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SEISMIC RISK MAPPING – STATE OF THE ART IN THE PECO* COUNTRIES (PART 2)

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Abstract: *The survey presents the results of the distributed among the PECO countries and their experts a questionnaire on the seismic risk mapping. This problem is considered as the common hazard in several PECO countries. The main aim of the questionnaire is to establish the state of the art of the risk mapping process on the earthquakes. The results after the processing procedure of the collected data are presented. They are illustrated by many tables and other information tools. They show very similar picture of the abilities of the different countries to map the seismic risk. The second part considers the seismic vulnerability and the risk mapping. The problem has several peculiarities in comparison with some other hazards also displayed in the same questionnaire:*

- *the vulnerability of the different structures to the earthquakes*
- *the vulnerability of population to the effects of the earthquakes*
- *the risk mapping as a combination of the hazard mapping and the vulnerable elements.*

Most of the countries are well prepared for these activities (i.e. base maps exist), but almost no one is using GIS technology for this mapping. The main aim of this survey is to make conclusions and some suggestions to the EC policy makers for the homogenization and legislation to be applied for all PECO countries. Most of the investigated countries mentioned that they would like to play positive role in such process.

*PECO is the EC acronym of the new member states and the candidate countries for the EU.

C) Seismic Vulnerability

Usually the seismic vulnerability functions are derived by analysis of the data from previous events and their effects on the buildings. There are only few examples of vulnerability assessment about the affected population (victims and injured). The preparation of seismic vulnerability maps is a heavy task, because it needs a lot of data collection, data base organization, cadastre creation (which does not exist in several countries) and heavy technical work. For this purpose a lot of funds and human resources must be provided. The integration efforts of the different institutions dealing with the different data sources such as national cadastres, the seismological surveys with their historical and recent catalogues, the digital mapping units, etc., could be very useful.

Analysis

The vulnerable elements at risk and their vulnerability according the experts' opinion are presented on Table 3. The results show major agreement among the experts about the level of vulnerability.

In general there is no official classification about the vulnerable elements of the seismic risk. In most seismic vulnerable countries as elements at risk - high (H) or very high (VH) - are considered the population and the infrastructures. They are the most threaten objects. In many cases the Cultural Heritage is also considered. Usually – the Ecological (possible pollutants dispersion, biodiversities affected, etc.) consequences are underestimated - indexes low (L), very low (VL) - according to the answers given by the experts. Frequently the private property is estimated as medium (M) threatened by earthquakes. Here must be mention that all these data are provided by the local experts on their subjective assessment and are not supported by deeper investigations. Some countries like Czech Republic and Slovenia do not provided data.

Table 3. Vulnerability (elements at risk) from earthquakes (according to the expert judgement)

Country	Human as individual	Human as social targets	Infrastructures	Cultural heritage	Private properties	Natural Resources	Ecology
Bulgaria	VH	VH	VH	H	M	VH	M
Czech Rep.	No data	No data	No data	No data	No data	No data	No data
Cyprus	M-H	VL-L	M	M	M	VL	VL
Estonia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hungary	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Latvia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lithuania	VL	VL	L	VL	VL	VL	VL
Poland	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Romania	H	VH	H	H	H	M	M
Slovenia	No data	No data	No data	No data	No data	No data	No data
Slovakia	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The collected information has preliminary and not complete views of the experts on the vulnerable elements considered at risk. These data couldn't be used for any statistical analysis due to the larger subjective elements incorporated in them.

The special questions have been launched to study the reversible and irreversible damages. Most of the experts noted that such terminology (of reversible and irreversible damages) is used in everyday practice, but not officially accepted. The data are presented on the Table 4. In general there is agreement among the experts about the reversible and irreversible damages and their classifications.

D) Earthquake Risk maps

In principle they are the result of a combination between seismic hazard maps and the vulnerability. Usually they try to present the possible consequences of a strong seismic event on the all seismically vulnerable elements (building stock, population, life-lines, environment, infrastructure, etc.). Scenarios are frequently developed to estimate possible consequences of the different magnitude events. This approach (for example US-HAZUS, UN-RADIUS, etc.) is completely different from this one existing for so called “near real time systems for seismic damage assessment”.

Table 4. On damages classifications - reversible and irreversible effects

Category	Effect	Country											
		BG	CZ	CYP	EST	H	LV	LT	PL	RO	SK	SLO	
Human	Injury	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Acute effect		nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Epidemic	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Economical loss	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
Infrastructures	Severe damages	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Functionality	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Economical loss	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Public service interruption	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
Cultural heritage	Economical loss	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Accessibility	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
Private property	Economical loss	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Functionality	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
Natural resources	Economical loss		nd		n/a	n/a	n/a	x		x	n/a	nd	
	Resources	x	nd		n/a	n/a	n/a	x		x	n/a	nd	
Ecology	Biodiversity		nd		n/a	n/a	n/a	x		x	n/a	nd	
Human	Death	x	nd	x	n/a	n/a	n/a	x		x	n/a	nd	
	Cancer		nd		n/a	n/a	n/a				n/a	nd	
	Health cronic effect	x	nd		n/a	n/a	n/a	x			n/a	nd	
	Disability	x	nd	x	n/a	n/a	n/a	x			n/a	nd	
Infrastructures	Destruction	x	nd	x	n/a	n/a	n/a				n/a	nd	
	Uneconomical recovery	x	nd	o	n/a	n/a	n/a				n/a	nd	
Cultural heritage	Cultural loss	x	nd	x	n/a	n/a	n/a	x			n/a	nd	
	Economy	x	nd	x	n/a	n/a	n/a	x			n/a	nd	
Private property	Economical loss	x	nd	x	n/a	n/a	n/a				n/a	nd	
Natural resources	Economy		nd		n/a	n/a	n/a	x			n/a	nd	
	Resources	x	nd		n/a	n/a	n/a				n/a	nd	
Ecology	Biodiversity		nd		n/a	n/a	n/a			x	n/a	nd	

n/a – not applicable
nd – no data
x – indicated by experts

Their target is to assess the negative consequences (usually destructions, deaths and injured, sometimes as well the necessary resources for the rescue operations) immediately after any strong seismic event all over the world (for example the systems of: EMERCOM, Japan, Israel, ETH, EC-JRC - http://dma.jrc.it/, etc.).

Analysis

According to the data collected by the questionnaires there are no seismic risk maps developed in the new member states and the AC, with some very light exceptions – for Bulgaria some schemes and publications exist giving as outputs the possible destructions, people deaths and injured and economic losses in some scenarios (Christoskov and Solakov, 1994). Almost all countries expressed their wishes to have the harmonized approach of seismic risk mapping, considering some positive effects of this action (unification of the methodology, easy readable maps, useful practical applications). But always the needs of additional funds arise in all PECO countries as an important condition for this action.

There are limited numbers of methodologies developed for the seismic risk mapping on European level. For example – the German approach is following mainly the possible destruction and mapping of the risky areas (Wahlstrom R., et al, 2004). Another approach (Spanish one) based on the world statistics of death and injured people suggests the risk calculations of the social consequences (mainly dead people and injured) (Samarjieva & Badal, 2002). Both approaches could be useful experience for the future development of this topic.

Conclusions

All countries are well prepared according the data collection and seismic hazard mapping. Most of the maps are on paper form, some in digital.

No special legislation targeted to the seismic risk mapping is established in the PECO countries

No seismic vulnerability maps are developed, with some minor exceptions (schemes used for the strong earthquakes consequences scenarios)

No seismic risk maps are prepared with some minor exceptions (some scenarios have been developed in Bulgaria).

All countries (with minor exceptions) recognize the usefulness of the seismic harmonized risk mapping.

Recommendations

The Pilot - project study (including the seismic risk mapping with additional multihazard, NATECH and transboundary effects mapping) could be useful for the common methodology approach for the risk mapping in general. Due to the existing common methodologies for the seismic hazard assessment, easy and unified data set, previous experience, etc, fast progress could be reach. Using the ready outputs of the seismic hazard maps, some modern mapping technologies improvements (GIS environment) and cadastre usage for the vulnerability assessment major achievements could be accessed. The tested methodologies could be implemented for larger areas on the next stage.

Using the results of the Pilot-project the Guidelines for the necessary homogenous data collection and processing procedures, software use, homogenous common methodology etc., could be prepared and edited. They will be very useful about the seismic risk mapping. For example many kinds of such methodologies, data used, quality assurance, etc. already exist for the seismic safety assessment of the NPP's, required by IAEA. (Prochazkova and Simunek, 1998 – for example)

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