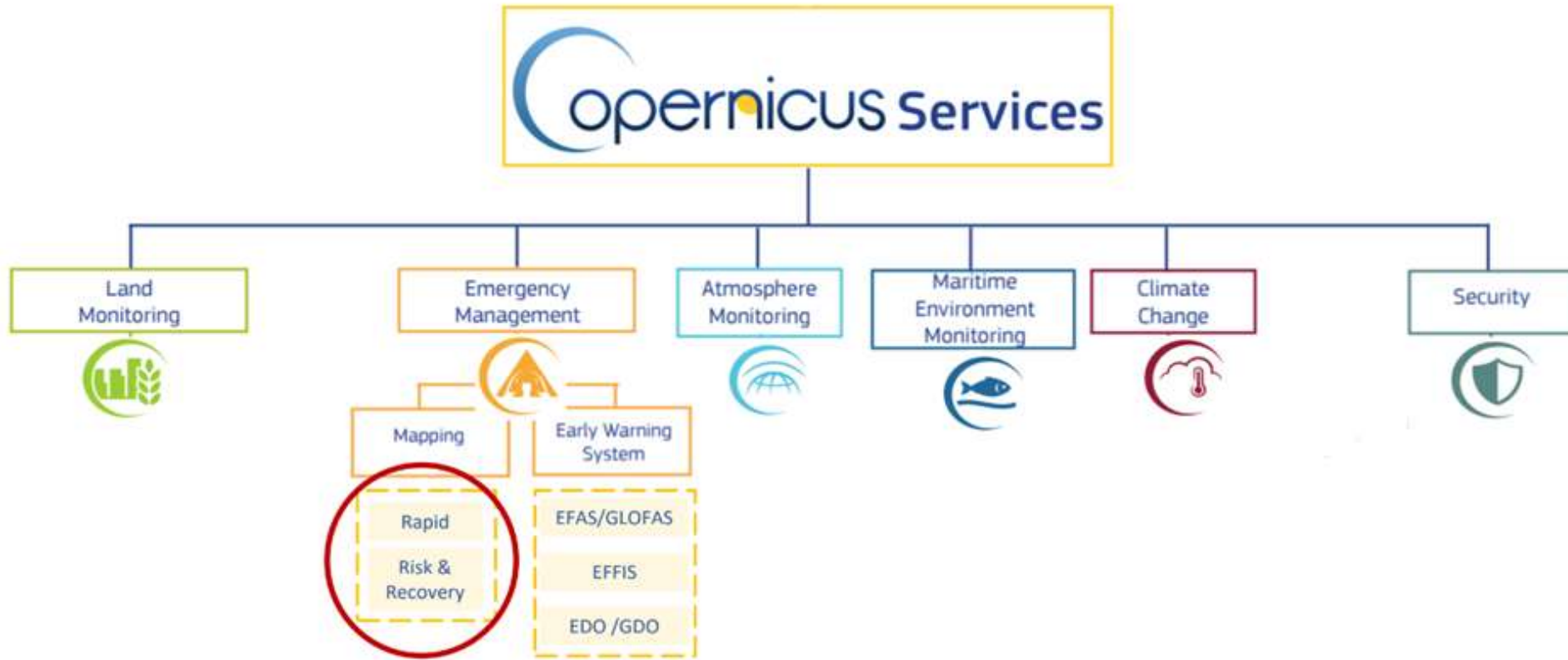
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- E.O. applications for environment & security**
- On Board Payload Data Processing**
- Space Astronomy Data Exploitation**
- Spatial Data Infrastructures & Interoperability**
- Satellite Ground Segment & Data Fusion Centre**



# COPERNICUS Core Services

Emergency Management





## CEMS provides services for:

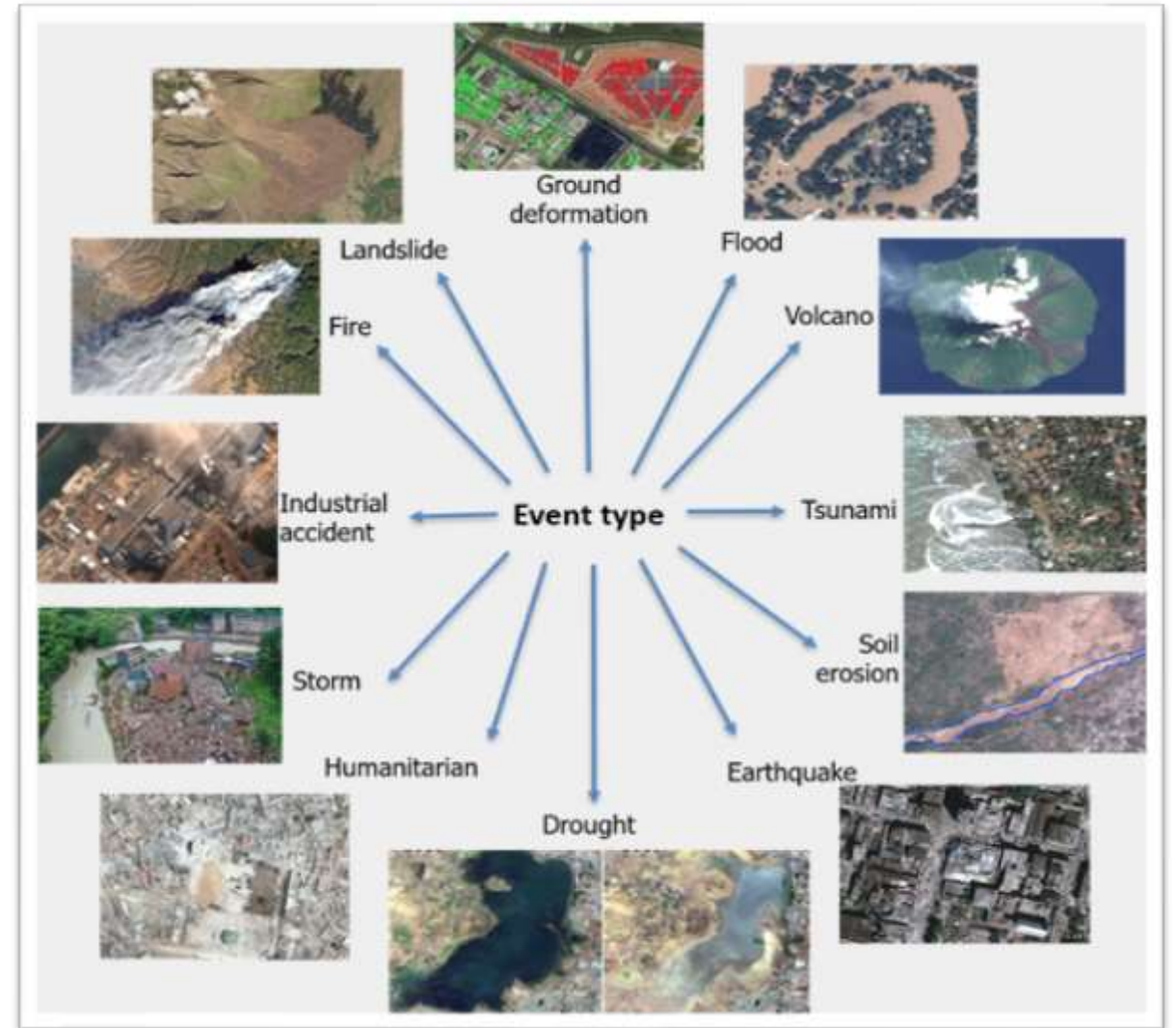
- ❑ Natural / Man-made disasters
- ❑ Emergency situations & humanitarian crises

## Products:

- ❑ Digital maps
- ❑ Geo-spatial data

## Geographic coverage:

- ❑ Global





# On-Demand Mapping Modules

- User driven mapping  
(of specific areas, for a specific disaster event, user defined scale)
- Complementary to national efforts
- Products available online <http://emergency.copernicus.eu/mapping>



## Risk & Recovery Mapping

- During working hours
- Supporting situations which do not require immediate action
- Tailored to user needs  
(case specific)
- Delivery in weeks/months
- Earth Observation and other data



**Preparedness, Prevention, Recovery**

## Rapid Mapping

- 24/7/365
- Highly standardised workflow & products
- Rapid tasking & delivery of satellite images
- Delivery in hours/days
- Only Earth Observation data



**Emergency Response**



Emergency Management

# Risk & Recovery Mapping





- **Reference Maps:** provide comprehensive knowledge of the territory and exposed assets and population.
- **Pre-disaster situation maps:** provide relevant and up-to-date thematic information that can help Civil Protection and humanitarian aid agencies plan for contingencies on areas vulnerable to hazards, aiming to minimize loss of life and damage, e.g. preparing timely response operations, organizing the temporary re-allocation of people and property from exposed locations, and facilitating timely and effective rescue. → **Preparedness**
- **Post-disaster situation maps:** provide relevant and up-to-date thematic information for use beyond the immediate response phase, such as assessing recovery needs, mapping the long-term impact of the disaster event, and monitoring progress in reconstruction efforts. → **Recovery**



## Standard activation (STD)

## Complex activation (FLEX)

Standard products

	Delivery time
<b>Floods</b>	
P04 Flood delineation	5-10 days
P05 Modeled flood extent for major events	5-10 days
P06 Temporal analyses of occurred flood events	2-5 days
<b>Forest fires / Wildfires</b>	
P07 Wildfire delineation and grading	5-10 days
P16 Post-disaster soil erosion risk assessment	5 days
P17 Post-disaster landslide risk assessment	5 days
<b>Damage assessment and reconstruction monitoring</b>	
P08 Detailed damage assessment analyses over affected areas	5-15 days
P09 Reconstruction monitoring	5 days
<b>Impact assessment/exposure after disaster</b>	
P14 Impact assessment/exposure analyses on asset and population	3 days
P15 Detailed impact assessment/exposure analyses on selected aspect	3 days
<b>Humanitarian crisis</b>	
P10 City growth analysis	2-3 days
P11 Human footprint evaluation of cities through nightlight analysis	2 days
P18 Human settlements mapping	5-10 days
P19 Population displacement location/monitoring	5-10 days
<b>Ground deformation</b>	
P12 Ground deformation analyses	5-7 days
<b>Reference data</b>	
P02 Reference dataset	5-15 days
P03 Land use and land cover dataset	5-15 days
P20 Detailed reference dataset for high-importance areas	5-15 days
P01 Digital Surface Model	5-10 days
<b>Map layouts for printing</b>	
P13 Ready to print maps and map books for field campaigns	2-3 days

Products based on users' needs

### Natural hazards

- Earthquakes
- Volcanic activity
- Tsunamis
- Soil/coastal erosion
- Floods
- Landslides
- Wave action, storm surge and coastal flooding
- Tropical cyclones
- Droughts
- Wildfires
- Ground deformation
- Windstorm
- Multi-risk

### Man-made hazards

- Chemical releases
- Industrial accidents
- Conflicts

### Reference and Preparedness

- Hazard
- Exposure
- Vulnerability
- Risk
- First Aid (Safe locations, shelters, evacuation routes, accessibility to rescue areas)
- Mitigation measures
- Assets Mapping
- Population estimates

### Post-event

- Delineation
- Grading
- Damage assessment
- Reconstruction monitoring
- Vegetation recovery
- Change detection



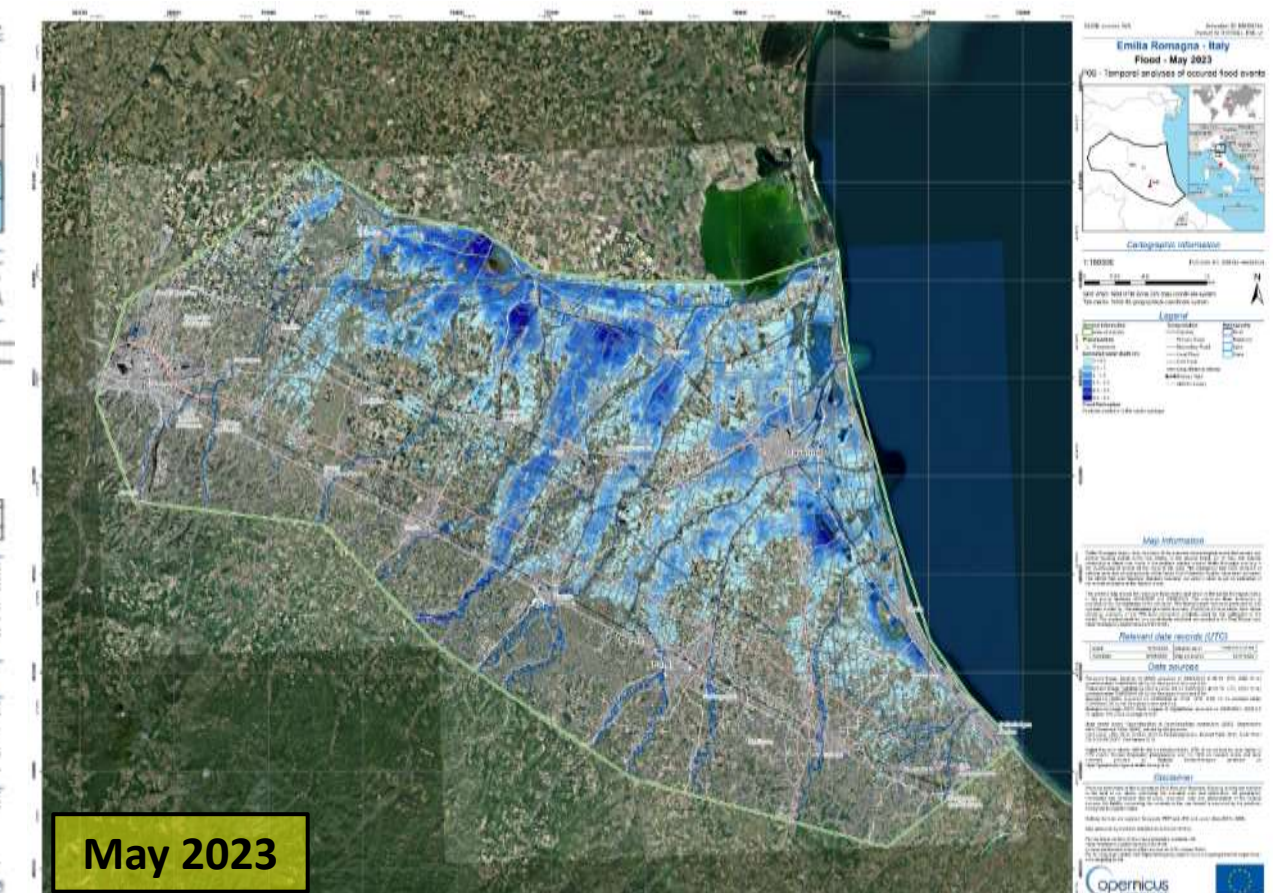
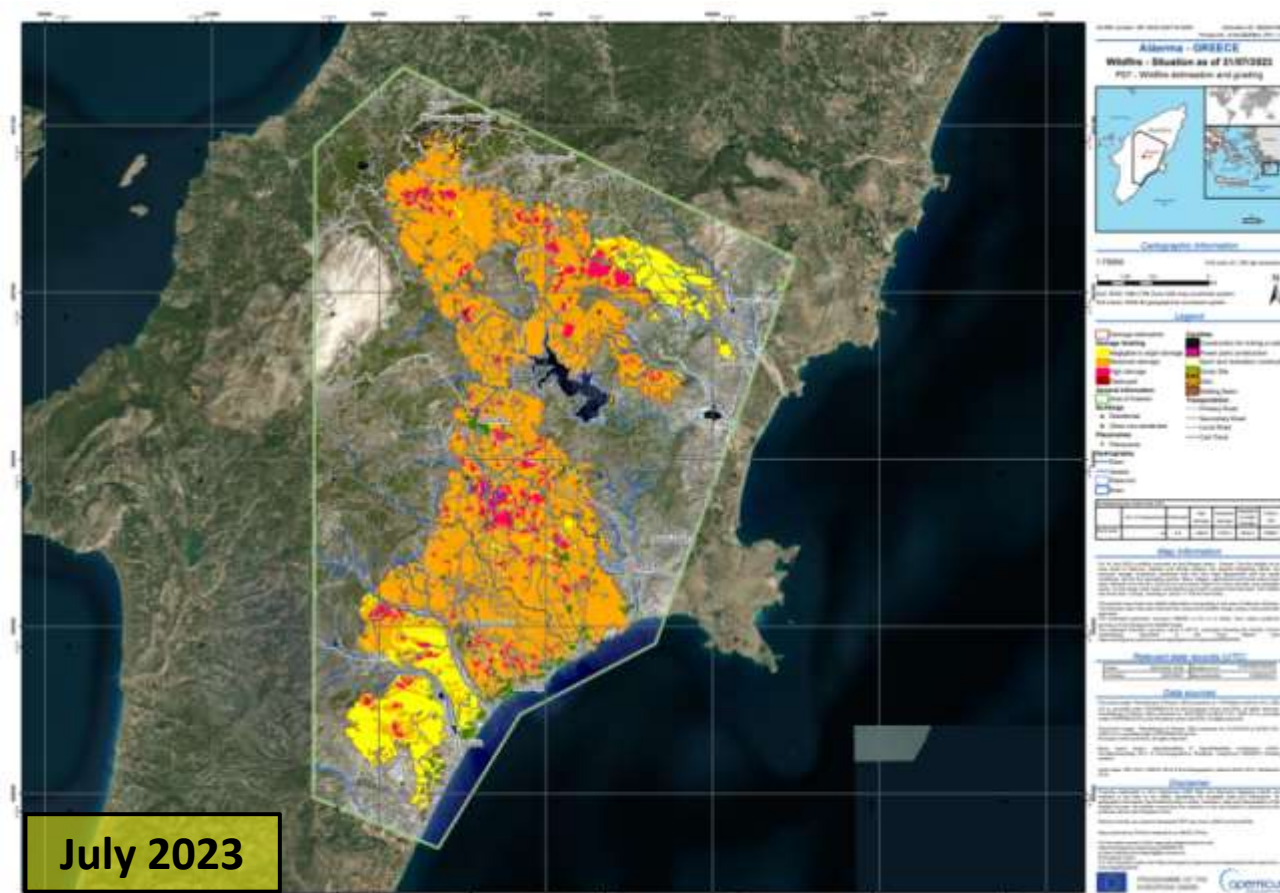


# EMS RRM : Standard Products

Emergency  
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- **EMSN159:** Wildfire in Rhodes Island, Greece
- **P07:** Wildfire Delineation and Grading

- **EMSN154:** Flood in Emilia Romagna, Italy
- **P06:** Temporal analyses of occurred flood events



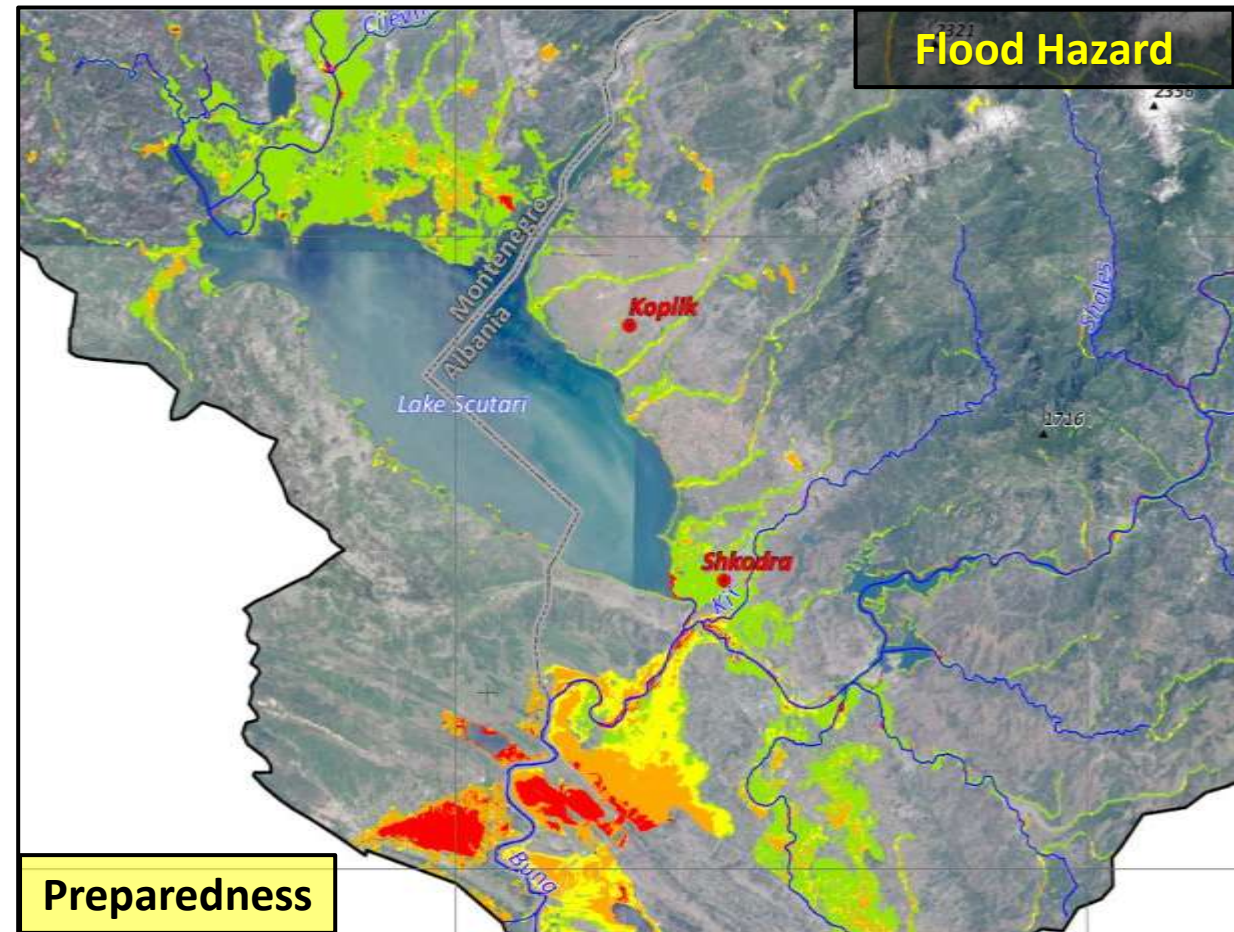
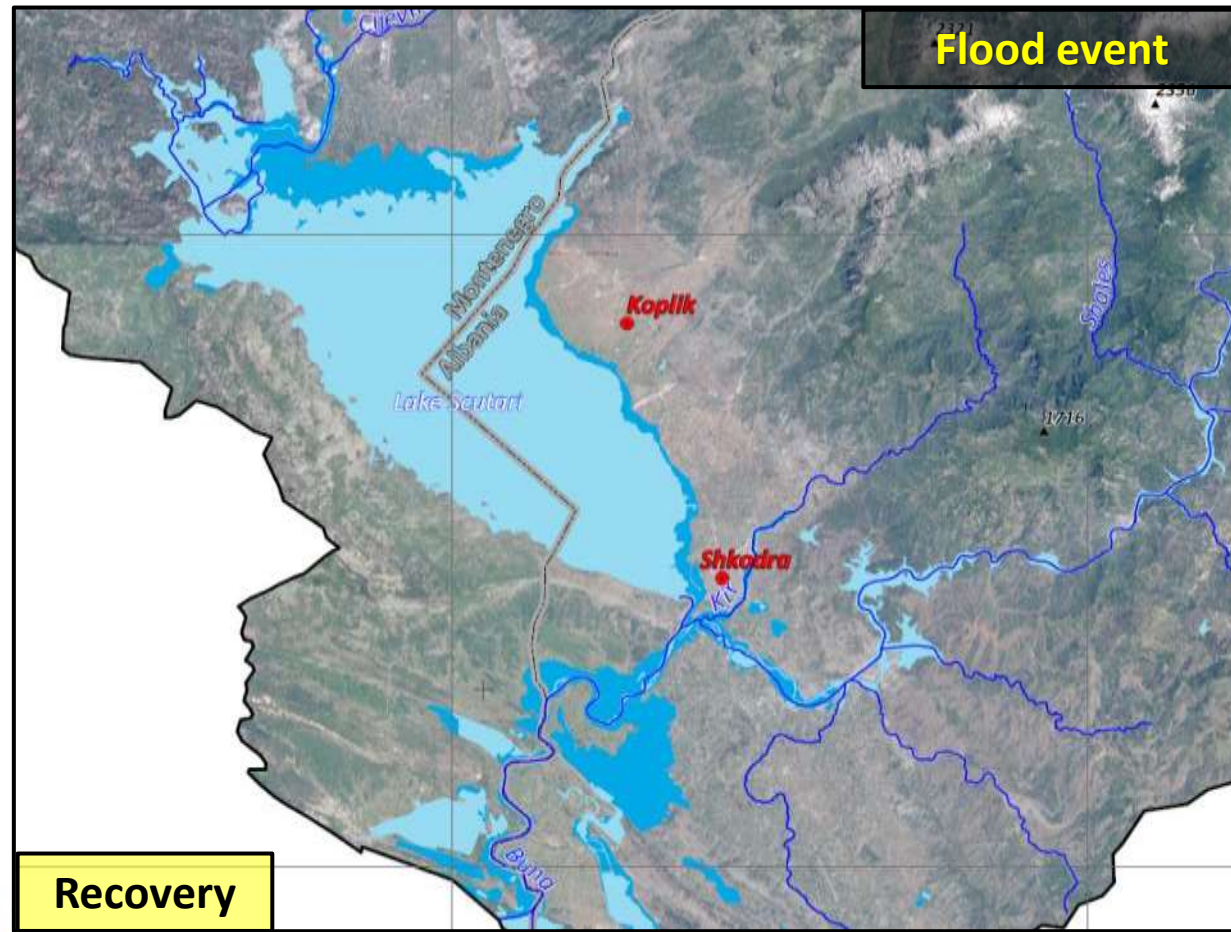


# EMS RRM - FLEX: Flood event

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Management

- Mapping of affected areas
- Damage assessment, Reconstruction monitoring

- Monitoring of the event over a period of time
- Hazard, Exposure, Risk maps





Emergency Management

# Risk & Recovery Team





Emergency  
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# EMS RRM - The industrial FLEX consortium

- 6 companies from 6 European countries:
  - Spain
  - Italy
  - Greece
  - Austria
  - Czech Republic
  - Belgium





Emergency  
Management

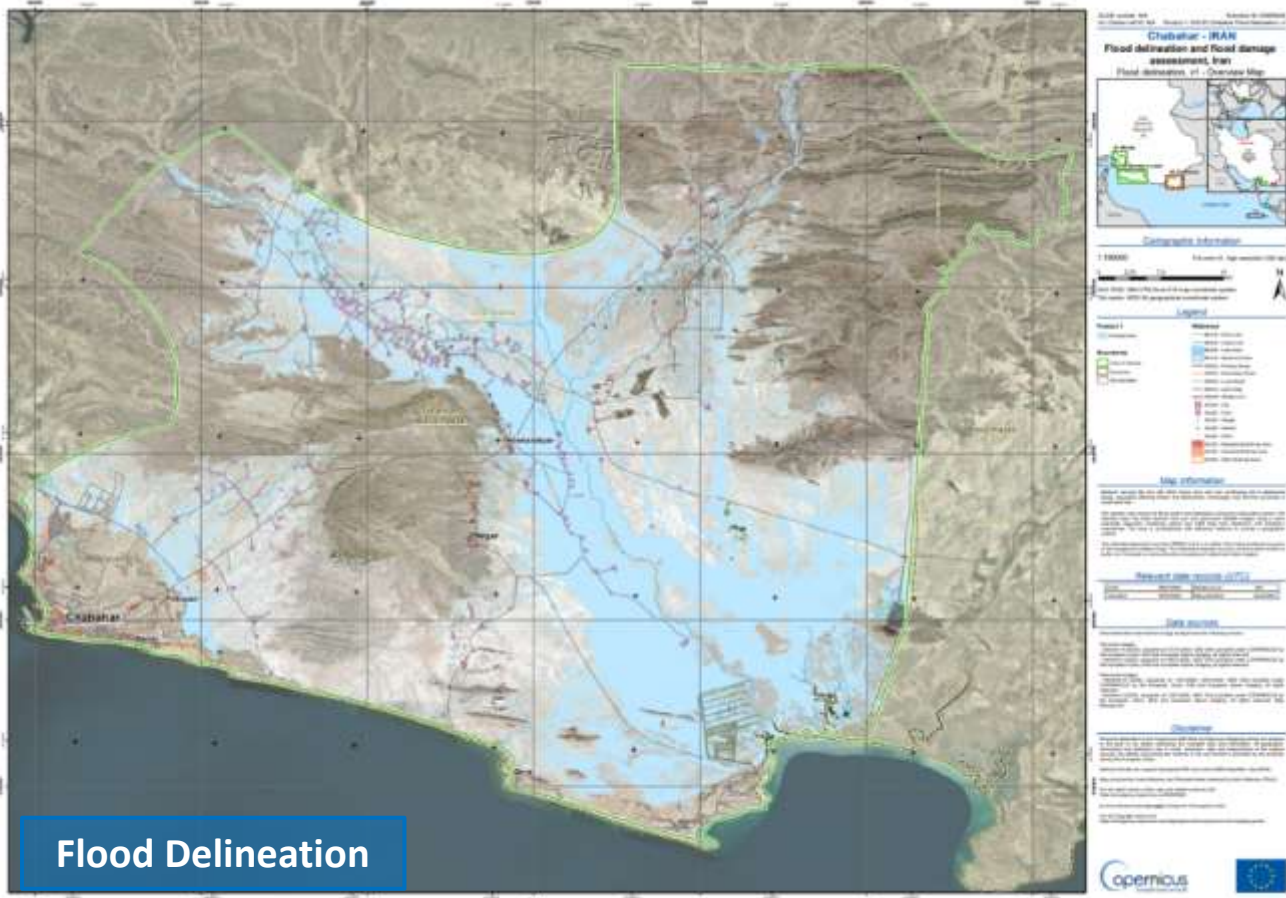
## EMS RRM – Planetek's Experience

Activation	Description
EMSN066	Flood delineation and flood damage assessment, Iran
EMSN093	Rockfall risk analysis in Valle Gran Rey, La Gomera (Spain)
EMSN096	Damage assessment and reconstruction monitoring of urban areas in Syria
EMSN142	Post-disaster evaluation and preparedness analysis of landslide risk in Ischia, Italy
EMSN146	Damage assessment and recovery support after the 2023 earthquake in Syrian affected areas



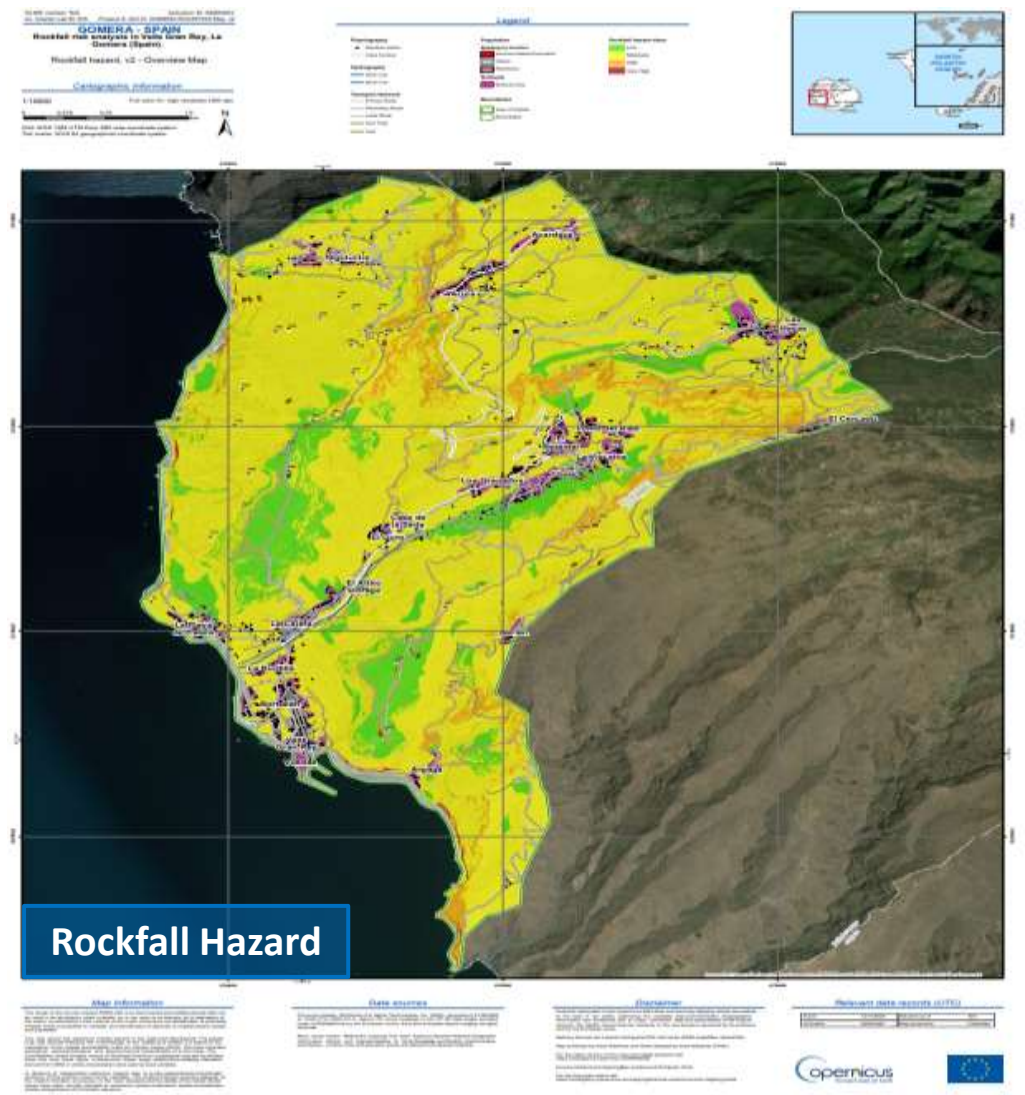
# EMS RRM - FLEX: Planetek's Activations

Emergency Management



Flood Delineation

EMSN066: Flood delineation and flood damage assessment, Iran



Rockfall Hazard

EMSN093: Rockfall risk analysis in Valle Gran Rey, La Gomera, Spain



Emergency Management

# EMSN142

## Post-disaster evaluation and preparedness analysis of landslide risk in Ischia, Italy





## EMSN 142 – Landslide in Ischia Island (Italy)

- **Event:** Landslide disaster, result of continuous heavy rainfall. More than 120 mm of rain in 6 hours was recorded.
- **When?** 25-26 November 2022
- **Where?** In the municipality of Casamicciola, on the island of Ischia, in the Campania region (Italy).
- **End User:** The Italian National Department of Civil Protection
- **Objective:** a) to support the evaluation of the post-disaster consequences of the landslide and b) to provide useful geospatial data for a preparedness analysis of Ischia island.
- **Type of activation:** Post-disaster, FLEX



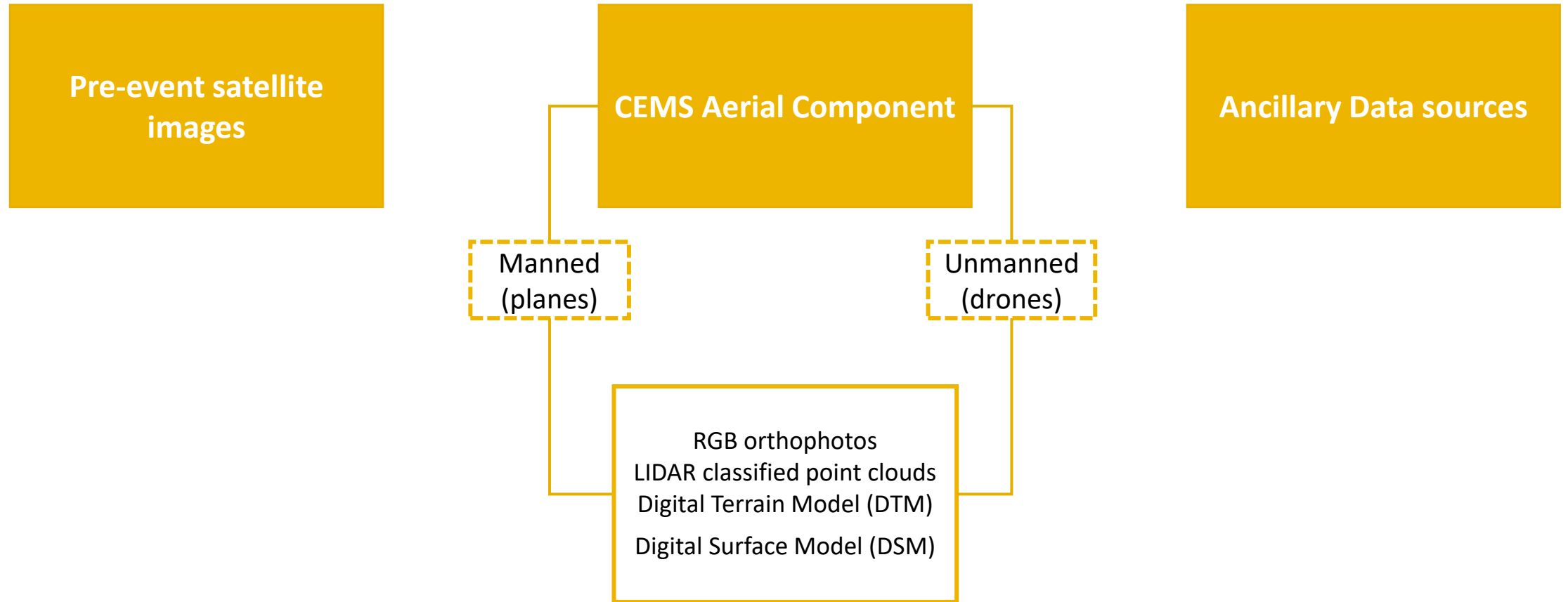




# E M S N 1 4 2 – Landslide in Ischia Island (Italy)

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## Data

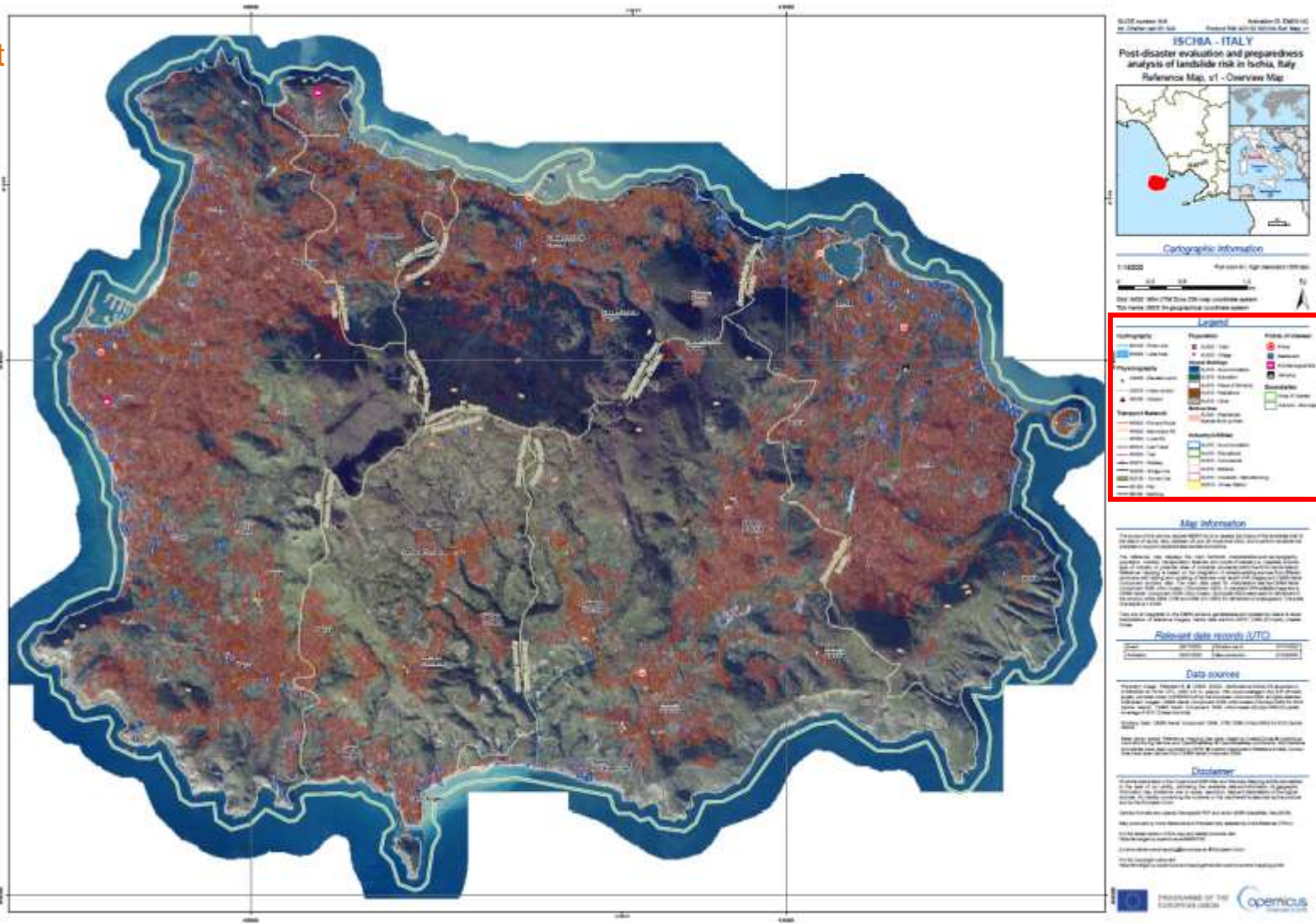




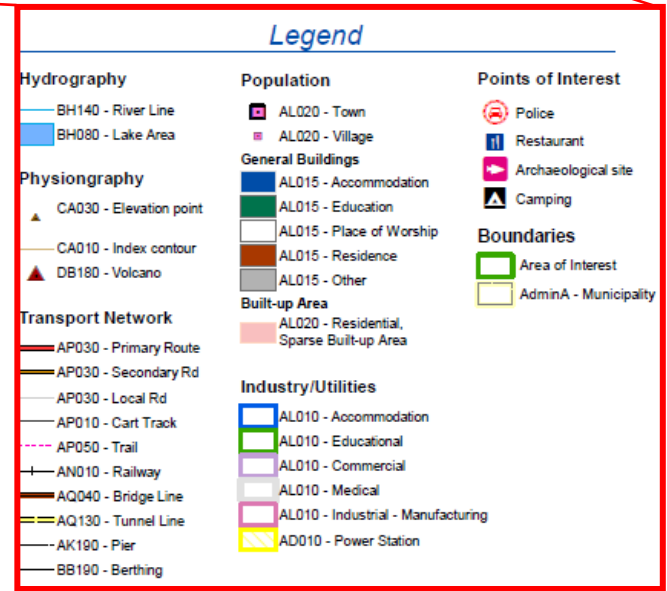
Emergency Management

# EMSN 142 – Landslide in Ischia Island (Italy)

## Updated reference mapping



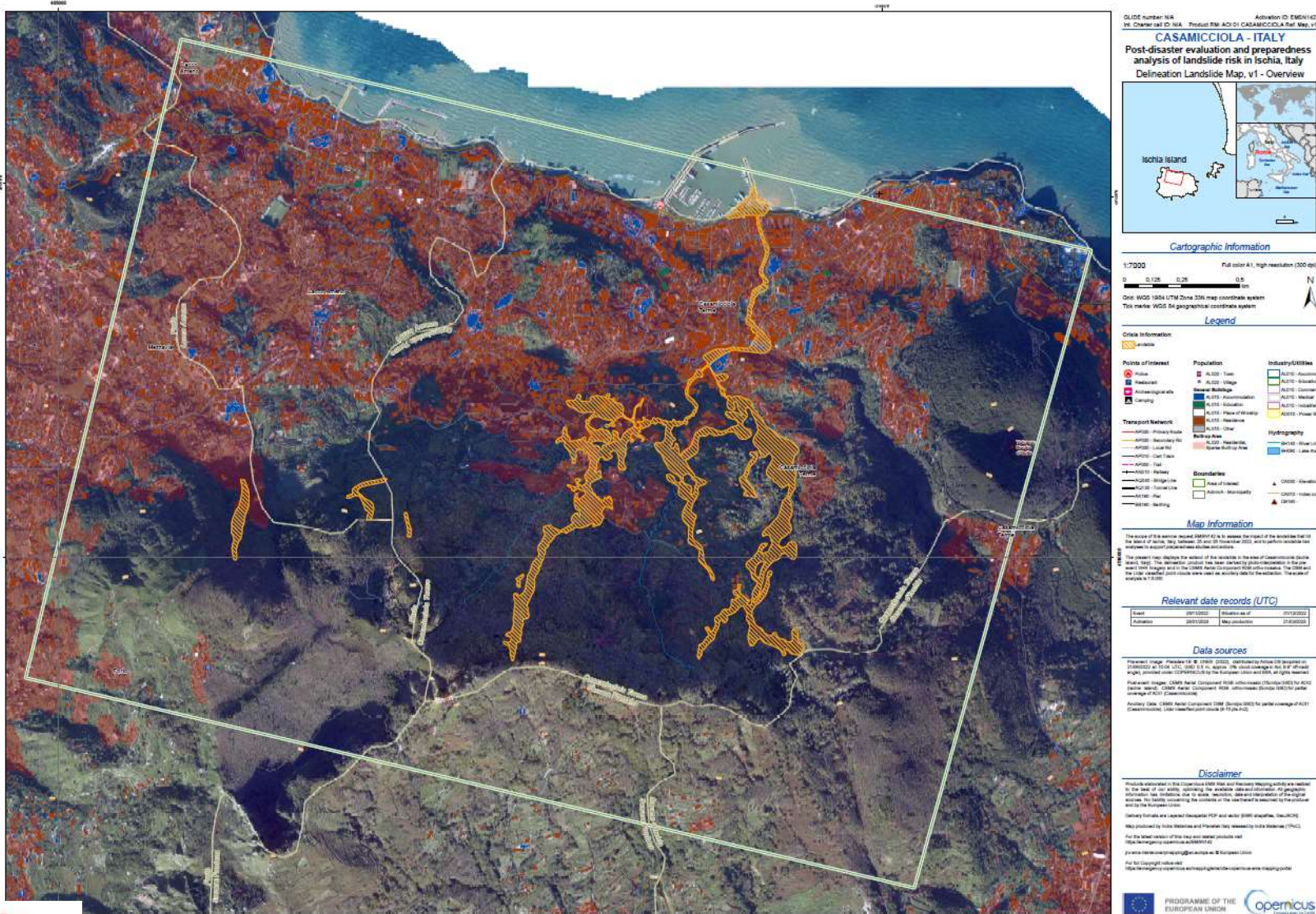
Topography, Population, Industry, Transportation features, Points of interest (i.e., hospitals, schools, and type of industry)





# E M S N 1 4 2 – Landslide in Ischia Island (Italy)

## Delineation of the landslides that affected the area during the event



Three-step procedure, including:

- extraction and detailed delineation from RGB orthophotos,
- use of LIDAR classified point clouds for affected spots with inaccurate spectral imaging
- refinement through photo-interpretation using DTM and DSM.

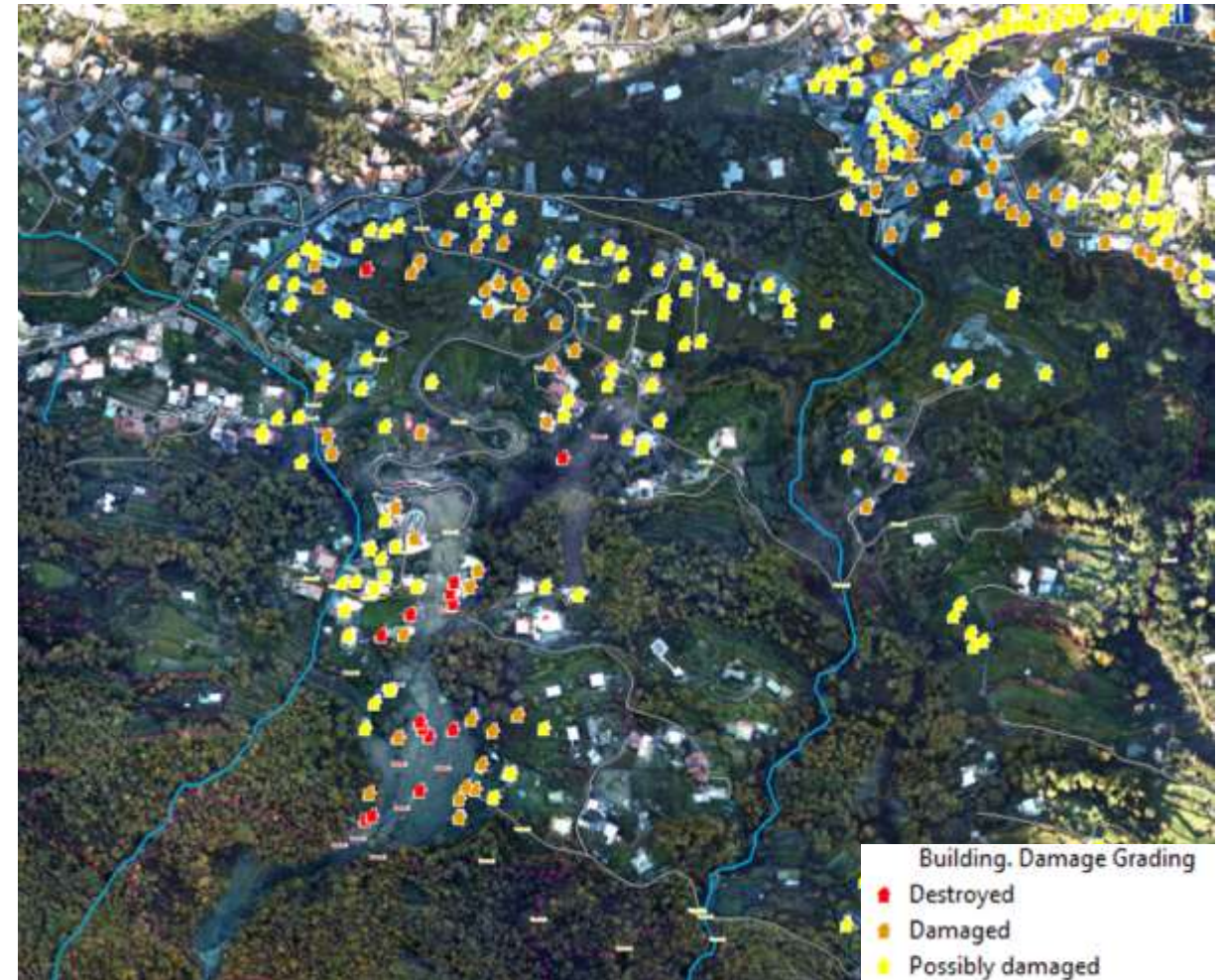
the deposition of mud was detected to lower altitude areas



## Detailed damage assessment

The assessment aimed to estimate the damages to critical infrastructure caused by the storm and landslides, and the layers assessed included the Transportation Network, Buildings, and Facilities.

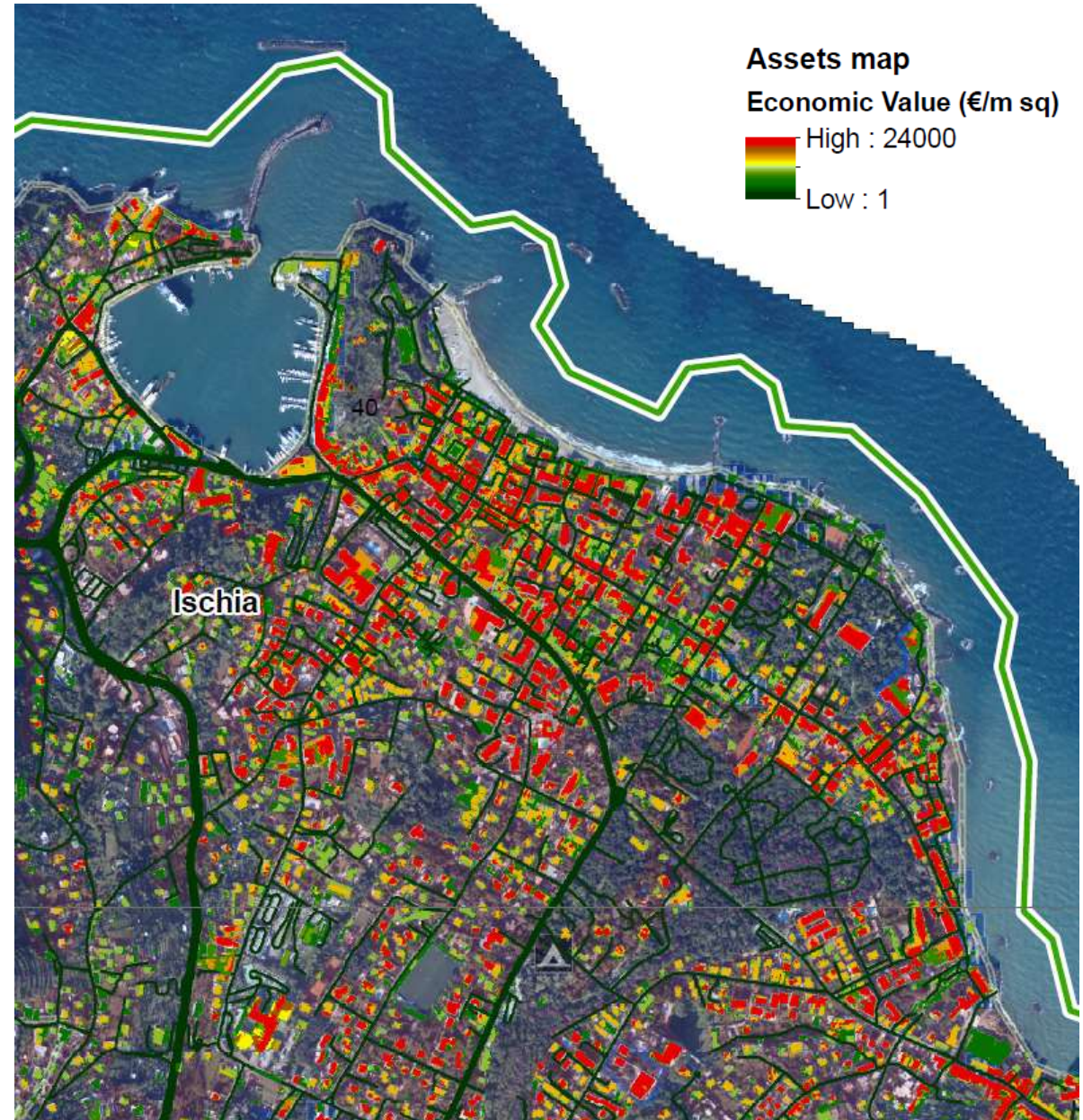
Assessment consisted of five grading classes: **Destroyed**, **Damaged**, **Possibly Damaged**, **No visible damage**, and **Not analyzed**.





## Assets Map

- Monetary value of tangible assets such as buildings and infrastructures, in €/m<sup>2</sup>.
- The map was produced using the Basic European Assets Map (BEAM).
- Buildings' values were calculated using construction costs in Italy, with adjustments applied to estimate the present value of the depreciated building.
- The value of content was considered for each building based on the area dedicated to residential, commercial and industrial uses.





## Estimation of economic consequences

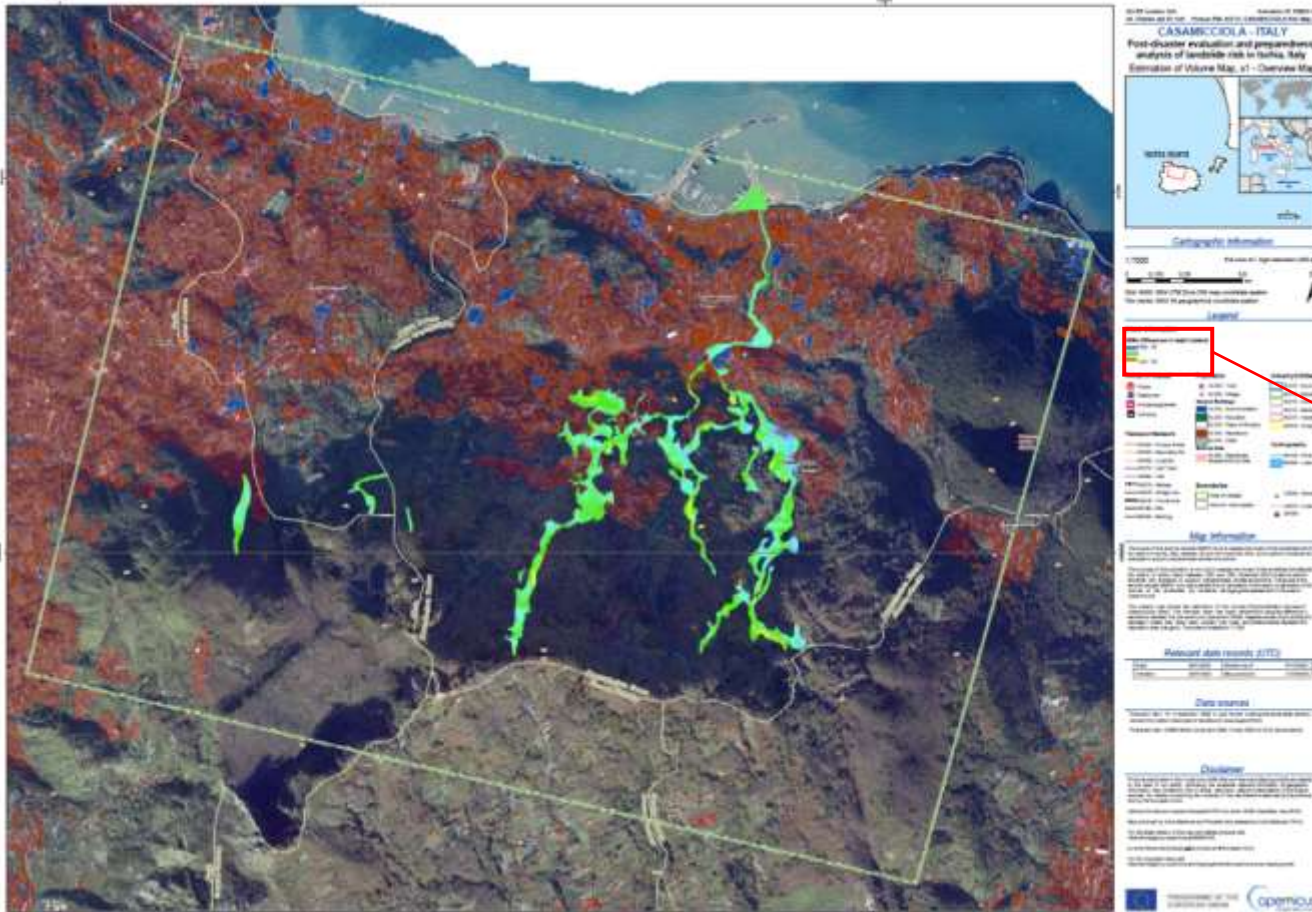
- Economic consequences of the affected infrastructures in the area of the landslides
- Combination of the Detailed Damage Assessment of landslides with the Assets map
- Summing all the economic values of the affected assets weighted by their damage degree





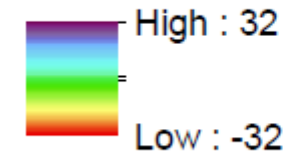
## Estimation of the volume of the landslides

Comparison of pre- and post- event DEMs to estimate the volume of mass moved during the landslide



Negative and positive values in the grid subtraction represent areas that have been eroded and deposited, respectively

**DEM's Differences in height (meters)**





# E M S N 1 4 2 – Landslide in Ischia Island (Italy)

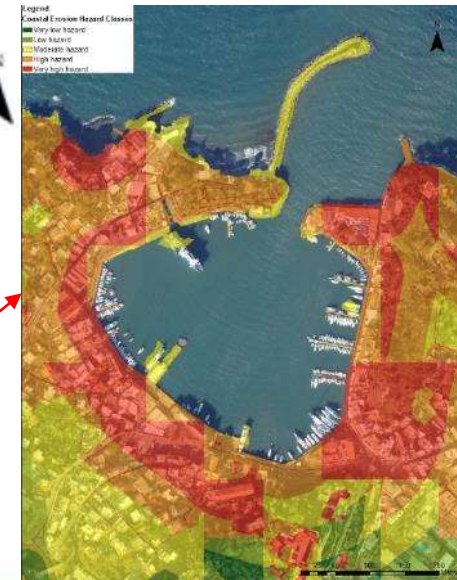
## Coastal erosion hazard analysis

Applied to all areas located 500m from the coastline and extended to areas lying under 20m

**Physical Vulnerability Index (PVI)** → computed based on variables such as adjusted geomorphology, shoreline change, slope, relative sea-level change, mean significant wave height, and mean tidal range.

**Socio-economic Vulnerability Index (SVI)** → computed based on variables such as Population, Land Use, Road network, Cultural heritage, Ports, Coast proximity.

**Coastal Vulnerability Index (CVI)** → includes physical and socioeconomic parameters. Vulnerability scale ranging from very low to very high.



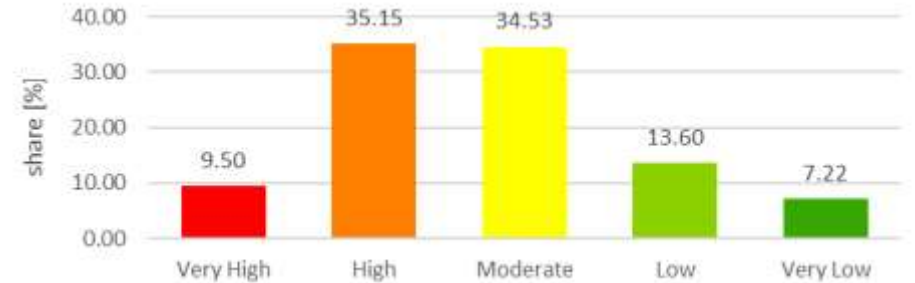




## Landslide hazard assessment

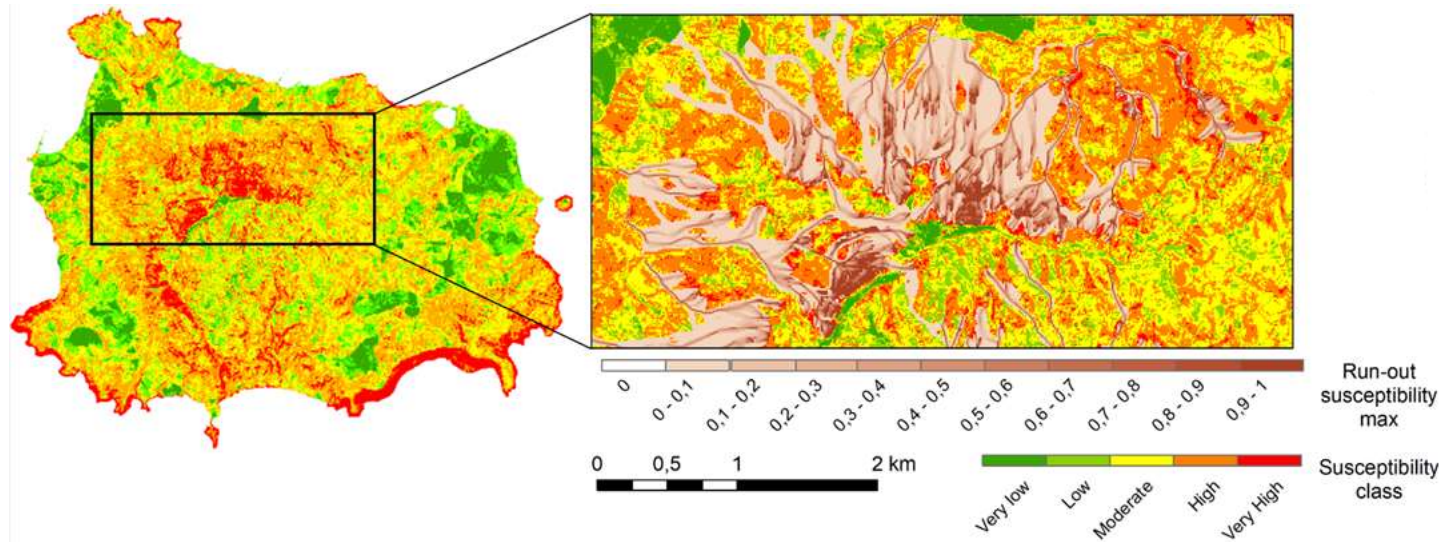
Landslide susceptibility modelling and analysis of triggering precipitation factor

- Landslide Susceptibility Model using Artificial Neural Network approach
- Statistical analysis of historical landslides in Campania and previous precipitation
- Modelling of run-out zones



Landslide Susceptibility classes on Ischia Island

➔ 5 landslide susceptibility classes



Main factors resulting to landslide:

1. High slope
2. Unstable and permeable bedrock
3. Closeness to geological faults
4. Absence of vegetation cover



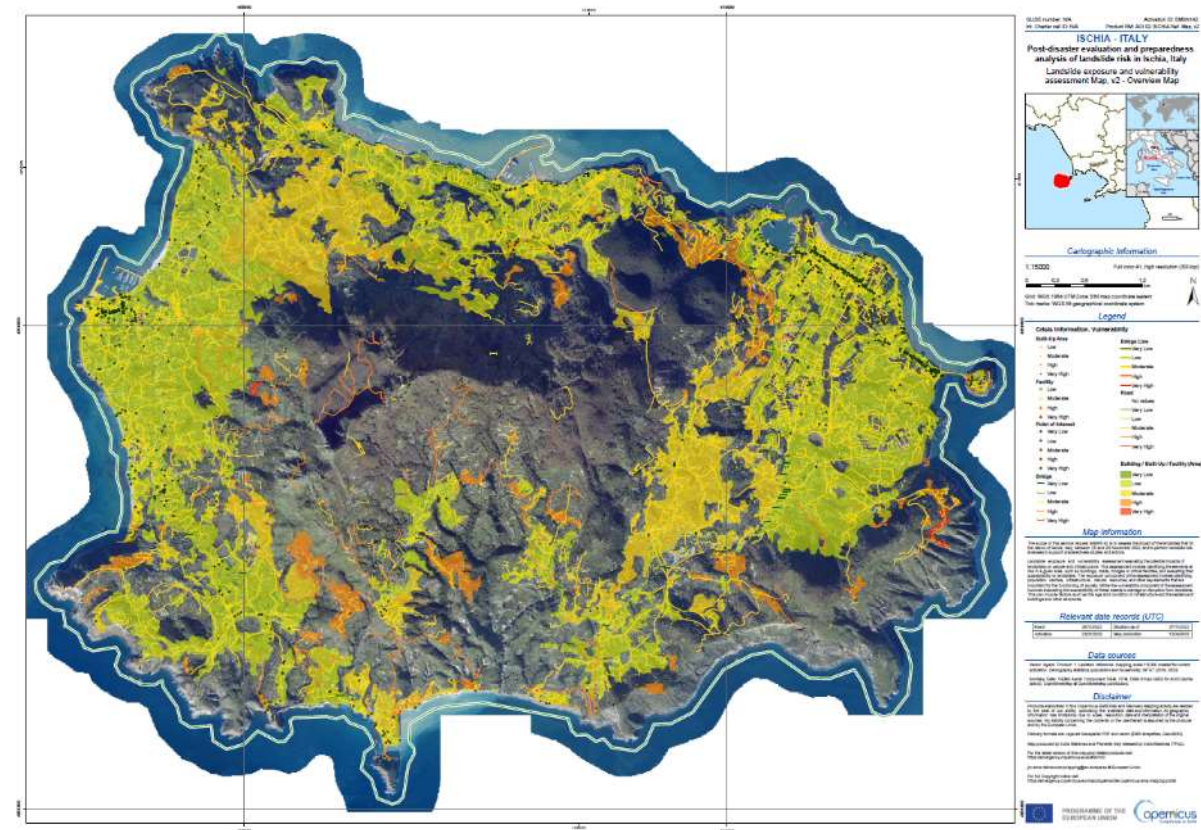
## Landslide exposure and vulnerability assessment

- Estimated number of guests per hotel based on building size
- Comparing low and peak season

Data: Residents, tourists and hotel guests before the pandemic in 2019 (ISTAT), not including daily visitors

municipalities	number of residents	number of accomodation establishments	bed-places in hotels	guests per hotel in peak season
Baranod'Ischia	9980	15	954	64
CasamicciolaTerme	7620	57	3371	59
Forio	17450	103	7694	75
Ischia	19640	82	7831	96
LaccoAmeno	4576	15	1742	116
SerraraFontana	3061	31	1412	46
total	62327	303	23004	-

*Residential and accommodation statistics for the municipality*





## Landslide risk assessment

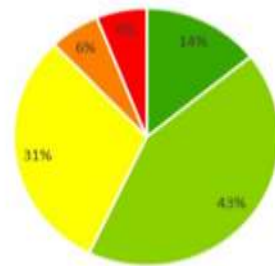
- RISK = HAZARD x EXPOSURE x VULNERABILITY
- Variables: Buildings, Build up areas, Facilities, Roads, Bridges, Points of interest
- Overall risk values were manually divided into 5 intervals according to the calculated values: 1-2: very low (1), 3-8: low (2), 9-18: moderate (3), 19-27: high (4), and 27+: very high (5)

Risk classes / type of element	1	2	3	4	5	Total
BridgeL	7	21	15	3	3	49
BuildA	3628	10440	5890	140	25	20123
BuildupA/P	2	31	66	10	24	133
FacilA/P	0	6	6	11	7	30
PoiP	86	406	220	80	100	892
RoadL	24	1711	1580	72	87	3474
Total	3747	12615	7777	316	246	24701

Risk results are classified (1: the lowest, 5: the highest) for individual interested elements

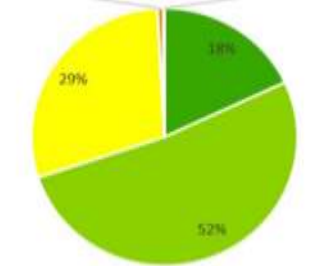
➔ Overall, most elements belong to the risk class 2 (low), 3 (moderate) and 1 (very low)

BridgeL: Elements at risk.



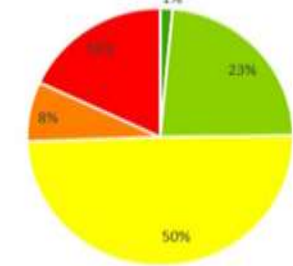
Very low Low Moderate High Very high

BuildA: Elements at risk.



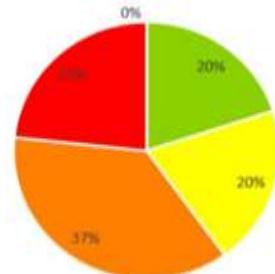
Very low Low Moderate High Very high

BuildupA/P: Elements at risk.



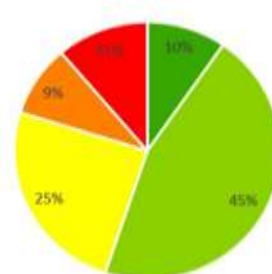
Very low Low Moderate High Very high

FacilA/P: Elements at risk.



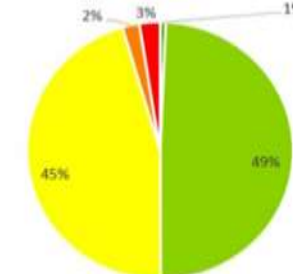
Very low Low Moderate High Very high

PoiP: Elements at risk.



Very low Low Moderate High Very high

RoadL: Elements at risk.



Very low Low Moderate High Very high

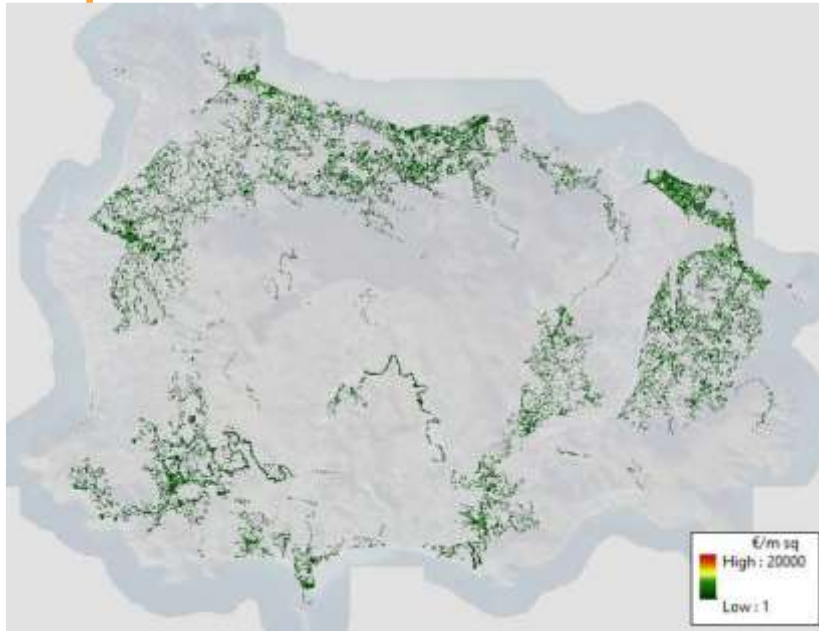
Percentage distribution of risk classes by individual elements at risk



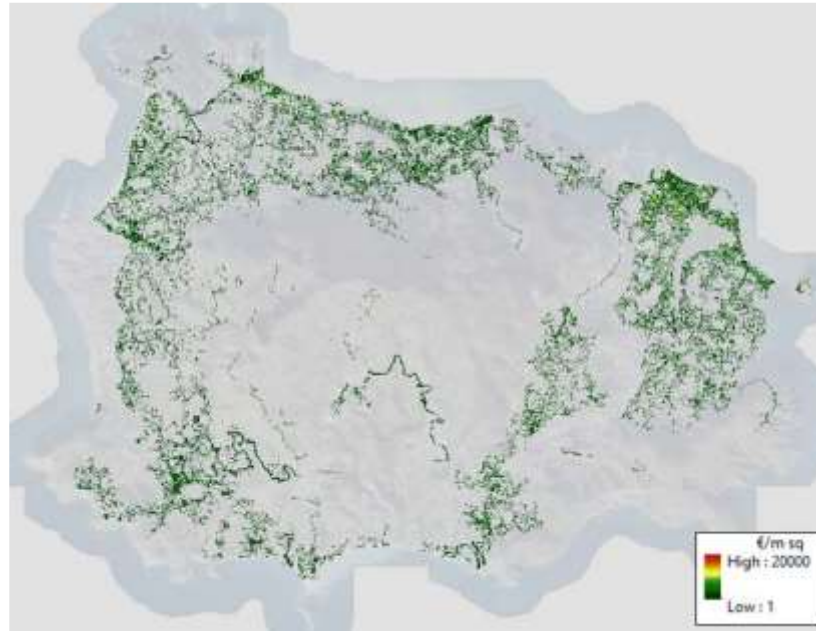
# E M S N 1 4 2 – Landslide in Ischia Island (Italy)

## Potential economic loss due to landslide risk

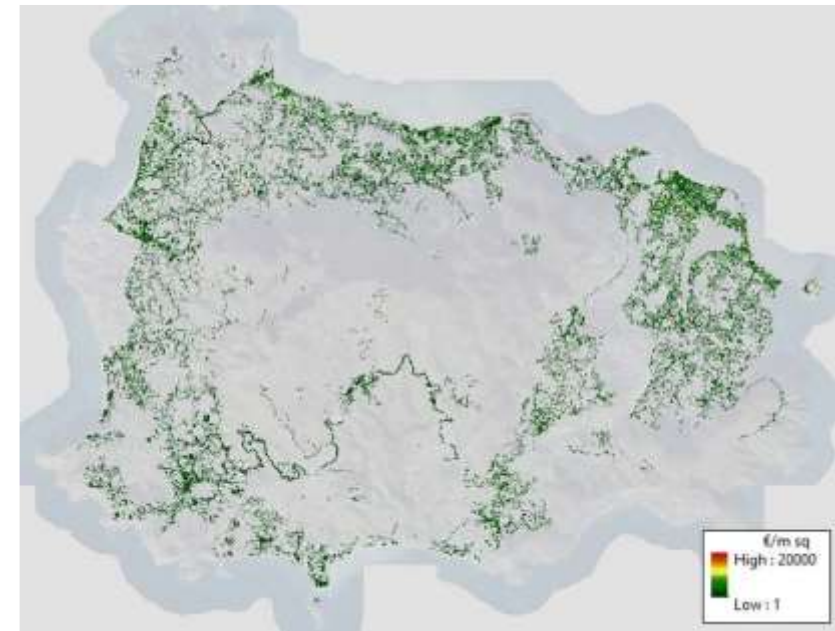
Potential economic loss due to landslide risk computed by combining products of landslide risk for selected triggering scenarios or specific return period with the assets map through summing all the economic value of the affected assets.



Low scenario



Moderate scenario



High scenario



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# E M S N 1 4 2 – Landslide in Ischia Island (Italy)

3D simulation video of the landslide



The scope of this service request is to assess the impact of the landslides that hit the island of Ischia, Italy, between 25 and 26 November 2022, and to perform landslide risk analyses to support preparedness studies and actions.

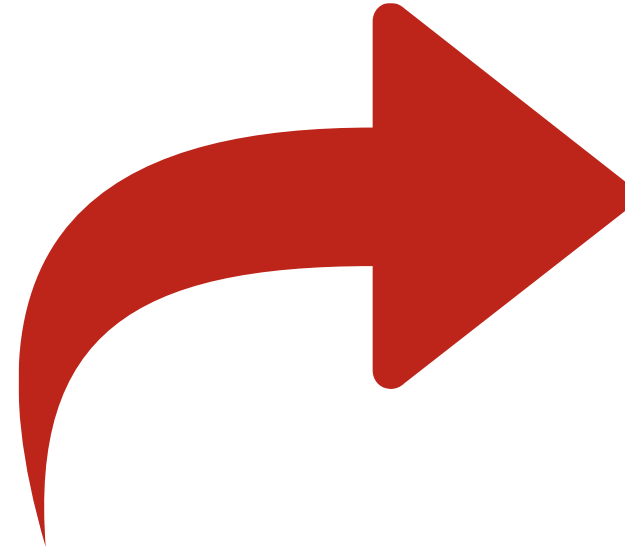




## Conclusion

- ✓ **Post-disaster Landslide Evaluation** → **Rehabilitation procedures**
  - ✓ **Damage Assessment** of the infrastructures and **Estimation of the Economic losses** →  
**Treatment of the economic consequences**
  - ✓ **Hazard, Exposure, Vulnerability, Risk** for subsequent disasters (supplementary landslides and coastal erosion) → **Prevention and Risk reduction**
  - ☐ **EMS N142** was beneficial to the **Italian Civil Protection** and the **National Authorities**.
- ✓ **RRM Activations are crucial for the design of the management strategies after a disaster and the decision-making processes.**

# Let's keep in touch



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