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ON THE ESSENTIALITY OF FURTHER RESEARCH ON COMPUTATIONAL ISSUES OF EARTHQUAKE ENGINEERING IN DIFFERENT COUNTRIES

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Abstract*. Further research on different issues of earthquake engineering is a major tool in global seismic protection. Considering the different, including financial, supports needed for carrying out appropriate researches, the nature of earthquakes, and the fact that the disastrous effects are not limited to one country or even region, financing earthquake engineering researches, in an international manner, is reasonable. Nevertheless, for materializing the financing, it is essential, especially in the nowadays hard financial situation, after the financial crisis, few years ago, to make an idea about the sections of the research in further need of support. As a seemingly staring step in this regard, the objective in this paper is to compare the need of further seismic research in different countries. And, in view of the considerable role of computational issues in other areas of earthquake engineering and meanwhile the title of the COMPDYN 2011 conference, the main attention in this paper is on the computational issues of earthquake engineering and comparing the essentialities of further researches in several countries based on their seismic hazard, carried out researches, and financial capabilities. As a main conclusion, Italy is the country with least essentiality and Chile and Iran are the countries with most essentialities for further research on the computational issues of earthquake engineering.*

1 INTRODUCTION

Earthquake is a natural disaster causing the most losses both in the number of human beings death and also from a financial point of view (see also Fig.1), e.g. the financial (export, im

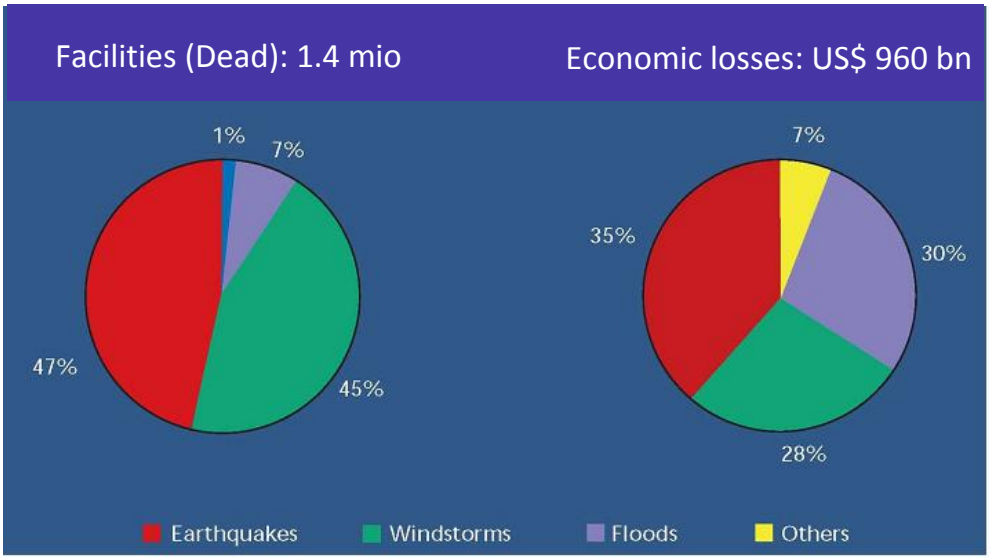

Figure1: A comparison between losses originated in natural disasters, from 1955-1999 [1].

port,…), ecological (radiation, air pollution . . .) . . . inter-connections between different countries and neighboring regions of the globe, the effects of an earthquake is not limited to the country, where the earthquake has occurred, or even, in cases, to the neighboring countries; for instance, consider the effects of the March 11 th, 2011 earthquake and Tsunami at Japan. Consequently, international financing on different issues of earthquake engineering research is meaningful; and hence, considering the nowadays hard financial situations (originating in the financial crisis, few years ago), and the fact that there are many earthquake engineering (including seismological) issues, special and local for each country (e.g. seismicity, some types of construction, some geotechnical problems), it is reasonable to investigates and compare the research needs in different countries, such that, to also dedicate the international and even national financial supports, in a better and when possible optimized manner.

The explanation above, the significant role of research on the computational issues of earthquake engineering on other issues and branches of earthquake engineering, and the title of the COMPDYN 2011 conference, together, lead to the essentiality of the objective of this paper implied in its title. The aim of this paper is to investigate the superiorities (between countries), for further research on computational issues of earthquake engineering. Based on the seismic risk, amount of researches carried out, and the financial potentials, the key idea is explained in Section 2, the comparisons are made in Section 3, the reasons of the observations are briefly explained and led to an extension of the observations in Section 4, some complementary discussion is stated in Section 5, and eventually, the paper is concluded in Section 6.

2 THEORY

2.1 Key idea

Considering the seismic hazards and financial potentials in different countries and regions, a reasonable expectation is more researches in countries, subjected to more seismic hazard and with more financial potentials. For a robust improvement (and also as seen in a separate

study [2]), the expectation of more research, noted above, is not only regarding research on earthquake engineering, but also, is valid for the relevant computational issues. Hence, by following the procedure below:

1. Selection of some countries/regions, with considerable earthquake hazard and different financial potentials.
2. Studying the amount of researches on earthquake engineering and the computational issues, in each country/region.
3. Based on the selections and achievements in the two stages above, making an idea about the countries/regions with more essentiality of further research on earthquake engineering and the relevant computational issues.

we would be able to materialize the objective of this paper.

2.2 Some selections

2.2.1 Countries/regions

Since the outcomes of researches are in general being reflected in publications, indexed, with their titles, the name of authors/coauthors, affiliations, keywords, and titles of journals/scientific events, in this likely first study on the subject, it is much simpler to select and consider some countries from different parts of the globe, as representative of the regions they are located in. In this regard, Chile, Greece, Iran, Italy, Japan, Mexico, and USA are the seven countries under consideration in this paper.

2.2.2 How to determine the amount of researches

2.2.2.1 Approach

In order to evaluate the amount of researches, an appropriate approach (in view a slight assumption) is to study the number of relevant documents in the literature; also see [2]. For materializing this approach, a scientific search engine, reliable, regarding the number of documents, is to be selected. In view of the existing literature, www.scirus.com and its advanced version provides the capability of reliable searches [2, 3], and hence is herein set as the search engine.

2.2.2.2 Phrases to be implemented in the search

Consider the phrase X, defined below:

$$X: \quad \text{"earthquake" OR "strong motion" OR "seismic"} \tag{1}$$

and its combination with names of the countries, set in Section 2.2.1, as:

$$X_i: \quad X \text{ and } \textit{name of country} \quad , \quad i=1, 2, 3 \ldots 7 \tag{2}$$

where,

$$\begin{aligned} &i=1: \textit{name of country}= \text{"Chile"} \\ &i=2: \textit{name of country}= \text{"Greece"} \\ &i=3: \textit{name of country}= \text{"Iran"} \\ &i=4: \textit{name of country}= \text{"Italy"} \\ &i=5: \textit{name of country}= \text{"Japan"} \\ &i=6: \textit{name of country}= \text{"Mexico"} \\ &i=7: \textit{name of country}= \text{"USA"} \end{aligned} \tag{3}$$

and, obviously X_i implies the amount of the researches carried out on earthquake engineering in the i th country. In order to study the amount of researches on the computational issues of earthquake engineering, we can consider the phrase:

$$Y: \quad \text{"computational efficiency" OR "computational cost" OR "approximate computation"} \tag{4}$$

and define the search phrase below:

$$Y_i: \quad X_i \text{ AND } Y \quad , \qquad i=1, 2, 3 \ldots 7 \tag{5}$$

as the amount of the researches carried out on the computational issues of earthquake engineering.

2.2.2.3 Type of the documents and the scope of search

"Any information type" is selected as the type of literature document ("content sources") to be searched for, in www.scirus.com (advanced version), and the scope is set, by selecting the two alternatives "Earth and planetary sciences" and "Engineering, Energy and Technology" as the "subjects area" in the www.scirus.com.

2.2.2.4 Time interval

Lack of literature in a single year and/or abrupt changes of the existing literature in consecutive years may cause problems in arriving at reliable achievements and ideas. Hence, it is meaningful to carry out the searches throughout years. Considering this, the comparisons are based on the literature searches carried out in the interval 1981-2010 (see also [2]).

3 EVALUATIONS

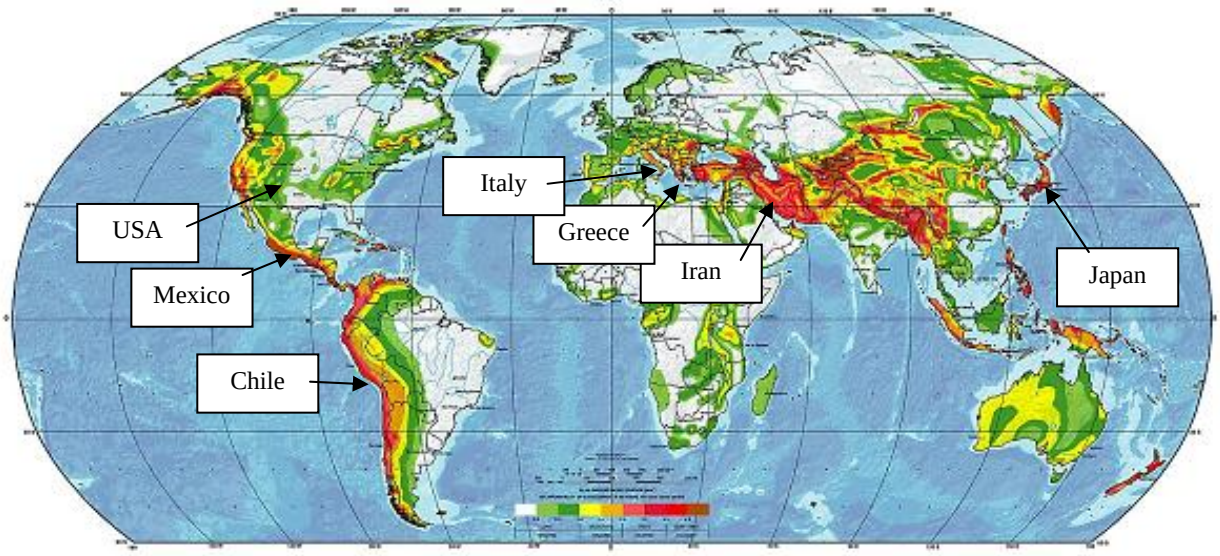

Figure 2: World seismic hazard map with the selected countries highlighted (taken form internet).

of the seven countries are roughly compared in Table 1, after some personal talks with some experts. The outcomes of the searches are compared in Fig. 3 and Table 2. In view of Fig. 3 and Tables 1 and 2, Chile and Iran are the countries with more essentiality of further research on earthquake engineering and the computational issues in earthquake engineering.

Chile (1)	Mexico, Greece, Japan (2, 5, 6)	Italy, Iran (3, 4)	USA (7)
More financial potential →			

Table 1: A rough comparison between financial potentials of the seven countries, selected in Section 2.1.

Country	1	2	3	4	5	6	7
Percentage of the earthquake engineering research relevant to computational issues	38	61	38	72	56	44	73

Table 2: The earthquake engineering research dedicated/involved in computational issues, in different countries.

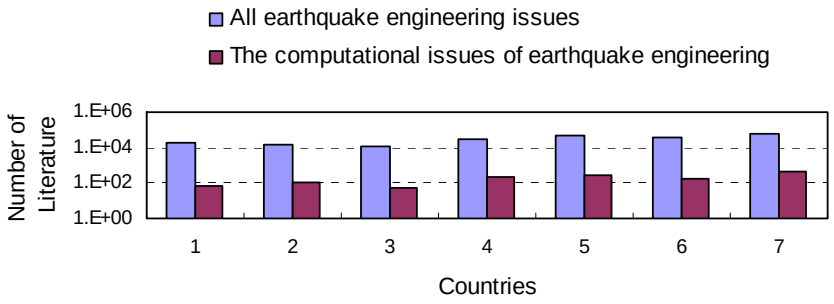

Figure 3: Number of literature on earthquake engineering and the relevant computational issues in countries.

Specifically, considering the financial conditions, notified in Table 1, Iran is the country, where, acceleration of research on the computational issues of earthquake engineering is not only essential but can have a much simpler explanation. On the other end of the spectrum, Italy is the country, where, the amount of research is comparatively good; still further research is surely recommended.

4 FROM EXPLANATION TO EXTENSION

Obviously at countries with high seismic hazard, more research is essential (especially, when the existing financial potentials are considerable). Nevertheless, when the countries are not well developed, the financial potentials are not being implemented in research projects, sufficiently, and in an appropriate manner; hence, further financings become essential. On the other hand, at developed countries, with moderate seismic hazard, and moderate financial potential, the developments of the countries lead to good managements of the financial potentials, towards the not considerable research needs (the seismic hazards are moderate), and hence, less essentiality of further research is being observed.

Researches on earthquake engineering and the relevant computational issues, in the past decades, were in very similar growth [2]. Meanwhile, many issues in earthquake engineering are being affected by the results of research on the computational issues. Considering these, the explanations in the previous paragraph sounds valid, for both earthquake engineering and the computational issues of earthquake engineering, not only for the countries taken under consideration here, but also, for arbitrary country/region in the world.

5 COMPLEMENTARY REMARKS

The approaches and achievements in the previous sections are rough. Ambiguities regarding number of countries, selection of countries and the relation between the need to further research, seismic hazard and financial potentials exist, all, implying the essentiality of more through study on the subject, briefly discussed in this paper.

6 CONCLUSION

Under some simplifying assumptions, the existing amount of research on computational issues of earthquake engineering is evaluated in view of the need to progress and research (seismic hazard) and financial potential. As a consequence,

1. Further research is essential in less developed regions/countries, subjected to high seismic hazard, e.g. Iran and Chile. Such a research can be simply explained when the financial potentials are considerable.
2. Regions/countries subjected to moderate seismic hazard, possessing moderate or good financial capabilities, specifically, when developed, e.g. Italy, are in the best conditions of research on earthquake engineering and the computational issues.
3. Countries/regions with high seismic hazard and moderate or good financial capabilities are also generally in a good condition regarding research on earthquake engineering and the computational issues of earthquake engineering.

Still, further research is recommended, in all conditions, with emphasis on the essentiality of further research in less developed countries under high seismic hazard.

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