The Role of the Centres of Competence in the Italian Civil Protection System

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1 - Introduction

Disaster Risk Reduction and Knowledge

Our society is under increasing pressure to address **Disaster Risk Reduction (DRR) at all scales,** from global to local.

Knowledge plays a primary role in DRR, as it can empower **policy and practice** to make **informed decisions** and **to coordinate actions**.

Despite the considerable amount of scientific information available and activities, **Disaster-related losses are on the rise almost worldwide** for many intertwined reasons:

- **Increased hazard**, e.g. caused by climate change and by the proliferation of industrial plants where dangerous substances are used or stored

- **Increased vulnerability and exposure**, e.g. due to diffuse and uncontrolled urbanization

Science vs. Decision Making

DRR management is based on two fundamental pillars:

- **technical decision-makers**
- **scientists**

Above them: **political decision-makers** → represent the political willingness and support DRR activities according to the electoral mandate

- **Technical decision-makers** → manage the entire risk cycle
- **Scientists** → provide data, products, models, scientific information and advice as a support for sound decision-making

Importance and role reciprocally acknowledged

How to implement the interplay between them for an effective DRM ?

Scope and summary of the presentation

The aim is to provide **an overview of the contribution of science** to **civil protection**, particularly of **earthquake and structural engineering science**, on the basis of the **experience made on a national scale** within the **Italian civil protection system**

The focus will be on:

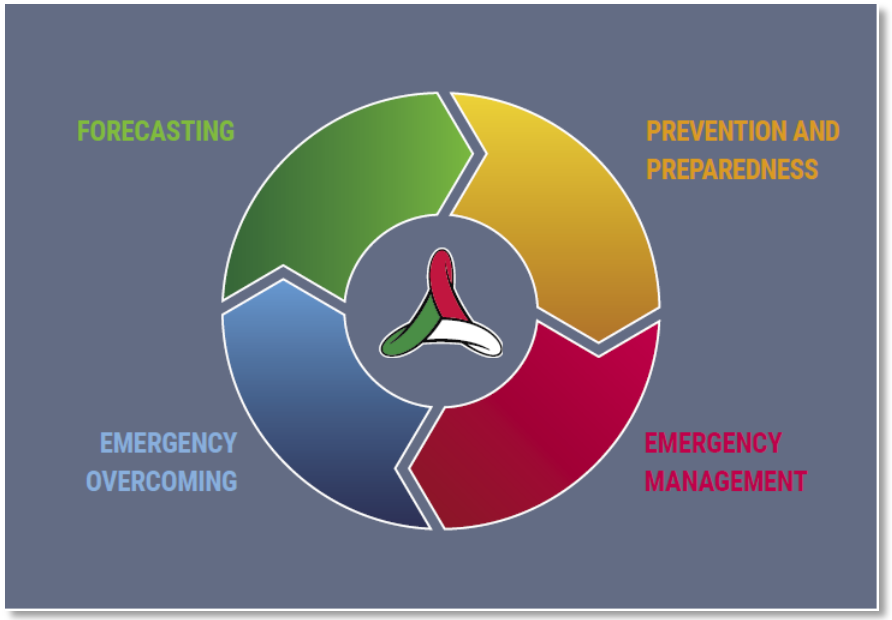
- The **complex relationship** between civil protection and the scientific community, and its **governance**
- The network of the **Italian CP competence centers**
- Some **activities and scientific products** of the centers dealing with **seismic risk**, summarized for illustrative purpose
- **Lessons learned, future perspectives and conclusion**

2 – Civil Protection & Science

The Risk Management Cycle

The DRM cycle has four phases implying different activities:

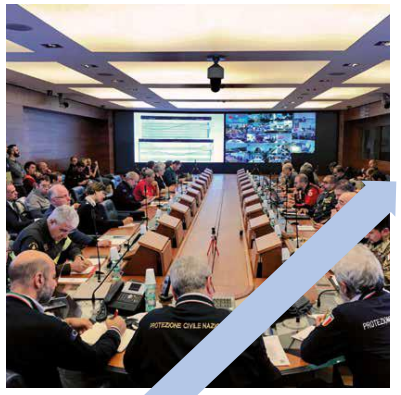
- **Forecasting**: identification and study of the possible risk scenarios
- **Prevention and Preparedness**: measures aimed at the risk reduction
- **Emergency Management**: integrated and coordinated set of measures and interventions for rescue and assistance
- **Emergency Overcoming**: removal of obstacles to the resumption of normal living conditions



A further phase devoted to **Reconstruction** follows for most risks → it is ordinarily managed by the government of the territory or by an Extraordinary Commissioner.

The Civil Protection system in Italy

The Italian **National Civil Protection Service** (NCPS) is made of:



- ***Components:*** State, Regions and Autonomous Provinces, local Authorities
- ***Operational Structures:*** i.e., Firefighters, Volunteers, etc.
- ***Contributing Subjects:*** professional orders, public and private companies, etc. Citizens may also contribute to the civil protection

The scientific community is mentioned among the Operational Structures

NCPS is:

- **coordinated** by the **Prime Minister** through the **Civil Protection Department**
- ruled by the **Civil Protection Code** (L.D. 1/2018)
- **multilevel**, with responsibilities at all levels and in a wide range of fields of the risk cycle

Civil Protection and Science – a relationship issued by law

Collaboration dating back to **1976** (aftermath of Friuli eq.)

Formal relationship in the **Law 225/1992**:

- scientific bodies and research institutions included as **operational structures of NCPS**;
- **Major Risks Commission** established for the first time.

Current **Civil Protection Code (L.D. 1/2018)**:

- recognition of the **important role** the scientific community plays in civil protection activities;
- **better regulation** of this role → question of **responsibilities** increasingly emerging, over the years and at both international and national level.

Role regulated by the law →

- it shapes practically the collaboration between scientists and CP decision-makers

Activities of the scientific community in the NCPS

a) **routine and operational activities** [...] which include, inter alia, **monitoring and surveillance** of events, development of **databases** and any other activity useful for **emergency management and risk forecast and prevention** which provides products of immediate use;

b) **experimental activities preparatory to the activities referred to in point a)**, as well as the production of scientific contributions and the synthesis of existing research useful to this end;

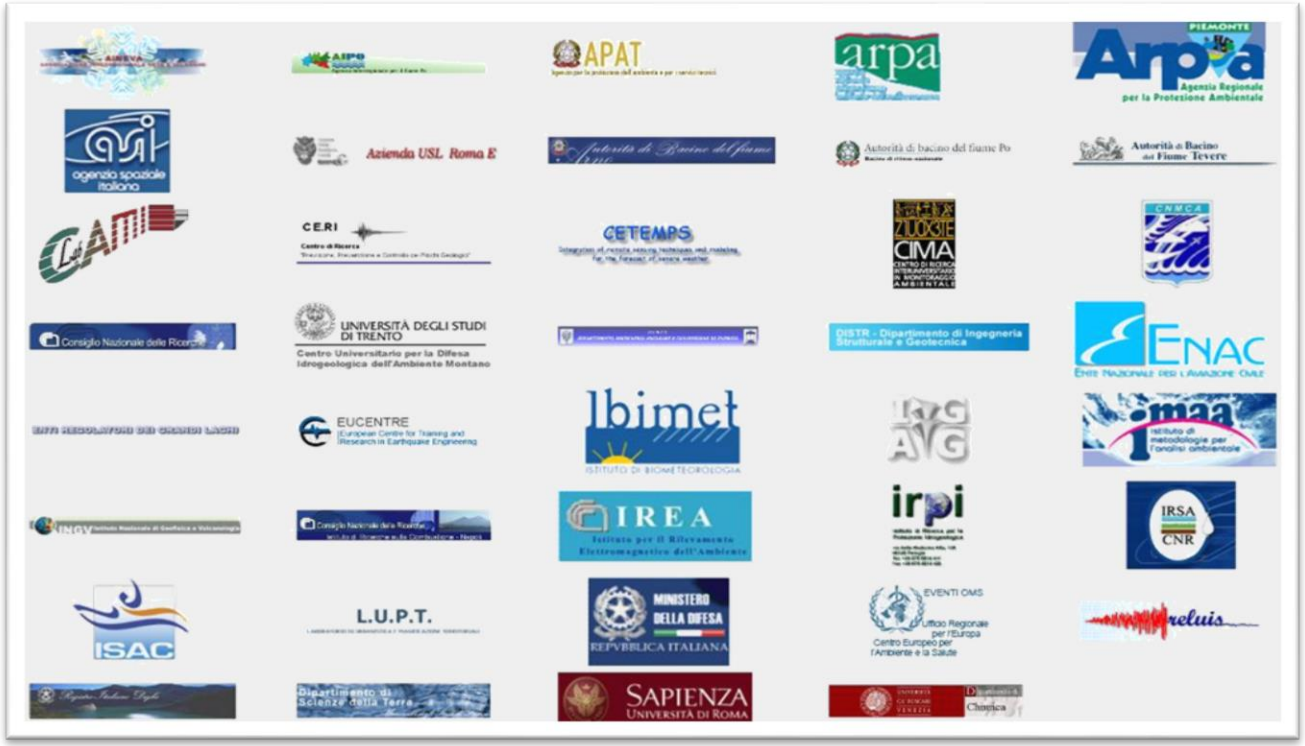
c) **targeted research preparatory to the development of products useful for risk management** [...] and the study of the related scenarios;

d) collaboration in the **preparation of technical regulations** of interest.

3 – Competence Centres

Competence Centres

Since **2004**, the **Competence Centres** are "***those entities that provide services, information, data, processing and technical-scientific contributions in specific fields***".



According to the Code (**2018**), "***research bodies and institutes, consortia and university structures*** *that own and make available* ***knowledge*** *and provide* ***products*** *resulting from* ***research and innovation****, which can be* ***integrated in the civil protection*** *activities, can be identified as Competence Centres*".

Networks of Competence Centres for the development of specific topics on integrated themes and in a multi-risk perspective → **CI3R**

Competence Centres for Seismic Risk - 1

- **INGV**

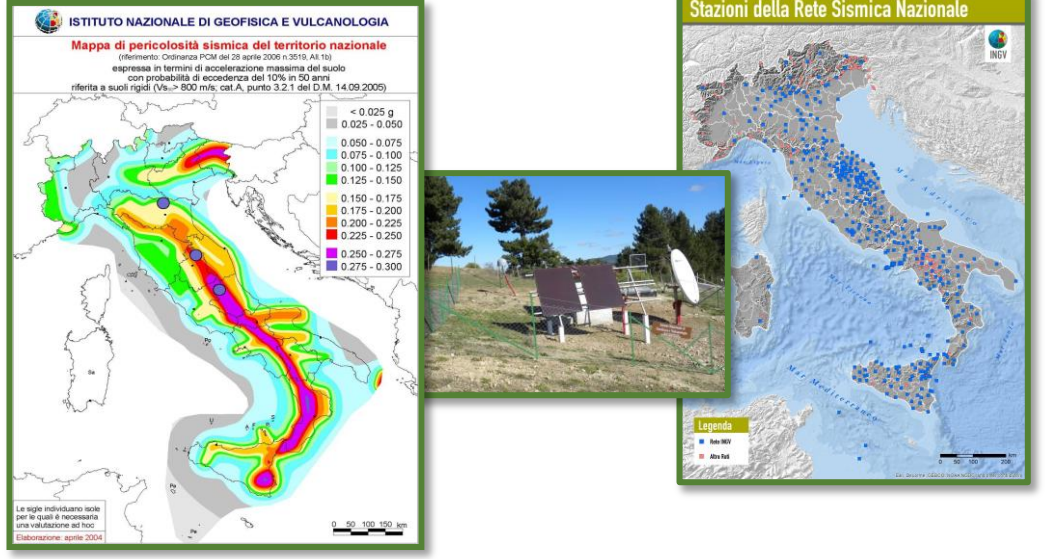
(Seismic monitoring and surveillance, research projects in seismology and seismotectonics; technical-scientific support in emergency)

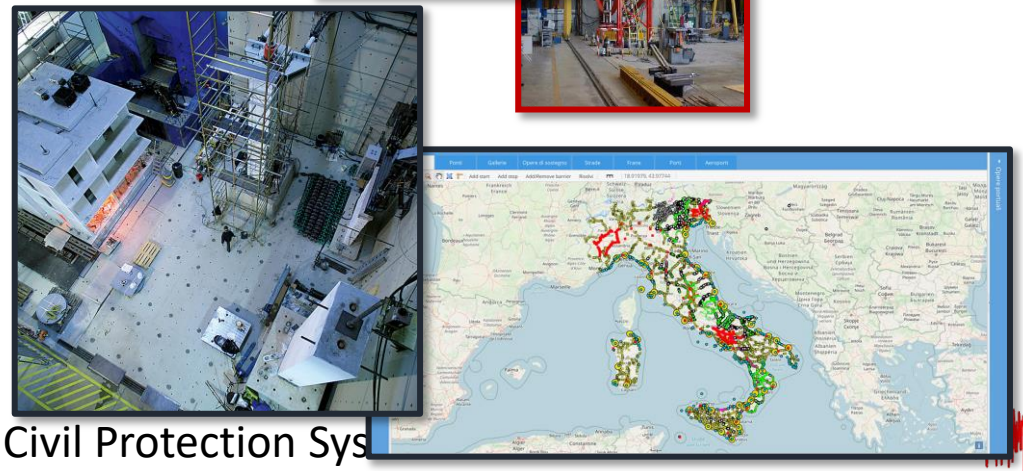
- **ReLUIS**

(Projects in earthquake engineering; technical-scientific support in emergency)

- **EUCENTRE**

(Projects in seismic engineering; technical-scientific support in emergency)





Competence Centres for Seismic Risk - 2

- **CNR (IGAG, IREA, IRPI)**

(landslides; satellite interferometry; technical-scientific support in emergency)

- **ISPRA**

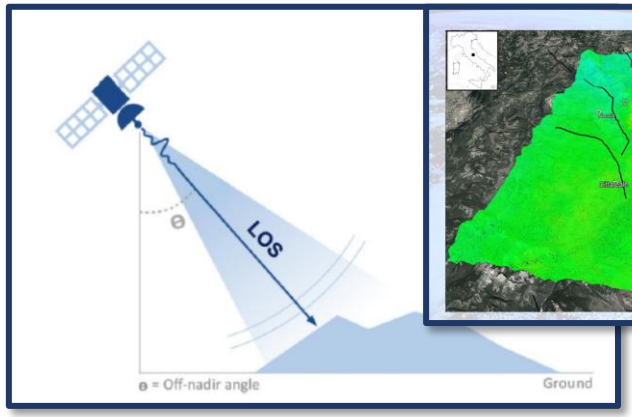
(geological cartography, seismo-induced geological effects; technical-scientific support in emergency)

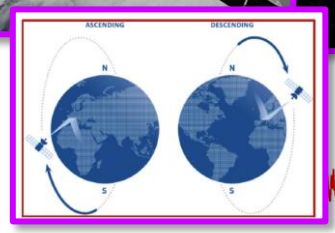
- **ENEA**

(post-event rubble management; technical-scientific support in emergency)

- **ASI**

(satellite data and services)





Operating Framework of Competence Centres

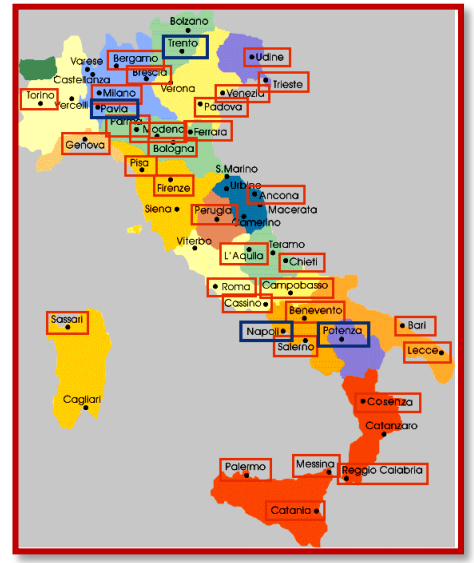
- **Multi-annual** agreements
- Activities and products **agreed with and co-financed by DPC**
- **Widest possible involvement of the scientific community** with expertise in given topics or with complementary skills and information
- Strong interaction between **Work Package managers** and **DPC representatives**
- Numerous **coordination meetings**, aimed at ensuring **homogeneous approach**, **knowledge integration** and final **consensus** on the results achieved

4 – Advances and Results from Earthquake and Structural Engineering Science

Earthquake and Structural Engineering Science for Civil Protection

Due to the importance of Earthquake and Structural Engineering science for civil protection purpose → in **2003** two Competence Centres were created:

- **ReLUIS** → an **inter-university consortium** of earthquake engineering **laboratories** that **involves almost all researchers** from Italian universities that deal with seismic, structural and geotechnical engineering; it is conceived as a **hub of aggregation** of earthquake engineering researchers



- **EUCENTRE** → a foundation with a **single operational headquarters** and **large experimental facilities** for earthquake and structural engineering

For **illustrative purpose**, attention is mainly focused on **some activities carried out by ReLUIS**, also **in collaboration** with EUCENTRE and other Competence Centers.

Earthquake and Structural Engineering Science for Civil Protection

- Studies Aimed at Improving **Seismic Risk Assessment**
- Studies Aimed at Improving **Structural Prevention Interventions** for DRR
- Studies Aimed at Improving Seismic and Structural Engineering **Building Codes**
- Studies Aimed at Improving **Structural Health Monitoring**

This presentation is especially aimed at emphasizing **working methods** adopted to provide scientific products for civil protection purpose

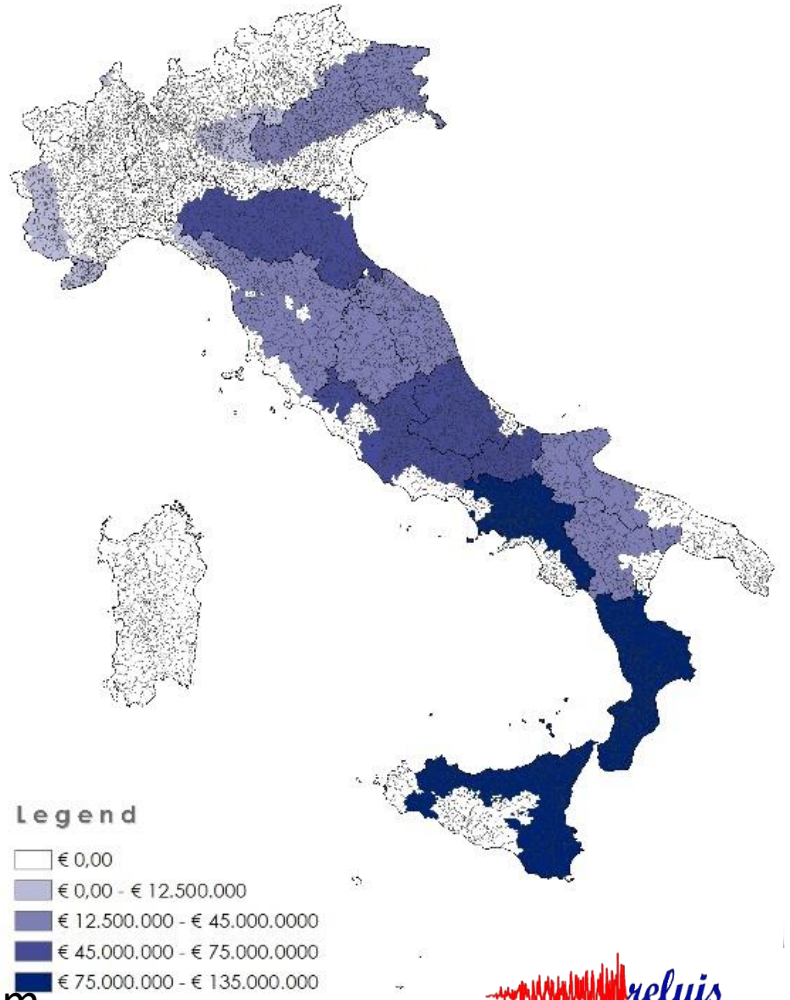
Studies Aimed at
Improving Seismic Risk Assessment

Improving Seismic Risk Assessment - Background

- "**Understanding Risk**" → first priority of the **Sendai Framework** (SFDRR, 2015)
- Art. 6 of the **Decision 1313/2013/EU** states that, …, Member States shall further develop risk assessments at national level ….

The availability of a framework for an effective DRM which includes a risk analysis is an **enabling condition** for a EU member State to access to some of the EU Structural Funds (**Regulation (EU) 2021/1060**).

In Italy, **seismic risk assessments** at national level have been used to **distribute funds for structural seismic prevention** among Regions since 2010



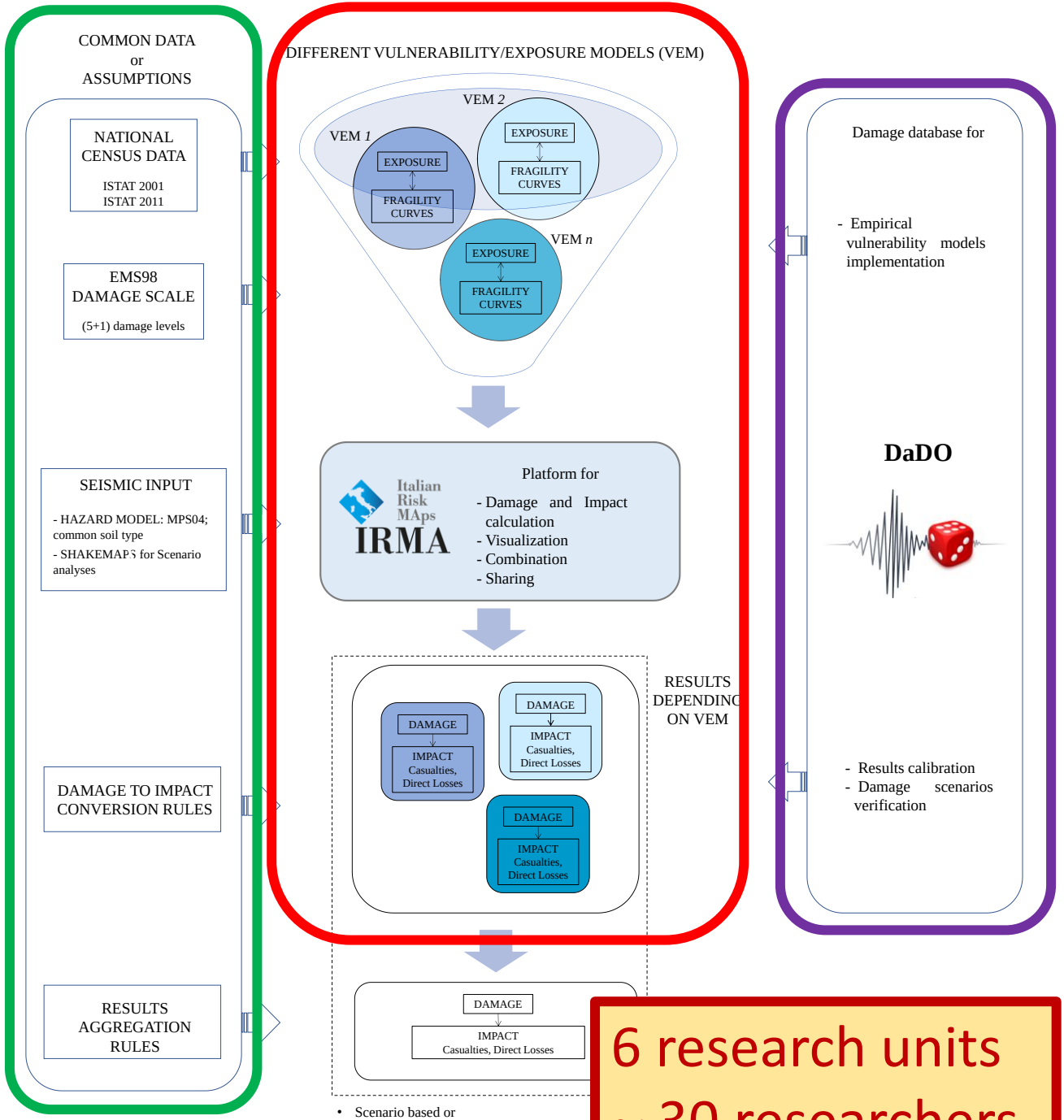
Improving Seismic Risk Assessment - Activities

- **NRA -** The support for National Risk Assessment 2018
- **IRMA** - Platform to share and combine data, models and results
- **MARS** - Seismic Risk Maps upgrade
- **CARTIS** - Typological Structural Characterization
- **Complementary** Studies on direct and indirect losses
- **RINTC** - Implicit Risk of structures designed according to National Standards

National Risk Assessment 2018

A shared “consensus based” methodology for seismic risk assessment

- ✓ Common data type and assumptions
- ✓ **Different vulnerability/exposure** models from scientific community
- ✓ **Database of Observed Damage** for results calibration and scenarios verification



6 research units
~ 30 researchers

National Risk Assessment 2018

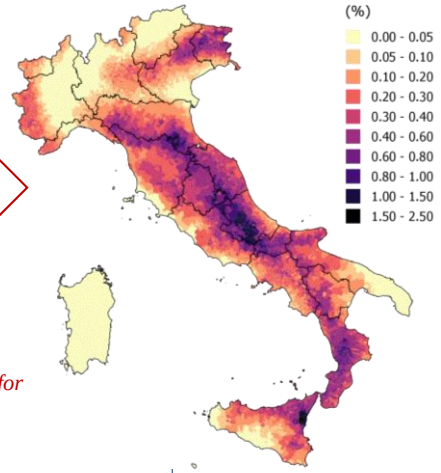
Multi-model approach

- 6 Vulnerability/Exposure models
  - 4 for **Masonry** buildings
  - 2 for **Reinforced Concrete** buildings

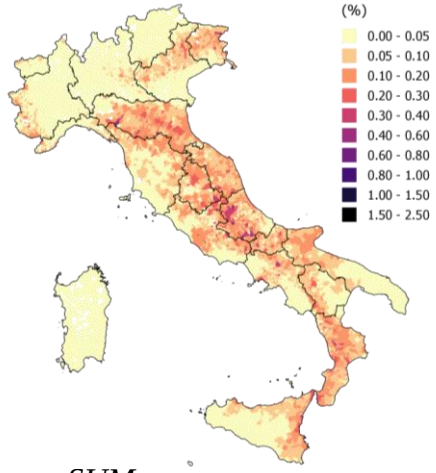
VEM1
VEM2
VEM3
VEM4

Average (equal weights applied for NRA 2018)

Average results for Masonry building stock



Average results for RC building stock



VEM5
VEM6

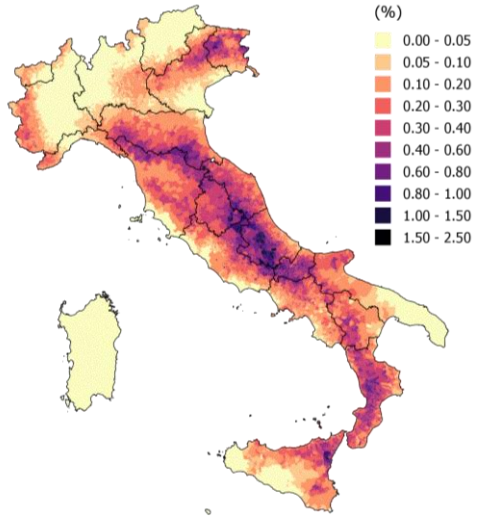
Average (equal weights applied for NRA 2018)

SUM

Empirical, analytical and hybrid-heuristic models

A shared methodology for risk assessment

- **Same fragility and exposure description** for all models
- **Same consequence functions** (direct economic losses, unusable buildings, injured/deaths)
- Final risk obtained by **results aggregation**



Average results for all buildings (Masonry + RC)

National Risk Assessment 2018

Summary of the results

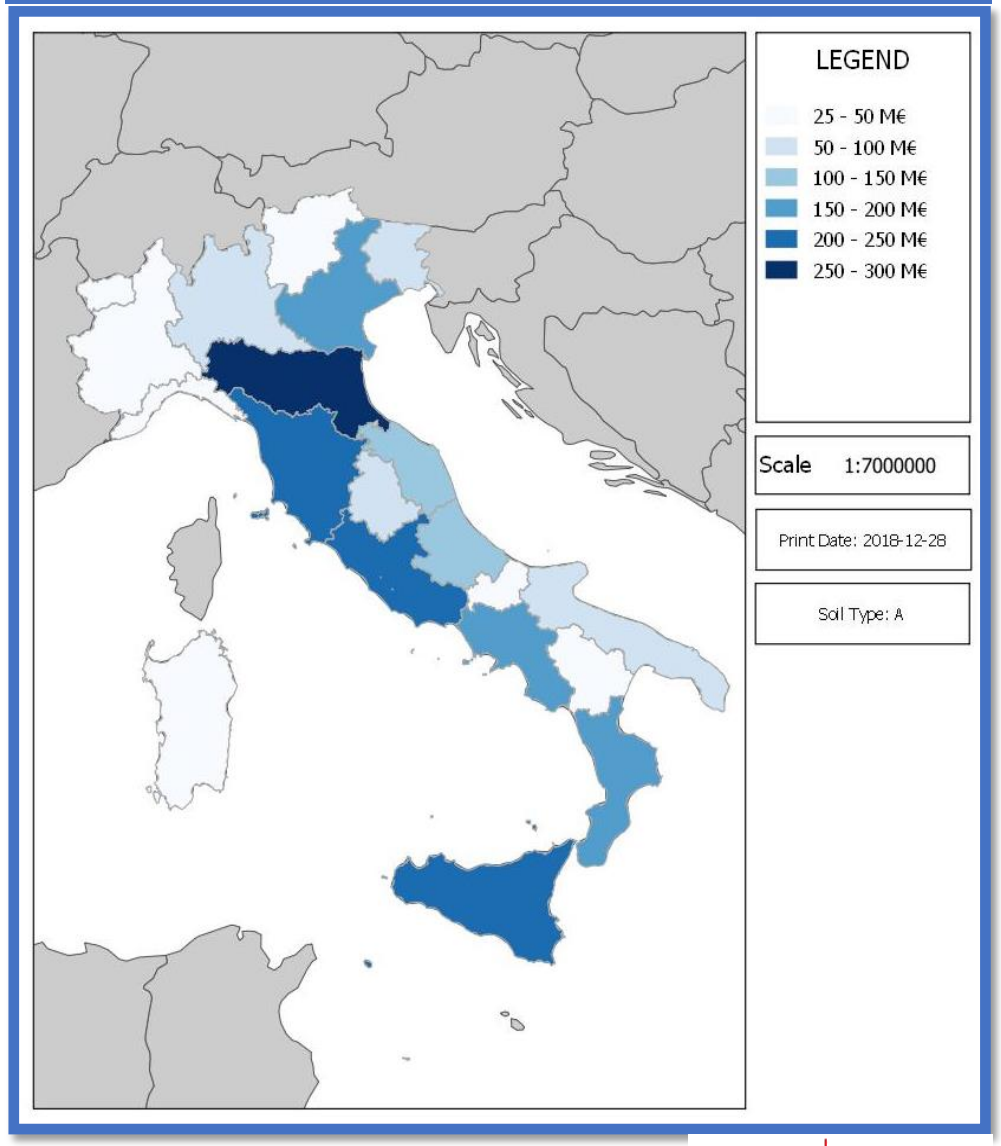
Average, maximum and minimum expected **annual** values of **fatalities, injured and homeless**

	Fatalities	Injured	Homeless
Average	505	1,744	78,602
Maximum	763	2,588	131,952
Minimum	123	469	40,381

Average, maximum and minimum expected **annual** values of **economic losses** and **unusable buildings**

	Cost (M€)	Short term unusable	Long term unusable
Average	2,130	20,938	15,635
Maximum	3,270	31,847	22,024
Minimum	1,270	9,962	7,404

Average **direct economic losses** expected in 1 year per Region



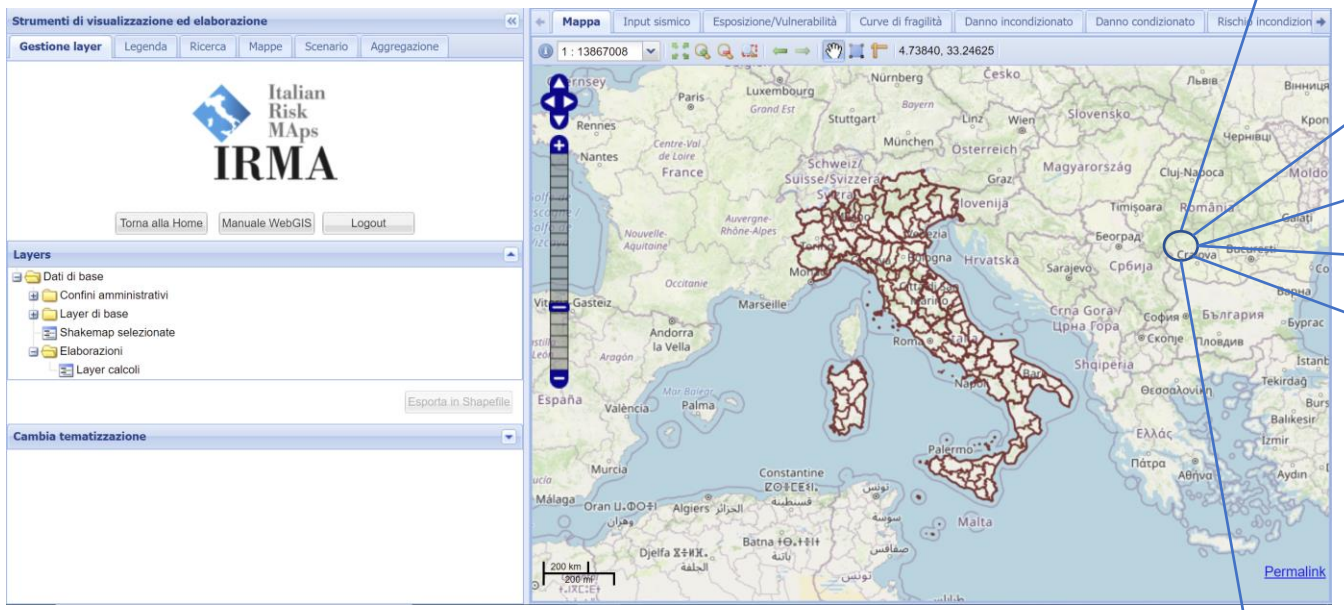
IRMA (2018-2021)

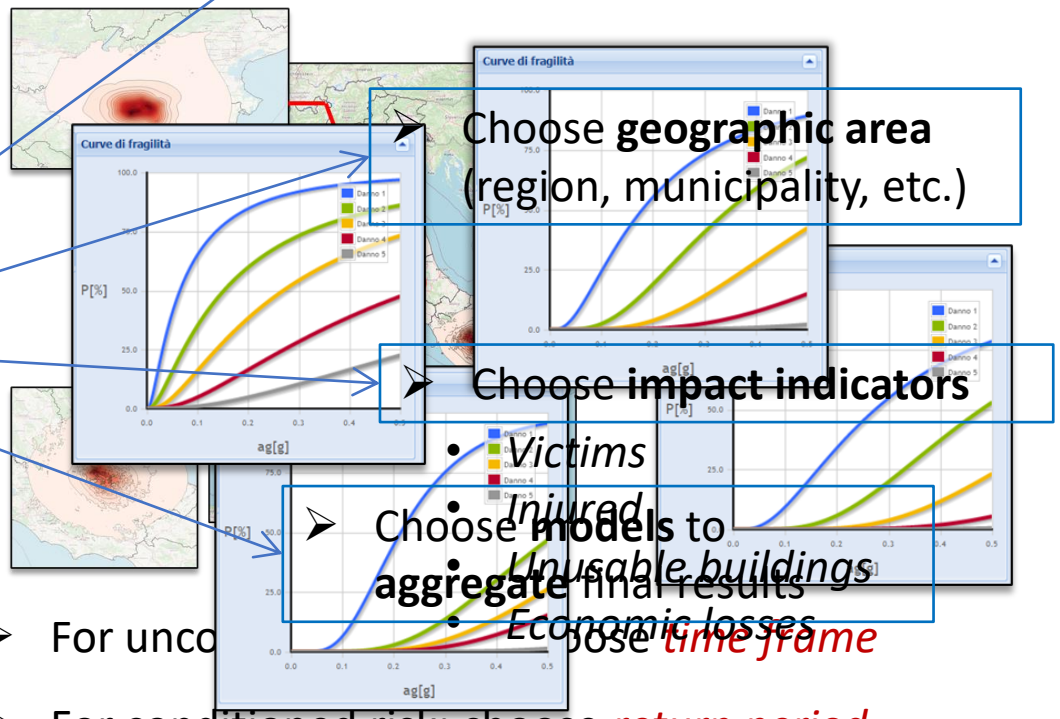
a platform to share, compare and combine data, models and results

Main features

Requirements from DPC + researchers' community

- Choose **type of analysis** (scenario, risk conditioned, risk unconditioned)
- Choose **vulnerability/exposure model**
- For scenario based: choose *shakemap*
- Choose **geographic area** (region, municipality, etc.)
- Choose **impact indicators**
  - *Victims*
  - *Injured*
  - *Unusable buildings*
  - *Economic losses*
- Choose **models** to **aggregate** final results
- For unco… choose *time frame*
- For conditioned risk: choose *return period*
- More features…





Developed by EUCENTRE FOR YOUR SAFETY.

MARS (2019-2021) - Seismic Risk Maps upgrade

MARS (2019-2021) - Seismic Risk Maps

- Review and update **vulnerability models** for residential buildings
- Improvements on all steps of the risk calculation:
  - **regional typologies**,
  - **subsoil classes**,
  - **consequence functions** for loss assessment
- Risk calculation for **special structure types**: *schools*, *churches*, *bridges*

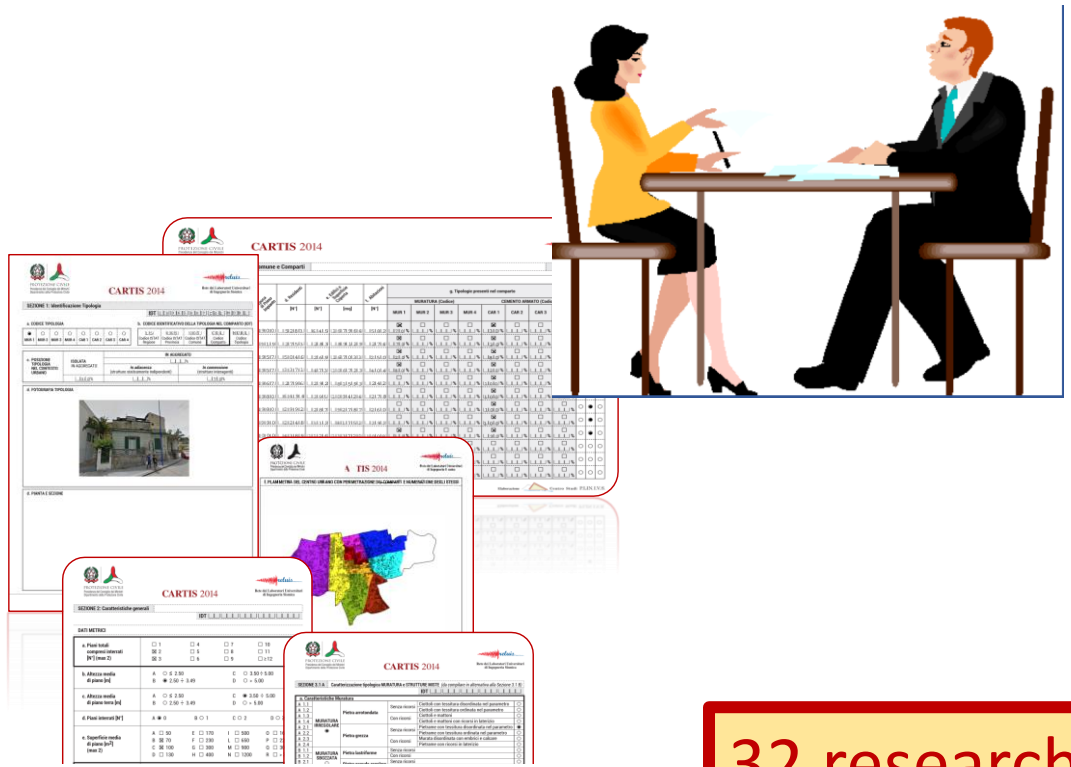
IRMA 2.0
Significant **implementations** have been made in the IRMA platform to allow for the **new calculations** required by MARS

26 research units
~ 100 researchers

CARTIS (Typological Structural Characterization) (2015-2021)

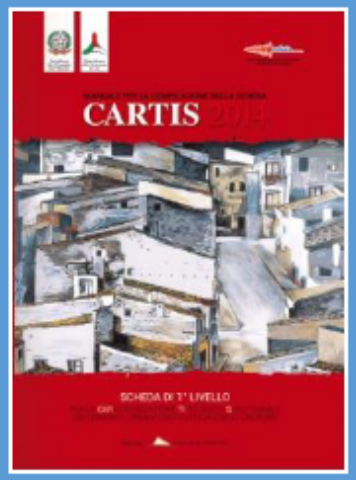
CARTIS aims at getting more accurate descriptions of the Italian building types **exploiting local knowledge**, in order to improve **vulnerability/exposure models**, then risk assessment at local and national level.

- Based on the compilation of **interview-based inventories** at the **municipality scale**.
- Suitable **survey forms and compilation manual**, to collect information on main building typologies in investigated towns.
- **Much more detailed information** with respect to available census data.



32 research units
~ 70 researchers

CARTIS (Typological Structural Characterization) - Concept



DB
CARTIS

REGIONAL TYPOLOGYCAL-STRUCTURAL CHARACTERIZATION

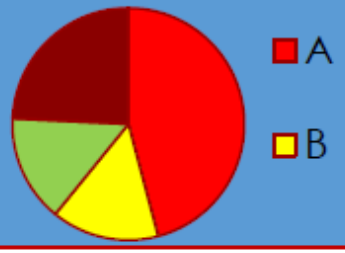
CENSUS DATABASE (ISTAT)

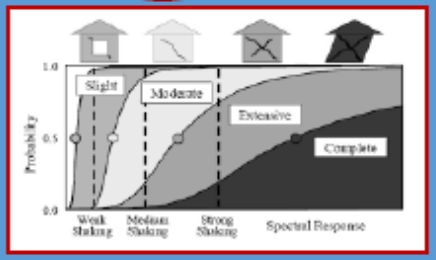
POPOLAZIONE E ABITAZIONI
CENSIMENTI PERMANENTI
Istat

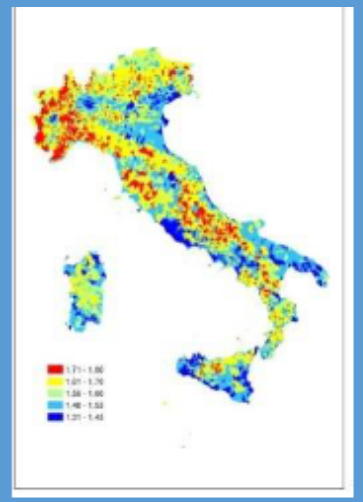
DAMAGE DATABASES

DADO
CENTRO STUDI PLINIVS

REGIONAL VULNERABILITY MODELS



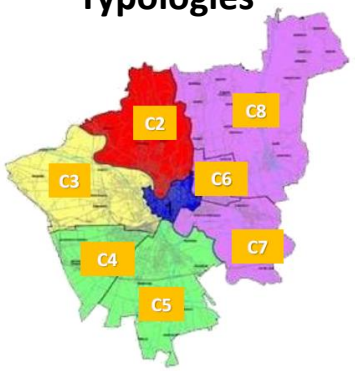




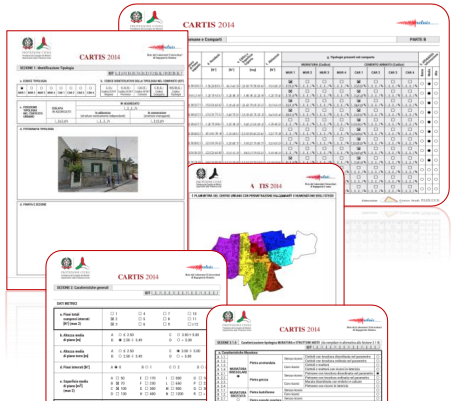
CARTIS APPROACH

Interview-based protocol

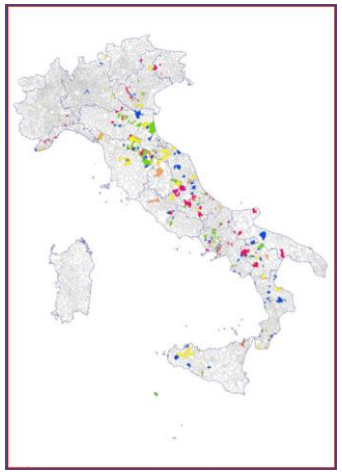
Town Compartments and Typologies



Cartis form



421 Municipalities surveyed until 2021



Complementary Studies for Seismic Risk Assessment (2015-21)

RC BUILD.S

MASONRY BUILDINGS

Direct Costs:
Repair

"LIGHT DAMAGE " RECONSTRUCTION

"HEAVY DAMAGE " RECONSTRUCTION

RC BUILDINGS

MASONRY BUILDINGS

Indirect Costs:
Population Assistance

7 research units
~ 20 researchers

Complementary Studies for Seismic Risk Assessment – Direct costs

… From data collected… to parametric direct costs

Definition of minimum and maximum %Cr associated to several damage states

DS	CrMin[%]*	CrMax[%]*
DS1	2	5
DS2	10	20
DS3	30	45
DS4	60	80
DS5	100	100

%Cr - Reconstruction Cost:1350€/mq

RINTC (Implicit Risk of structures) (2015-2021)

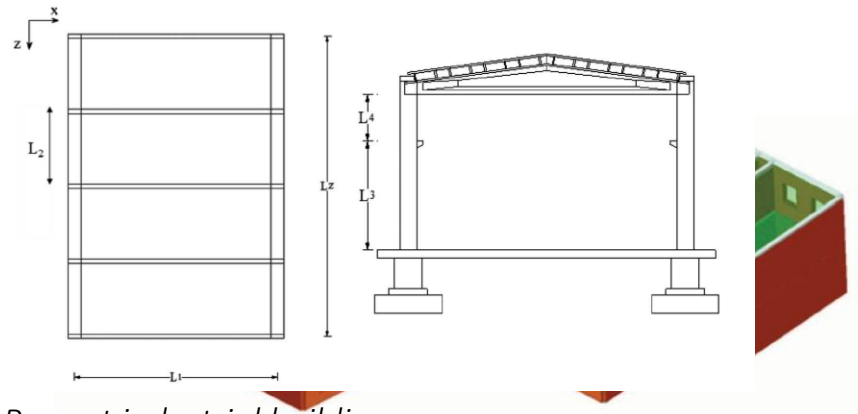
Implicit seismic risk of structures designed according to the Italian National Standards NTC

Investigated structural typologies:

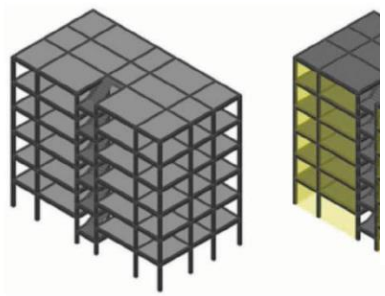
- ✓ Unreinforced masonry
- ✓ Cast-in-place reinforced concrete
- ✓ Precast reinforced concrete
- ✓ Base-isolated reinforced concrete
- ✓ Steel

Different geometrical configurations selected for the investigated structural typologies, **representative of the national building stock**

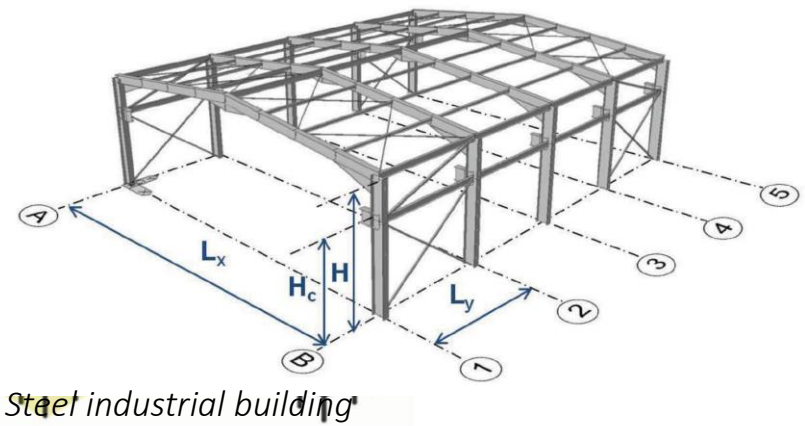
Case-study structures **designed according to NTC**, modeled and analyzed by R.U. with specific expertise from different universities



Precast industrial building
Residential masonry bui



Residential RC buildings



Steel industrial building

12 research units
~ 60 researchers

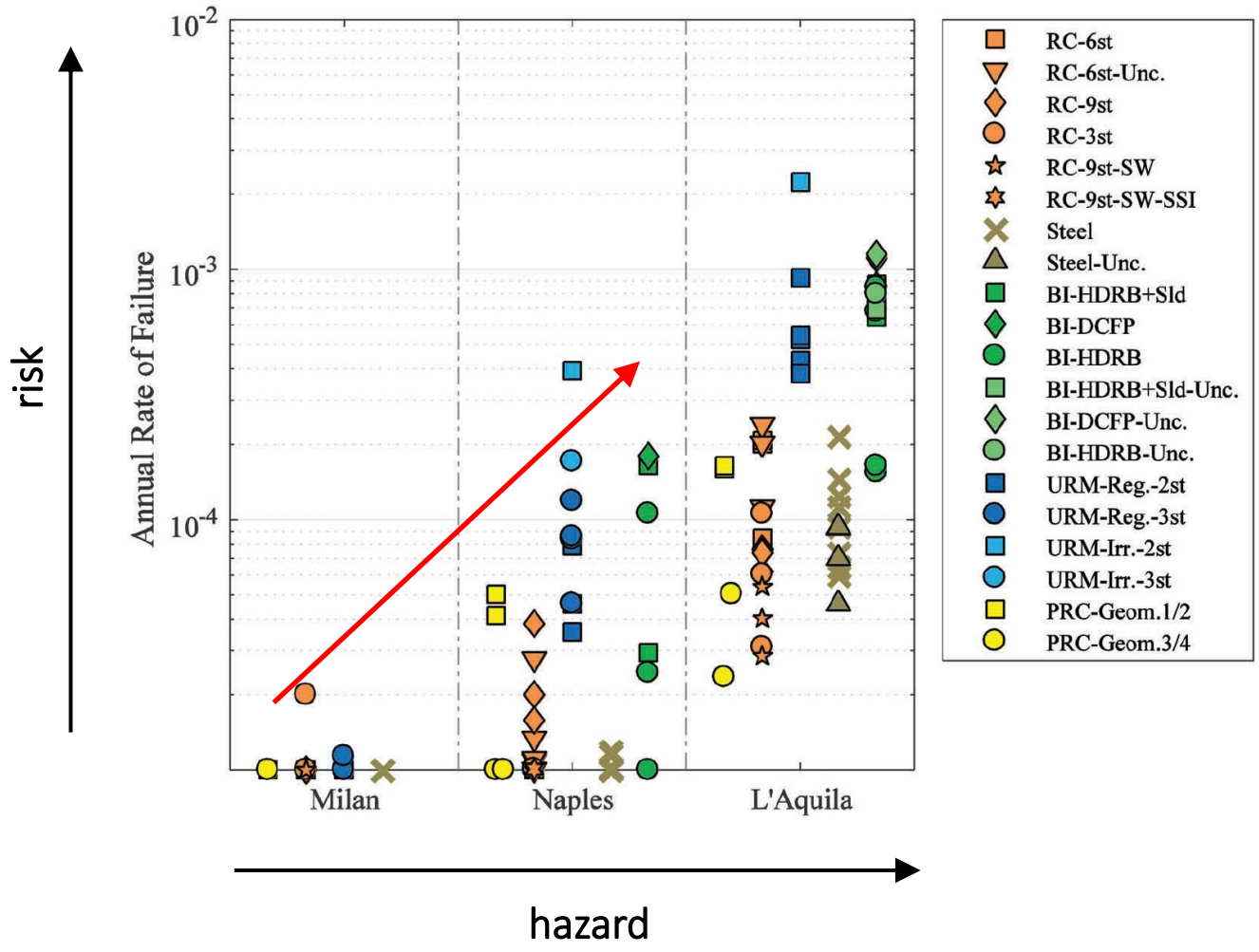
RINTC (Implicit Risk of structures)

✓ **Main finding**: annual failure rates were found to increase with seismic hazard (non-uniform risk across sites with different hazard)

Open questions/ongoing research:

- Seismic risk of **existing structures**, as-built or retrofitted
- **Risk-targeted design** aimed at non-hazard-dependent risk
- Seismic risk of **bridges**

Annual failure rates at Global Collapse



Summary of returns from DPC-ReLUIS activities

Main returns for the civil society:

- **Seismic risk assessment**: rational distribution of funds for DRR interventions and compliance with EU requirements and with SFDRR
- **Structural interventions**: greater effectiveness of the post-earthquake reconstruction and of the structural prevention activities in Italy
- **Building code**: fundamental contributions to national (NTC2018) and European codes and indications for new generation codes
- **Structural Health Monitoring**: correct and effective use of satellite interferometry in civil engineering and integration of remote and on-site monitoring

Main returns for the scienfic community:

- **Continuous exchanges** within and between research groups
- **Full availability of results, methods and data** for the scientific and technical communities
- Substantial growth of the **scientific production**

5 – Lessons Learned and Future Perspectives

Lessons Learned - Synergies

The **complex interaction** between science and civil protection, if properly managed, can lead to important **synergies and mutual benefits** for both parties:

- Scientific advances can enable more **effective civil protection decisions and actions**, even if they can sometimes lead to **critical issues** for the civil protection system, which has to **readjust accordingly its activities and operational procedures**
- The scientific community can take advantage of a **broadening and different finalization of its research perspectives**, a **clearer focus** on the possible application of scientific activities and their **positive social implications**, a significant increase of the **scientific production**

Lessons Learned - Hybrid Experts Profile

Hybrid experts → civil servants who:

- have a solid **expertise in both** research and public administration
- can understand and use the **language of the two fields**
- their **expertise** is **recognised by both** the scientific and the decision-making communities

They are called upon to play an **interface role**, being able to link

- **demands, expectations** and (often short) **timescales** of decision-makers
- **data, information, uncertainties** and (longer) **timescales** of scientists

Hybrid experts have been working in the Italian civil protection for a long time

6 - Conclusion

Concluding remarks

- **Need and opportunity** for the scientific community and the world of civil protection to **cooperate and develop** their interaction capability
- **Focus** of science on the real priorities of the society, fostering an **optimized use of available resources**
- **Positive examples of the Italian experience (**with reference to earthquake engineering scientific community)
- Great effectiveness of organization which operate as **research hubs,** to **involve hundreds of researchers** and to **cooperate** with other CC
- **Scientific products** for civil protection based on the most **up-to-date knowledge** and on a **wide consensus** in the scientific world
- Growing need at all levels for **multirisk** approaches and **multidisciplinary** research → strengthening of **networking activities** among Competence Centers

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