

Risk analysis of the Alto Garda area by means of microzonation and structural characterisation of buildings mapping

Conference Poster**Author(s):**

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Publication date:

2024-07-02

Permanent link:

<https://doi.org/https://doi.org/10.3929/ethz-b-000718088>

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02 July 2024, Milan, Italy

Risk analysis of Alto Garda via microzonation and structural characterisation of buildings mapping

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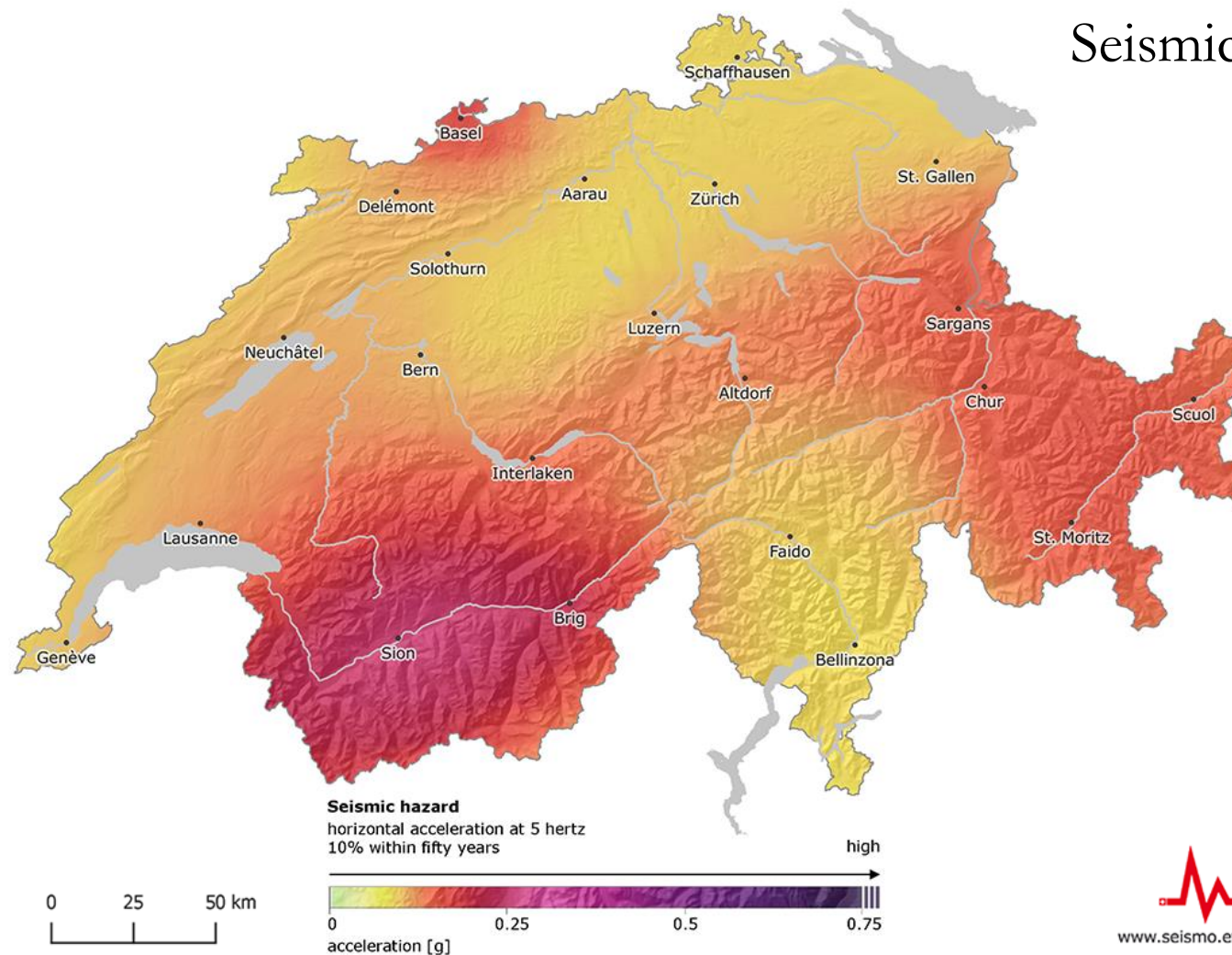
Project MAERS

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Conclusions & Future Perspectives

Hazard level:

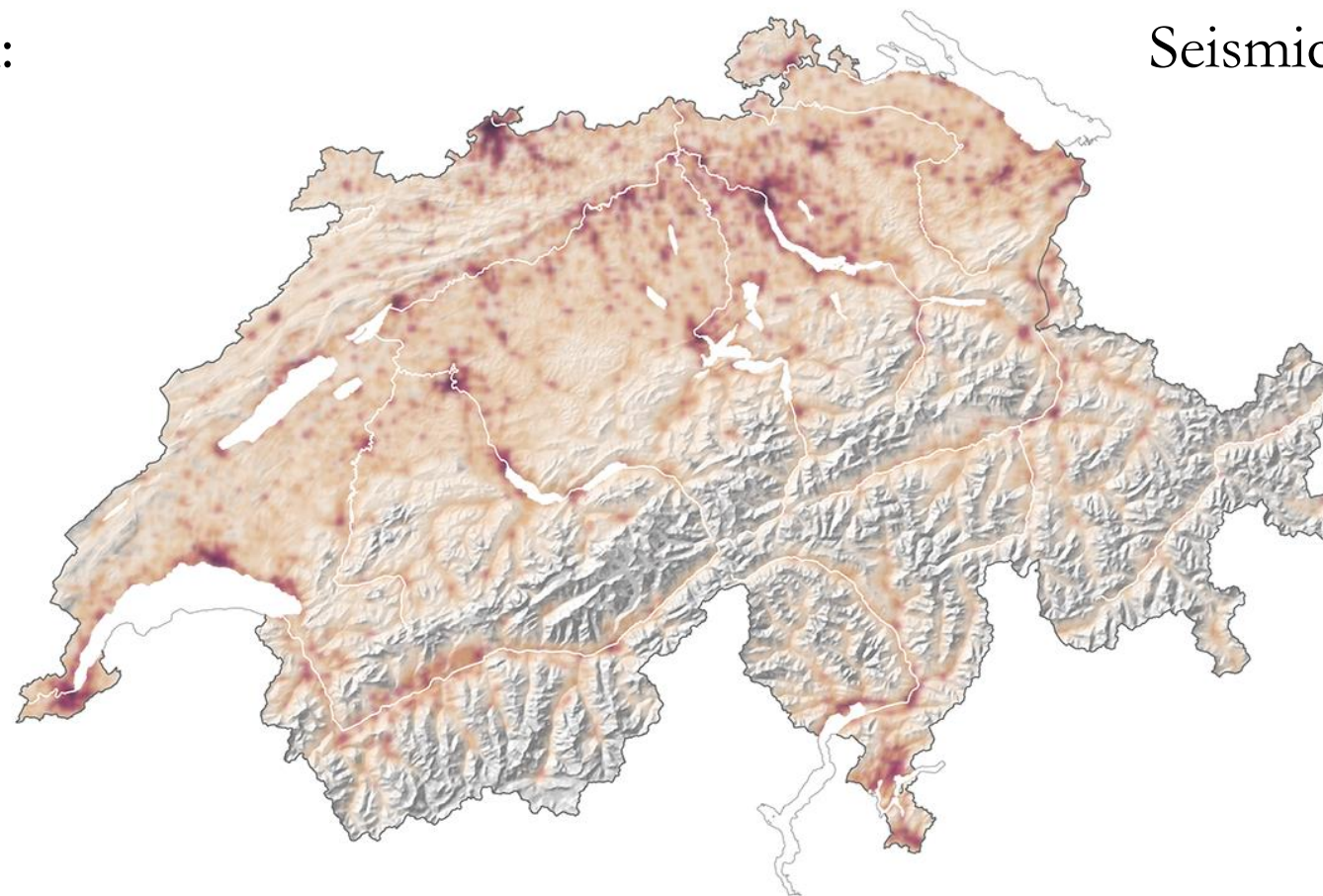
Seismic Risk $\neq$ Seismic Hazard



Source:
<http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/maps/>

Vulnerability level:

Seismic Risk $\neq$ Seismic Hazard



0 25 50 km

Affected assets

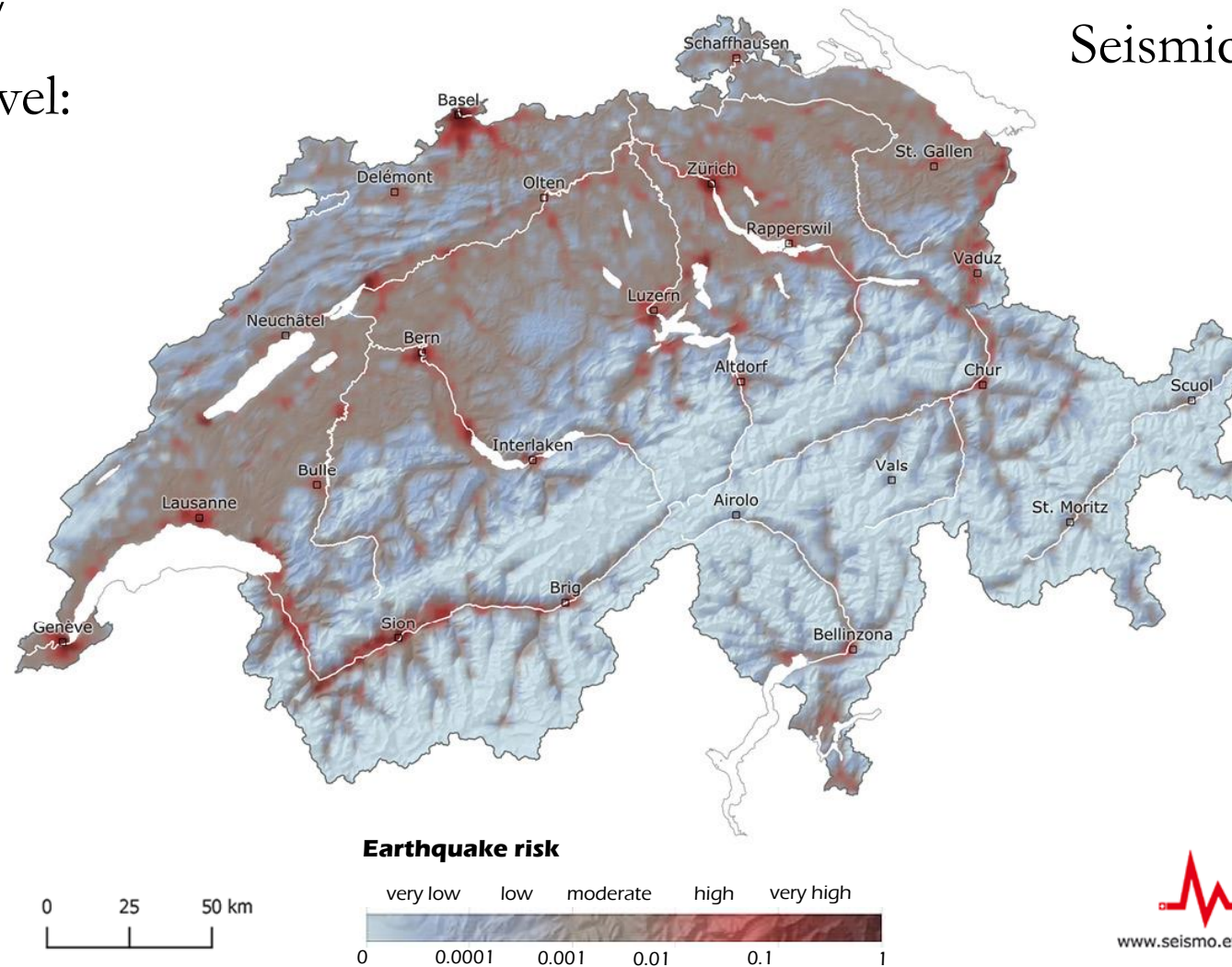
Number of residential, commercial
 and industrial building per km²



Source:
<http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/maps/>

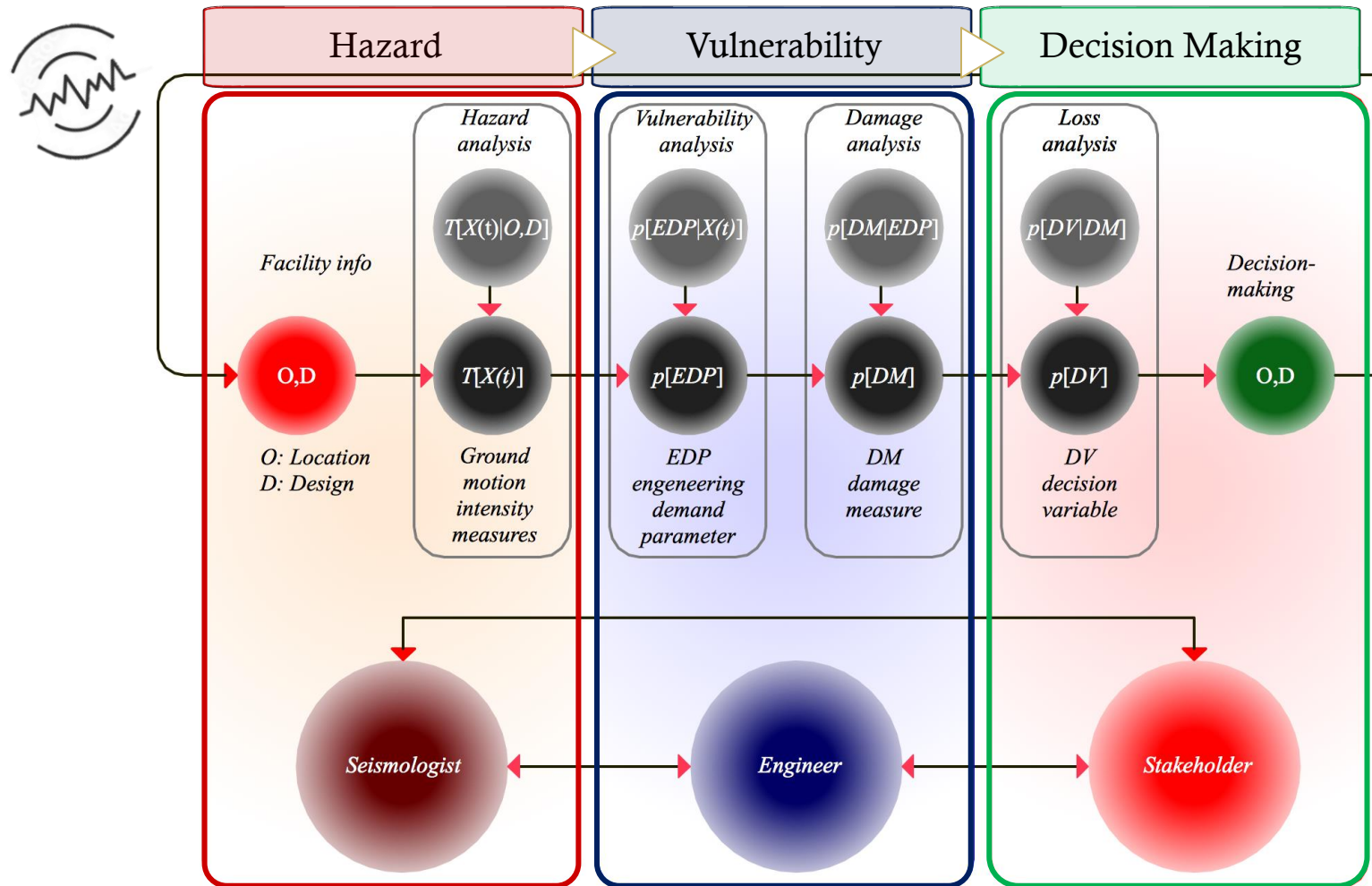
Decision making/
 risk assessment level:

Seismic Risk $\neq$ Seismic Hazard

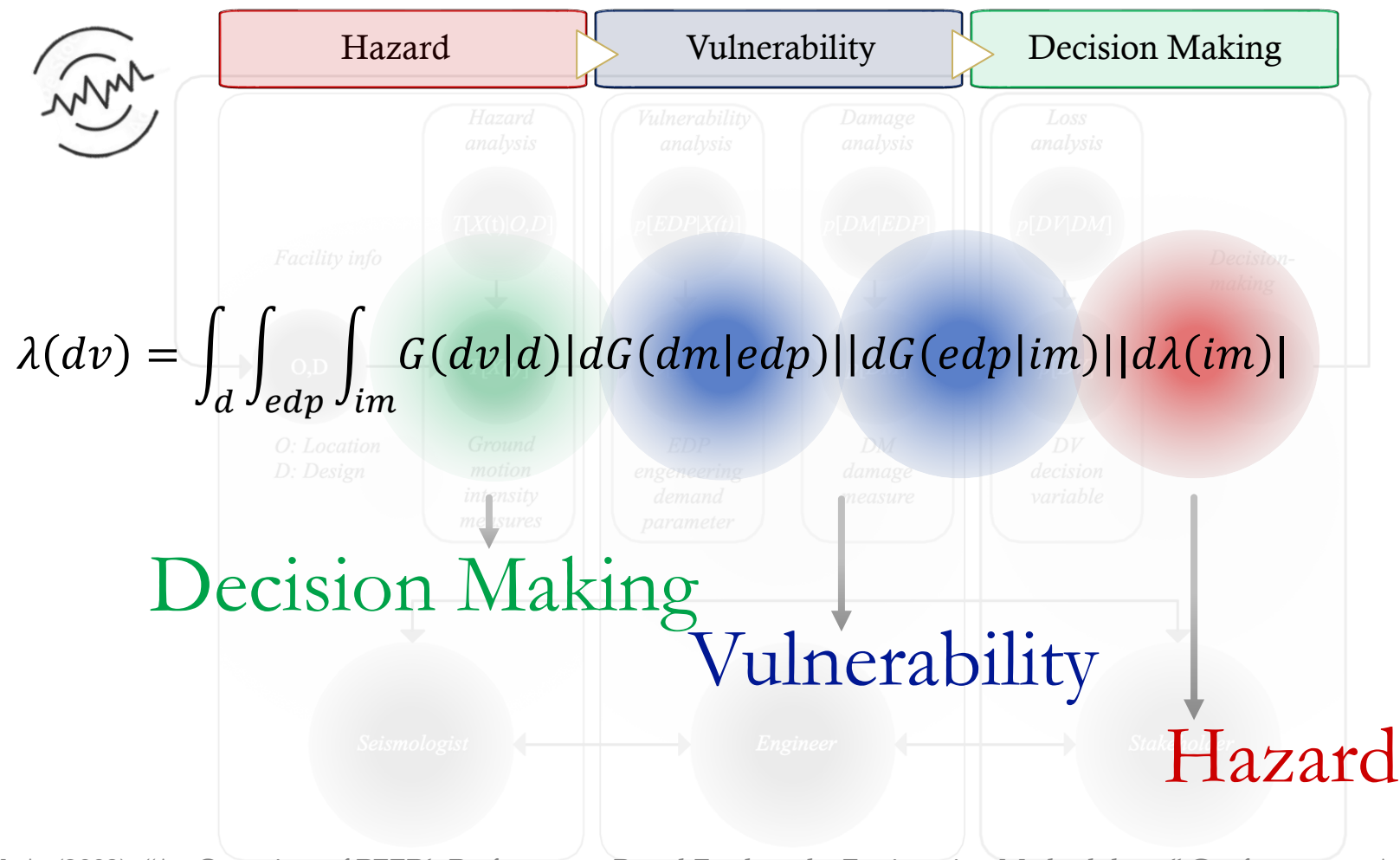


Source:
<http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/maps/>

The PEER-PBEE framework:

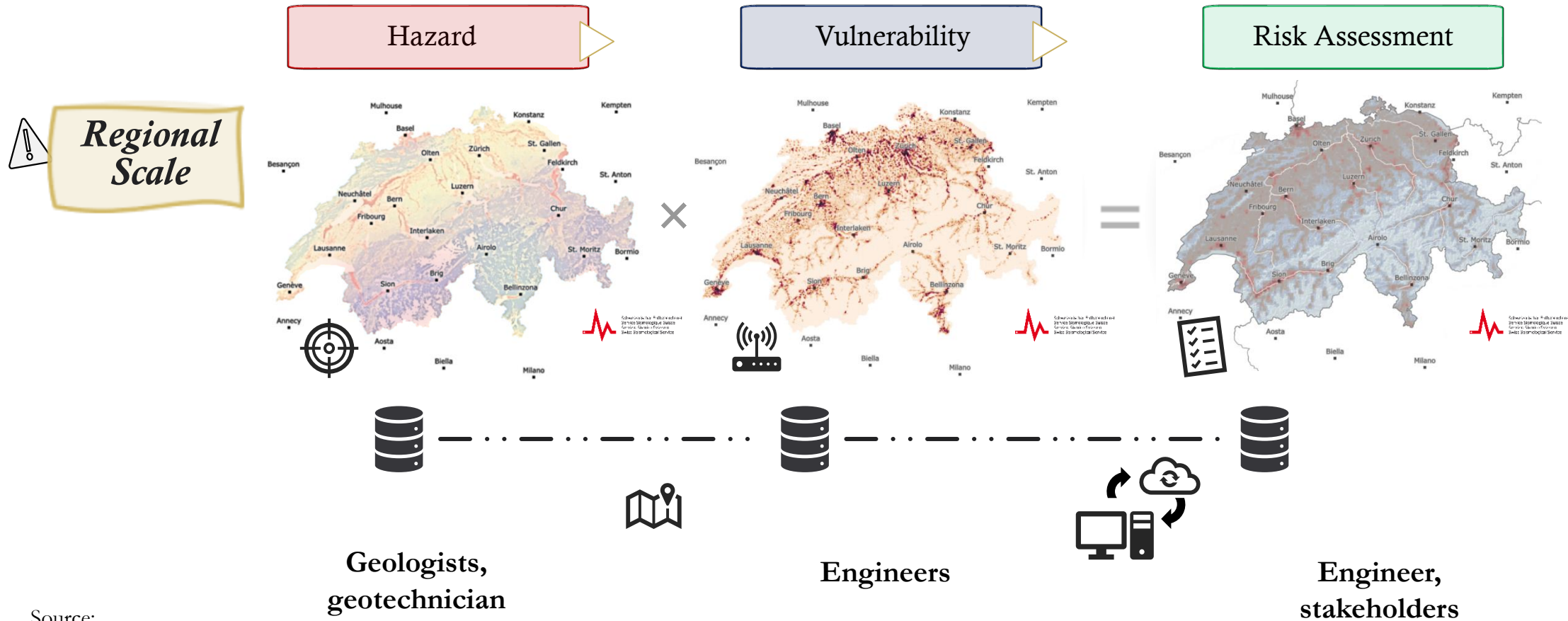


The **PEER-PBEE** framework:



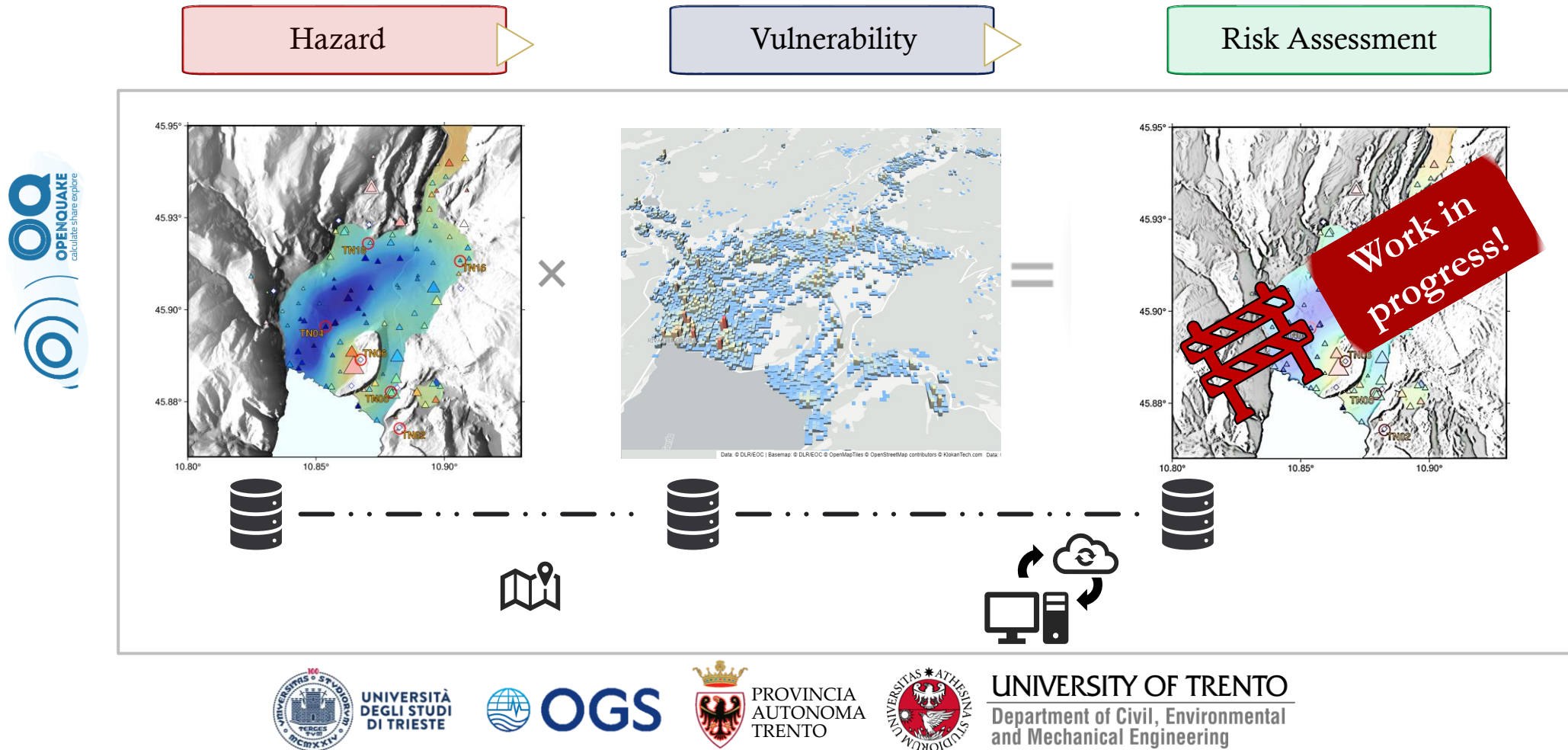
*Porter, K. A. (2003). "An Overview of PEER's Performance-Based Earthquake Engineering Methodology," Conference on Applications of Statistics and Probability in Civil Engineering (ICASP9), Civil Engineering Risk and Reliability Association (CERRA), San Francisco, CA.

Regional risk assessment:



Source:
<http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/maps/>

Regional risk assessment: Alto Garda area



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- Regional Seismic Hazard & Microzonation
- Vulnerability Assessment

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Conclusions & Future Perspectives

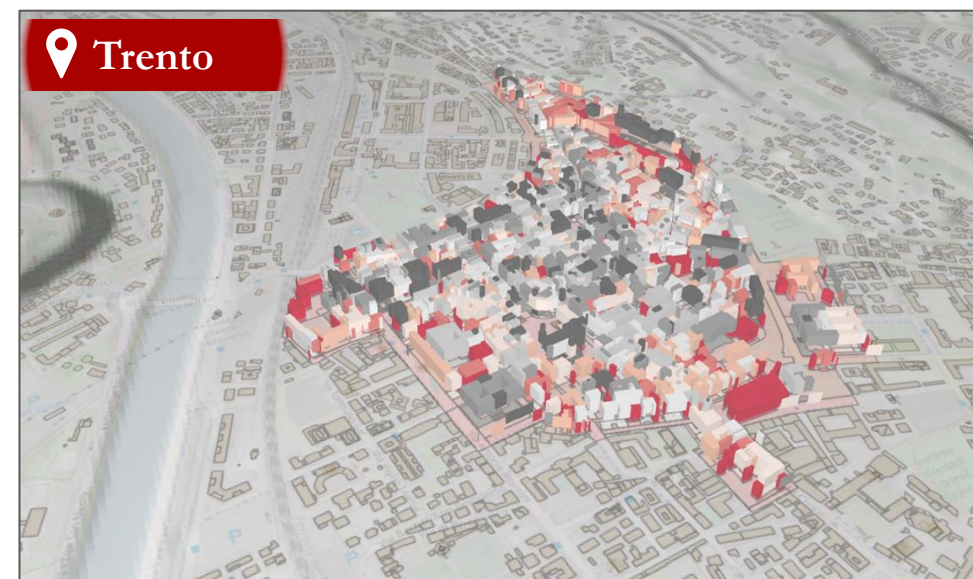
The project **MAERS**



Seismic **E**xposure and **R**isk **M**aps for regional level scale

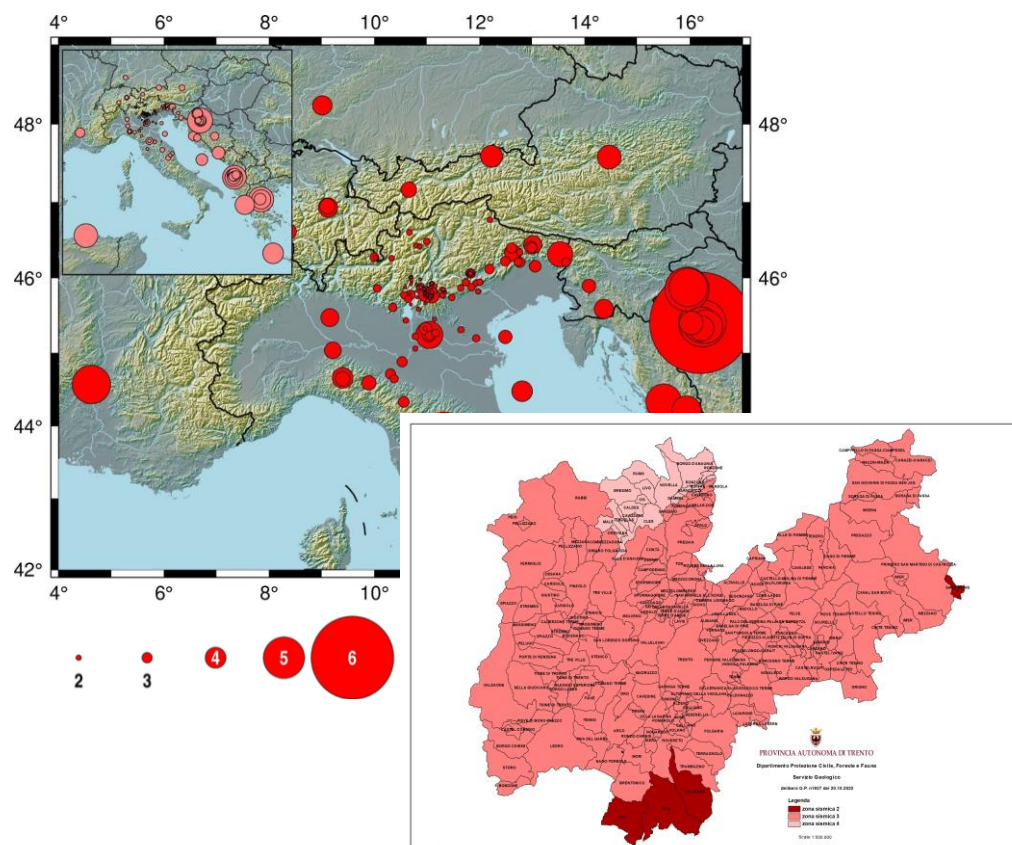
Project (main) objectives:

- Digital system integrating seismic microzonation campaign data with hazard analysis
- Seismic vulnerability and exposure mapping for civil and strategic structures
- Seismic risk maps on regional scale



MAERS: new regional seismic hazard maps

New seismic classification*

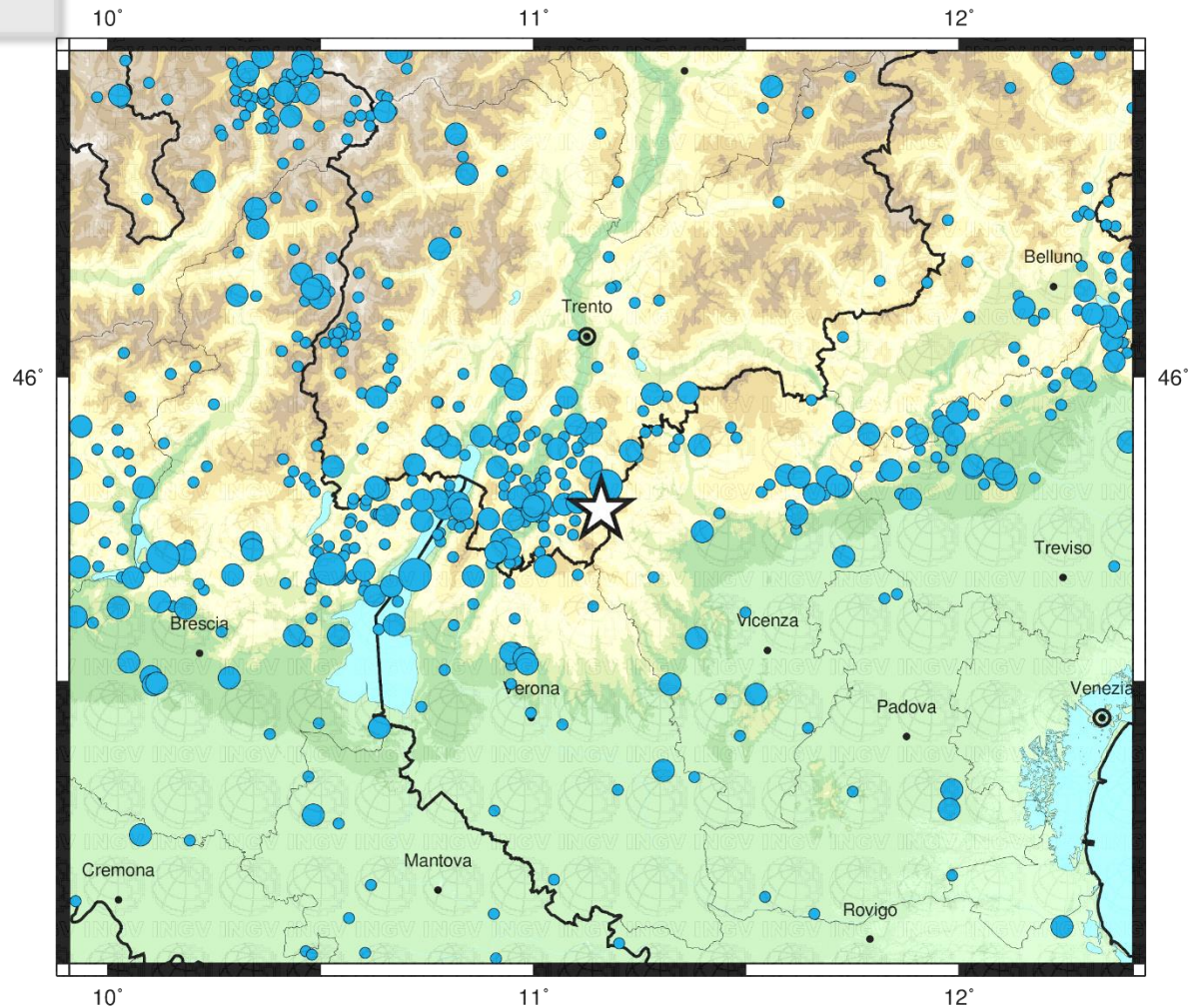


Alto Garda area



*<https://www.provincia.tn.it/News/Approfondimenti/Classificazione-sismica>

MAERS: relevant seismicity in the area



Magnitudo

- da 2.5 a 2.9
- da 3.0 a 3.9
- da 4.0 a 4.9
- da 5.0 in su

Tempi

- ultima ora
- ultime 24 ore
- ultime 72 ore
- giorni precedenti

Seismic events localised by the National Seismic Network from 2017 to the present day with a magnitude of ≥ 2.5 .
 Data: *iside.rm.ingv.it*

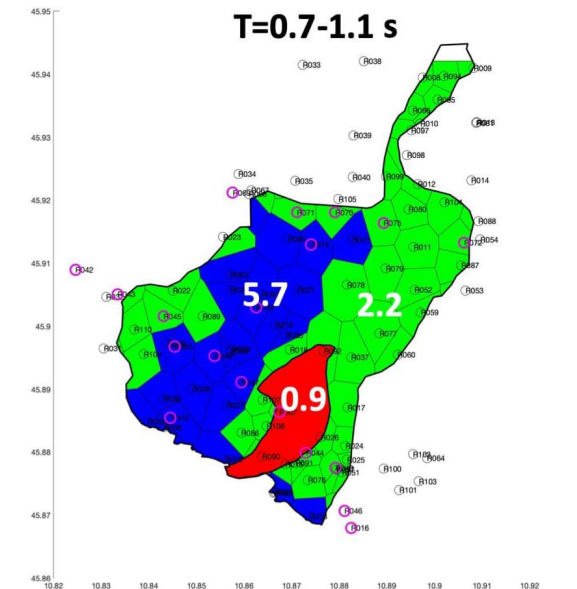
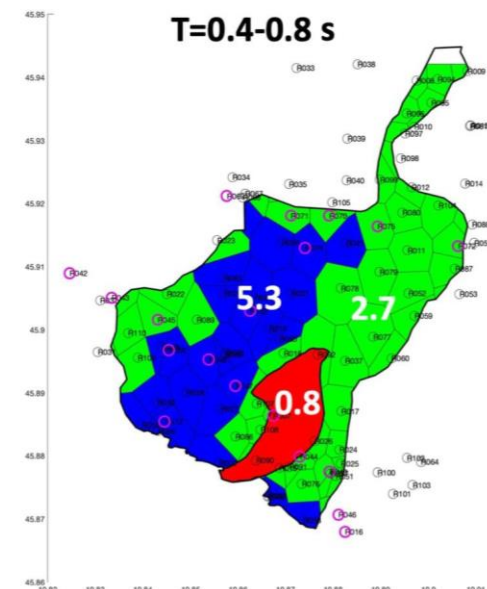
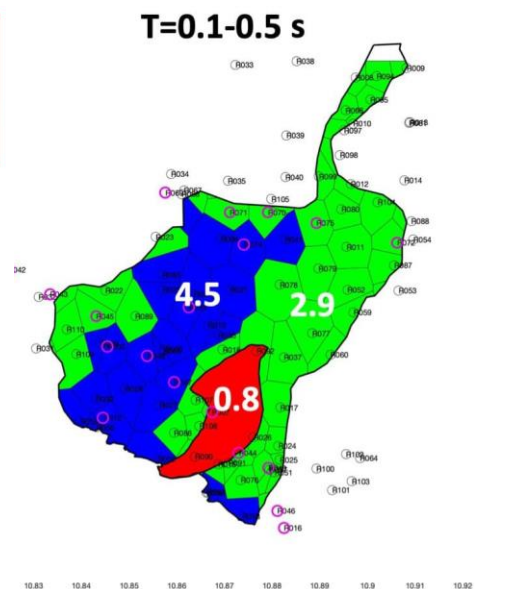
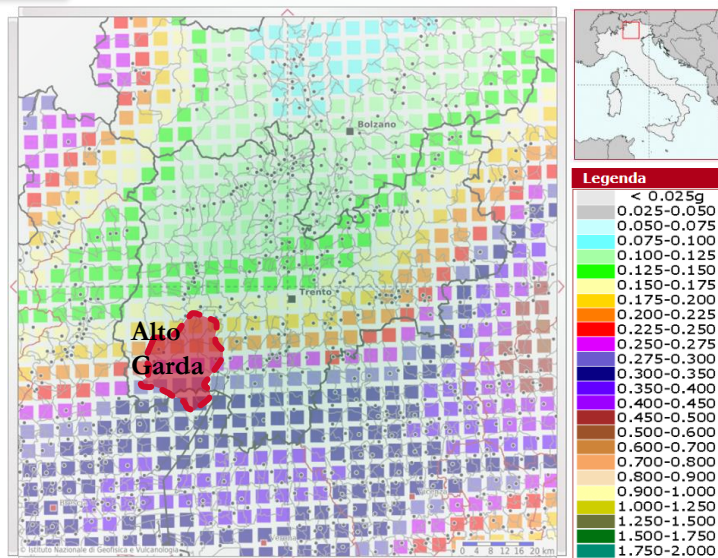
Data e Ora (Italia) 📅 ⓘ	Magnitudo 📉 ⓘ	Zona ⓘ
2024-05-01 17:49:07	ML 2.7	3 km NW Brentonico (TN)
2024-05-01 13:11:54	ML 2.2	3 km SE Malcesine (VR)
2024-04-15 14:48:39	ML 2.0	3 km SE Racines (BZ)
2024-04-13 17:46:53	ML 2.2	1 km SW Bossico (BG)
2024-04-12 14:55:18	ML 2.2	2 km W Trecenta (RO)
2024-03-13 14:49:00	ML 2.0	3 km SE Ala (TN)
2024-01-07 07:58:20	ML 2.4	4 km NW Possagno (TV)
2023-12-30 06:47:10	ML 2.8	3 km SE Ala (TN)
2023-12-06 17:55:43	ML 2.8	3 km NW Brentonico (TN)

1976, December – Earthquake located at Riva del Garda

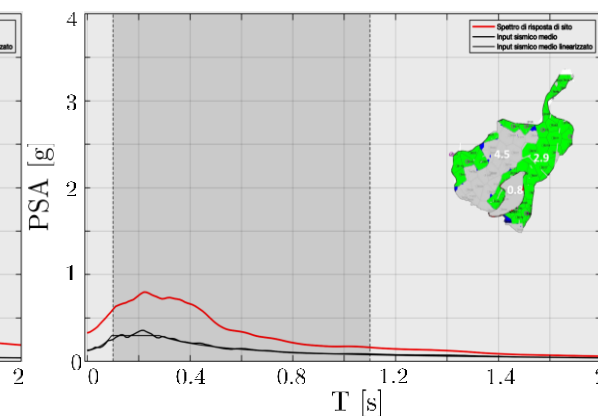
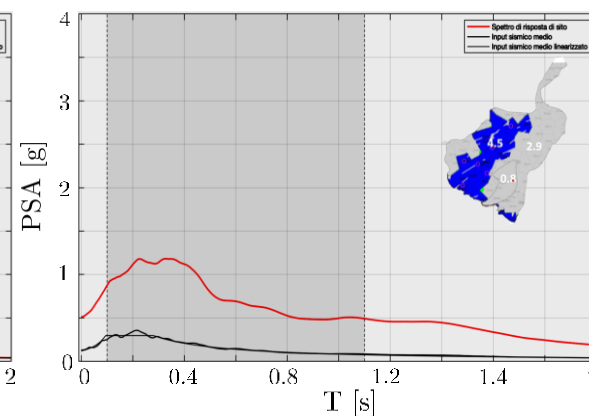
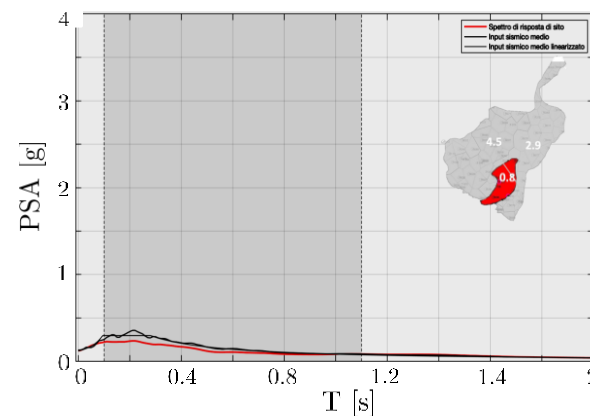


- Magnitude ~4.3, Mercalli Scale 6.5
- No fatalities, 300 refugees
- 10 billions Lire ~ 50 billions Euro actualized
- Indirect losses can be estimated at a ratio of 3:1

Microzonation studies: spectral amplification factors



Source: Fig. 7.6-7.8, Local acceleration response spectra for each of the 3 clusters (CLU1=red, CLU2=blue, CLU3=green) and spectral amplification factor maps (FA), @Garbin, M., Laurenzano, G., Parolai, S. (2022). “Studio riguardante la risposta sismica locale del tratto terminale della valle del fiume Sarca in prossimità del Lago di Garda,” Activity Report 2019/2022. PAT.

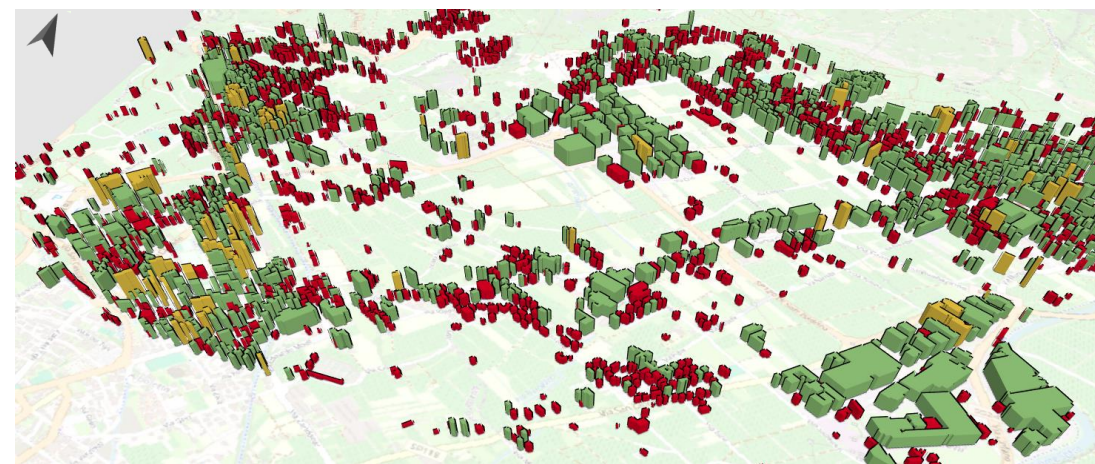
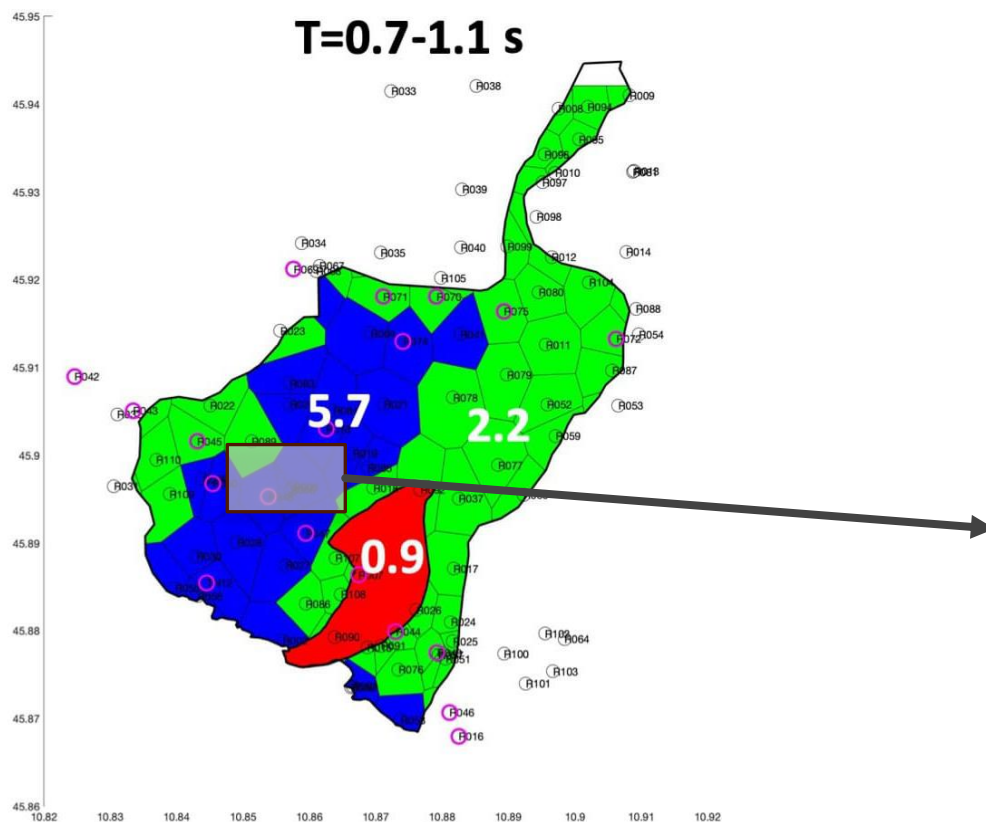


MAERS: Vulnerability analysis

Goal: to estimate the main period T_1 of the structure

$$T_1 = C_1 \cdot H^{3/4} \quad (7.3.5) \quad \text{NTC08}$$

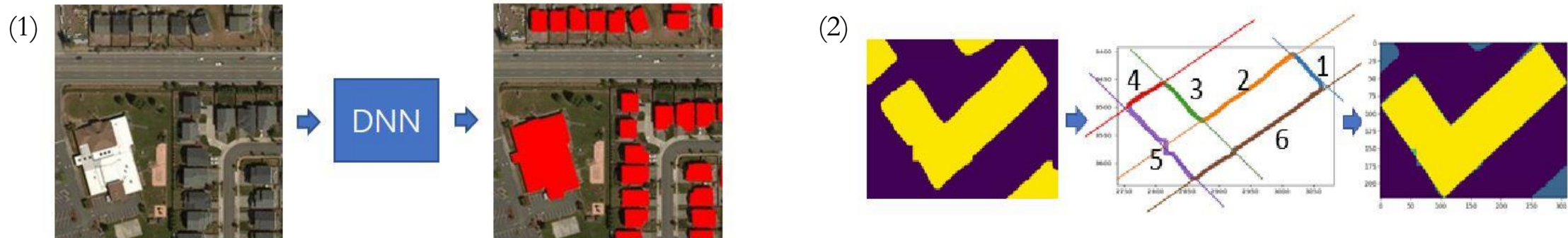
- 0.085 steel frame structure
 - C_1 : - 0.075 rc frame structure
 - 0.050 other
- H: height of the building



MAERS: Vulnerability analysis

Data retrieval: building heights $\mathbf{H}$ from *satellite imagery* → <https://github.com/microsoft/GlobalMLBuildingFootprints>

1. Semantic segmentation: recognizing building pixels on an aerial image using deep neural networks (DNNs)
2. Polygonization: converting building pixel detections into polygons



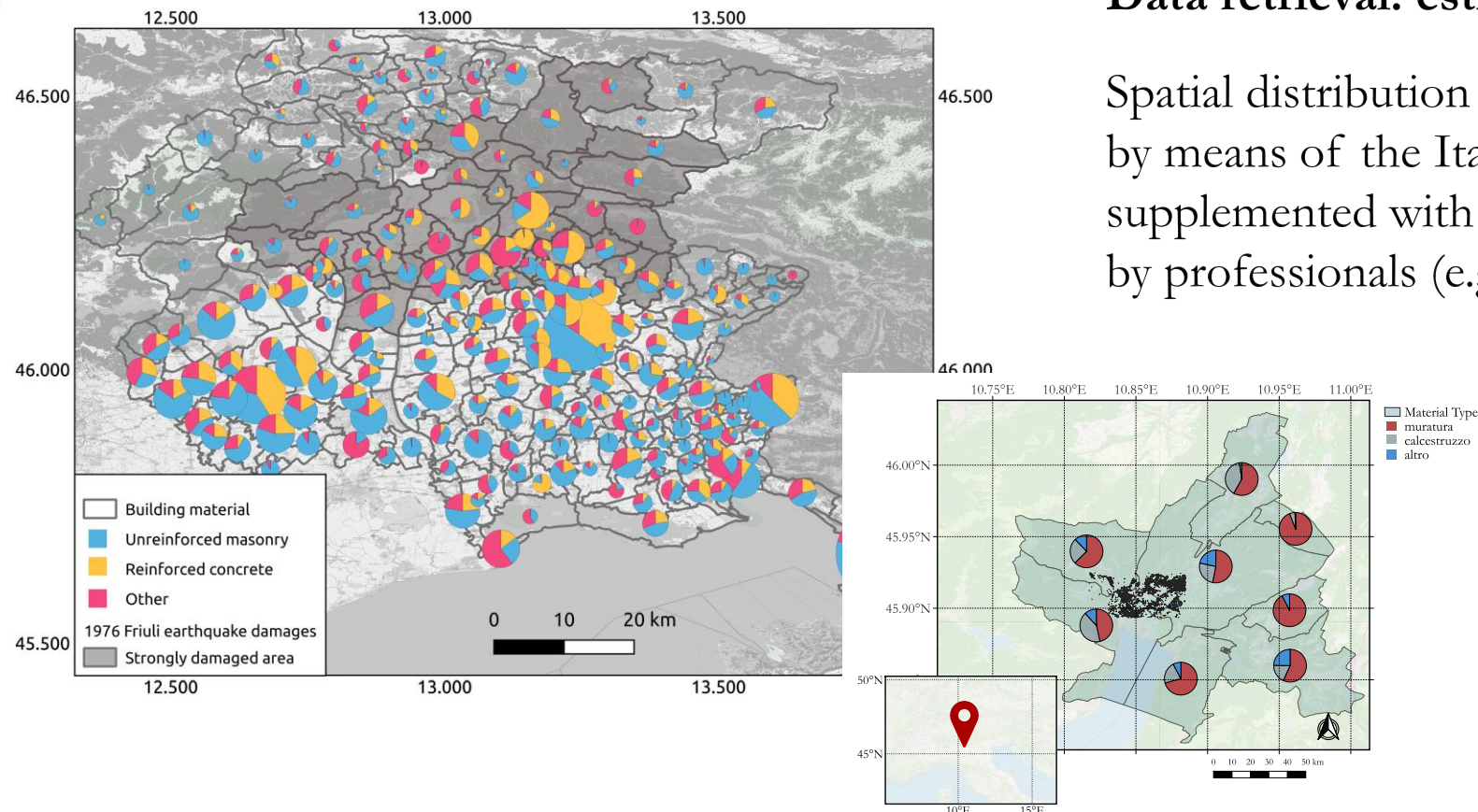
3. Training of the DNN to estimate building heights combined with experimental/cadastral data

Source: Bing Maps; Microsoft GlobalMLBuildingFootprints. Database with 1.3B identified buildings between 2014 and 2023, based on satellite imagery provided by Maxar, Airbus, EOS, Vexcel and IGN France. (01/05/2024)

MAERS: Vulnerability analysis

Data retrieval: estimates of C_1

Spatial distribution of building materials, identified by means of the Italian ISTAT census (2011) and supplemented with visual inspections carried out by professionals (e.g. engineers, architects)^(1,2).

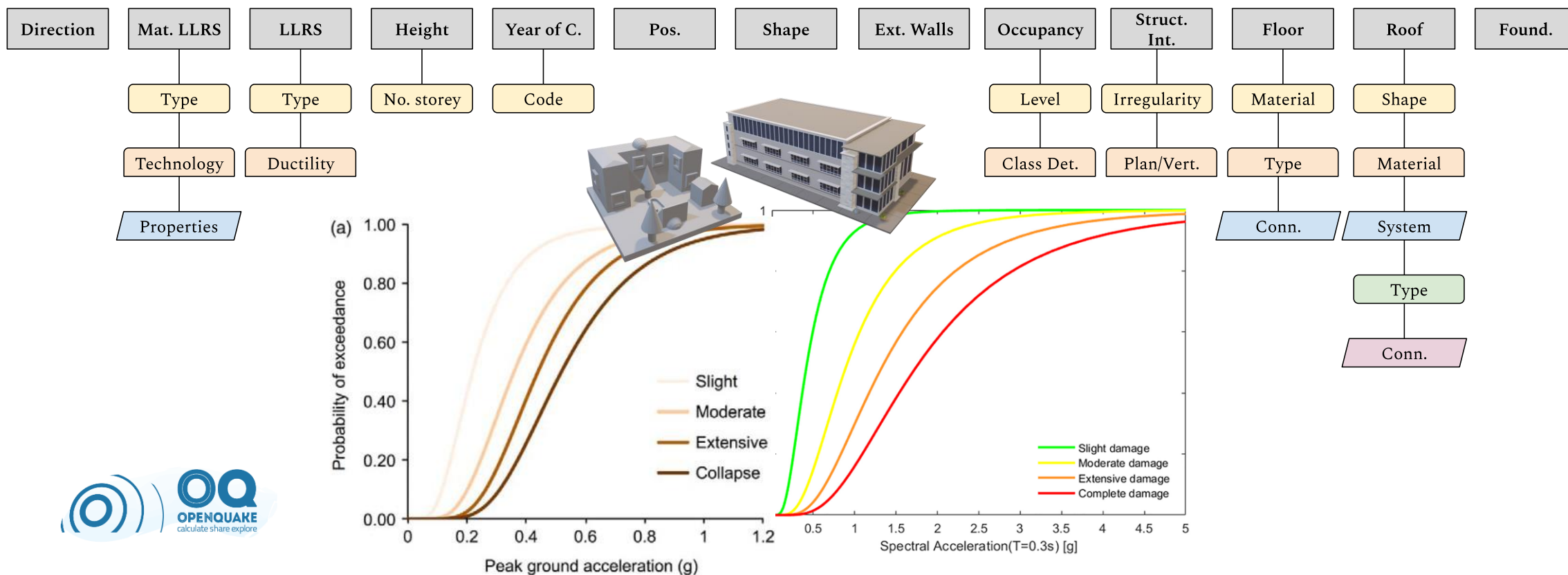


Source: ⁽¹⁾ Gallipoli, M.R., Petrovic, B., Calamita, G. et al. *Towards specific T–H relationships: FRIBAS database for better characterization of RC and URM buildings*. Bull Earthquake Eng 21, 2281–2307 (2023). <https://doi.org/10.1007/s10518-022-01594-7>.

⁽²⁾ Poggi, V., C. Scaini, L. Moratto, G. Peressi, P. Comelli, P. L. Bragato, and S. Parolai (2021). *Rapid Damage Scenario Assessment for Earthquake Emergency Management*, Seismol. Res. Lett. 92, 2513–2530, <https://doi.org/10.1785/0220200245>.

MAERS: Vulnerability analysis

Identification of archetypes of fragility functions: structural taxonomy



Source: Brzev S., C. Scawthorn, A.W. Charleson, L. Allen, M. Greene, K. Jaiswal, and V. Silva (2013), *GEM Building Taxonomy Version 2.0*, GEM Technical Report 2013-02 V1.0.0, 188 pp., GEM Foundation, Pavia, Italy, doi:10.13117/GEM.EXP-MOD.TR2013.02.

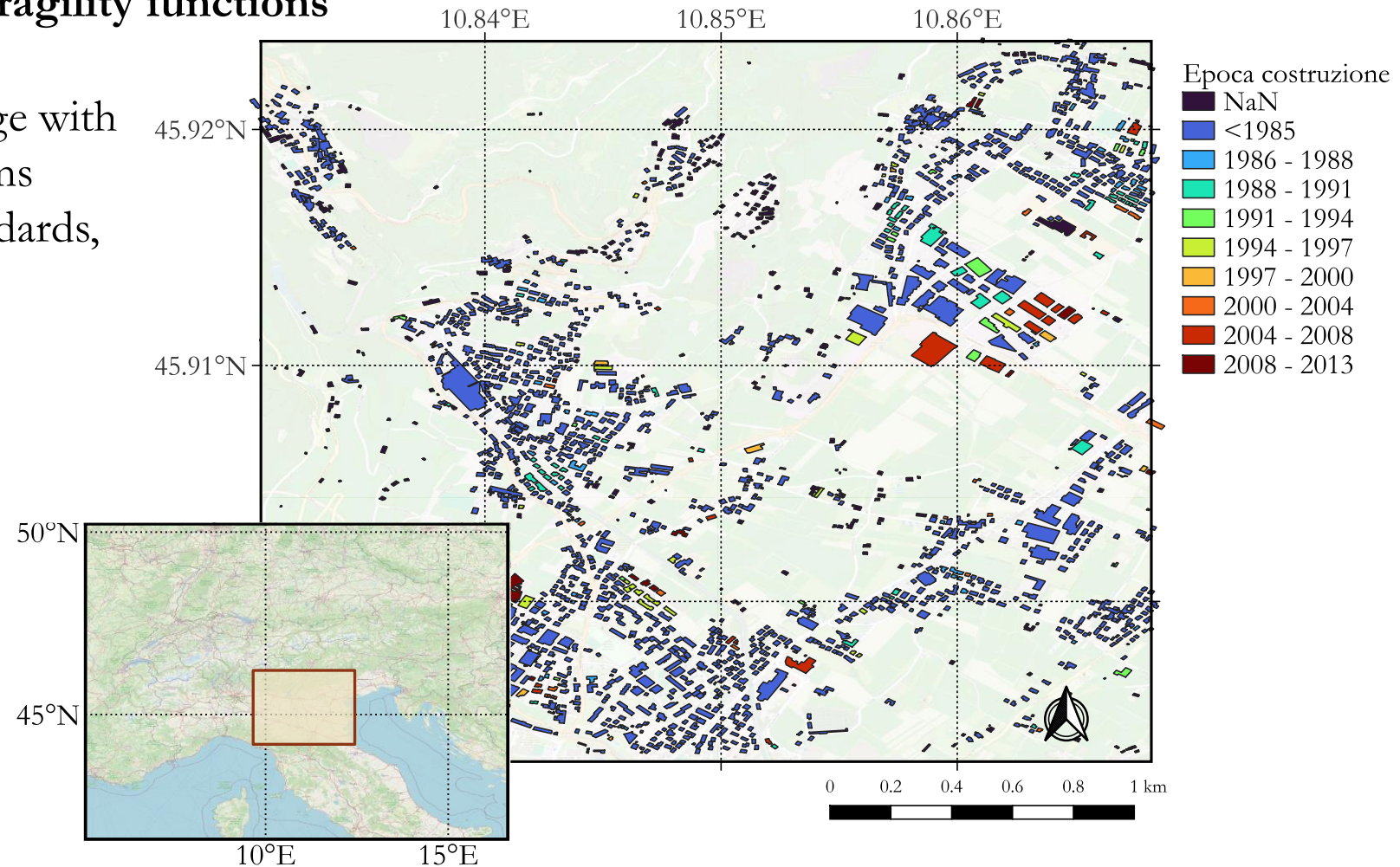
MAERS: Vulnerability analysis

Identification of archetypes of fragility functions

- Correlations among building age with lateral load redistribution systems (seismic design), code and standards, techniques, etc.

According to FRIBAS database⁽¹⁾, paramount parameters:

- Construction material
- Plant/height regularity
- Slab type
- ...



⁽¹⁾ Source: FRIBAS <https://doi.org/10.5281/zenodo.65054.42>

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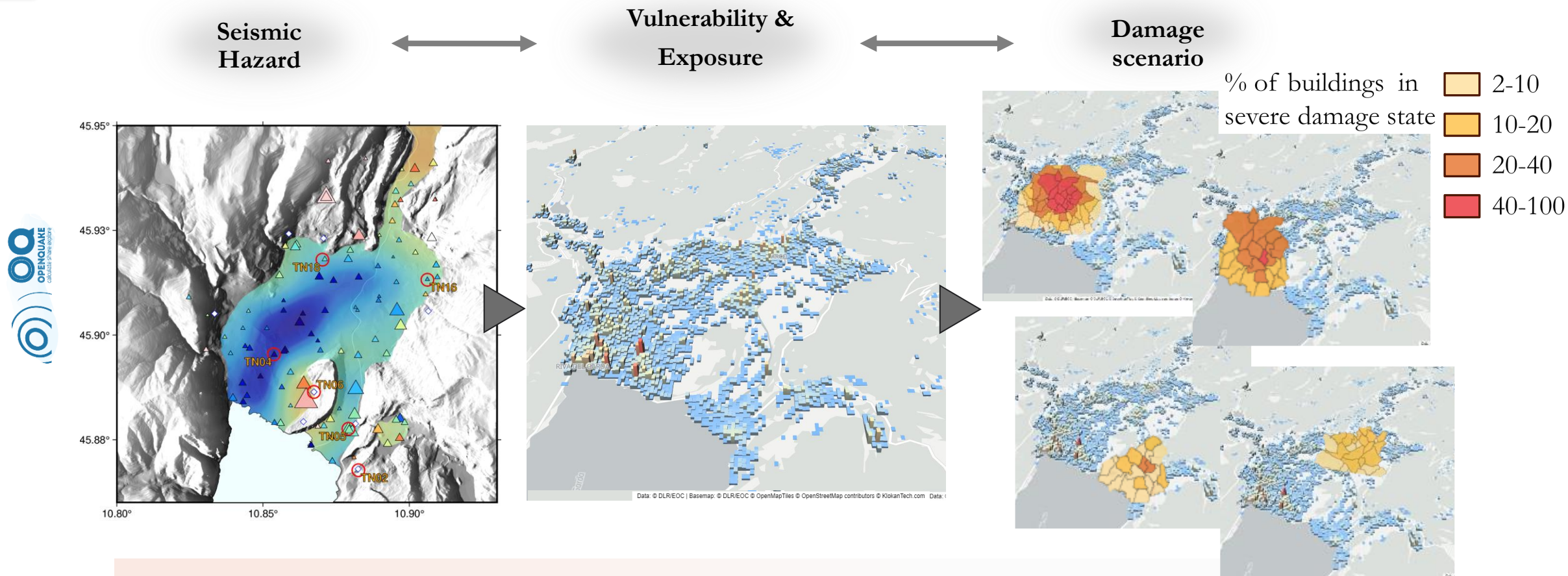
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Conclusions & Future Perspectives



- Updating of the taxonomy framework for fragility assessment
- Identification of critical area/ archetypes of buildings for the Alto Garda area

Acknowledgments



Marco Broccardo



Alfio Viganò



Giovanna Laurenzano



Stefano Parolai

RISK ANALYSIS OF ALTO GARDA VIA MICROZONATION AND STRUCTURAL CHARACTERISATION OF BUILDINGS MAPPING

A reliable seismic risk assessment at national and regional scales has become a major focus for researchers and practitioners, as well as decision-makers and territorial stakeholders. The two primary components of risk assessment, i.e., hazard models and vulnerability analysis, have been the subject of extensive study. In fact, they play a critical role in improving risk management strategies, planning infrastructure and engineering facilities, and supporting disaster response management at a regional scale. Within this framework, a detailed regional risk assessment for the Trentino Alto Garda region, in northern of Italy, is presented herein. The recently completed seismic site response study of the area is considered for the hazard analysis contributing to improves the assessment at local scale and with high spatial resolution. Additionally, data mining of structural building information databases and statistical models of the building asset that take advantage of the main building characteristics evaluated by means of seismic noise measurements and analysis, are used to develop exposure maps. As a result, the hazard and exposure maps are integrated to derive a first semi-quantitative seismic risk assessment for the case study area.





Thanks for your attention!
Questions?

RIVA DEL GARDA