Seismic hazard in Asia*

K. R. Sreenivasan, Director, International Centre for Theoretical Physics (ICTP), Trieste, Italy has approved a network project entitled 'Seismic hazard in Asia assessed by pattern recognition of earthquake-prone areas, multi-scale seismic zoning, intermediate-term earthquake prediction algorithms, and realistic modelling of earthquake ground motion in megacities'. Seven countries, namely India, China, Pakistan, Bangladesh, Nepal, Vietnam and Italy participated in this network. The proposal is aimed at pre-disaster plans: prediction of expected earthquake effects in important cities of South-East Asia, in order to reduce the possible impact of great earthquakes. The first meeting and workshop of this network project was organized at ICTP by Imtiyaz A. Parvez (CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore), inviting at least two delegates from each participating country, including researchers of ICTP, MITPAN and University of Trieste, Italy. G. F. Panza (ICTP and University of Trieste) was the local organizer. The following members were present in the meeting: Shyam S. Rai (India), Zhifeng Ding and Wang Guoxin (China), Tahmeed M. Al-Hussaini and Mehedi A. Ansary (Bangladesh), B. N. Upreti and Harihar Paudyal (Nepal), Farhana and Talat Iqbal (Pakistan), Cao Dinh Trieu and Nguyen Phuong Hong (Vietnam), Karim Aoudia, Fabio Romanelli, Franco Vaccari, Antonella Peresan and Mariangela Guidarelli (Italy) and Vladimir and Kossobokov and Igor Kuznetsov (Russia). The workshop was also attended by the students of the ICTP–ESP diploma course.

The meeting started with talks by Sreenivasan, Panza and Parvez. Sreenivasan stressed the importance of such a network project particularly for the Asian region, because this region is under high seismic threat and the geological systems, starting from the Hindukush to the Andaman and Nicobar through the Himalayas, are quite complex and cover many political and national boundaries. With the experience of past catastrophic events, Sreenivasan advised to work together and integrate the findings in order to consolidate available data with the ultimate aim of predicting and mitigating the impact of such catastrophe. Panza welcomed the delegates and explained the importance of the network project. He also mentioned about the ongoing network projects in North Africa and Latin America. He said that this project was conceived a couple of years ago, inspired by the successfully completed global network project (UNESCO/IGCP Project 414), and the ongoing North African (UNESCO/IGCP Project 457) and Latin American (UNESCO/IGCP Project 487) network projects. Panza mentioned that due to a change in the policy by IGCP and on new format, the project could not be submitted to IGCP and hence it was decided to seek a launching support from ICTP. Parvez also emphasized the importance of seismic hazard studies in Asian countries like India, China, Nepal, Bangladesh, Pakistan and Vietnam, as these regions are under severe seismic threat. The meeting started with a two-days workshop, and the next three days were for computational exercises and discussion. The workshop began with talks by Panza, Kossobokov, Aoudia, Romanelli, Parvez, Vaccari and Kuznetsov.

Panza discussed the problems related with the issues in probabilistic seismic hazard assessment and stressed the merits of realistic modelling of ground motion using neodeterministic techniques. He pointed out two main problems with probabilistic seismic hazard: the Gutenberg Richter law (b-values) and the attenuation relations. The former is entirely based on the size of the seismogenic zone and completeness of earthquake catalogue and the latter depends on the availability of strong-motion records, which also vary significantly from one region to the other. Panza mentioned that the quantification of the critical ground motion expected at a particular site requires identification of parameters that characterize the severity and damage potential. Such critical ground motion can be identified in terms of energy and displacement demands – the latter particularly relevant for seismic isolation which should be evaluated by considering the seismological, geological and topographical factors affecting them.

Kossobokov spoke on 'Quantitative earthquake prediction: Basics, implementation, perspectives; Earthquake forecast/prediction: Verification, accuracy, limitations and unified scaling law for earthquakes and seismic hazard assessment'. He also discussed unified scaling law for earthquakes and seismic hazard assessment. He explained that the fractal nature of earthquakes and their distribution in space implies that traditional estimations of seismic hazard for cities and urban agglomerations are usually underestimated. He compared the results to traditionally scaled estimates based on the observed recurrence rates in the extended neighbourhoods of a mega-city. The general level of such an underestimation of the rates is too large to be ignored in seismic risk and earthquake loss evaluations necessary for a knowledgeable disaster prevention and mitigation.

Aoudia talked about active deformation and earthquake hazard: Models and case studies. He discussed the different length and timescales of the earthquake cycle and the 'aseismic seismic' continuous spectrum of behaviours that stand as a backbone for both earthquake prediction and seismic hazard assessment. The presentation bridged seismology, space geodesy and active tectonics tied through realistic modelling of both faulting and lithosphere rheologies.

Romanelli focused on the ground motion modelling for seismic-hazard assessment: Source and site effects. He explained that in the sedimentary basins generation of the local surface waves and local resonance can give rise to a complicated pattern in the spatial ground-shaking scenario. For any object of the built environment with dimensions greater than the characteristic length of the ground motion, different parts of its foundations can experience severe non-synchronous seismic input. In order to perform an accurate estimate of the site effects, and of differential motion, in realistic geometries it is necessary to make a parametric study that takes into account the complex combination of the source and propagation parameters. Romanelli showed examples of strong influence of the rupture

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and site effects on the ground-motion characteristics, in terms of amplitude and duration.

Parvez spoke about the activities of seismic-hazard assessment in India. He started with the seismicity map of the Indian subcontinent which has faced 13 great earthquakes of magnitude greater than 8.0 during the last 200 years. He also stressed the damages caused by three devastating earthquakes: Bhuj (2001), Sumatra (2004) and Pakistan (2005) occurred in this century. Parvez explained about the histories of seismic zoning maps in India, which currently have been modified in 2002 after Bhuj earthquake. He then showed the first ever neodeterministic seismic hazard map of India prepared in collaboration with ICTP. He also discussed the attenuation law of the Himalayan region and showed that, for a given magnitude, the amplitude of seismic ground motion is almost three times more in eastern region than in the western Himalayas. Parvez also showed results on the site-specific microzonation studies in India. This area of research is still growing in India and a lot needs to be done. He showed examples of realistic modelling of seismic inputs in Delhi and the variation of time histories due to site property variations.

Franco Vaccari explained the methodologies and computational aspects of neodeterministic seismic hazard at national/regional level and site-specific seismic-hazard assessment for megacities under seismic threat. He also discussed the relevance of input data collection, quality checking and their proper preparation in digital form in detail. He explained the computer exercises which had been prepared for the participants to try out themselves and produce ground-shaking scenarios at regional and local scale, performing parametric analyses to test the variability and the robustness of the results.

All other participants involved in the project of different countries also presented their activities on seismic hazard and earthquake prediction in their respective countries.

The following four topics of research emerged as appropriate for the network project: (i) Neodeterministic country-wide seismic hazard assessment. (ii) Microzonation studies in megacities of Asian countries. (iii) Intermediate-term middle-range earthquake prediction using CN and M8 algorithms. (iv) Identification of earthquake-prone areas with morphostructural zoning and pattern recognition.

All participants agreed to work on the above topics. Neodeterministic seismic hazard assessment will be done at the country-level and six megacities, namely Kathmandu, Delhi, Islamabad, Dhaka, Dalian and Hanoi have been selected for the first phase of site-specific microzonation study. Participants from Pakistan, China and Nepal have also shown interest to work on topics (iii) and (iv). Vaccari and Kossobokov had arranged computer exercises with an example database for all the participants. Some of them used the example database and tried to prepare inputs in their own database. Guidarelli, Romanelli and Parvez helped the participants in these exercises. Panza concluded the meeting with the proposal of establishing two data centres; one at ICTP, and the other at C-MMACS, and the data should be accessible to each partner of the project. He also requested Parvez to find partners from Myanmar and Indonesia for the network, as these two Asian countries are highly seismic-prone. He also suggested writing a proposal in the framework of IGCP for further partial support. Parvez proposed to organize, with scientific support from ICTP, the next meeting in C-MMACS, during November 2007, which was agreed upon unanimously.

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MEETINGS/SYMPOSIA/SEMINARS

UGC Sponsored National Workshop on 'Development and Maintenance of Lab Equipment'

Date: 24–27 April 2007
Place: Bangalore

Eligibility: Physics Lecturer and Physics Lab Assistants of Degree Colleges.

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