

# NEAM-COMMITMENT: Strengthening Tsunami Risk Governance through National Inundation Mapping and Multi-Hazard Evacuation Planning



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## INTRODUCTION

The NEAM-COMMITMENT endeavors to contribute primarily to **two key components of tsunami risk governance: capacity building through tsunami hazard assessment and mapping at national scale, and improved tsunami evacuation planning at the local level through a multi-hazard approach.** In this context, the project supports the development of national tsunami inundation maps for **Cyprus, Greece, and Spain**, achieved through **targeted capacity building and technical exchange with Italy.** Complementing this effort, it advances a **multi-hazard methodology for tsunami evacuation management** that explicitly accounts for cascading effects, such as earthquake-induced infrastructure disruption or concurrent coastal hazards, and tests this integrated approach in selected pilot sites in **Methoni, Greece and Stromboli, Italy.** Together, these efforts strengthen regional preparedness by combining harmonized hazard mapping with innovative, operationally relevant evacuation planning.

**Strategic alignment:** Contribution to the objectives of the UN Ocean Decade Tsunami Programme and the Sendai Framework for Disaster Risk Reduction 2015–2030

## METHODOLOGY

➤ **Maximum Inundation Height (MIH) from Probabilistic Tsunami Hazard Assessment**

**Figure 1.** Empirical probability density function (EPDF, blue bars) and empirical cumulative density function (ECDF, orange bars) of the ratio between the maximum Run-up (Rd) and the mean of the MIH at each POI. (Tonini et al., 2021)

- National Coastal Planning is based on **TSUMAPS-NEAM.**
- The Model provides the **Hazard Curves** for each Point Of Interest (POI). The distribution of these curves appropriately weighted represents the **epistemic uncertainty** associated to the **hazard model.**

The Hazard Curves provide **MIH values** in each POI for different level of uncertainty of the model (**percentile of uncertainty distribution**)

## Technical Implementation

**Open-source implementation:** Development of a dedicated Python script integrated into the QGIS environment, ensuring both accessibility and reproducibility in line with FAIR principles.

**Streamlined Processing:** The tool streamlines complex GIS tasks, enabling one-step execution to transform offshore MIH values into spatial inundation maps.

- Input data:**
  - a. **Mandatory:** Digital Terrain Model (DTM), shoreline, MIH values.
  - b. **Optional:** Water bodies, such as rivers and coastal lakes.
- Outputs:** Creation of "Wet Area" vector and raster files at the native DTM resolution for each defined set of design parameters.
- Scalability:** Ability to handle multiple cases at once, making it easier and faster to create tsunami inundation maps for different areas and sets of design parameters.

Learn more about the project activities at <https://civil-protection-knowledge-network.europa.eu/projects/neam-commitment> or by scanning the QR code.

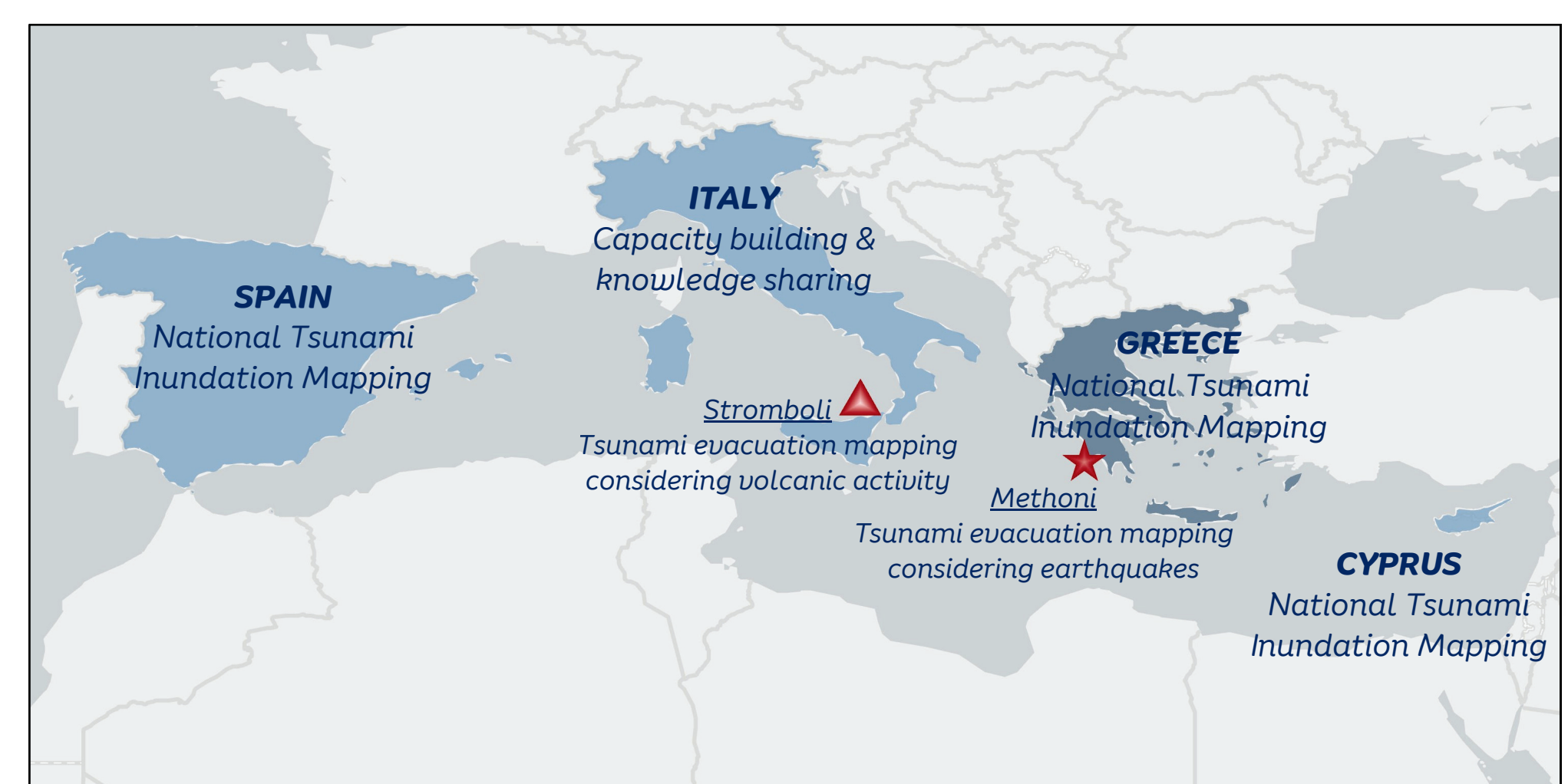


Figure 2: Map showing the geographic extent of the NEAM-COMMITMENT project.

## Tsunami Inundation Mapping National Level (Cyprus, Greece & Spain)

Prepared individually by the three partner countries, **Greece, Spain, and Cyprus**, these datasets informed discussions during the **National Workshops**, enabling decision makers and competent authorities to define suitable **design parameters and safety factors** for national inundation mapping.



Figure 5: Example of coastline segmentation of Cyprus and conversion of MIH values at POIs to run-up points along the coast, using a dedicated Python tool.

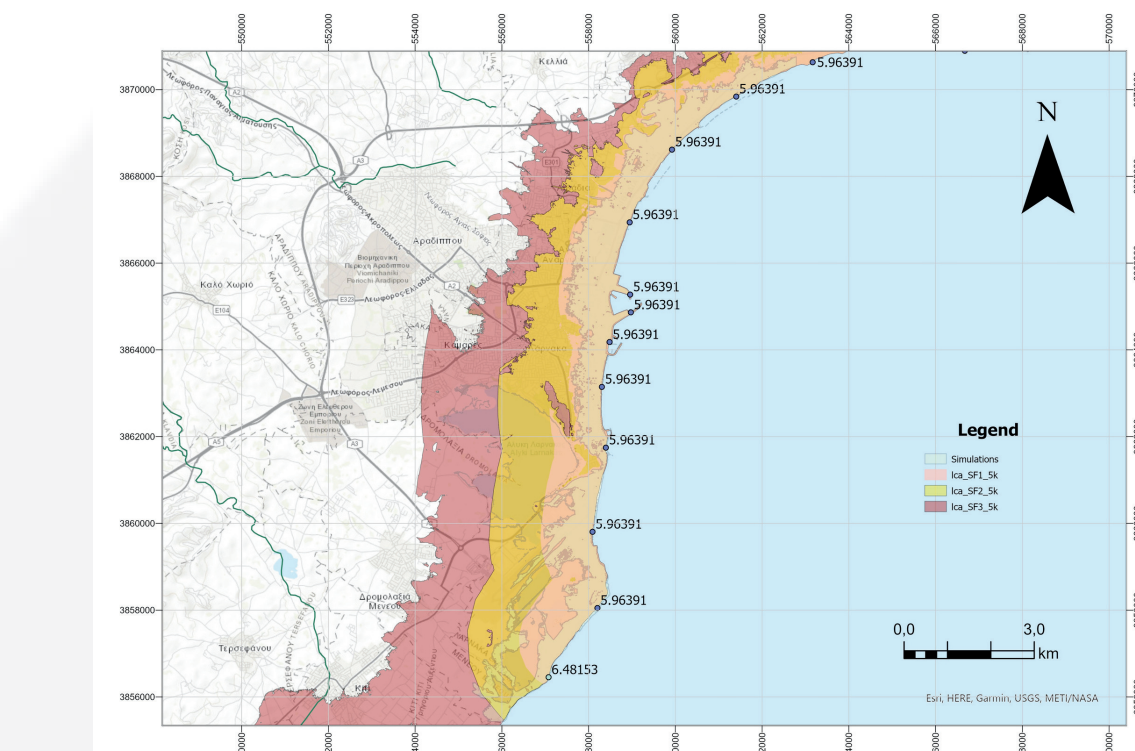


Figure 6: Example of inundation mapping for the Municipality of Larnaka (S Cyprus), showing safety factors of 1 (light pink), 2 (yellow) and 3 (dark pink), for 1% PoE in 50 yrs (ARP 5.000yrs) and the 84th percentile of uncertainty.

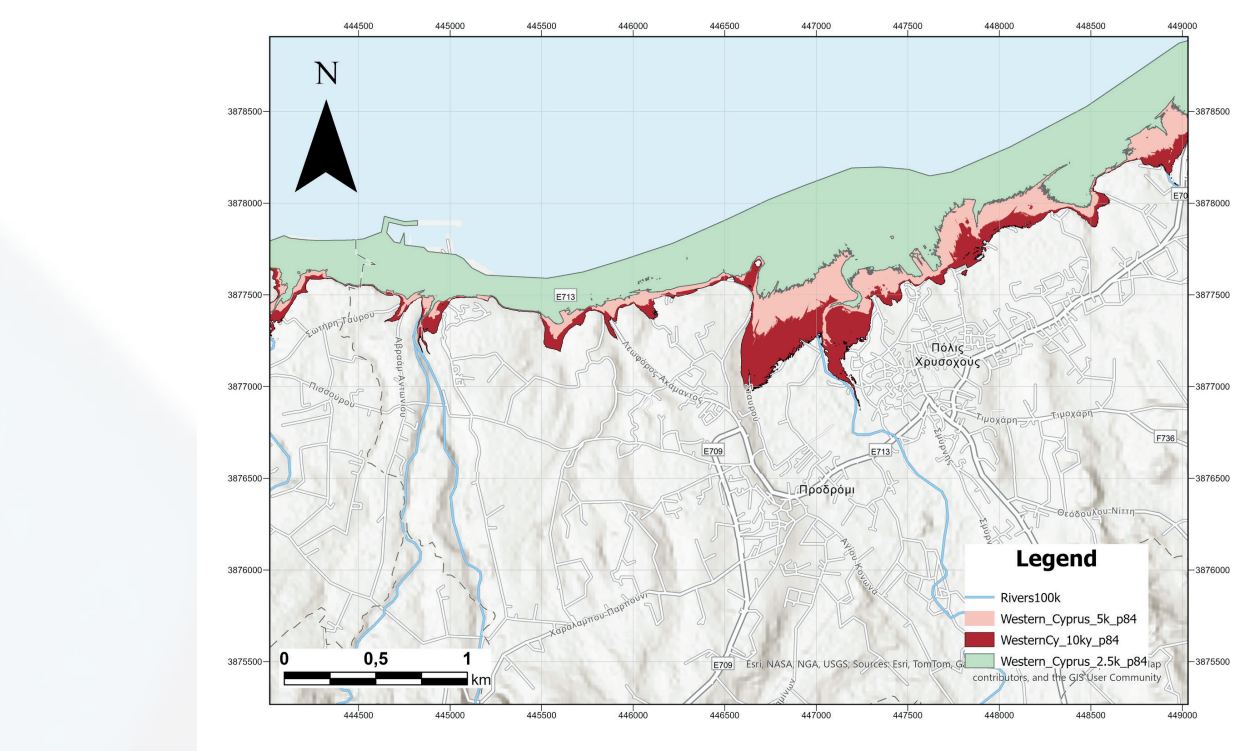


Figure 7: Example inundation maps for the Municipality of Prodromi (NW Cyprus). Scenarios represent a 2%, 1%, and 0.5% Probability of Exceedance (PoE) in 50 years, corresponding to Average Return Periods (ARP) of 2,500, 5,000, and 10,000 years, respectively.

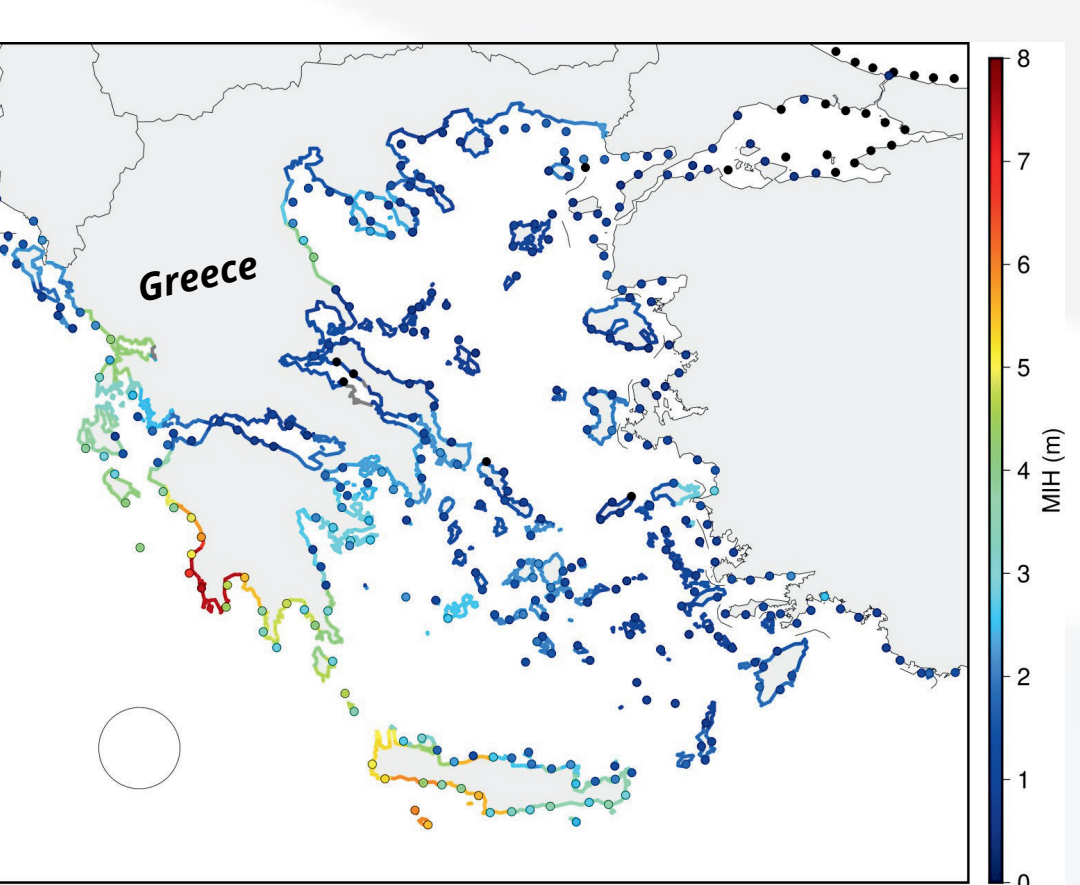


Figure 8: Method for assigning design MIHd along the coastline (Greece). The MIHd at each coastal point is defined as the maximum MIH among POIs within a circular search radius (40 km). Exceptions are applied in areas with specific geomorphological constraints, such as very shallow waters (absence of POIs close to the coast), narrow peninsulas, or small islands requiring adjusted radii.

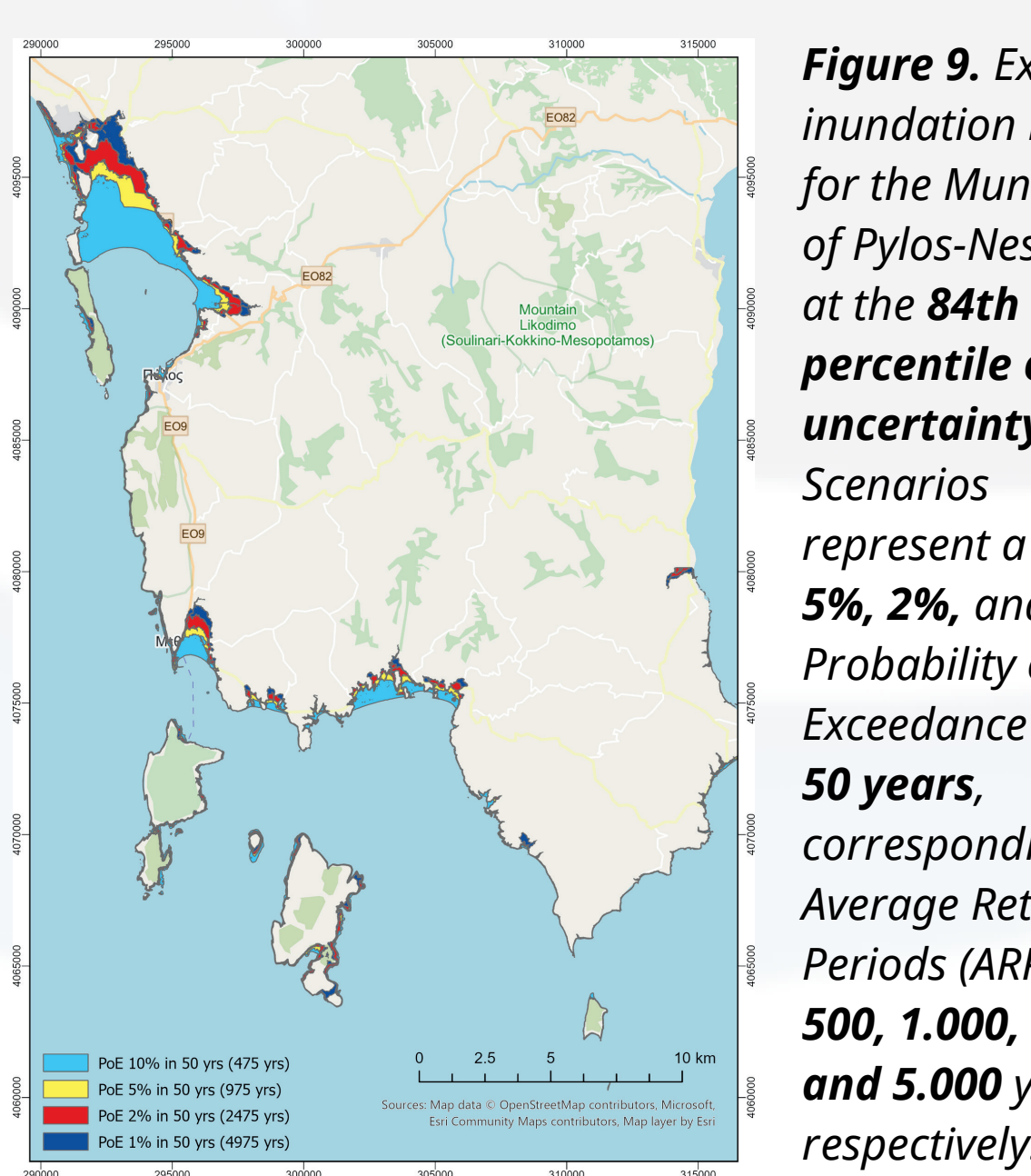


Figure 9: Example inundation maps for the Municipality of Pylos-Nestoras at the 84th percentile of uncertainty. Scenarios represent a 10%, 5%, 2%, and 1% Probability of Exceedance (PoE) in 50 years, corresponding to Average Return Periods (ARP) of 500, 1,000, 2,500, and 5,000 years, respectively.

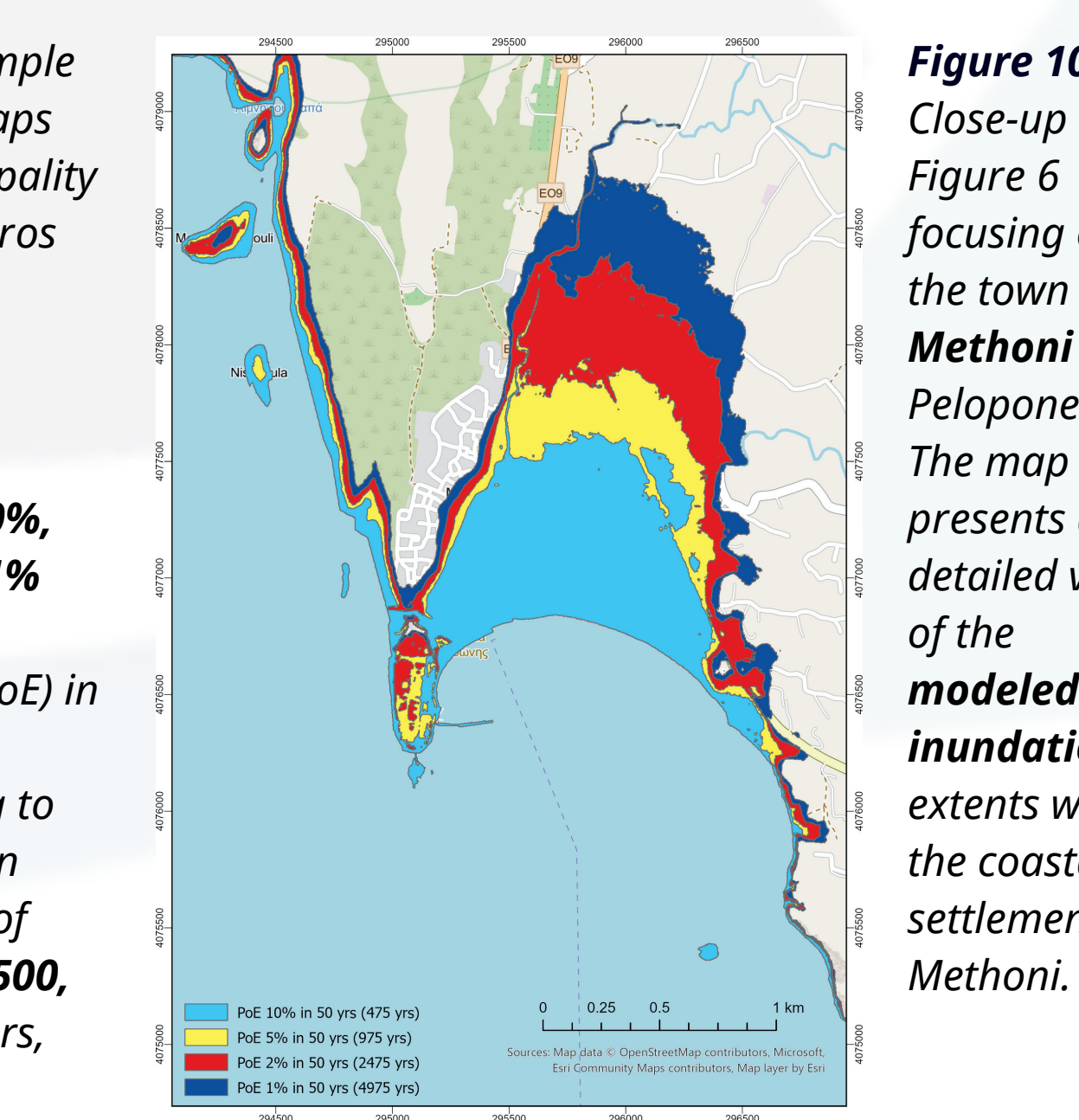


Figure 10: Close-up of Figure 6 focusing on the town of Methoni (SW Peloponnese). The map represents a detailed view of the modeled inundation extents within the coastal settlement of Methoni.

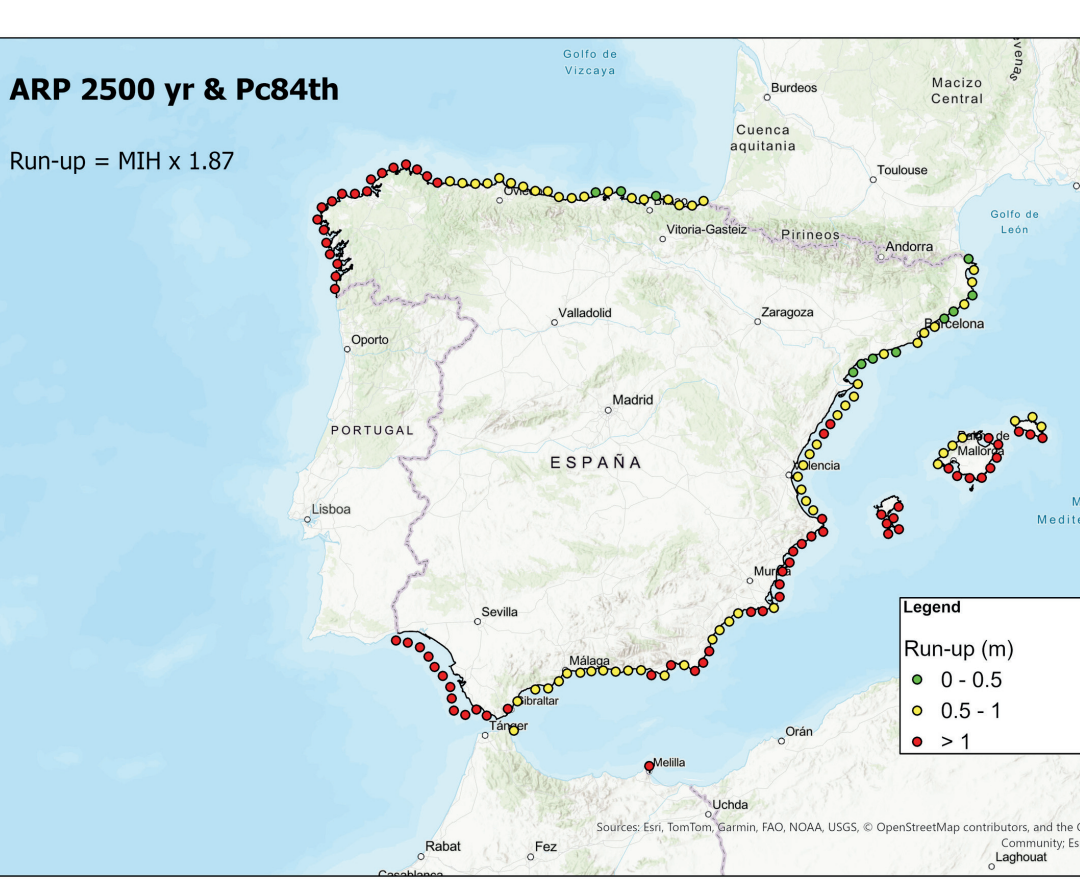


Figure 11: Example of coastline segmentation of Spain and conversion of MIH values at POIs to points along the coast, using a dedicated Python tool.

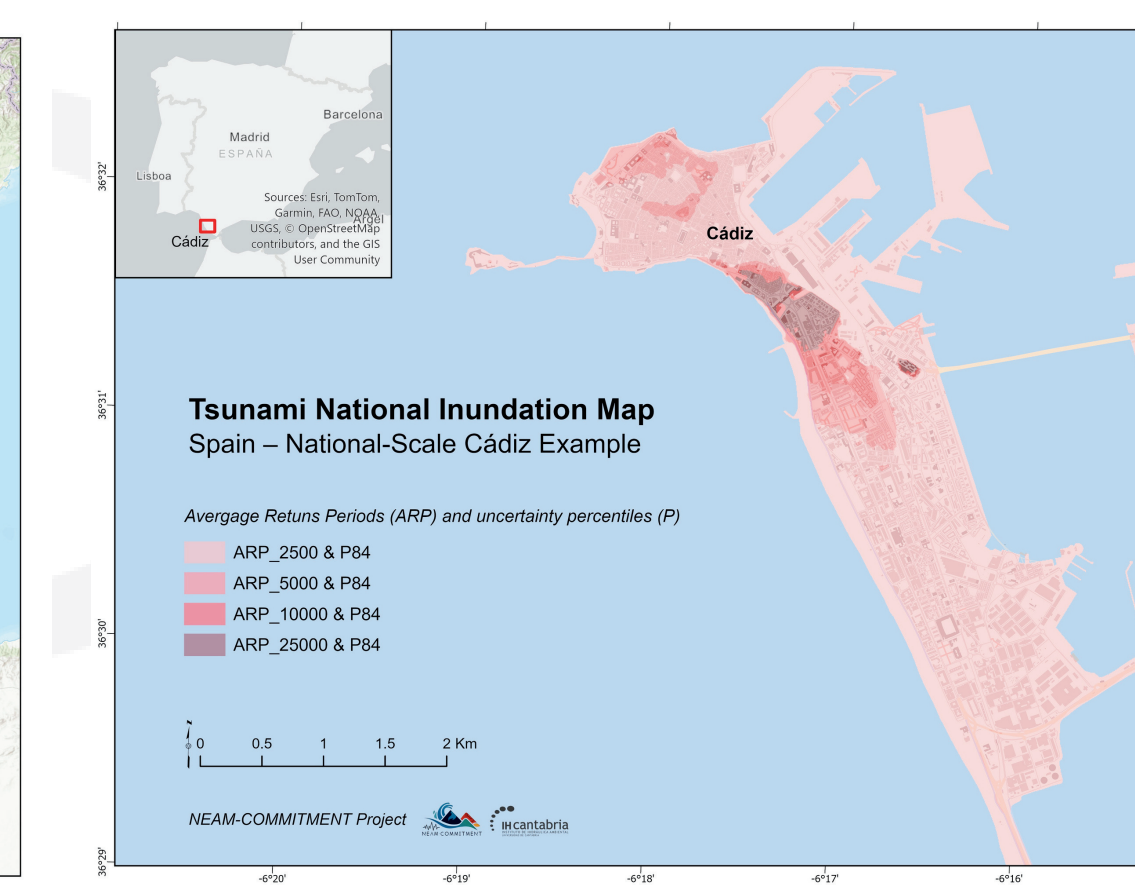


Figure 12: Example inundation maps for the Municipality of Cadiz at the 84th percentile of uncertainty. Scenarios represent a 2%, 1%, 0.5%, and 0.02% Probability of Exceedance (PoE) in 50 years, corresponding to Average Return Periods (ARP) of 2,500, 5,000, 10,000, and 25,000 years, respectively.

ARP	2500		5000		10000		25000	
	pc84	pc98	pc84	pc98	pc84	pc98	pc84	pc98
Andalucía	5.28	6.74	7.31	9.26	4.67	11.8	6.74	10.4
Galicia	2.11	2.51	2.74	3.29	3.45	4.18	4.8	5.7
Iles Balears	1.68	2.2	2.51	3.24	3.58	4.58	5.64	6.98
C. Valenciana	1.24	1.61	1.92	2.43	2.78	3.48	4.22	5.2
Melilla	1.15	1.49	1.83	2.31	2.77	3.48	4.4	5.38
Marcia	1.06	1.4	1.61	2.1	2.29	2.95	3.52	4.38
Asturias	0.52	0.59	0.65	0.77	0.81	0.95	1.04	1.13
Cataluña	0.48	0.59	0.75	0.89	1.09	1.3	1.71	2.03
Ceuta	0.44	0.59	0.73	0.99	1.17	1.55	1.95	2.5
Cantabria	0.43	0.49	0.54	0.62	0.67	0.78	0.86	1.04
Pais Vasco	0.39	0.45	0.49	0.58	0.61	0.72	0.81	0.94

Figure 13: Table with comparative MIH values across different Autonomous communities of Spain for several ARP levels (2,500, 5,000, 10,000, 25,000) and two percentiles (84th and 98th) of uncertainty.

## CONCLUSIONS

The NEAM-COMMITMENT project successfully integrates **national-scale hazard assessment** with local-level **evacuation planning**, effectively bridging the gap between scientific research and operational disaster risk reduction. The project delivers **national tsunami inundation maps, local evacuation maps** using a **multi-hazard approach**, and practical **tools and guidelines** to improve tsunami risk governance across the North-East Atlantic, the Mediterranean, and Connected Seas (NEAM) region and beyond. By establishing methodological **guidelines** aligned with IOC-UNESCO's standards and developing tools designed for replication and scalability, the project ensures the sustainability of its outcomes across the **NEAM region** and beyond. Ultimately, this comprehensive approach fosters a **science-informed culture of preparedness**, ensuring that **advanced tsunami hazard modeling** is translated into effective, life-saving **evacuation strategies**.

## SCIENCE-INFORMED PARTICIPATORY APPROACH TO DECISION-MAKING

**National and local tsunami inundation maps** will be developed through a **science-informed, participatory decision-making process** that actively engages the **institutions, authorities, and stakeholders** responsible for disaster management. By involving **decision-makers** throughout the technical, analytical, and validation stages, the **co-designing process** builds a shared understanding of the hazard and strengthens ownership of the final products. This **collaborative approach** not only improves the quality and relevance of the maps but also maximizes their effectiveness when implemented in real preparedness and response planning.



Figure 3: The Stromboli pilot site is characterized by the combination of volcanic and tsunami hazards, with potential cascading effects from volcanic eruptions impacting evacuation routes. The Multi-Hazard workshop in Stromboli established a solid foundation for the subsequent participatory mapping and decision-support activities, confirming the feasibility and added value of co-designed, science-informed multi-hazard evacuation planning at the local scale. (photo credits: Pio Di Manna)



Figure 4: The pilot site of Methoni combines seismic and tsunami hazards, where potential seismic impacts may influence tsunami evacuation routes. The multi-hazard workshop in Methoni laid a strong foundation for subsequent participatory evacuation-mapping activities at the local scale and underscored the added value of co-designed, science-based multi-hazard evacuation planning. (photo credits: Pio Di Manna)

## Tsunami Evacuation Mapping - Integration of Multi-Hazard Impact Local Level (Methoni - Greece, Stromboli - Italy)

A new methodology for **tsunami evacuation mapping** was developed to capture the complexity of multi-hazard **cascading events**, such as earthquake-triggered or volcano-triggered tsunamis. In the pilot sites of **Methoni (Greece) and Stromboli (Italy)**, evacuation zones, escape routes, and safe assembly areas were identified. Hands-on workshops facilitated collaboration between scientists, local authorities, and community representatives, supporting the development of tools that are operationally feasible and ready for incorporation into civil protection planning.

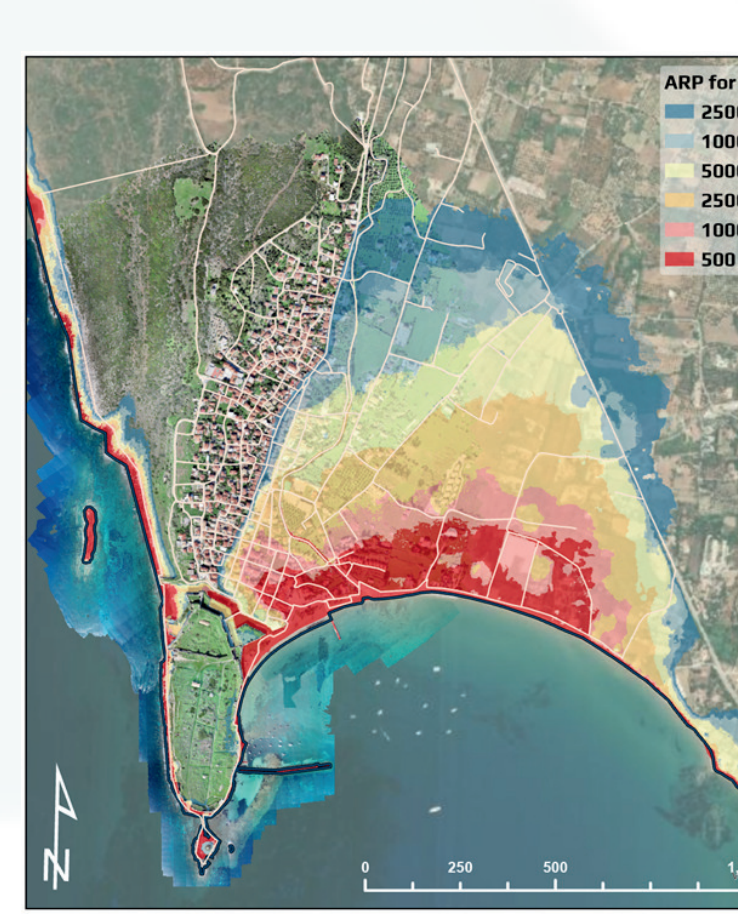


Figure 14: Tsunami flood maps for the town of Methoni for two different percentiles of uncertainty, 84th (left) and 98th (right). Each map displays the probability of exceedance in 50 years: 10%, 5%, 2%, 1%, 0.5% and 0.2%.

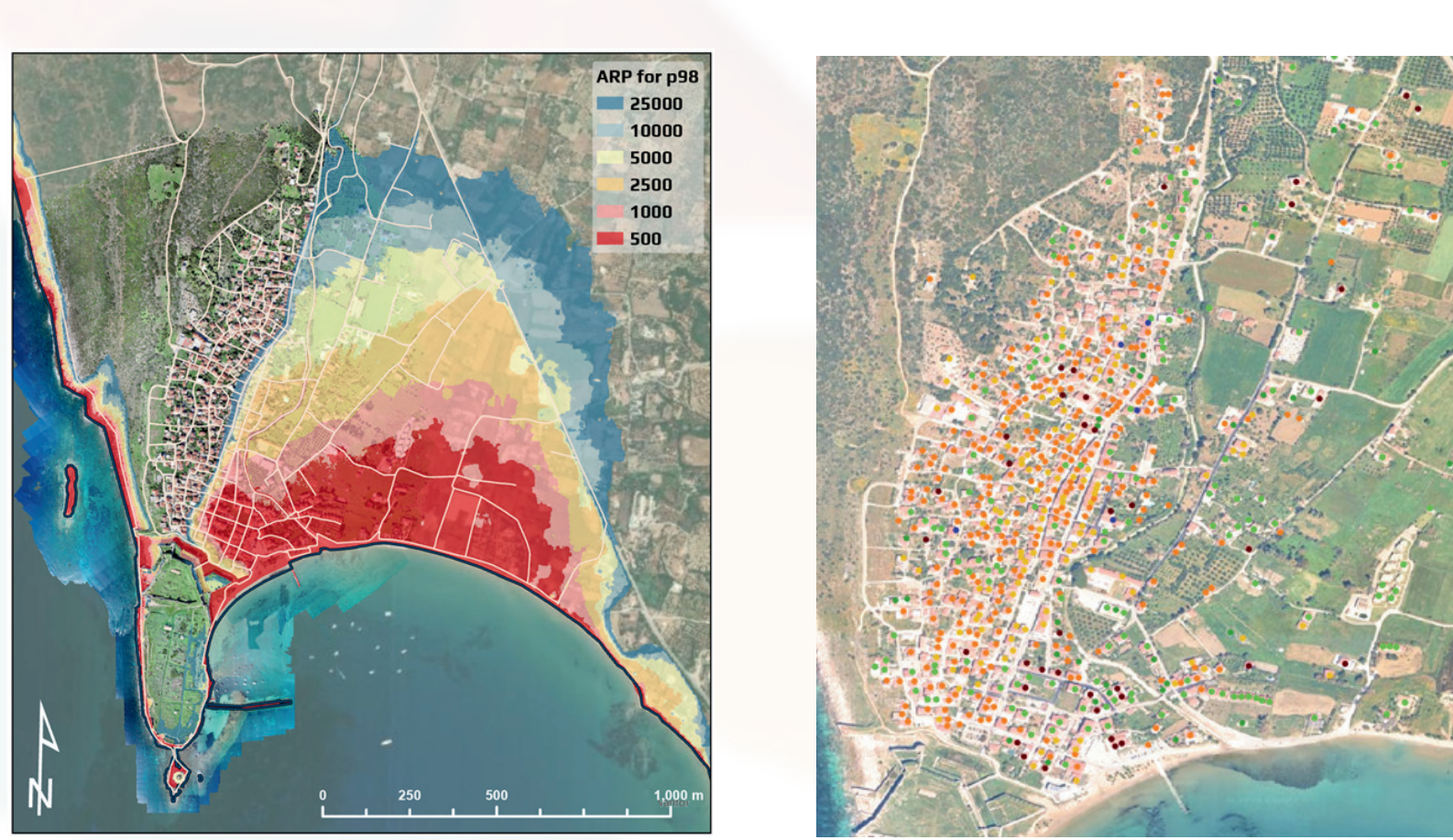


Figure 15: Exposure modelling - Distribution of buildings according to the construction material

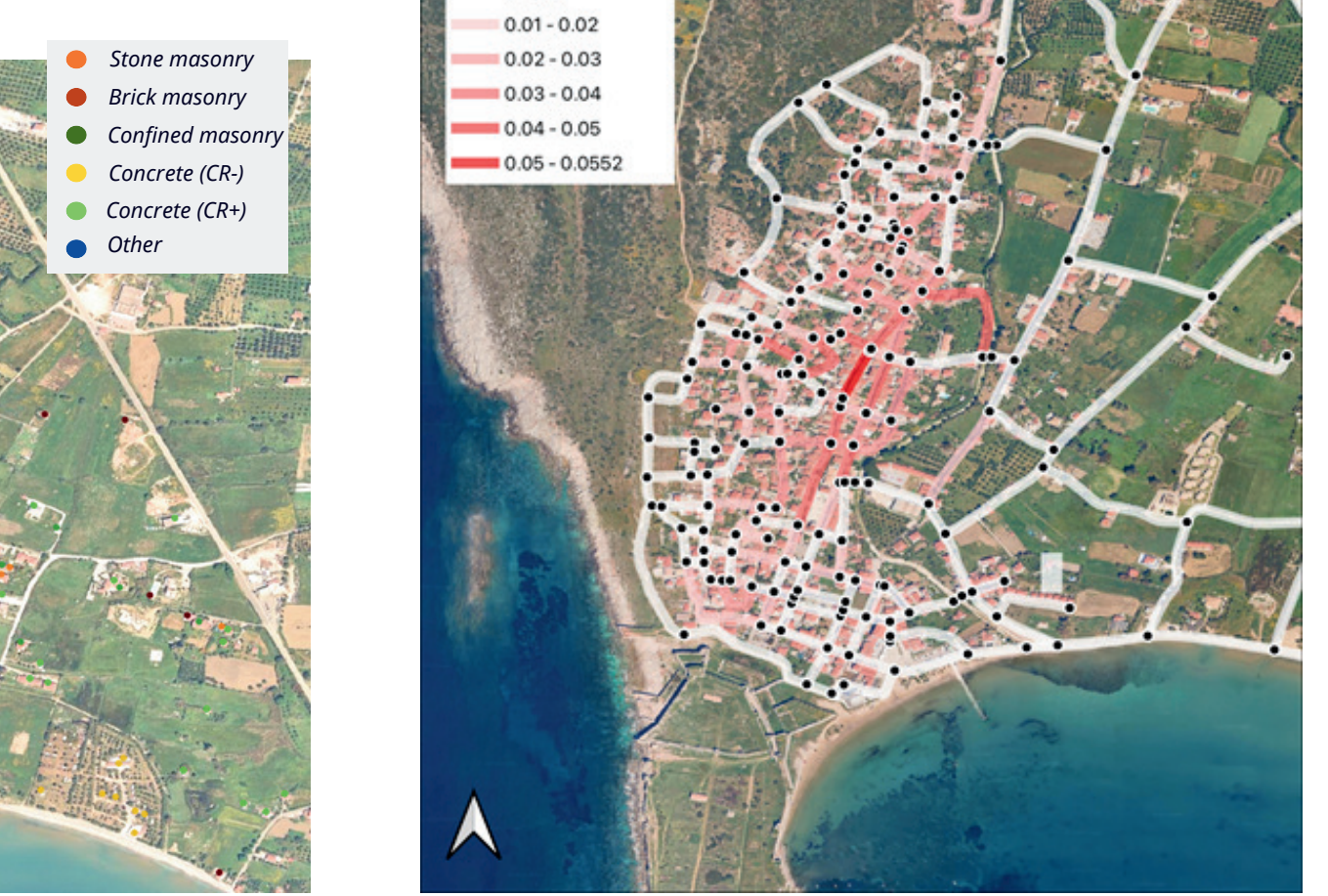


Figure 16: Earthquake impact, illustrated as disruption probability, on candidate evacuation routes

## METHONI - GREECE

## STROMBOLI - ITALY

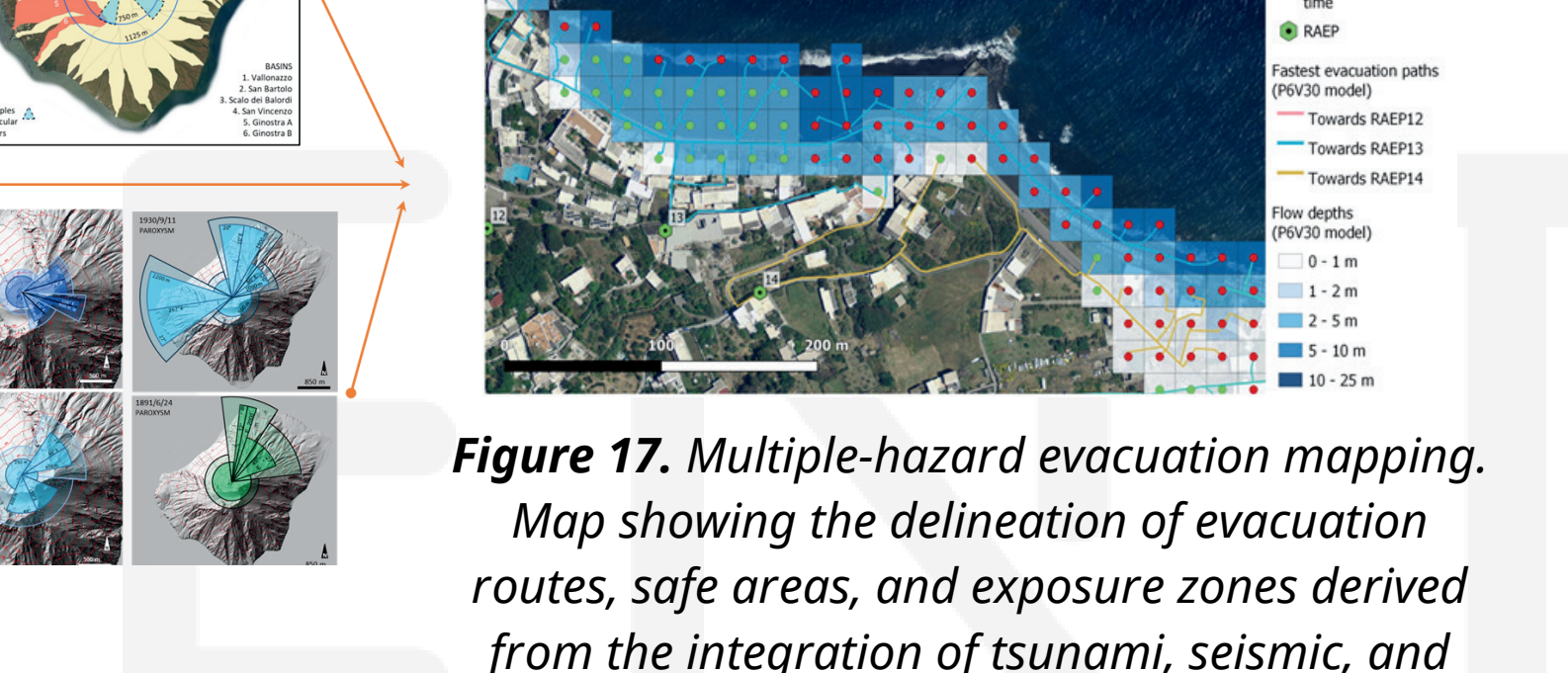
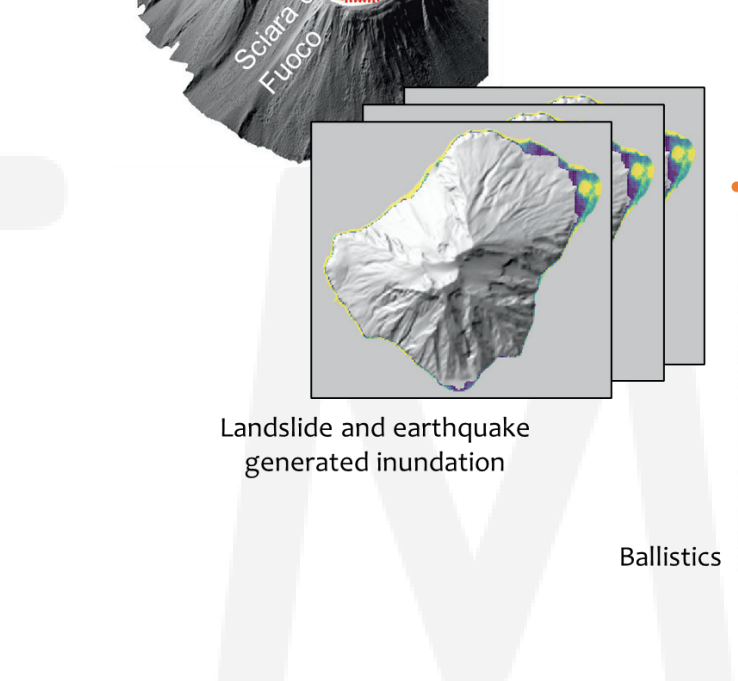


Figure 17: Multiple-hazard evacuation mapping. Map showing the delineation of evacuation routes, safe areas, and exposure zones derived from the integration of tsunami, seismic, and secondary hazard scenarios.

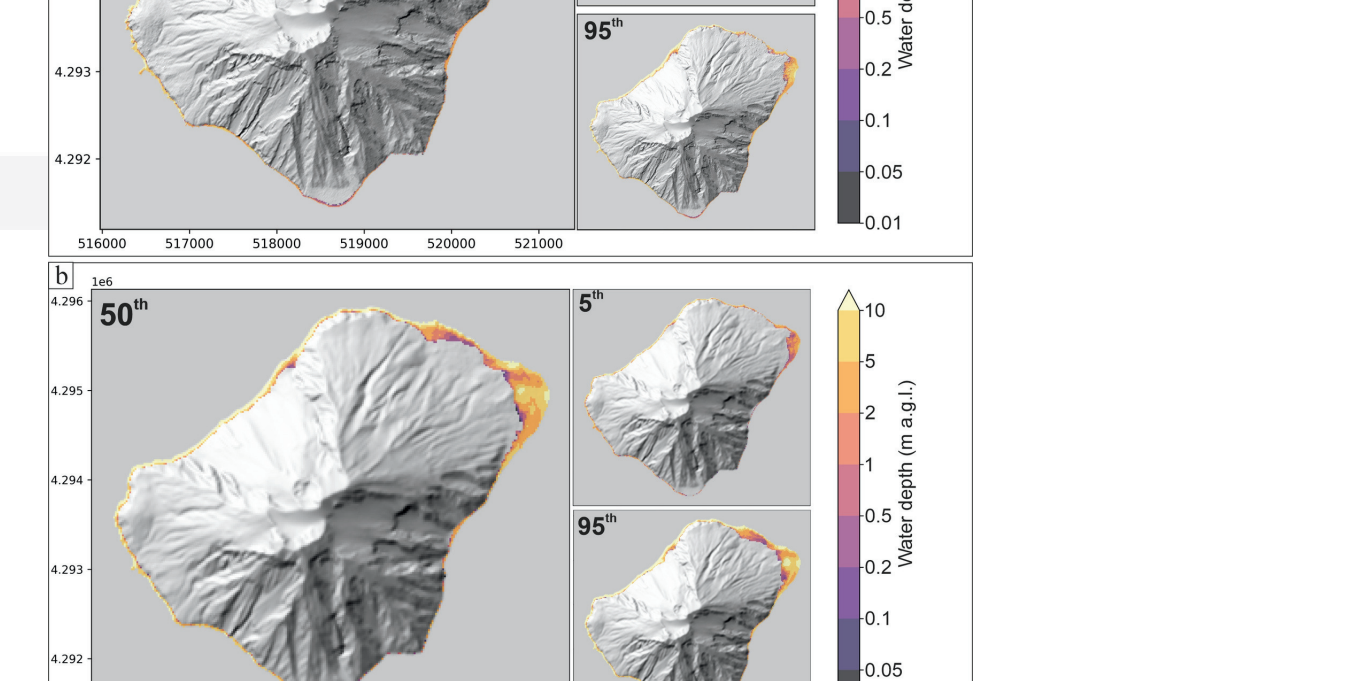


Figure 19: Probabilistic inundation hazard maps for tsunamigenic landslides with volumes 1-30 x 10<sup>6</sup> m<sup>3</sup> occurring along the Sciarra del Fuoco within the next 50 years. Maps are presented as three percentiles (5th/50th/95th) that take into account epistemic/aleatoric uncertainty, and show the water depth corresponding to a 10% exceedance probability. Maps were produced from 264 simulations (with different initial position, volume and density contrast of the landslide) that were done using a topo-bathymetry with a) 10 m resolution and b) 20 m resolution. The development of probabilistic hazard maps from volcanic source has been supported by "Convenzione Attivativa per il potenziamento delle attività di servizio, Task 2.2" in the framework of "Accordo Quadro DPC-INGV 2022-2025"

## REFERENCES FOR FURTHER READING

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