Earthquake Engineering, Tenth World Conference © 1994 Balkema, Rotterdam. ISBN 90 5410 060 5

Second International Forum on Seismic Zonation, Madrid, Spain, July 23, 1992

W. Hays
US Geological Survey, Reston, Va., USA

B. Rouhban
United Nations Educational, Scientific and Cultural Organization, Paris, France

M. Herráiz
Universidad Complutense de Madrid, Spain

International Fora on Seismic Zonation (IFSZ) are a joint initiative by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the U.S. Geological Survey (USGS) in the framework of their 1990 Memorandum of Understanding. The first forum was organized in August 1991 in Stanford, California, immediately after the 4th International Conference on Seismic Zonation. The second forum was organized in conjunction with the 10th World Conference on Earthquake Engineering. To date the following organizations have cosponsored the fora: USGS; UNESCO; International Association for Seismology and Physics of the Earth's Interior; the Secretariat for the International Decade for Natural Disaster Reduction; Stanford University; the Earthquake Engineering Research Institute; and the California Department of Conservation, Division of Mines and Geology. A Directory of International Resources for the Practice of Seismic Zonation has been compiled and is available from UNESCO, USGS, or any of the sponsors.

The goal of the second forum was "to develop consensus recommendations for a generic expert system on the practice of seismic zonation." An expert system is a software/hardware computer system which can help nonexperts solve a particular problem in science, engineering, or business. An expert system uses artificial intelligence concepts to ask questions, give advise, search for, and justify answers--tasks that are normally associated with human behavior and human intelligence. In addition the concept of a hypothetical International Team on Seismic Zonation (ITFZ) which could help to apply expert systems worldwide in either the posteartquake or preearthquake environment was examined as part of a long-term process to improve seismic zonation maps and earthquake risk management policies and practices."

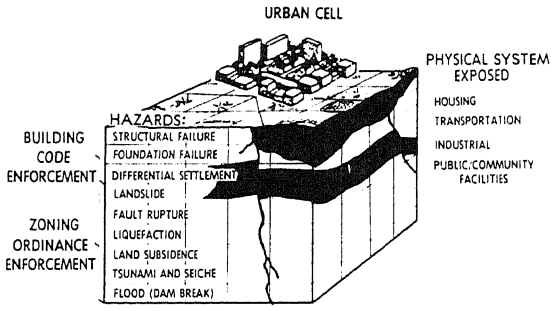

Figure 1. Seismic zonation requires an integrated assessment of a communities' solid earth , built environment, and social-economic-political systems.

Seismic zonation is the division of geographic region into smaller areas or zones expected to experience the same relative severity of an earthquake hazard (e.g., ground shaking, ground failure, surface faulting, tsunami wave runup, etc.). The resulting zonation maps provide community policymakers and decisionmakers with a wide range of options for ensuring sustainable development. For maximum benefit to policymakers and decisionmakers of a community, seismic zonation maps should integrate basic data on the solid earth system, the built environment, and the social-economic-political system of the community (Figure 1).

The key questions are summarized below.

1. Solid Earth System (i.e., defines the physical characteristics of the source, path, and site which control earthquake hazards (e.g., ground shaking and ground failure hazards)).

- Where have earthquakes occurred in the past?
- Where are they occurring now?
- What is the magnitude and depth distribution of the past and present seismicity?
- How often have earthquakes of a given magnitude recurred?
- What are the dominant earthquake generating mechanisms?
- What levels of ground shaking have occurred in the past? Ground failure? Surface fault rupture? Tsunami wave runup?
- What are the maximum levels that might be expected in future earthquakes?

2. Built Environment System, (i.e, defines the temporal and spatial distribution of buildings and lifeline systems exposed to earthquake hazards).

- What are the physical characteristics of the present inventory of buildings and lifeline systems (e.g., age,

type of materials, number of stories, elevation, plan, foundations, etc.)? The future inventory?
- How have these buildings and lifeline systems performed in past earthquakes (e.g., what are the vulnerability relations for each type of building and lifeline)?
- ...

3. Social-Economic-Political System, (i.e., defines the community's earthquake risk management policies and practices (e.g., mitigation, preparedness, emergency response, and recovery)).
- What risk management policies and practices (i.e., building and land use regulations) have been adopted by the community in the past?
- How have they been enforced?
- How effective have they been?
- ...

Seventy scientists and engineers from twenty countries attended the second forum and participated in three working groups formed several months before the forum. In the working groups, it became clear that the first step in addressing the problem of seismic zonation and in establishing the knowledge base for an expert system is to design a system that meets the needs of policymakers, decisionmakers, and public officials. The use of an expert system was recognized and acknowledged as an efficient way to assist and enable community and national leaders to decide on the most relevant policies to enact, and to provide a scientific and technical basis for descisionmaking. The categories of questions for the expert system on seismic zonation are those which will be asked by local officials whose communities have either been impacted by or are at risk from future earthquakes. The following questions were singled out for continued study:

1. What can happen during an earthquake in a community (i.e., a scenario)?

2. Do realistic scenarios already exist for communities and countries around the World? Can they be made available?

3. To what degree should the scenario encompass the relief, recovery/rehabilitation, and the reconstruction phases?

4. What are the timelines, opportunities, and mechanisms for dispatching a special postearthquake expert-team (i.e., the ITSZ)?

5. If the scenario is incorporated as part of the expert system, how should the scenario be adjusted to represent the actual damage and disruption?

6. What kinds of guidelines and/or questionnaires should be prepared to facilitate development of a realistic scenario?

7. What is the relationship between the ITSZ and the local national experts?

8. How should the reliability of the expert system and its authors be evaluated?

The participants agreed that a three-step process should be followed in order to accomplish the expert system within the next 2-3 years. The steps are:
- determine the questions that the system should respond to;
- develop a generic software system which incorporates the questions;
- test the system by applying it in earthquake prone regions either before or after a damaging earthquake, and refine it, as necessary.

The participants also proposed that the initial development of the expert system be undertaken by a working group to be created under the leadership of Professor Haresh Shah, and that Stanford University, one of the cosponsors of the forum, serve as the institutional headquarters of the group. Interested researchers and professionals willing to participate in the work are urged to contact Professor Shah.

The development of the expert system will be undertaken, to the extent possible, in cooperation with The International Association of Earthquake Engineering's new World Seismic Safety Initiative (WSSI). Collaboration with other existing programs such as the USGS's Worldwide Earthquake Risk Management program (WWERM) and the Global Seismic Hazard Assessment Program (GSHAP), a part of the International Lithosphere Program, will be encouraged.

The Third International forum on Seismic Zonation is being planed for May 6-7, 1993. in Memphis, Tennessee, USA in conjunction with a National Earthquake Conference. Contact Dr. B. Rouhban (UNESCO) or Dr. W. Hays (USGS) for information.

ACKNOWLEDGMENTS

We acknowledge the support and contributions of our colleagues throughout the world. We especially want to express our appreciation to Dr. Pierre Mouroux, BRGM; Dr. James Davis, CDMG; and Dr. Guillermo Santana, University of Costa Rica; who chaired the three working groups, created before the forum. Special appreciation is also extended to Dr. Charles Thiel, who first suggested the idea of an ITSZ and facilitated discussions in Madrid.

REFERENCES

Chorafas, Dimitris N., 1987, *Applying Expert Systems in Business.*, McGraw-Hill, Book Company, New York, 232p

Tanimoto, Steven L., 1987, *The Elements of Artificial Intelligence*, Computer Science Press, Seattle, Washington, 527p.