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Study on Safeguarding Cultural Heritage from Natural and Man-Made Disasters: **Seismic Risk**

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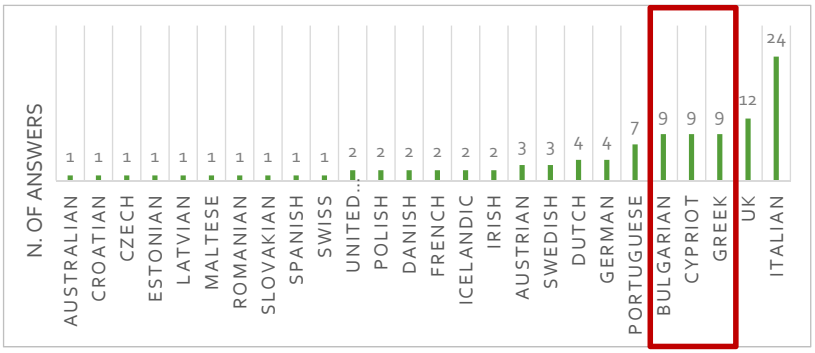
Introduction

The National Technical University of Athens (NTUA) has been tasked to investigate the measures for the protection of cultural heritage against earthquakes.

Countries under the responsibility of NTUA:



The investigation was conducted by:

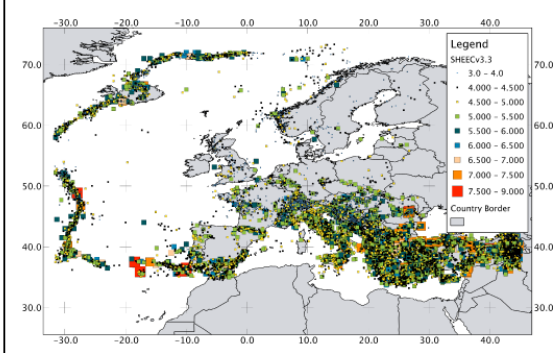
- Encouraging experts to participate in the project by submitting the questionnaire
- Meeting and interviewing experts
- Analyzing the information obtained from interviews and answers of the questionnaires by experts of all countries, in order to detect gaps and proceed to recommendations for the efficient safeguarding of cultural heritage

Earthquake Risk Assessment

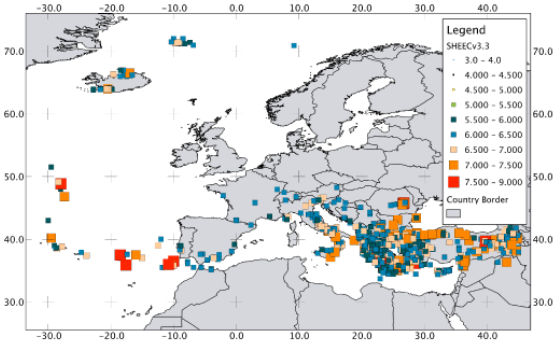
Earthquakes in Europe:

- The countries that have suffered the most are **Italy**, **Greece**, **Turkey**, **Spain** (Mediterranean Countries) and **Iceland**
- Major earthquakes have also occurred in Spain, France, Albania, Bulgaria and Romania
- Smaller earthquakes which caused minor damage have been recorded in other European countries

New European Seismic Hazard Maps (according to SHARE-EU project -2016)



All events of MW≥3.5



All events of MW≥6.0

Earthquake Risk Assessment

Mediterranean countries vulnerable to earthquakes also exhibit rich cultural heritage.

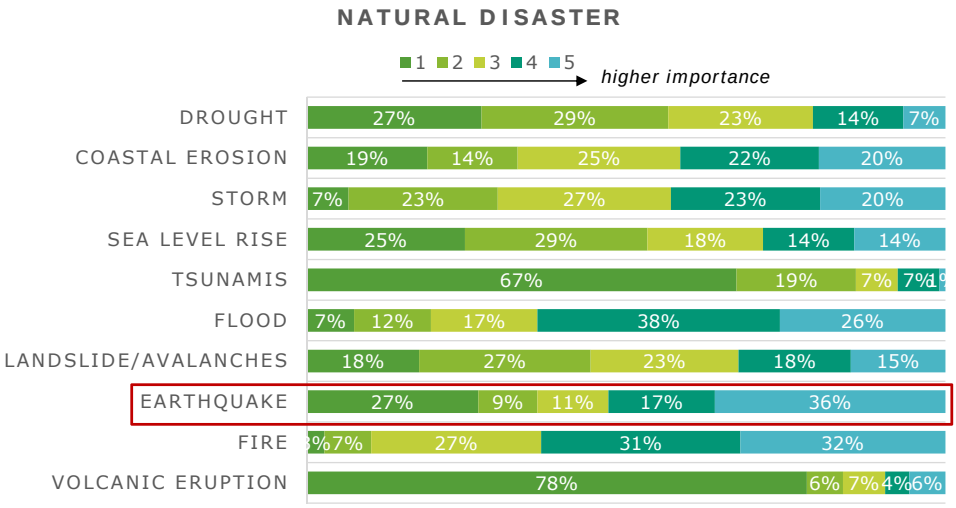
Medieval City of Rhodes (Greece)

Historical City of Venice (Italy)

Historic City of Toledo (Spain)

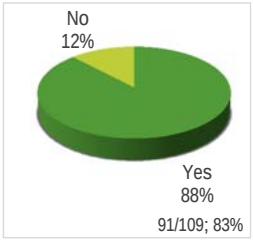
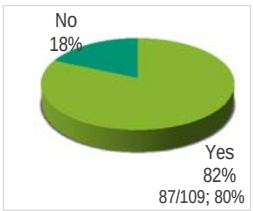
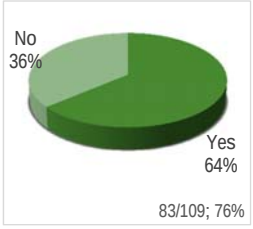
Earthquake Risk Assessment

In the questionnaire topic
"In your opinion, how much is the cultural heritage of your member state/region exposed to each of these risks?"
earthquake is considered to be the most disastrous risk.



Earthquake Risk Assessment

"Do you know of any existing national strategies or practices (in your country) for safeguarding cultural heritage?
If yes, please specify the type of strategy, and indicate which of the risks apply."

Type of strategy		Total affirmative answers	Specifically for Earthquake
Preparedness		80	23
Emergency		71	20
Recovery		53	18

Scale of Loss

European Natural Disaster Statistics for years 1980 to 2008

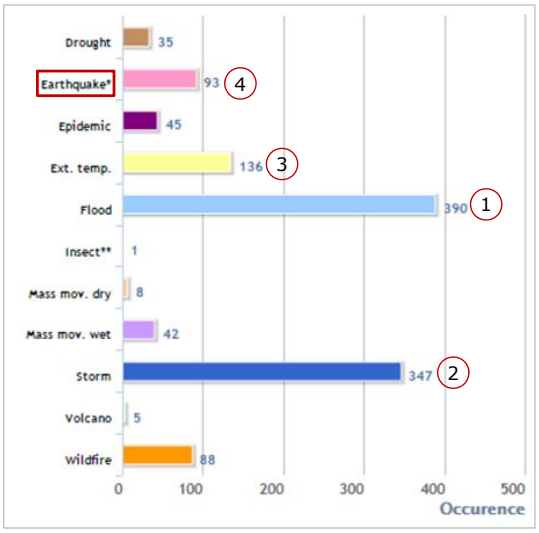
Overview

No of events:	1,190
No of people killed:	121,644
Average killed per year:	4,195
No of people affected:	33,031,632
Average affected per year:	1,139,022
Ecomomic Damage (US$ X 1,000):	266,918,923
Ecomomic Damage per year (US$ X 1,000):	9,204,101

Killed people per event

	Drought:	0.06
2	Earthquake*:	352.80
	Epidemic:	9.78
1	Extreme temp:	602.98
	Flood:	6.14
	Insect infestation:	...
	Mass mov. dry:	28.38
	Mass mov. wet:	27.98
	Volcano:	...
	Storm:	6.25
	Wildfire:	4.77

Number of total events



http://www.preventionweb.net/english/countries/statistics/index_region.php?rid=3

Existing Initiatives

GREECE

- Systematic conduction of Research on earthquake engineering; Applications on numerous monuments
- Regular participation in research programs (state/EU funding)
- Operation of the Earthquake Planning and Protection Organization
- Civil Protection Emergency Plan

Restoration works on the Parthenon

CYPRUS

- Restoration Incentives offered by the State
- Regular participation in research programs (state/EU funding)
- Organizations, Committees and Planning of works between Greek Cypriot and the Turkish Cypriot sides
- Civil Defense Emergency Plan

Neolithic settlement of Choirokoitia

BULGARIA

- Participation in research programs (state/EU funding)
- Cultural Heritage-Related Strategies in progress

Early Christian Church of Parthicopolis

Existing Initiatives

The main disadvantage was that there was **no adequate information** by experts from other countries

- Extremely vulnerable to earthquakes

AND

- With significant cultural reserve of universal value

Therefore, it is **difficult to get the real picture** of what is applicable regarding initiatives in these countries.

An additional observation derived by the answers provided in the questionnaire is the **subjectivity factor**.

Gaps and Deficiencies

Lack of preparedness is proved to be the most significant deficiency!

PRIOR-EARTHQUAKE GAPS

KNOWLEDGE RELATED - RESEARCH - SCIENTIFIC

1. **Gap in knowledge** for protecting the structured cultural reserve
2. Absence of systematic **inspections** for individual properties and entire historical centers
3. Lack of monument **classification**
4. Lack of **regulatory literature** for structural documentation, assessment and pre-earthquake interventions
5. Limited **assessment** of suitability of museums and display cases

MANAGERIAL-POLITICAL

1. Insufficient **Education** for Engineers, Employees and Public
2. Lack of criteria for **prioritizing** the needed actions
3. Lack of **incentives** for maintaining privately-owned listed building

Gaps and Deficiencies

POST-EARTHQUAKE GAPS

KNOWLEDGE RELATED - RESEARCH - SCIENTIFIC

1. **Gap in knowledge** for rescuing the structured cultural reserve
2. Lack of **regulatory literature** for post-earthquake inspections, assessment and restorations

MANAGERIAL-POLITICAL

1. Insufficient **Education** for Engineers, Employees and Public
2. Lack of criteria for **prioritizing** the needed actions
3. Lack of **incentives** for restoring privately-owned listed building

Gaps and Deficiencies - Preparedness

Almost no measures were taken **prior** to the phenomenon

⇨ **THE GREATER GAP**

Vrisa, Lesvos, Greece, 2017

Amatrice, Rieti, Italy, 2016

L'Aquila, Abruzzo, Italy, 2009

Unfortunately, antiseismic provision was applied only on a very limited number of buildings, where some effective restoration works prevented serious damages, while the arbitrary ones caused even greater damage.

Residence in Vrisa

Residence in Amatrice

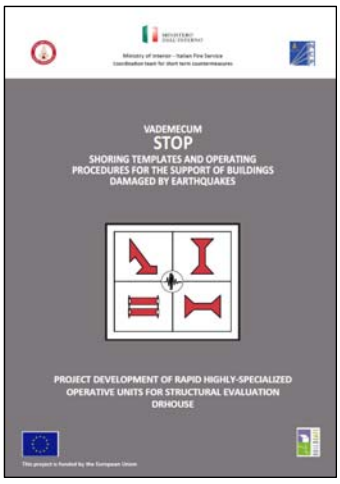
San Marco, L'Aquila

Gaps and Deficiencies - Emergency

Speaking of emergency actions, the competent authorities (Civil Protection, Fire Service, National Organizations etc.) usually react fast and in a coordinated manner. Their priority, as it should, is to safeguard human lives and then to preserve cultural heritage.

Temporary Shoring in Santa Giusta, L'Aquila

National Fire Brigade Men Anime Sante's dome, L'Aquila



Guidelines for temporary shoring after L'Aquila earthquake (2010)

Guidelines for the rehabilitation of Lorca's cultural heritage (2011)

Yet, the losses are still there.

Gaps and Deficiencies - Recovery

It is proven that strengthening is applied only after the earthquake.

Nevertheless, in many cases, the cities remain abandoned, many of the displaced inhabitants continue to live in temporary housing and cultural heritage assets continue to be unrepaired.

L'Aquila, eight years after the earthquake: a Red Zone, preventing access to the medieval center, still exists

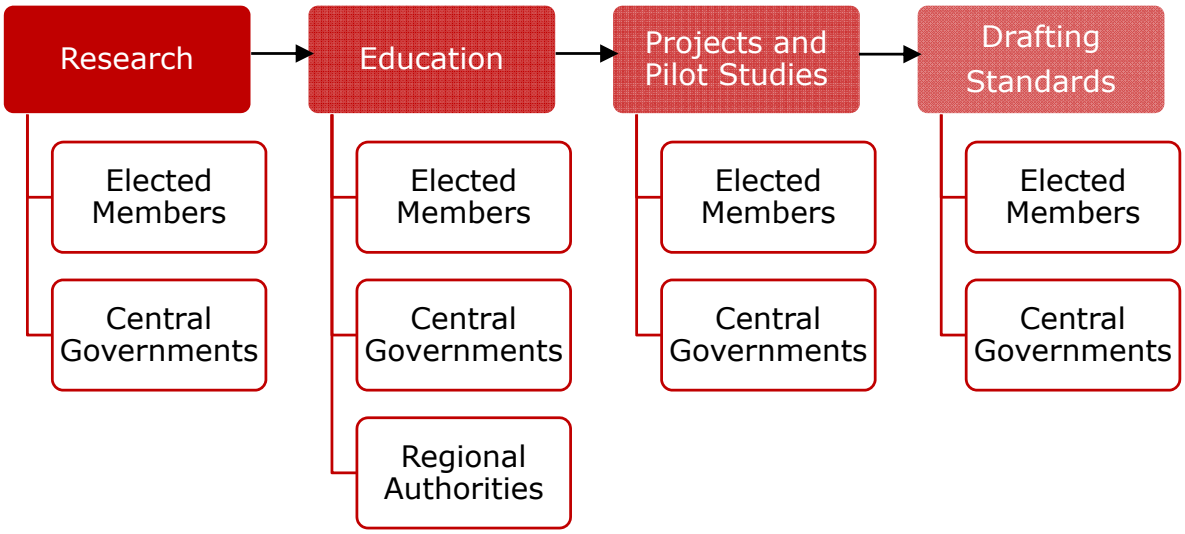
Amatrice, one year later

Lorca's case: an example of good practice. Almost all historical buildings and the items of cultural value housed in them have been repaired.

Iglesia de Santiago: (left) shortly after the 2011 earthquake, (right) in 2014

Recommendations

The structure of the recommendations is based on the relative stakeholders:

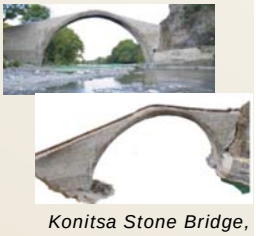


In any case, the responsible stakeholders for each segment are interrelated.

Recommendations – Elected Members

1. Developing **awareness** for the elected members themselves ⇨ **Disseminating** the earned awareness and understanding
2. EU **funding** for enhancement of **research** on: **Assessment** of structures, **Intervention** techniques, traditional and innovative **Materials**
3. EU **funding** for enhancement of **education** for:
   - **Engineers** → Postgraduate Studies; European/International Programs
   - **Technicians** → Training Centers
4. EU **funding** for **specific projects**:
   - pilot pre-earthquake reinforcement
   - Restoration of specific monuments for specific municipalities
   - Structural documentation (of monuments and/or historical centers) in specific municipalities
5. **Drafting European Standards** for safeguarding cultural heritage assets

COOPERATION WITH THE **ACADEMIC COMMUNITY**



Konitsa Stone Bridge, Greece, 2017

Recommendations – Central Governments

1. Enhancement of **research** on: **Assessment** of structures, **Intervention** techniques, traditional and innovative **Materials**

2. Enhancement of **education:**
   - acquiring familiarity with **cultural issues**
   - in-depth understanding of the **mechanical behavior** of traditional materials and structural typologies.
   - raising awareness about the value of "**human life**"

3. Conduction of **pilot studies** for **groups** of structures



4. **Classification** of monuments based on multiple factors and establishment of **priorities** for their protection

5. Establishment of **incentives** (financial assistance, tax relief) for private owners

Recommendations – Regional Authorities

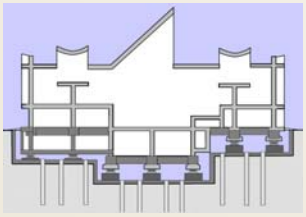
1. Enhancement of **education** in a **local** level for:
   - **Engineers** → Seminars providing guidelines for handling specific works
   - **Employees:** In-job training through → Seminars on the Emergency Plan of each sector; Earthquake drills
   - **Public** → Seminars about the value and the potential of financial development of historic centers; Earthquake preparedness seminars

2. **Municipal** provision for **pre-earthquake inspection** of listed buildings

Recommendations – Operational Bodies (1)

1. **Structural documentation** of monuments by specialized engineers, by taking specific steps
2. **Instrumentation** of as many monuments as possible
3. **Seismic isolation** of monuments and museum sculptures

Instrumentation of monuments and walls of Acropolis, Greece



Seismic Isolation - National Museum of Western Art in Tokyo, Japan

Seismic Isolation - Hermes of Praxiteles, Ancient Olympia Museum, Greece

Recommendations – Operational Bodies (2)

4. Finding effective **solutions** to **protect museum collections** regarding:
   - The base of display cases
   - The placement of objects on them
   - Monitoring displacements after an earthquake

Overturning of pedestal, National Archaeological Museum, Greece

Object secured with clips

Sculpture on aluminum structure

5. Earthquake resistance **evaluation** of **museums housed** in **monumental** buildings

Each cultural heritage asset is unique and requires different approach and remedy!

Thank you for your attention