Chapter 3. Geographical Variations in Needs

The seismic risk of the globe varies greatly from place to place in terms of the interoccurrence time of damaging earthquakes, the types of structures and the density of population. For the IDNDR program of IASPEI to be effective, it is necessary to consider not only general seismological research but also the special problems that arise through local conditions. In the past, IASPEI has organized Regional Assemblies, first at the National Geophysical Institute at Hyderabad, India in 1982, then in Africa in 1990 jointly with UNESCO and ICL, which more fully allow for geographical differences. Such special assemblies focus attention of the world seismological community on regional problems and also support the work of local scientists through personal interactions otherwise difficult for them to achieve. The policy of IASPEI has also been to hold its regular assemblies in a selection of geographical parts of the world which have an interest in earthquake problems, seismological research, and teaching. It is important during the IDNDR for this policy to be continued and for a plan to be developed so that regular special assemblies can be held in each of the main seismically-active subcontinental areas in the next ten years (see Appendix A).

The Nairobi meeting in August 1990 consolidated efforts already made in East Africa by a number of seismological research groups, in particular from Nordic countries, and an international group concerned with the Kenyan Rift. We believe that the initiatives begun there should be continued strongly during the IDNDR.

Also, IASPEI has endeavored to lend support to seismological groups in developing areas of the world such as Southeast Asia and South America by modest travel assistance to its Assemblies. These travel subsidies are evidence to the local governments and agencies that the local work is in good international standing. There is little doubt that IASPEI should seek further funds related to the IDNDR for such assistance. It should be noted, that the last IASPEI Assembly held in South America was that in 1973 in Peru. Because the next Assemblies will be in Europe (1991) and New Zealand (1993-94), it is recommended that IASPEI plan to hold either a regular or regional meeting in a Latin American country before 1995 (see Appendix A). Special efforts should be made by IASPEI Commissions to concentrate on research and technology transfer and educational programs especially relevant to that region.

Certain countries which are well represented in IASPEI have highly developed scientific and risk reduction programs related to earthquake hazards. Some of these, such as the United States and Japan, have large areas which are highly vulnerable to earthquakes. Others such as the western European countries have an interest driven to a large extent by scientific interest

Apartment building damage in Leninakan, Armenian Earthquake, December 7, 1988.

in seismology and physics of the Earth's interior but have only moderate-to-low indigenous seismic risk.

Chapter 4. IASPEI Program Goals

This chapter focuses on those general scientific objectives of IASPEI activities dedicated to IDNDR that deserve high priority. Because disaster mitigation is the reason for these priorities, there is an opportunity to identify the ultimate users of the research results. Such information exposes both the scope of earthquake vulnerability and the breadth of the need for additional knowledge. The products of seismological research must be made readily accessible to those who have need of them in society at large.

Transfer of Knowledge

An important contribution would be for a proposed special IDNDR Secretariat of IASPEI (see Recommendation RA6, in Chapter 8), with assistance from the appropriate Commissions, to develop a list of institutes and experts that work on seismic hazard assessment and seismic zonation. Many of these institutes have representatives and scientists already associated with IASPEI but the production of a directory would enable IASPEI to have complete access over the Decade to this important group of earthquake scientists.

IASPEI has already begun through its computer algorithm packages, to make available computer programs for basic seismological work. Its manual on interpretation of seismograms is proving most helpful to observatories and students. In the IDNDR, this aspect of the organization should be increased and long-term plans be worked out for continuous funding for these activities. This type of activity should be extended to the enhancement of training facilities in seismology and geophysics, to the identification of possible supporting funds, to the expansion of critical cooperative research projects, and to experimental test sites (already underway by some IASPEI Working Groups - see Appendix B). Such enterprise would be an important central service provided by the IASPEI Secretariat for the IDNDR that should be much appreciated by many workers in the field.

In the same way, it is proposed that the work done at the above institutes on major aspects of seismic risk mitigation be documented. The full computer database would include the description of local seismic networks and their operations, data processing procedures and experimental and field equipment. Further, an index should be prepared showing the availability of related computer programs, equipment, training, and funding. Private sector geotechnical companies and instrument and computer manufacturers can contribute much to this activity.

Research Needs

The main international agencies involved with the IDNDR, as well as national IDNDR committees, have already begun to define the areas of seismic risk reduction where most scientific and technological impact can occur. Nevertheless, it is still essential for the IDNDR Committee of IASPEI and the appropriate Commissions to be charged with explaining those research areas where additional effort is especially needed.

A notable research gap involves long-term earthquake prediction. Related studies would include the assessment of earthquake probabilities in seismogenic zones, variation of earthquake activity in time and space, time series analysis with trends and non-stationary assumptions. More focussed work, with a strong physical basis, is needed to identify what mainshock precursors, given the experience of the last two decades, are still likely candidates for forecasting.

An example of another important field that needs enhanced research is strong motion seismology. Further insights are required on the properties of strong ground motion as a function of distance, earthquake size, focal depth, source mechanism, and ground conditions. The approach adopted in earthquake engineering for many years is to use peak ground accelerations as a scaling parameter and seismologists have contributed to the statistical analysis of this quantity. It now is clear that, for engineering purposes, not only seismograms of ground velocity and displacement are important but also special incoherency of ground motions between neighboring points is required for design of large structures. The growth of base isolation structural systems around the world has led to analysis using quasi-static structural response methods. For such systems, realistic ground wave displacements must be defined. This demand connects with early work in seismology, which modelled ground displacements but which were not thought then to be of engineering value. The emphasis then was on high-frequency acceleration records for smaller structures such as nuclear reactors.

Clearly, the careful definition and description of the main seismological research priorities is a lengthy and ongoing process, involving not only active researchers but also scientists and engineers more interested in applications and practice. As this process proceeds, it is suggested that a tabulation be made which relates the scientific need specifically to the user of the research results. Two illustrations of the recommended analysis follow.

Illustration 1.

Need. Characterization of future ground ruptures and seismic wave generation.

Users. This research is applied by practicing engineers, public decision makers and land-use planners.

Objectives. The quantitative identification of seismic sources and seismic source processes and the resulting seismic wave initiation requires the following work:

(i) Regional tectonic settings need to be understood and defined, including the distribution of crustal strain, the mapping of active faults at the surface and within the subsurface.

Product: Accessible geodetic and geological data systems, fault maps, geological cross-sections.

(ii). The seismic history of specific faults has to be characterized using geological, seismological and geophysical methods.

Product: Active fault segmentation maps, paleoseismic reports, seismicity analysis and probabalistic long-term predictions on fault segments.

(iii). The source of the seismic waves must be defined quantitatively.

Product: Models of the fault rupture process, influences of fault mechanisms on synthetic seismogram models, models of wave propagation.

Illustration 2.

Need: Reliable quantitative forecasts of the response of the ground.

Users: Geotechnical engineers, structural engineers, public decision makers and insurance industry.

Objectives: The realistic characterization of actual seismic ground response requires the following work:

(i). The wave mix and components of the ground response and the reason for variations must be determined more clearly.

Product: Improved models of earthquake ground motions and the definition of characteristics which favor amplification.

(ii). Intensities and phasing of strong ground motion must be understood.

Product: Theoretical and statistical analysis of strong motion catalogs, aftershock sequence studies and probabilistic ground motion intensity maps with frequency dependence, sets of standard ground motion recordings and associated response spectra.

(iii). The characterization of ground conditions. The influence of deep rock structure, the nonlinear and scattering character of the surficial materials and the bedrock, soil amplification factors, and the ground failure susceptibilities.

Product. Manuals of seismic velocities and attenuation values. Guide books on rock and soil parameters and modelling techniques.