



XXXII Congresso Geografico Italiano

S19 - Governance, risks and natural events: actors and conflicts

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Combining social vulnerability and seismic hazard to produce integrated risk scenarios

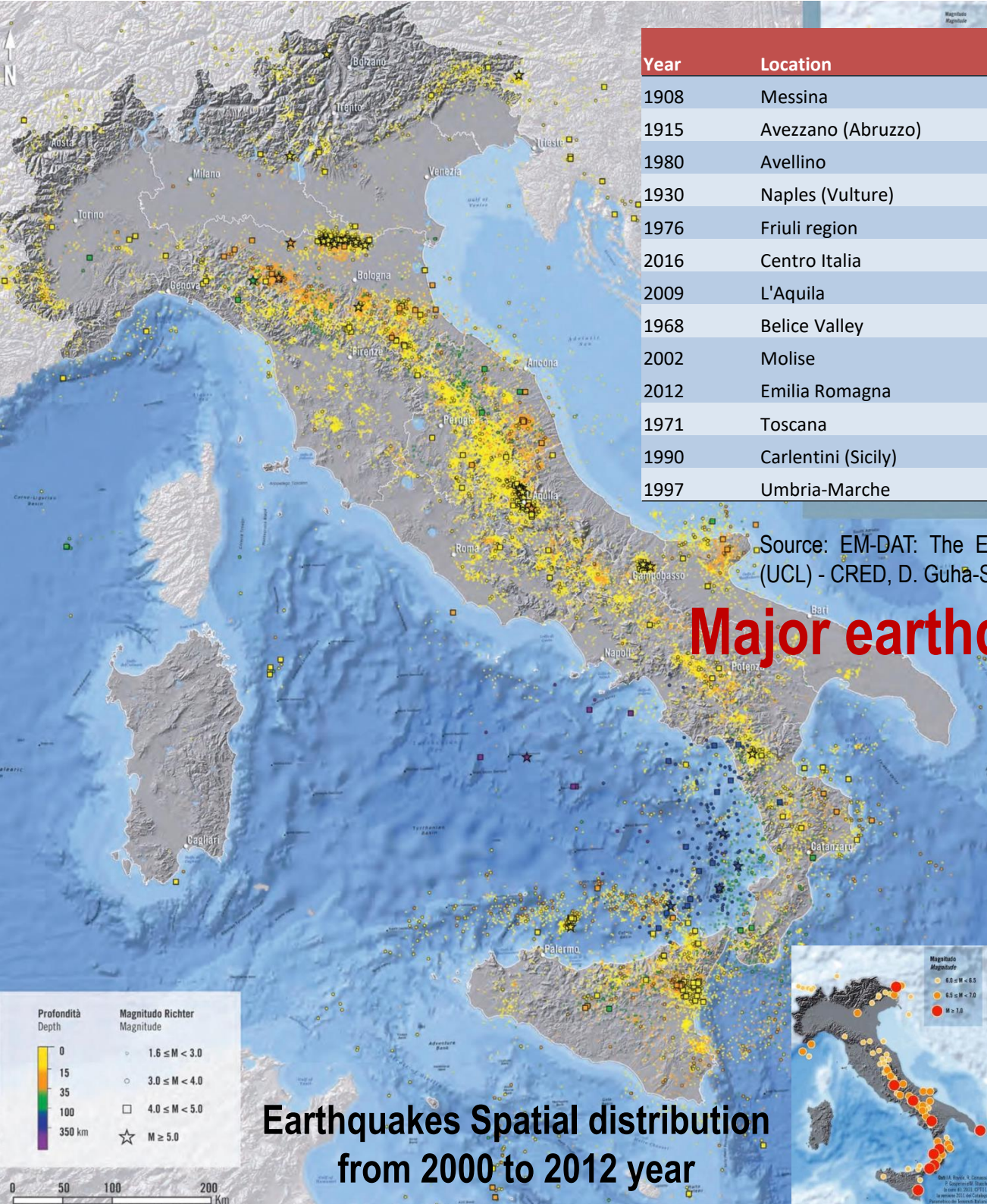
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Year	Location	Total affected	Total deaths	Total damage ('000 US\$)
1908	Messina	150000	75000	116000
1915	Avezzano (Abruzzo)	0	29980	60000
1980	Avellino	407700	4689	20000000
1930	Naples (Vulture)	10000	1883	0
1976	Friuli region	218222	922	3600000
2016	Centro Italia	4854	296	5000000
2009	L'Aquila	56000	295	2500000
1968	Belice Valley	55563	224	250000
2002	Molise	8533	30	796000
2012	Emilia Romagna	11050	27	15800000
1971	Toscana	4220	22	41600
1990	Carlentini (Sicily)	2700	19	500000
1997	Umbria-Marche	38100	14	4524900

Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

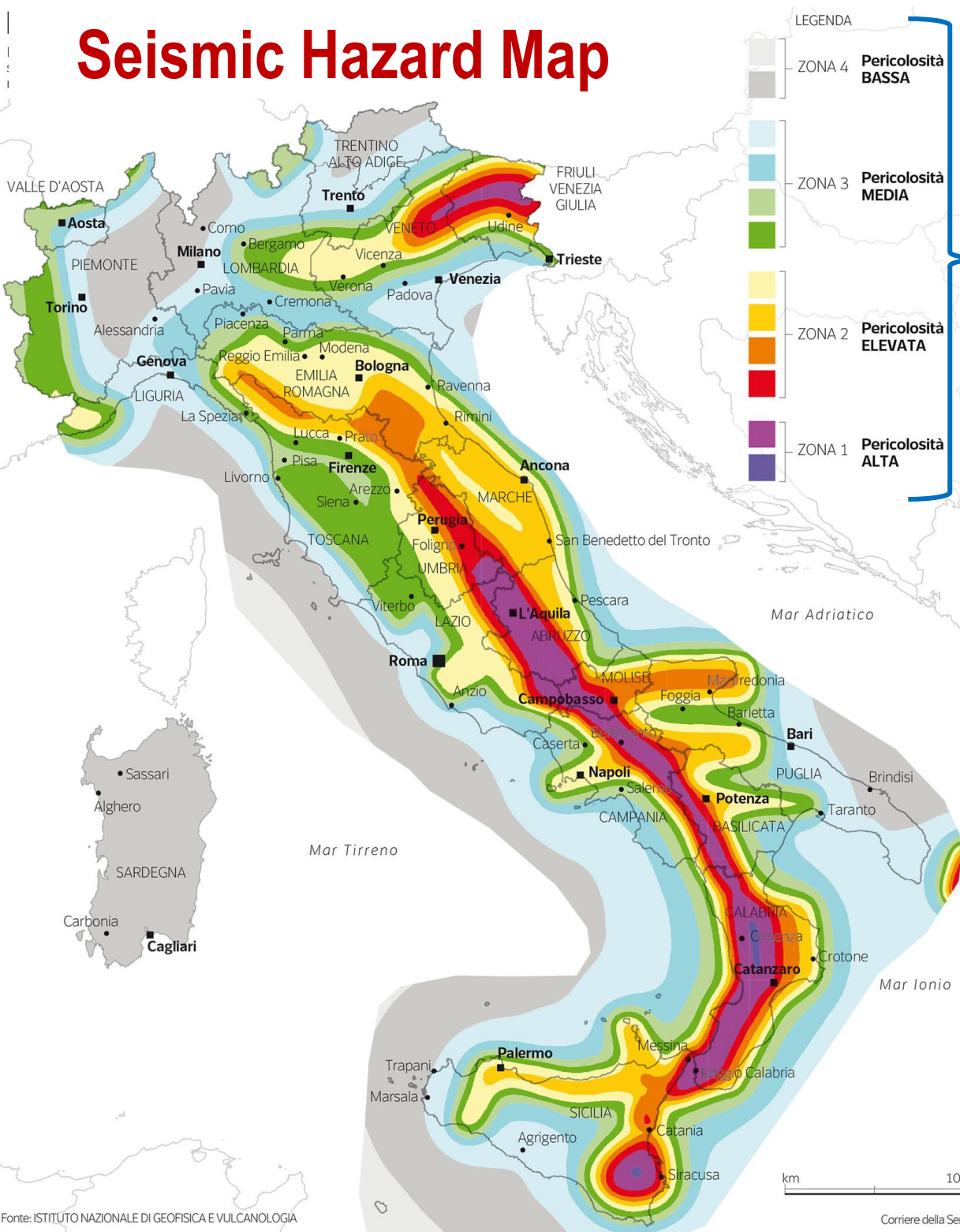
Major earthquakes from 1900 year

- **70%** of the population lives in municipalities **classified seismic**;
- **40%** in 2,956 highly seismic ones;
- **35%** of homes in earthquake zones are **anti-seismically constructed**



**What are you
doing to
reduce seismic
risk in Italy?**

Seismic Hazard Map



Norme Tecniche per le
Costruzioni, DM
14/01/2008 del Ministero
della Infrastrutture

Seismic actions for the construction of
new buildings or structures;

Guidelines for Seismic
Microzonation, Gruppo di
lavoro MS, 2008

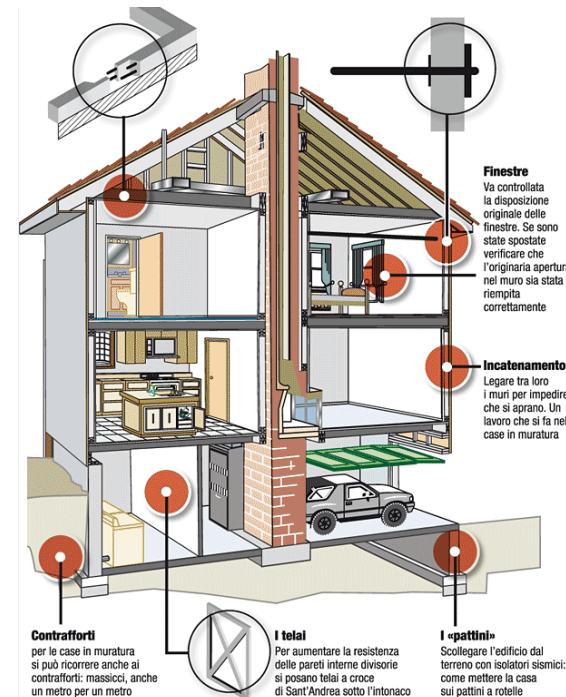
Highly useful tool for seismic
prevention and risk assessment in
land management, for the design of
buildings or structures and for
emergency planning.

Risk concept

$$R = H \times V$$



Eartquake events



Antiseismic buildings

What is vulnerability?

- Vulnerability describes the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard;
- There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors.

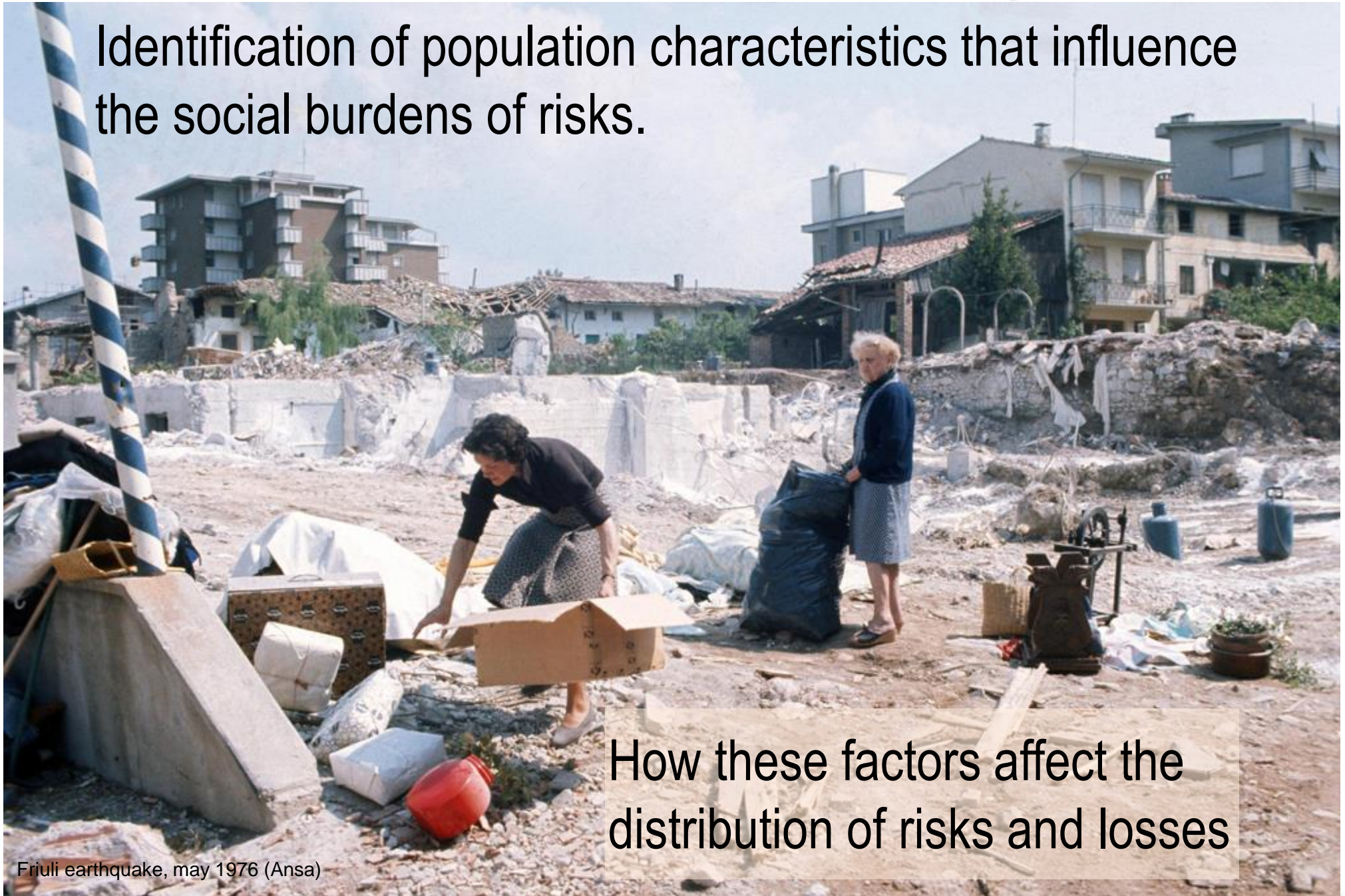


Vulnerability approach

- ✓ people, not physical forces, are the principal cause of risks and disasters;
- ✓ focus on reducing community vulnerability;

Social Vulnerability

Identification of population characteristics that influence the social burdens of risks.



How these factors affect the distribution of risks and losses

Some Italian examples:

AGE (children < 14 years and elderly > 65 years) (+)

more vulnerable, highly dependent, limited mobility, illiteracy and economic vulnerability.

EDUCATION (high and low education) (+ & -)

ability to understand information about emergency plans or warning information and to avoid dangerous situations.

RESIDENTIAL PROPERTY (building from 1972) (+)

quality of residential construction

ANTHROPIZATION (Population density) (+)

rapid population growth is often unlikely to be absorbed by the country providing inefficient services to the population

ETHNICITY (Foreign residents) (+)

ethnic groups with different languages, cultures and educational levels that could determine cultural barriers in a community



How to represent the concept of social vulnerability?

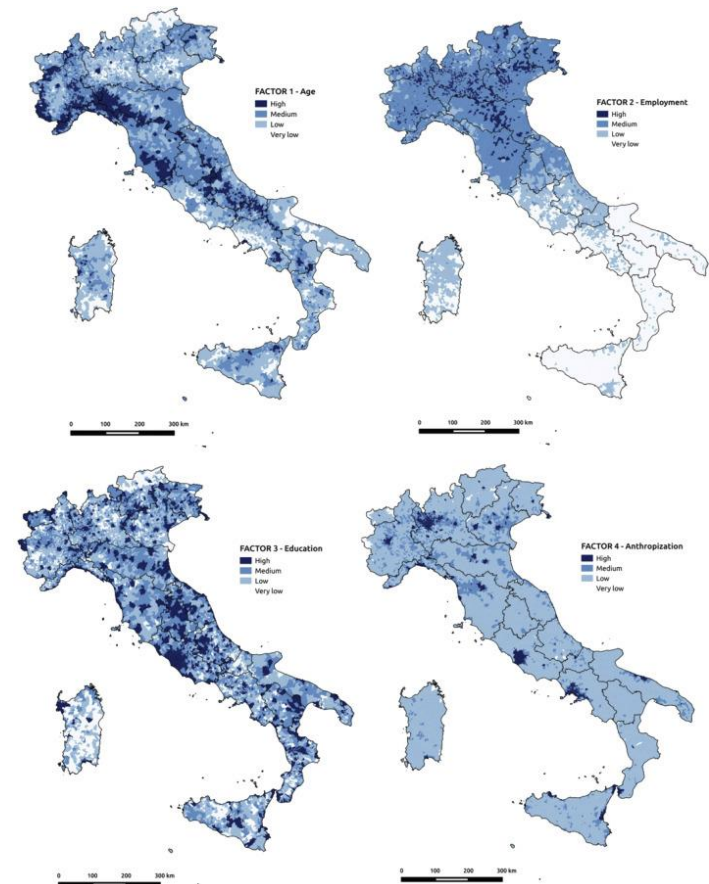


Social Vulnerability Factors

County level socioeconomic dataset based on the 2001 data warehouse of the 14th population and housing census (ISTAT).

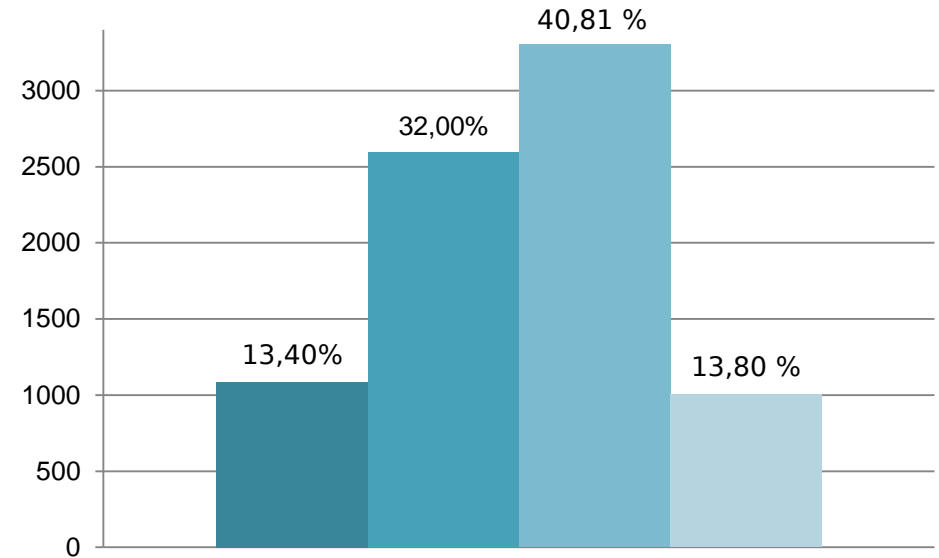
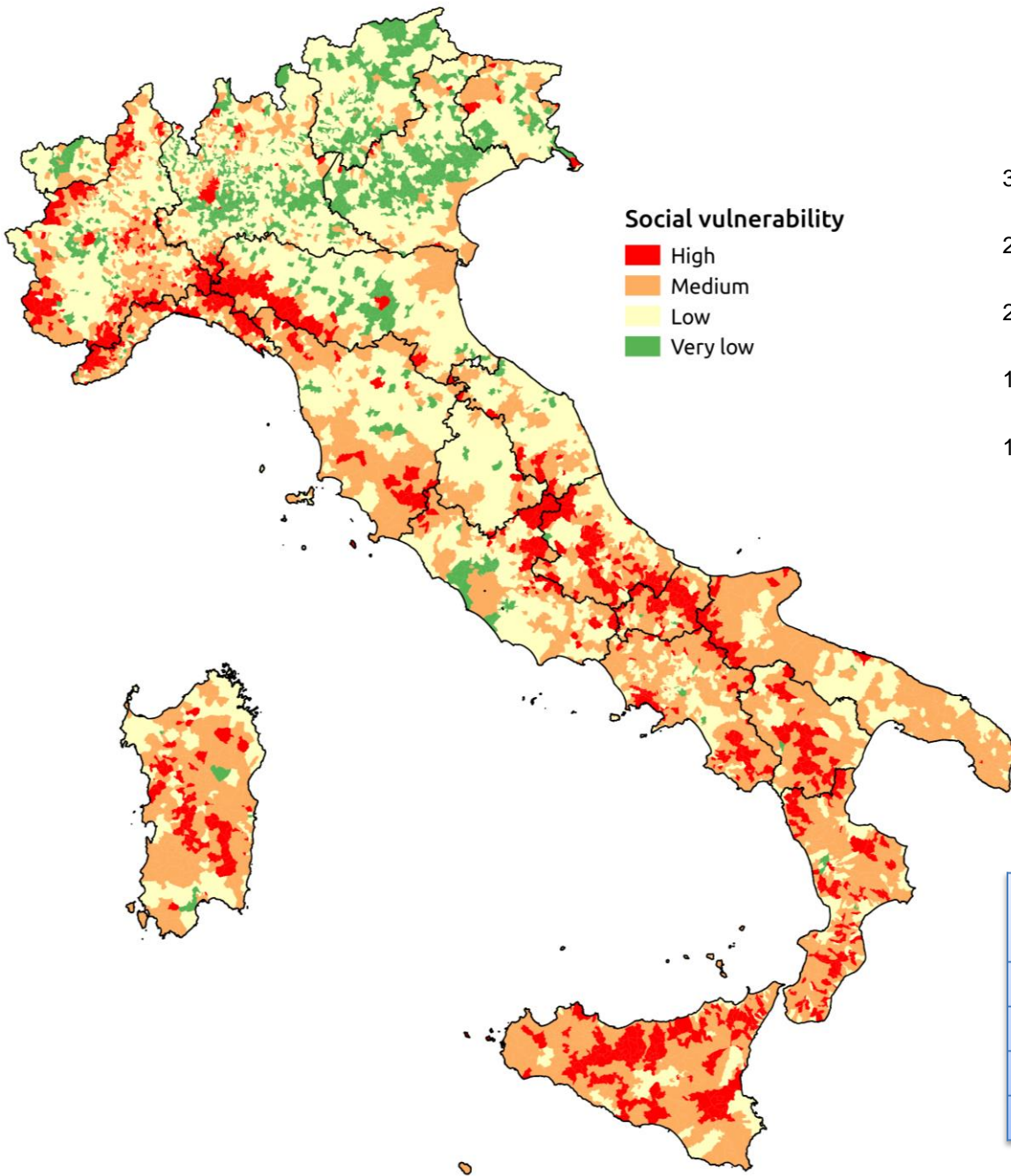
15 proxy variables → 4 factors explaining the 74.6% of the variance:

1. **Age** (29.5%);
2. **Employment** (22.4%);
3. **Education** (12.9%);
4. **Anthropization** (9.5%).



See: *Frigerio, I., et al (2016). A GIS-based approach to identify the spatial variability of social vulnerability to seismic hazard in Italy. Applied Geography, 74, 12-22.*

Mapping Social Vulnerability



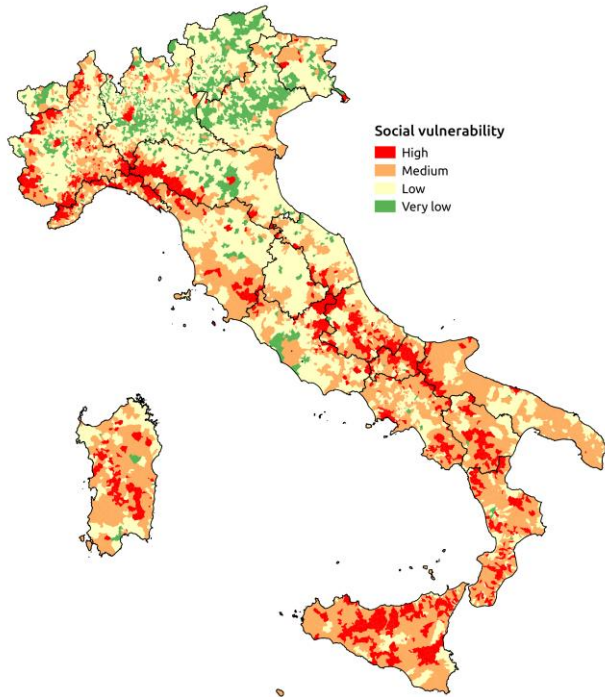
SVI CLASSES	N° OF MUNICIPALITIES	PERCENTAGE (%)
Very Low	1085	13,40
Low	2592	32,00
Medium	3305	40,81
High	1116	13,80

**How to produce
integrated seismic risk
scenarios?**

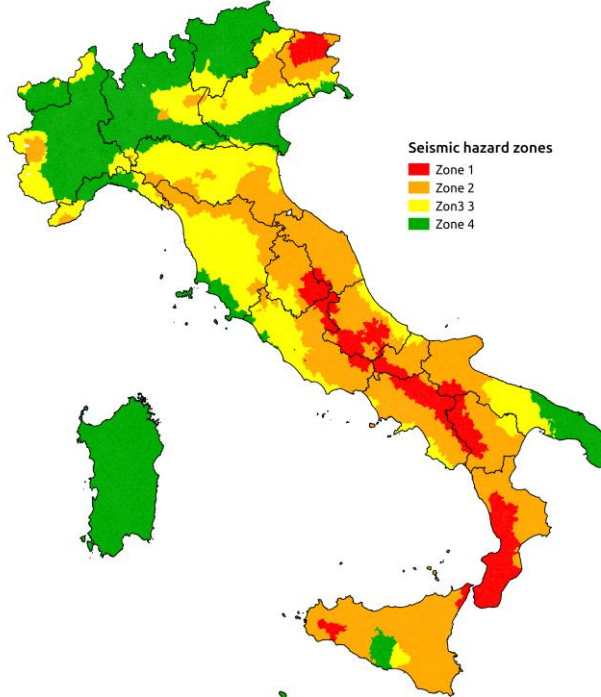
Social Vulnerability

Seismic hazard

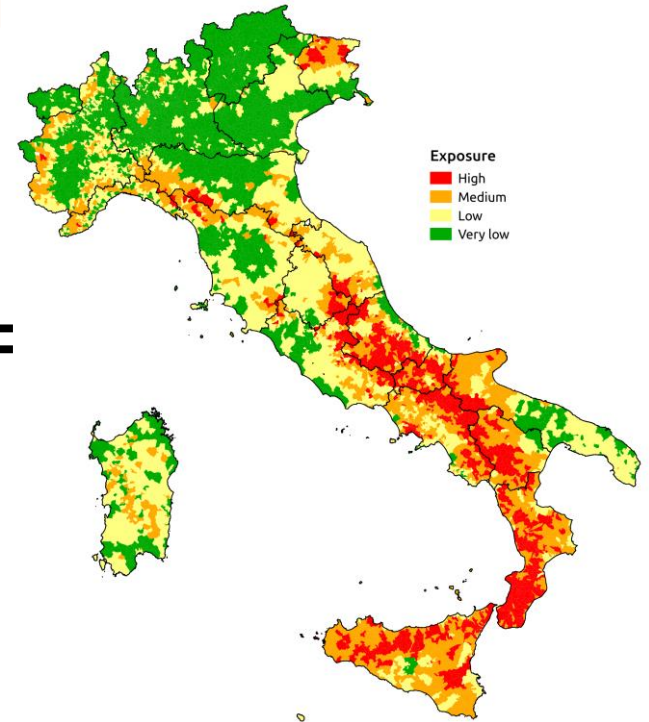
Exposure map



Social vulnerability
 High
 Medium
 Low
 Very low



Seismic hazard zones
 Zone 1
 Zone 2
 Zone 3
 Zone 4



Exposure
 High
 Medium
 Low
 Very low

+ =

SOCIAL VULNERABILITY	SEISMIC HAZARD			
	Zone 4	Zone 3	Zone 2	Zone 1
Very low (4)	16	12	8	4
Low (3)	12	9	6	3
Medium (2)	8	6	4	2
High (1)	4	3	2	1

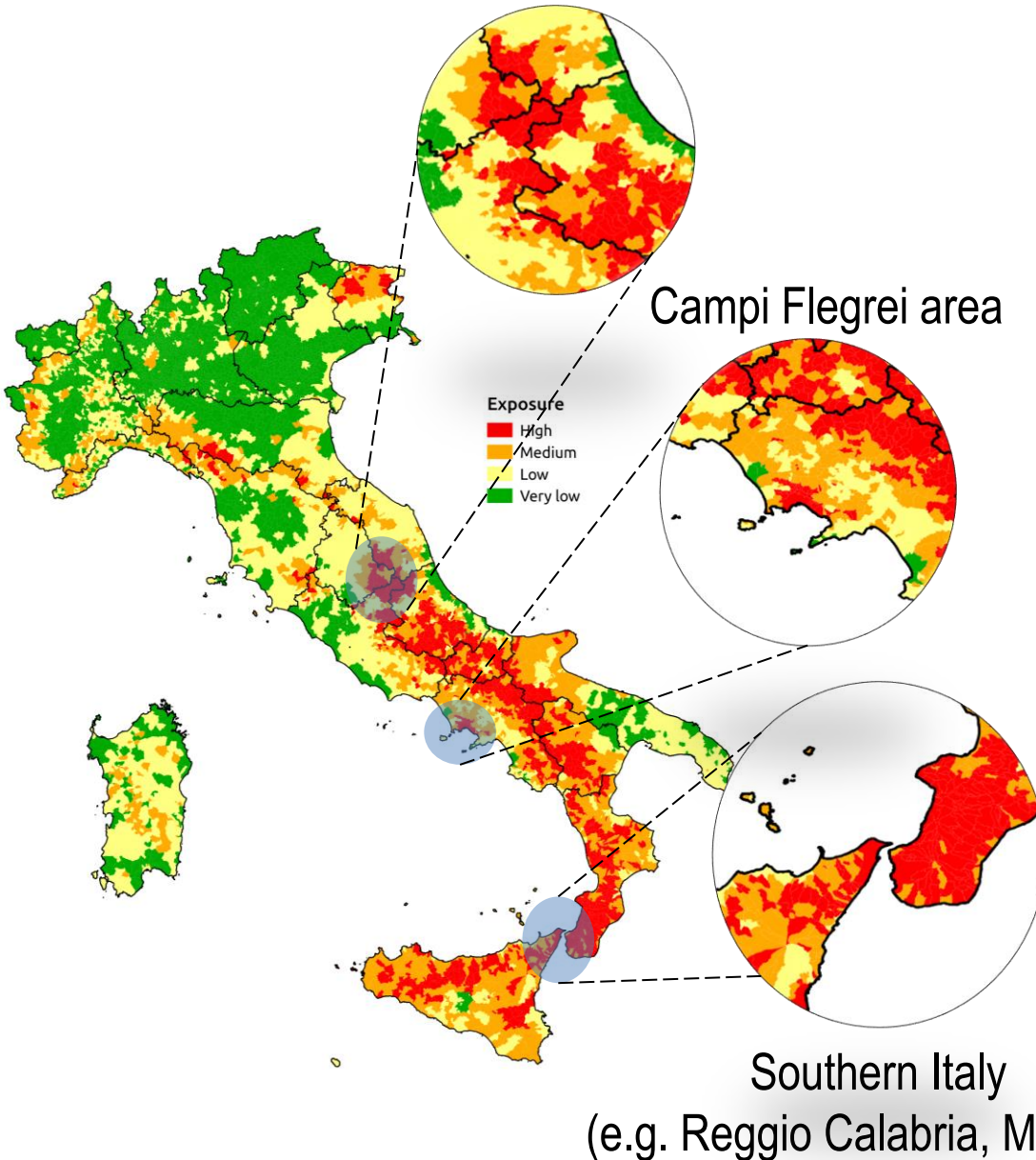
The risk matrix was used to build the integrated risk;

The matrix was calculated by adding the different values of social vulnerability and seismic hazard classes;

**How do we make
outputs useful and
applicable to policy and
practice?**

Some critical areas

Central Italy (e.g. Amatrice, Accumuli)



Goal: Provide scientific basis for disaster and hazard reduction policies

For policy makers, it is crucial to know which are the more socially vulnerable zones against hazards in order to identify appropriate cost-effective risk reduction strategies to be implemented at national and at the local level.

Why this study is important?

- It is a robust and scalable metric for comparing places on their social vulnerability;
- combination of social and physical process possible with a GIS based approach;
- basis for understanding what are the Italian socioeconomic conditions that make a community more vulnerable than another;
- evidence of disparities in potential impacts and ability to recover from catastrophic failures

Why this study is important?

- consider all these inputs when making emergency management plans such as for provision, prevention and emergency preparation;
- the social vulnerability map at a national scale could be used in a preliminary stage of regional planning;
- Policy—prioritize mitigation efforts and preparedness resources

Take home message



Lisbon earthquake, 1775

Thank you for your attention

For more info

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Geomatic Laboratory (UNIMIB): <http://geomatic.disat.unimib.it>

Web App, SVI to Earthquake Hazard: <https://goo.gl/54SNaL>

References

- **Frigerio, I., & De Amicis, M.** (2016). *Mapping social vulnerability to natural hazards in Italy: A suitable tool for risk mitigation strategies*. Environmental Science & Policy, 63, 187-196.
- **Carnelli, F., & Frigerio, I.** (2016). *A socio-spatial vulnerability assessment for disaster management: insights from the 2012 emilia earthquake (Italy)*. Sociologia urbana e rurale.
- **Frigerio, I., et al** (2016). *A GIS-based approach to identify the spatial variability of social vulnerability to seismic hazard in Italy*. Applied Geography, 74, 12-22.
- **Frigerio, I., et al.** (2016) *Costruzione di un indice di vulnerabilità sociale in relazione a pericolosità naturali per il territorio italiano*. Rendiconti Online Della Società Geologica Italiana 39, 68-71.