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Towards an Integrated Seismic Hazard Zoning Map for South Asia

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Preface

Developing the seismic hazard maps has been always an important step in order to represent the seismicity and seismic hazard as the basis of earthquake resistant design in the civil engineering projects and for planning purposes. Different studies on seismological and seismic hazard assessment have already performed in different scales in the south Asian countries.

As for the input data, we do need to have, at least, the active faults map and the seismicity data in order to define the seismic source zones for the seismic hazard analysis. Some of the countries in the south Asian countries have published detailed fault maps, on which the active and capable faults are determined based on the international definitions. Some of other countries have only some old published maps. On these maps the faults are either not classified to be active or capable, or non-active. Either in some cases, the maps are not so complete to show the major (fundamental) fault lines. In view point of the seismic networks, some of the countries has short period, long period and/or broad band networks. The broad band networks are developed in some countries, such as Iran (INSN network), where there is a network of 15 broadband stations having communicating directly with its central station in Tehran. Other coun-

tries might have some few broadband stations (3 stations; in the case of Pakistan) or even no seismograph stations (in the case of Afghanistan). Fig.1 shows a 1973-1994 seismicity map of south Asian countries (USGS, GIS digital database, 2001). The quaternary and active faults of Iran are projected to this map. Other major faults are mentioned on the map as existed in the database.

A Vision; Preliminary Acts

The seismic hazard zoning map might be prepared for the region based on an accepted scale. We may decide on a small, but reasonable, scale (i.e.; 1:250000 or 1:1000000 if possible). The countries like Afghanistan should not be neglected in these efforts. The neighboring countries having an established seismic network and a bulletin (such as Iran and India, in the case of Afghanistan) might provide the clarification on the earthquake catalogs for such regions. The catalog of these regions having no network at the present time might be published in the earthquake catalog of the neighboring countries as part of their bulletins.

The next step might be the gathering the data on active and fundamental fault from the south Asian countries and then try to clarify the database and provide a unified fault map for south Asia.

In order to provide the seismicity database of the region, the teleseismic data published by ISC might provide a preliminary unified catalog of seismicity data. This seismicity catalog can be used as a landmark. Such database might be improved having the catalogs published by the national seismic networks.

Developing an Attenuation law for the south Asian Region

An important stage of this study will be developing the coefficients for the attenuation model for different part of the south Asia. The basic model is already selected (as proposed by Boore et al 1997 and Ambraseys and Simpson 1996) in a study in Iran and the coefficients of the attenuation relationships are estimated. Zaré 1999 (in his PhD thesis) and Zaré 2004 have published two sets of attenuation models for Iran based on the maximum and spectral acceleration, using the Iranian strong motion data The Iranian strong motion network has a set of 1100 stations, in which some 5000 three-component accelerograms are recorded (by the end of 2005). In an parallel attempt, the models proposed by Boore, Joyner and Fumal 1997 and Ambraseys and Simpson 1996 are tested in Iran and shown reliable results (as for the attenuation rate and resulting acceleration values) comparing to the recorded strong motions in Iran.

Conclusion

Developing the integrated seismic hazard zoning map for the south Asian countries is

a priority for the region. The Bam earthquake of 26 December 2003, Mw6.5, (more than 32000 fatalities) occurred in a zone having no evident seismic activity in the last 2000 years. One year later, the Banda Ache earthquake of 26 December 2004, Mw8.9, and the Tsunami that followed the event caused a major earthquake induced fatality (more than 350,000 persons) even in the countries that are not known to be in a major seismic risk (Sri Lanka is an evident example). The recent earthquake of Balakot, Pakistan (Mw7.6) caused a life loss of more than 73000 in an area that is known, according to the seismic hazard zoning map of Pakistan, to be a *"moderate"* seismic zone. These recent major seismic events in the southern Asian countries show that serious acts are necessary to be taken. Based on the experiences obtained in these events, I would like to summarize my propositions in the following directions:

- Since the most populated/great cities of the worlds are located in the south Asian countries (Beijing, Shanghai, Karachi, Tehran, New Delhi, Bangkok, Kuala Lumpur, Jakarta, Dhaka, Kabol, Xi'an, Mashhad,...), it is suggested that the Seismic Hazard and Risk Analysis for the Great cities in the south Asian Region might be put in Agenda with an important priority.
- The microzonation studies in the great cities might be a follow up study. Such studies need the detailed databases on the geotechnical conditions of each of the great cities of south Asia.
- Seismic Risk Management for the great cities in the south Asian cities might be started afterwards.