PROCEEDINGS

of the Executive Briefing on

STRATEGIC PLANNING TO REDUCE ECONOMIC IMPACTS OF EARTHQUAKE HAZARDS THROUGHOUT THE WORLD

NATIONAL ACADEMY OF SCIENCES

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OFFICE OF U.S. FOREIGN DISASTER ASSISTANCE

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PREFACE

The *Executive Briefing on Strategic Planning to Reduce the Potential Economic Impacts of Earthquake Hazards Throughout the World* was held in Washington, D.C., on March 8-9, 1988, under the joint sponsorship of the Office of U.S. Foreign Disaster Assistance/U.S. Agency for International Development, the U.S. Geological Survey/ Department of the Interior, and the National Academy of Sciences.

The purpose of the briefing was to introduce leaders of the financial sector (investors, developers, and insurers), international agencies, and the U.S. Government to the concepts of a new program initiative: *Worldwide Earthquake Risk Management* ("WWERM" or "the initiative"), and to obtain support for implementation of the initiative.

Goals of the initiative are to:

1. Assist the worldwide financial community, concerned United States and international agencies having investment, development, and insurance programs in earthquake-prone regions of the world, and the affected countries with their strategic planning and risk management; and

2. Foster the development of self-reliance in foreign countries to deal with earthquake-related problems.

Planners of the initiative expect, within the first five years, to begin providing technical and planning assistance to at least fifteen countries in earthquake-prone regions of the world, the worldwide financial community, and national and international agencies that have investments in these countries, yet to be selected; and to collect and disseminate basic data and techniques for loss estimation and reduction to government officials and professionals in these countries. These *Proceedings* are a summary of the views of speakers and panelists who participated in the March briefing. Their presentations described related activities of their agencies and organizations; reported activities around the world that may affect or complement the initiative; defined how some agencies and organizations may be able to participate; and, most important, responded to the proposal to initiate the WWERM initiative.

The initiative presented four initial strategies to support proposed WWERM activities:

1. **Networking** -- Linking the existing worldwide knowledge base on earthquake hazards with the investment agendas of the financial community;

2. **Mapping** -- providing technical products (maps) to support earthquake risk management policies;

3. **Improving practices** -- providing guidance for incorporating damage- and loss-control measures in design, construction, and land-use practices; and

4. **Professional skill enhancement** -- providing a forum where professionals in earthquake-related fields in earthquake-prone countries can expand their professional skills in earthquake risk management.

Responses to the proposal to establish WWERM were overwhelming favorable.

Tuesday, March 8, 1988

INTRODUCTION AND WELCOME

Introduction by Walter W. Hays;
Welcome by Alan Woods.

INTRODUCTION

WALTER W. HAYS
Deputy Chief for Research Applications
Office of Earthquakes, Volcanoes, and Engineering
U.S. Geological Survey; and
Facilitator for the Executive Briefing

Each participant has been given a briefing book entitled *Strategic Planning to Reduce Economic Impacts of Earthquake Hazards Throughout the World*. This document contains information to supplement some of the presentations. It also includes biographical data about the speakers to permit us to spend more time on the substance of this meeting and less on introductions, and to encourage those in attendance to meet and talk with each other during the breaks and at the informal social hour this afternoon between 5:00 and 6:00 p.m.

I would like to call your attention to Section C of the briefing book, which contains information about, and photographs of, some of the devastating earthquakes that have occurred. Several of these earthquakes will be discussed in presentations over the next two days.

Finally, the briefing book contains a list of participants in this meeting, including speakers and attenders.

(p. 3 follows)

WELCOME

ALAN WOODS
Administrator
U.S. Agency for International Development

Welcome to this meeting on Worldwide Earthquake Risk Management (WWERM). In some ways, this is a very brash meeting. It presumes that earthquakes, the most capricious and destructive of natural hazards, are manageable -- not controllable, but manageable. It says that we believe that risk management activities can indeed reduce the risk of loss in earthquake-prone regions of the world.

I would like to thank Julia Taft of the Office of U.S. Foreign Disaster Assistance (OFDA) at the U.S. Agency for International Development (USAID), and Dallas Peck of the U.S. Geological Survey (USGS) for sponsoring this program. Much work has gone into this briefing to introduce you to the Worldwide Earthquake Risk Management initiative. The meeting is an intellectual exercise in the sense that we want you to take home more than information about earthquakes and earthquake planning. We also want you to formalize the participation of your agency or group in activities to mitigate earthquakes and help other countries become self-reliant in mitigating earthquakes that occur abroad.

Those earthquakes can be enormously damaging economically. I was in El Salvador about three weeks ago at the site of the October 1986 earthquake. The results of that earthquake are still apparent a year and a half later. The evidence of the impact is still there. It caused massive damage in a 20-square-block area. Buildings that the USAID helped to erect collapsed, including the United States Mission, and equipment USAID supplied was destroyed. (A specific requirement for the new USAID structure was earthquake resistance). The earthquake disrupted USAID projects in the country, particularly educational programs. Children had to be moved outside to temporary buildings on school grounds, and USAID had an immunization program underway in buildings that were unsafe for habitation. I also visited a hospital that had to be relocated because of the earthquake.

The event in El Salvador was destabilizing generally in a country already destabilized because of its political situation. It continues to affect El Salvador's potential for growth, and would have been even more disastrous had the President of El Salvador not become very involved in relief efforts. Most important, some 1,100 people died, 20,000 were injured, and more than 500,000 were displaced. USAID lost a lot of the good people it had trained and depended upon. They lost their lives.

I may be taking a line from someone else's talk, but hundreds of billions of dollars can be saved worldwide on the basis of a common uniform risk map, the development of which is one task contemplated by the WWERM initiative.

Finally, since we know how to target and minimize risk, the agencies, international organizations, and other groups represented here today have a responsibility to work in partnership to make risk management a greater priority in developing nations. The El Salvador earthquake illustrates how important risk management is. The Minister of Planning in El Salvador estimates recovery costs at more than $1 billion -- 25 percent of El Salvador's gross national product (GNP). We in the earthquake community are partly responsible for that. We have enough practical experience to be able to minimize earthquake risks. We need to pay better attention to the data and make it available to more people. This seminar makes us better able to shoulder that responsibility.

Tuesday, March 8, 1988

SESSION I

GLOBAL ASPECTS OF EARTHQUAKE HAZARDS, RISK, INVESTMENT, AND INSURANCE

Objective	Provide an overview of the global elements of hazards, risk, investment, and insurance.
Panel Discussion	Information needs of insurers to deal with the capacity problem.
Moderator	Karl V. Steinbrugge

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REDUCING EARTHQUAKE RISK THROUGHOUT THE WORLD

JULIA V. TAFT
Director
Office of U.S. Foreign Disaster Assistance (OFDA)
U.S. Agency for International Development

INTRODUCTION

The responsibilities of OFDA within the U.S. Agency for International Development include coordinating all United States Government responses to disasters and dealing with disaster preparedness. We see this meeting as an important networking activity that will help us perform those functions better. Not only are friends and colleagues here, but also representatives of the National Academy of Sciences ("NAS" or "the Academy") and several offices within USAID, the Department of State, the Department of Health and Human Services, and the private sector. The latter, particularly the insurance industries, consists of groups and individuals who are colleagues to us in the Federal Government in this activity. We welcome also representatives of international economic development organizations. We can reduce the risk of earthquakes only if all of us works together. I hope this briefing helps us learn what kinds of information and formats each other needs to make our work easier. The wonderful maps around the perimeter of the room certainly will help us.

Some of those maps show tsunami possibilities from seismic gaps. Others depict information on the vulnerability to earthquakes of various areas around the world. We need to make sure that this information is translated in ways that make it useful in the processes where decisions and assessments are made about design and construction.

At lunch today, Dr. Press will talk about international hazards reduction. We want to get off on the right track with the International Decade for Natural Disaster Reduction (IDNDR) and want you to participate with us.

The issues of risk management include a number of acronyms such as IDNDR and WWERM. Bear with us as we use our governmental jargon, and please interject if you have questions.

(Slide) The purpose of this Executive Briefing is to present information on the nature and magnitude of earthquake losses that have been experienced by many countries throughout the world during the past twenty centuries, and that will be experienced again unless effective risk management policies are adopted and implemented. By risk management, we mean a long-term process that leads to the adoption of policies and strategies designed to keep potential future losses from earthquakes within accepted limits. The next speaker, Dr. Dallas Peck, Director of the U.S. Geological Survey, and I will describe the four components of the new program initiative that is designed to reduce earthquake losses in the future from the physical phenomena (hazards) of ground shaking, ground failure, surface fault rupture, tectonic deformation, and tsunamis that accompany an earthquake. Other speakers later today and tomorrow will add specific details. For example, Mr. Karl Steinbrugge and a panel of four experts will describe the information needs of insurers.

NEW INITIATIVE

(Slide). For many years, OFDA has supported the application of earthquake hazards information in order to achieve three major goals throughout the world:

1. Alleviate suffering and enhance recovery by providing efficient, rapid, and appropriate responses to requests for emergency relief;

2. Save lives, property, and resources in the future by introducing practical strategies for risk management; and

3. Foster greater self-reliance within and among nations located in disaster-prone regions of the world by helping them to develop adequate preparedness, mitigation, response, and recovery capabilities within their overall risk management policies.

OFDA and the USGS have agreed to cooperate in a major new program initiative to accelerate progress toward these goals during the next five years. One objective of this Executive Briefing is to describe the components of this initiative and ask for your support. This five-year OFDA/USGS program initiative is designed to cut significantly the economic and life losses from earthquakes.

The initiative has two goals:

1. To provide technical and planning assistance to the countries involved and to investors, developers, and insurers having programs in earthquake-prone regions of the world so that each group can devise and enact realistic strategies and policies for risk management that are appropriate for the investor, the country, and the public; and,

2. To foster greater self-reliance of the professionals in earthquake-prone countries so that each country can develop its own risk management programs more efficiently.

(Slide: Four Initial Strategies.) The OFDA/USGS program initiative will have four strategies:

1. *Hazard mapping.* Starting with 15 selected countries, assigned priorities according to factors such as the number of population centers at risk, we will begin a sequential process that will lead to development of a world seismic hazard map. Such a map will save hundreds of billions of dollars when the information it depicts is reflected in building codes and other mitigation measures.

2. *Improved practices.* Working with professional "partners" in the 15 selected countries, we will foster a long-term research-applications program that will lead to improved practices in earthquake-resistant design, construction, and land use.

3. *Professional skill enhancement.* Working with our partners, we will devise and implement a program of professional skill enhancement that is appropriate for meeting the needs of the professionals in the country who will be enacting improved damage and loss-control measures.

4. *Networking.* Keeping global, regional, and national perspectives in mind, we will foster and improve communications as they relate to earthquake risk management,

linking OFDA, USGS, and foreign professionals with investors, developers, and insurers in a way that leads to improved earthquake risk management.

We believe that everyone -- investors, developers, and insurers; government officials and professionals in countries at risk from earthquakes; and the United States Government -- will benefit from the OFDA/USGS program initiative because it will lead to improved worldwide earthquake risk management. We believe also, as presentations on specific countries later today will show, that losses from earthquakes can be reduced to acceptable levels within a reasonably short time.

IMPACTS OF PAST EARTHQUAKES

When we look at the world from the perspective of the financial sector making or planning investments in one or more of the earthquake-prone regions of the world, we see that each region has many urban centers where people and capital investments are concentrated and exposed to a variety of natural hazards. These natural hazards include: earthquakes, floods, volcanic eruptions, landslides, tsunamis, and windstorms; each varying in its frequency of occurrence, duration of impact, severity of impact, and suddenness of onset. Earthquakes are a unique natural hazard because of their capacity to strike an urban center with little or no warning and to cause great economic and life loss over a broad region within only a few seconds to a few minutes. To complicate matters, a long series of aftershocks usually follows the main event and causes additional impacts. Throughout the world for as long as mankind has been keeping records, earthquakes have struck population centers in virtually every region, destroying human settlements and capital improvements, killing, injuring, and leaving homeless tens to hundreds of thousands, and severely disrupting the economy and the infrastructure. Nothing is spared from destruction -- homes, high-rise buildings, government buildings, commercial buildings, embassies, dams, hospitals, schools, bridges -- unless effective risk management policies have been adopted and implemented.

When we look back through time at the historical record of loss of life in the World's worst earthquakes, two facts are very clear. First, the number of casualties has been very large, for example:

- 450,000 in Iran in three earthquakes occurring in the years 856, 893, and 1779;
- 480,000 in India in two earthquakes occurring in the years 893 and 1737;
- 1,430,000 in China in six damaging earthquakes occurring in the years 1290, 1556, 1731, 1920, 1927, and 1976;
- 472,000 in Japan in three major earthquakes occurring in the years 1703, 1730, and 1923; and
- 230,000 in Syria in the year 1138.

(Slide: Community seismic risk urban cell.) Second, history keeps repeating itself in these and other earthquake-prone regions because man has been slow to adopt and enact risk management policies, and because population density has significantly increased. Were these events to occur today, even greater population losses would be sustained.

Although many historical examples of the economic losses can be given, I will only give seven examples from earthquakes occurring this century. Other speakers may add additional details later in the briefing.

1. (Slide: collapsed unreinforced masonry building in Whittier.) The October 1987 Whittier Narrows, California, earthquake (M=5.9) caused direct economic losses in excess of $358 million and demonstrated that unreinforced masonry buildings in an urban center are very vulnerable to nearby moderate-magnitude earthquakes.

2. (Slide: 1987 Ecuador earthquake showing damaged trans-Ecuadorian pipeline.) The March 1987 Ecuador earthquake (M=6.9) triggered landslides that ruptured the trans-Ecuador oil pipeline, the Nation's prime economic asset. The earthquake caused economic losses approaching $1.5 billion, an estimated 1,000 deaths, left 60,000 homeless, and crippled the economy. It also disrupted, and continues to disrupt, the lives of more than 100,000 people whose only access was via the pipeline.

3. (Slides of Mexico City: [a] Collapsed Nuevo Leon apartment complex; and [b] a hospital.) The September 1985 Mexico earthquake (M=8.1) severely disrupted the economy, causing about $6 billion in direct economic losses and 10,000 to 20,000 deaths in Mexico City, the world's most populous urban center.

4. (Slide: Damaged apartment building in El Asnam, Algeria.) The October 1980 El Asnam, Algeria, earthquake (M=7.2) caused economic losses of $4 billion and left 6,000 dead and 300,000 homeless. A similar disaster 34 years earlier in 1954 also devastated northern Algeria. Algiers, the capital, was almost completely destroyed in a large earthquake in 1716.

5. (Slide: China earthquake.) The July 1976 Tangshan, China, earthquake (M=7.8) destroyed the entire city, requiring a decade and enormous resources to recover.

6. (Slide: Managua earthquake.) The December 1972 Managua, Nicaragua, earthquake (M=6.2) disrupted the entire Nation's industrial production, leaving 10,000 dead, 20,000 injured, 300,000 without homes, and damage equal to a year's GNP for that country. Some observers believe that the inability of the then-President (Samoza) of Nicaragua to organize appropriate responses to the damage contributed to his ouster. The inability of governments, in general, to deal with the consequences of a damaging earthquake is a potent political issue because it affects investments in the country. A cataclysmic event challenges the quality of investments, becoming an economic issue as well.

7. (Slide: 1923 Tokyo earthquake.) The June 1923 Tokyo, Japan, earthquake (M=9) and the subsequent fire caused direct economic losses of $2.8 billion and killed more than 140,000 people.

CONCLUSIONS

After a review of the facts, we must conclude that the global risk from earthquakes is increasing rapidly with time because of three factors:

1. Increasing capital outlays worldwide, especially in developing countries where earthquake risk management is not well advanced;

2. Rapid growth of the world's population and its continued concentration in urban centers that are located in earthquake-prone regions and that have a large inventory of unsafe buildings, vulnerable critical facilities essential for the functioning of the urban center, and fragile lifeline systems essential for its daily existence.

3. Increasing interdependence of people and governments on local, regional, national, and global scales.

Through this program initiative and its interrelationship with the International Decade for Natural Disaster Reduction (IDNDR) and other complementary programs, we propose to do something about the problem. I believe the time is right for a creative program which has as its goal reducing earthquake risk to acceptable levels, especially now that IDNDR is unfolding for 1990-2000. You will hear more about the IDNDR later today in the luncheon address by Dr. Frank Press, President of the National Academy of Sciences. We hope that all of you will consider joining us in approaching this challenge as we unite in concerted action to protect lives and investments.

(p. 13 follows)

STRATEGIES FOR EARTHQUAKE RISK MANAGEMENT

DALLAS L. PECK
Director
U.S. Geological Survey

INTRODUCTION

Let me first express my appreciation to the Academy for this meeting site, and then wonder why we didn't do this years ago. This information exchange among the banking and insurance industries and government officials is certainly important to the networking aspects of the responsibilities many of us have in our professions; so if you see someone you should know, take the opportunity to give him or her your card.

As Mrs. Julia Taft indicated in her presentation, recent earthquake events such as those that struck Mexico City in September 1985 and Ecuador in March 1987, have reminded us of the great economic losses and life losses that a damaging earthquake can cause within a time span of just a few minutes. Events like these were disasters because the one factor that mankind controls, *risk management*, was inadequate. We cannot do anything about the energy release (magnitude) of the earthquake or how close it is to an urban center; but we can certainly do something about risk management.

It is clear that a coordinated, long-term effort must be made throughout the world to reduce the growing risk from earthquakes. The effects of ground shaking, ground failure, surface fault rupture, tectonic deformation, and tsunami -- phenomena that accompany an earthquake -- can and must be mitigated through creative worldwide risk management.

NEW PROGRAM INITIATIVE

The cooperative program initiative, WWERM, of the OFDA and the USGS has two primary goals during the next five years:

1. To provide technical and planning assistance to the worldwide financial community and concerned United States and international agencies having investment, development, and insurance programs in earthquake-prone regions of the world;

2. To provide basic data and techniques for loss estimation to government agencies and professionals in countries located in earthquake-prone regions, enabling them to deal with their earthquake problems more efficiently.

We must work together to mitigate the damages of earthquakes. Through risk management, the effects of earthquakes -- magnitude, location relative to urban areas, degree of risk within the urban area -- in every country can be diminished. There are six critical steps leading to earthquake risk management. As we envision them, all six are feasible. They are:

1. *Hazard mapping* -- the most effective and essential initial step. This activity produces maps showing the spatial and temporal variation of a given earthquake hazard (such as ground shaking) in a given period of time. We have some maps of

the San Francisco area that are good examples of what is needed for urban areas throughout the world.

2. *Improved design, construction, and land-use practices* -- practical applications of the hazard maps in order to increase the safety of a structure while balancing the economic, political, and social considerations.

3. *Disaster simulation* -- an innovative application of the hazard maps within the framework of the knowledge of design, construction, and land-use practices in order to identify all of the causative and resultant factors associated with an earthquake disaster.

4. *Warning systems* -- a process to enhance the communication of hazards and risk information to and from the people and organizations at risk.

5. *Disaster response plans* -- planning to anticipate and meet the time-varying needs of the recovery period following a damaging earthquake.

The OFDA/USGS program initiative will emphasize four components:

1. *Hazard mapping* in 15 selected countries, the beginning for a world seismic risk map;

2. *Improved practices* for earthquake-resistant design, construction, and land use in each of the 15 countries;

3. *Professional skill enhancement* in each of the 15 countries and some of the neighboring countries; and,

4. *Networking* on a global, regional, and national scale.

A brief discussion follows about each component of the initiative.

HAZARD MAPPING

Maps of the ground-shaking hazard will be constructed in 15 selected countries where the potential risk is high and investment in development programs is either underway or planned. Such maps require a comprehensive body of technical data and knowledge on: (a) seismicity; (b) seismogenic zones; (c) regional seismic wave attenuation; and (d) local soil response. Regional geologic and seismicity data are essential for the construction of earthquake ground-shaking hazard maps, and we already have information from many countries that will help in designing the maps.

Dr. Ted Algermissen of the USGS will describe hazard maps in more detail; some aspects of the seismicity data for various parts of the world, however, follow.

(Slide: comparison of seismic risk in the United States)

Regional seismicity data. Since 1967, when the theory of plate tectonics was introduced, scientists have significantly improved their understanding of the physical processes causing earthquakes. Now, we have good answers to the questions: *Where? Why? How often?* and *How big?* We know that several million earthquakes large enough to be recorded occur annually throughout the world and that the epicenters of these earthquakes clearly mark the boundaries of about twenty major and minor tectonic plates.

(Slides: World Seismicity from 1960-1980; and another showing the subduction process.) The plates are converging in some locations and diverging in others. Areas of convergence include well-known subduction zones such as:

1. (Slide.) Alaska, where the Pacific plate is being subducted or underthrust beneath the North American plate. The M=9.2 Prince William Sound earthquake, which caused $1 billion (1979 dollars) in direct losses in 1964, is one example of a destructive earthquake in this region.

2. (Slide.) Japan and the Kuril Islands, where the Pacific plate is being subducted beneath the Asian plate. The damaging earthquake of 1923 which caused $2.8 billion in direct losses is one of many examples in this region. Dr. Richard Wright of the National Bureau of Standards will provide additional details later today on programs in this region.

3. (Slide.) The Indonesia-Australia-Philippines region is another region where many damaging earthquakes have occurred.

4. (Slide.) The New Zealand region, where spectacular deep subduction is taking place.

5. (Slide.) Middle America, where the Cocos plate is being subducted underneath the North American plate. The September 1985 Mexico earthquake is a recent example of a destructive historical earthquake in this region. The Caribbean Basin also has experienced destructive historical earthquakes. Professor José Grases of the Central University of Venezuela will provide details on some parts of the Caribbean Basin.

6. (Slide.) South America, where the Nazca plate is being subducted beneath the South American plate. The May 1960 and March 1985 Chile earthquakes and the 1975 Peru earthquake are examples of destructive earthquakes in this region. Details on programs in this region will be provided by Dr. Ted Algermissen, USGS, and Paul Krumpe, OFDA.

(Slide.) The tectonic plates are colliding at other locations, such as the Mediterranean Sea-Middle East region. The collision there of the African and European plates contributes to the high level of seismic activity in locations of North Africa such as Morocco and Northern Algeria, where devastating earthquakes occurred in 1960 and 1980. Spain, Jordan, Italy, Syria, Turkey, Yugoslavia, Greece, and Iran all have been struck repeatedly by damaging earthquakes. Additional details on programs in these regions will be provided by Dr. Badaoui Rouhban, UNESCO; and Dr. Walter Hays, USGS.

In Asia, complex tectonic processes have generated damaging earthquakes many times in India, China, and the Soviet Union. Dr. David Russ of the USGS will provide details on programs in China.

IMPROVED PRACTICES

Improved practices for design, construction, and land use always follow when maps of the ground-shaking hazard (and the ground-failure hazard) are available in a country. These maps provide a good basis for decisionmaking and for answering the six technical questions of concern to investors, developers, and insurers, as well as the government officials and professionals of each country located in an earthquake-prone region. These questions are:

1. *When* will the next damaging earthquake occur?

2. *Where* will it occur?

3. *How severe* will the damage be?

4. *How great* will the accumulated losses be?

5. *How long* will it be until the next damaging event occurs?

6. *How rapidly* is the exposure to loss increasing?

PROFESSIONAL SKILL ENHANCEMENT

A long-term process involving workshops, conferences, planning meetings, and other interactive activities is required to define the needs of professionals and to develop, refine, improve, and extend the skills of professionals in each country. The process is most effective when the professionals have an opportunity to learn by doing: by participating in the construction of a hazard map, by creating program plans, and by solving the political and social problems associated with the enactment, implementation, and evaluation of improved design, construction, and land-use practices in the countries where they work. Post-earthquake investigations are essential for professional skill enhancement.

NETWORKING

Interpersonal and programmatic networks are essential elements of earthquake risk management. Networks linking investors, developers, insurers, professionals, and government officials will be established on global, regional, and national scales to ensure that all available resources are integrated and used to maximum advantage. One goal is to take advantage of each "window of opportunity."

One of those windows of opportunity will exist here next year. The NAS and USGS are co-hosts for the first time since 1933 in the United States to a major international meeting in Washington, D.C., at which approximately 10,000 people will gather in 1989. I hope to get the support of the people here, and to announce to the International Geologic Congress (IGC) that efforts are underway to reduce hazards within a partnership that involves all of us.

CONCLUSIONS

I believe, on the basis of experience in many countries throughout the World, that the earthquake risk in any country can be reduced significantly by improving the earthquake risk-management process. The four basic strategies for effective risk management -- hazard mapping; improved practices for design, construction, and land use; professional skill enhancement; and networking on global, regional, and national scales -- can all be realized. I am personally very optimistic about the Worldwide Earthquake Risk Management program initiative, partly because of the International Decade for Natural Disaster

Reduction, a new program of the National Academy of Sciences which will be discussed by Dr. Frank Press. I also believe that we all will be impressed by our accomplishments when we look back in time five to ten years from now.

Finally, I leave you with this thought from Linus Pauling: "Science is the search for truth." We need to have the spirit of science in support of our efforts to find the right solution -- the just solution -- to international problems.

(p. 19 follows)

INSURANCE CONSIDERATIONS FOR INDUSTRIAL FACILITIES

STANLEY J. COUVILLON
Assistant Vice President
Industrial Risk Insurers

In my remarks, I will give you a brief background of what the Industrial Risk Insurers (IRI) do, and how we analyze earthquake potential and, more important, respond to the questions that arise as a result of our analyses.

IRI is a worldwide, all-risk industrial property insurer, and insures some of the largest facilities in the free world. Most IRI professional staff, whether in loss prevention, underwriting, or management, are engineers by education and interested in loss prevention people by training. IRI is one of the most prominent organizations in the Highly Protested Risk (HPR) market. As such, we make periodic site surveys to evaluate construction, protection, hazards, and local management.

Earthquake protection is written as an endorsement to IRI's All Risk policy on the basis of an annual aggregate account limit. Earthquake coverage cannot be written without also writing the property coverage. Rates for premium purposes are based on individual site evaluations, *i.e.*, earthquake zone; construction and height of buildings; contents; soil conditions; and the relationship of the site with respect to the nearest major fault. The total amount of earthquake insurance IRI can underwrite is strictly controlled by geographic areas subject to damage from a single incident.

Several years ago, with the assistance of a consultant, IRI developed a computer model to analyze earthquake exposure. In doing so, a number of questions recurred. The specific answers (or concurrence in theory) by various experts in the field of earthquake research either vary widely or are non-existent. Considering the extent of the earthquake threat and exposure to insured values throughout the world, expert agreement or consensus opinion is needed for the following:

- **Commonality of data**. In other areas of the world, seismic information is presented using various techniques and parameters. It would be advantageous if a uniform format can be developed for seismic data publication. IRI has a geologist on board who analyzes data to help us complete our own risk analysis.

- **Frequency vs. Intensity**. Earthquakes, like other natural hazards, need to be quantified. What is the maximum anticipated magnitude for the known major faults in various tectonically active regions of the world, and what is the reasonably expected frequency for such events? If, for example, a Richter magnitude 8.25 event is postulated for a given fault, the probability of that occurrence is unclear. Is it to be expected once in 50 years, 100 years, 500 years, 1,000 years, or will it occur with greater frequency?

- **Fire following earthquake**. IRI's insurance policy covers a variety of perils. Estimating fire-loss potential for an insured location has been practiced for many years and is the basis for general underwriting. There is no question that some fire loss is expected following an earthquake. The extent of that fire loss is presently undetermined. Additional study is needed to investigate the industrial, commercial, and residential aspects of fire following an earthquake. At IRI, we estimate losses on an individual basis. A facility on 100,000 square acres, much of it open space, that deals with non-combustible materials will certainly be rated far differently than a petrochemical company on densely occupied land.

- **Conflagration.** With the use of modern materials in construction over the last 40 years, is a conflagration, as occurred following the 1906 San Francisco earthquake, a viable factor? Does it differ between congested residential areas and the more open industrial areas? Do external elements increase the conflagration potential? We at IRI are not convinced that conflagration is particularly applicable.

- **Aftershock.** Like most insurance companies, IRI accepts the definition that an earthquake event includes seismic activity within 72 hours of the initial shock. What intensity and location can be expected for aftershock in relation to the major shock? What potential effect will it have on structures already weakened?

- **Property damage factors.** California has established property damage estimates for various construction and content classes. Assuming these estimates are correct, how do other factors (such as combustible loading, hazardous occupancies, outside exposures, *e.g.*, flammable liquid tanks, elevated tanks, irregular shaped or closely adjoining buildings, *etc.*) adjacent to a site affect that estimated loss? What is the potential damage from a vapor cloud explosion at a chemical plant? Should a uniform system be established in other countries around the world?

- **Time-element loss.** A factor is needed to identify potential delays in resumption of commercial operations. There is no question that the life safety and health aspects must receive first priority, but prompt restoration of business is also essential.

- **Environmental impact.** Given the fact that an earthquake will occur and with the current emphasis on the environment, what effects will potential contamination or land deformation have, and who will be responsible for paying for the cleanup or restoration? Can it all be cleaned up or restored?

- **Earthquake vs. other perils.** Even if earthquake coverage is not provided, there will be fires, sprinkler leakage, collapse, contamination, *etc.* What political and legal ramifications should be expected as they relate to payments for damage resulting from earthquake involving other perils, particularly on locations that did not have earthquake coverage?

- **Site-specific analysis.** More information is needed to properly evaluate a particular location than can be gathered without an actual visit. Can analysis be made for such things as soil condition, landslide potential, land use (commercial and residential), predominant wind conditions, *etc.*, from appropriate map data? IRI is unique in that we survey every site on the basis that the more we know about it, the better we understand the earthquake potential.

These major questions are of concern to us, and we believe that general consensus is needed in these areas to properly prepare for a potential disaster.

THE POTENTIAL FOR FINANCIAL LOSSES

DARRELL W. EHLERT
Allstate Insurance

The goals of this meeting are both worthwhile and timely. As a member of an earthquake project committee, I can tell you that we feel that a large earthquake will be devastating. Although we know it, it is difficult to convince policymakers, including those in Congress, that we need to prepare for a cataclysmic event in more ways than loss mitigation. It is also necessary to deal in greater depth with the theory of what causes earthquakes and where ground displacements are likely to occur. Very little has been done to measure accurately the after-effects of a major event on people, property, and the economy; and this knowledge is lacking worldwide. I hope that this briefing session will increase our awareness of the need to make adequate preparations for loss mitigation and financial recovery.

Quite frankly, I have no desire to sell earthquake insurance in any great volume. To me as well as to many others in our industry, the hazard is considered to be uninsurable in light of the uncertainties that surround earthquakes. Yet, people who live in seismic zones and are generally aware of the potential for loss tend to buy insurance. Those who feel that they are not in a risk area do not buy it.

Some of the unknown factors in determining an appropriate level of risk assumption are: *Where will the earthquakes occur? How often? How intense will be the resulting damage and how widespread?* Even if these questions could be answered properly, earthquake insurance has additional problems that are not even related to the quaking.

Some of these problems are financial. Insurance companies are not allowed by IRS rules to set up reserves for things that have not yet happened. This makes it difficult for the insurance industry to prepare for future earthquakes even though we know they are going to occur every 100 or 150 years. Furthermore, if a company should set up a fund out of profits earned, and the fund began to grow and the surplus became large, the company would get into trouble with regulators and stockholders. As can be seen, it is difficult to establish a fund of any kind to pay for long-term events.

If insurance companies could offer full earthquake coverage, secondary problems -- not directly resulting from the shaking and, thus, not covered -- would still exist. There are, for example, three levels of loss not related to shaking. The first level comprises the injuries and deaths covered under workers compensation insurance for workers injured on the job as a result of damages to structures, and the losses from fires that follow a great earthquake. Most of the damage from the 1906 San Francisco earthquake was caused by the fires that followed it.

The second level of losses involves liability. In this age of entitlement, the insurance business can expect a rash of liability claims in negligence actions for uninsured damages. Some of the things scientists and engineers are doing contribute to that eventuality. New ways to protect buildings from earthquakes are constantly being identified; but 20-year-old buildings do not meet those standards. An earthquake today equals municipal liability. Some of the charges that will be made in legal actions are *You didn't make the contractor follow the state-of-the-art building codes* or, *You allowed me to work in an unsafe building* or, *You read the literature and you knew that if an earthquake came I* *would get hurt*. People will be suing everyone in sight. Even if the insurance industry should win some of the suits, the costs of defending them would be enormous.

The third element of loss is mental anguish, which goes beyond the damage to people and property.

A great earthquake is going to affect municipal buildings -- schools, dams, bridges -- all the things that cities issue bonds to cover. Insurance companies, especially casualty companies, are the largest investors in municipal bonds. Allstate has $750 million in municipal bonds in California alone. We believe that some of those bonds would go into default after a major event, at least if the area around the city were destroyed to the extent that people couldn't pay their taxes. Furthermore, severe losses to the insurance companies could result in their having to liquidate assets to cover their losses. If insurance companies should liquidate, bond prices would go down and investors would incur capital losses.

In addition to the direct losses, business in the area would be disrupted. People couldn't work, businesses couldn't open, payrolls would not be met, and people couldn't pay their insurance premiums. Banks also might be affected and become unable to move funds around. These kinds of disruptions would put other businesses out of business and the insurance companies would have to pay not only for business interruptions, but also for living expenses of homeowners.

We have tried to estimate losses in an attempt to project the full extent of potential damage to commercial and residential property, but that is only one element of the total insurance problem. We had Dames and Moore make a study of fire following earthquakes. They found that fire losses as great as three and one-half times the shake damage losses, depending on the wind conditions. Beyond these models, experts that help us project losses come up with frightening numbers. Losses could reach $50 to $60 billion from a M=8.5 event on the northern San Andreas fault. We believe such an occurrence would affect the rest of the country because many insurance companies will be forced out of business in terms of an inability to write new policies. This will cause an insurance crises in the rest of the country unless the government steps in and does something about it.

As we talk about these numbers, we are aware that it is "Sunday supplement stuff" that generally is not credible to the lay public. We need the help of engineers and, specifically, the USGS in convincing policymakers that we are serious. We need to balance this against the danger that we may go too far and convince people too much. If that should happen, panic may result. People then will want more earthquake insurance than we can justify writing.

In summary, we will have problems dealing with a very large earthquake. We hope that this meeting and the resulting networking will produce some effects to allow us to work together with you not only to alleviate the damaging effects of a disaster, but also to find a better way for us to prepare financially.

MOBILIZING UNDERWRITERS' CONFIDENCE AND CAPACITY THROUGH USABLE INFORMATION

EDWIN A. SIMNER
Merrett Group
Lloyds, London

To put my remarks in perspective, let me begin with a few words about Lloyds. The company comprises 300 individually competing insurance units; consequently, none of us speaks for "Lloyds." I am speaking as a reinsurer -- one step removed from the gathering of information -- involved with one of my country's few natural disasters. It happened last October in California. We in the United Kingdom are expected to pay $1,100,000 in losses.

Seismologists, structural engineers, and related professionals are currently able to provide useful data and to design useful earthquake-resistant buildings with increasing confidence as their composite understanding advances.

An earthquake is a complex phenomenon involving a high level of interrelated, scientifically based analysis, and is measured over a long time frame. There are few realistic expectations at present that scientists will be able to predict earthquakes within a useful, short span of time.

Insurance, on the other hand, is essentially a short-term activity that expects fairly immediate potential gains or potential losses, and uses simplified, low-level, pragmatic approaches to satisfy the needs of investors.

This dichotomy is not entirely negative.

Earthquake scientists and engineers are looking for commercially recognized benefits of their apparently esoteric knowledge. Insurers and reinsurers are looking for risks to insure which can be measured according to their pragmatic standards and which give them confidence. Investors, corporate and governmental, are looking for investments with the pure risks (*i.e.*, the non-trading risks) adequately secured.

The missing linkage to satisfy all three is the transferral of existing knowledge in a usable form. The key words are **Transfer, Existing**, and **Usable**.

Transfer -- This requires recognition of the importance of consistent presentation of scientifically derived information. It also requires a compromise in accepting that not all end users, including underwriters and reinsurance underwriters, are able to absorb information in its pure scientific form. But - and this is an important "but" - it does not imply that scientific disciplines need to be compromised; rather, it implies that the information needs to be communicated at several levels to satisfy the several levels of ability in the audience to absorb and to use the information.

Existing -- This requires recognition that the problems of time prediction, site-specific prediction, and the prediction of magnitude cannot currently be presented as an elegant equation susceptible to a single precise solution. What is known already is useful. It may not be all-encompassing, but that is not sufficient reason for non-scientists to dismiss its usefulness.

Useable -- This emphasizes the importance of transferring the existing knowledge in a format in which it is useful to insurers and investors.

Focusing on the concepts in those three key words results in a crucial component of the earthquake reinsurance business: **Confidence.**

Confidence is needed at several levels: (1) by scientists to ensure that their work will be used in a realistic way; (2) by investors so that their exposure is limited to the pure investment/trading risk with which they can deal; (3) by insurers to increase the chances that their premiums are adequate in relation to the exposure of their financial capacity.

I would like now to share with you some parochial observations from an underwriter at Lloyds.

(SLIDE, underwriting concepts: building factors + site factors = damage potential.) In determining damage potential, reinsurers need to know a number of things about site factors. What is the capacity of the plant? What kind of stock is stored there? What types of non-structural damage might occur? In other words, the reinsurer needs to have information on which to project the possibility of fire, or to understand the load of the structure in relationship to its design. The reinsurer needs to estimate the effectiveness of emergency response measures. What are the condition and capacity of the water utility's equipment? Will there be available manpower for response efforts? How will communications be controlled? How will response efforts be made more difficult by event size, conflagration potential, or weather conditions? The answers to these questions are generally known by someone, somewhere, and we need a way for those answers to be known by the reinsurer.

Insurance is a competitive industry, the essence of which is to spread the risk, and each underwriter is subject to the commercial pressures of the industry. The confidence to insure a risk is generated by reinsurers. This must be so because reinsurers are asked to write earthquake insurance with only the most trivial of information. For example, I have all too frequently refused to provide reinsurance because the broker presenting the request could not or would not give me fundamental information. For example, in response to my question *Where is the risk located?* the response was not "Newport," "Santa Barbara," or "Los Angeles." The broker thought it sufficient to merely say that it was in California. Surely, someone, somewhere must have known the location of risk. Why couldn't I know?

Another critical item of information for the reinsurer is the age of the building, which must be known for us to determine the likelihood of compliance with reasonable earthquake-resistant building codes. Someone, somewhere, knows whether the building is 5, 10, 15, or 50 years old, and we should have that information, too.

The height of the building and its construction details are other elements of knowledge the reinsurer needs. The details include such things as shape, distance from faults, and location with respect to major damage zones. Is the building under discussion a one-story, wood-frame building, or is it a tall, unreinforced masonry structure? Do we need to worry about high-frequency/short period or low-frequency/long period types of exposure? Again, someone, somewhere must know the answer to these questions.

The geology of the area also is important. Given the time, I would be able to discover a great deal of information about the subsoil, history, repeat periods, and local building codes in a risk area. We do not have this time, however; we are most frequently expected to make decisions within a very limited time scale. We must, therefore, look to the scientists and engineers to provide us with geological information, and we need this information in an accessible place. The scientists have it, and we should have it, too.

(Slides:
1. Giving some headings of information needed by reinsurers;
2. Giving more information which an individual underwriter needs (Building factors, construction type, height).
3. Damage potential information needed.
4. Geology.
5. Minimum information: Location, site soil type, building classification, height, age.)

At the risk of suggesting that I am in the minority, I do believe there are too many insurers prepared to accept the lack of fundamental information. The information we need is simple -- but not trivial. Yet it is often not available to the underwriter or, perhaps more specifically, to the international underwriter who, as part of the worldwide insurance network, provides the fundamental capacity to insure large risks. The direct, immediate insurer whose offices are located, for example, in the state of California enjoys the option of sending his engineer specialist to the site to evaluate that specific address. That insurer, however, is unlikely to be able to provide anything approaching the required total capacity for insurance.

My belief is that a latent capacity to insure against earthquake risk exists in the world's insurance markets. If we are unable to obtain fundamental, simple information about risks we are asked to insure in a sophisticated environment such as California, how much more unlikely is our chance of obtaining that information in Third World countries? The capacity that exists needs to be mobilized by developing the confidence of underwriters. That confidence, expressed partly by the transfer of usable information, will result in increased capacity.

I wish the WWERM initiative the very best of luck in its efforts to help with the problems of risk assessment and information transfer.

(p. 27 follows)

SESSION I -- Q & A

Q (John Wiggins.) I would like the panelists to discuss the difference between risk in the United States, which includes liability and environmental problems, and the Third World countries and other countries where these kinds of losses may or may not be important. In other words, discuss the differences between a sophisticated and non-sophisticated country.

A (Darrell Ehlert.) The difference between Third World countries and the United States on the subject of insurance is that insurance is much more utilized here in the United States than in most other countries. As highly industrialized as is the United States, however, only about 20 percent of the potential earthquake losses are covered by insurance. In many other countries it is probably close to nothing. In Mexico, there was quite a bit of insurance, primarily on commercial structures such as the apartments that tilted. Where there was insurance, there was recovery; but we have a long way to go before the level of coverage is really sufficient.

A (E.A. Simner.) It is strange that in the Third World, countries with a seismic problem tend to have earthquake insurance coverage thrown in automatically and apparently for free. It is a dichotomy. Earthquakes in the Third World generally are not quite the problem they are, for example, in California, but we need to not give away coverage in one area and appear to shed crocodile tears in another area where an event occurs and no coverage was applicable.

(p. 29 follows)

CLOSING COMMENTS

KARL V. STEINBRUGGE
Consultant
Moderator, Session I

Thank you for your well expressed views on some of the many scientific, engineering, business, and other problems -- all of which are interrelated to varying degrees.

Speaking from my own background in engineering, the multitudes of papers and reports addressing individual aspects of specific problems in my limited areas of interest become almost overwhelming.

To an insurance person viewing this diverse research, and often not having the time or understanding to digest this information, some sort of a synthesis process is desirable. A somewhat parallel situation exists with earthquake prediction. Disaster response agencies have available the findings of prediction validation councils. Perhaps there should be some entity which provides counterpart loss-estimation synthesis for the financial community, including insurance, banking, and other financial institutions.

(p. 31 follows)

Tuesday, March 8, 1988

SESSION II

THE GLOBAL EARTHQUAKE THREAT TO NEW AND EXISTING FINANCIAL INVESTMENT AND DEVELOPMENT PROGRAMS

Moderator	Dwight A. Ink, U.S. Agency for International Development
Objective	Provide an overview of the earthquake threat as it relates to investment and development programs throughout the world.
Panel Discussion	A look at the earthquake threat and investment and development programs throughout the world

OPENING REMARKS

DWIGHT A. INK
U.S. Agency for International Development and
Moderator, Session II

I have been struck by the extent to which we fail to use information already available to us dealing with earthquakes and economic investment in seismically active areas. We have much information about the impact of foreign aid and economic development assistance, but we have had difficulty in reconciling these bodies of knowledge.

Few of us realize how devastating earthquakes can be in developing countries. It is hard to imagine the damage that would occur from an 8.5 Richter magnitude event. Ecuador and El Salvador both have had events of this strength this past year. A proportionate blow to the U.S. economy could conceivably leave us facing devastation amounting to $40 to $60 billion each. We have never experienced anything approaching that in the history of this country, so we cannot imagine that this level of impact occurs in other countries. Yet, we have investments in those countries.

The theme of this conference is pertinent to the investment problem and to the extent to which we probably do, but should not, ignore the seismic risk in countries where our dollars are invested. The planning process in every country should include information about the potential risk to investments being made in earthquake-prone zones.

Finally, we need to ask ourselves, *What steps can a donor nation take and how much impact can it have through economic assistance projects in alleviating this problem?*

The panel will deal with this question.

(p. 35 follows)

THE NATURE OF THE GLOBAL EARTHQUAKE RISK PROBLEM

S.T. ALGERMISSEN
U.S. Geological Survey

Earthquakes have been recognized as threats to life and property since the beginning of civilization, but the magnitude of the earthquake problem is not widely appreciated. Consider that during the past twenty years, at least 300,000 deaths have resulted from earthquakes. Worldwide monetary losses for the same time period are not well known, but they clearly have totalled many billions of dollars. For example, the recent (1985) major earthquakes that affected Mexico City resulted in primary losses to buildings of at least the order of $4.0 billion and 8,000 fatalities. Additional losses resulting from disruption of the economy, loss of function, etc., are not known but these additional losses must be large. Both earthquakes (M_S=8.1 on September 19, and the M_S=7.3 aftershock on September 20) that caused the losses were located off the west coast of Mexico, about 400 kilometers from Mexico City.

It is interesting to contrast the earthquake that affected Mexico City with the 1972 shock that essentially destroyed the central area of Managua, Nicaragua. The Managua earthquake was of moderate magnitude (M_S=6.4) and occurred at shallow depth beneath the city. Life loss has been estimated at about 9,000-10,000 with primary losses to structures of about $850 million (in 1972 dollars). Thus, we have two recent earthquakes of very different types that caused similar serious losses to major urban centers and had very adverse affects on the economies of the two countries. The important generalization is that in a variety of seismotectonic environments, earthquakes over a wide range of magnitudes and over a considerable range of distances are capable of causing catastrophic damage. Significant life loss and property damage are possible not only in the vicinity of a great earthquake, but also at great distances from these earthquakes at sites characterized by poor ground conditions and the presence of multi-story structures. The existence of such sites thus amplifies the hazard due to great earthquakes.

Furthermore, significant life loss and property damage also are possible with much smaller earthquakes when they occur near a city. Such earthquakes may be at least an order of magnitude more likely to occur than great earthquakes, and the smaller ones make the dominating contribution to long-term average loss.

What earthquake effects cause economic loss and casualties? Ground motion is the primary cause of losses because damaging ground motion can be transmitted great distances (as in the case of Mexico City), and may trigger geological effects that result in substantial additional losses. Common geological effects caused by strong ground-shaking are landsliding and liquefaction, a type of soil failure. An example of a major landslide triggered by earthquake ground motion is the landslide that buried Yungay, Peru, during the 1970 (M_S=7.8) earthquake off the coast of Peru, and resulted in about 15,000 deaths in the village. Soil liquefaction caused major economic losses at Niigata, Japan as a result of the 1964 (M_S=7.5) earthquake.

A second cause of losses, less important but often spectacular, is surface fault displacement. Losses associated with fault displacement at the surface are limited because many damaging earthquakes worldwide do not have associated surface ruptures.

In any event, the area that can be affected by surface rupture is limited. Seismic sea waves, or tsunamis, generated by earthquakes are also an important cause of losses.

What practical methods are available to limit future losses from earthquakes worldwide? Reducing losses requires a global assessment of earthquake hazards and risks. "Hazard" is taken to mean the phenomena associated with earthquakes that create the potential for loss (risk). A hazard assessment is required for *any* assessment of risk; however, hazard assessments can be used directly to limit future losses through land-use planning and the specification of ground motion levels for building design and building codes.

Deterministic and probabilistic techniques are available to estimate the earthquake hazard. Probabilistic techniques have an advantage in that they provide a more objective comparison of seismic hazard (and ultimately of risk) at a number of locations. A considerable amount of work has gone into the assessment of seismic hazards on a global basis, and the seismological and geological data exist for a rational, integrated global assessment of earthquake hazard. Available methods of risk assessment are more controversial, but current research will lead to global risk assessments that will prove to be a critical element in earthquake disaster mitigation and in global investment planning.

Is global earthquake risk increasing? There is no question that it is increasing. While there is no reliable scientific evidence to suggest any long-term increase or decrease in global earthquake activity, other factors have increased the seismic risk. The press of population expansion has led to the development of sites that are undesirable for development from the earthquake hazard point of view. The increased use of multi-story structures causes an ever-growing portion of the built environment to be susceptible to damage from earthquakes at great distances. Thus, the need for global earthquake hazard and risk assessment is urgent to assure that consideration is given to the best sites for future major economic development, or, if a poorer site must be used, that the designs of structures are adequate to resist earthquake ground motion.

Until global earthquake hazard and risk assessments are available and applied to a wide range of land-use planning and building design and investment strategies, earthquake-related life and property losses will continue to rise.

In looking at some representative earthquake losses and reviewing some of the phenomena associated with those losses, it becomes clear that earthquakes are not simple. How well we understand their complexity, will govern our success in mitigating their effects.

(Slide: fatalities, losses in billions of 1986 dollars.) Because earthquake effects are complex, we are not doing a very good job of identifying catastrophe potential. If we were, losses from past events would not have been so great. It is a measure of our lack of understanding of effects, and a lack of application of what we do know about earthquakes, that levels of losses incurred globally have been so high.

(Slide.) Some of the earthquake effects that cause losses are surface fault displacement, ground motion (including landslides and soil liquefaction), and tsunamis. Only a small fraction of the world's great earthquakes produce tsunamis, however.

(Slide.) This depicts fault offset in an orange grove in southern California, and illustrates that although fault breaks may result in important losses, fault breaks are not as important as ground shaking because the surface faulting area is always small.

(Slide.) In Japan in the 1960s, there was extensive soil liquefaction which resulted in large losses.

(Slide.) This very famous landslide in Peru in 1970 originated in the high Andes. Rock and snow fell 3,000 meters and generated enough slush to bury about 15,000 people. This is a true catastrophe. A measure of success of this program will be whether we can learn to identify the potential sources of this level of catastrophe.

(Slide.) This is a location map that shows where the Mexico earthquake hit. Considerable loss of life occurred at a considerable distance from the earthquake.

(Slide.) One thing I didn't talk about was regional deformation in Alaska, where there was an uplift as great as eight meters and subsidence perhaps as great as two meters. Of course, for coastal facilities and maritime countries, submergence by two meters is fairly significant. We can expect these sorts of things to happen again in great earthquakes throughout the world.

(Slide.) There was a maximum uplift of the order of eight meters around Montague Island, Alaska.

(Slide.) This is the setting of the 1960 earthquake in southern Chile, where an area of the order of 1,000 kilometers in length was uplifted or subsided. Had it occurred in central Chile, it would have been a greater disaster. Nevertheless, it was an important effect of the earthquake. Like that in Managua, the Chile earthquake had political and economic implications for the country as a whole.

(Slide.) This is a cross section indicating the nature of the subsidence.

(Slide) We know about the tremendous loss of life and facilities in the Mexico City earthquake in 1985. Two important points should be made about those earthquakes. First, they were a long way from Mexico City -- about 400 kilometers. Some observers say that will not happen anywhere else, but I think it is quite possible. The nature of the phenomenon is very similar to others, and we have to plan for future, similar events.

(Slide of pancaked building in Mexico)

(Slide.) This is Bucharest, Rumania, after the 1977 earthquake that occurred 150 kilometers from Bucharest, but which was smaller than the Mexico City earthquake. Side effects are visible in many locations, as can be seen in this building which was shaken badly and was subjected to soil liquefaction.

(Slide.) This is another building in Bucharest, which housed an important computer center. The center and the building were lost.

(Slide) This is Lago de Managua. Modern earthquakes can cause a great deal of damage if they occur at the right place. Central Managua was destroyed and has not been rebuilt fully. For comparison, the San Salvador earthquake was much small (M=5.5).

(Slide of Managua)

(Slide.) With this type of construction, there will be loss of life.

(Slide.) We have addressed the problem in two ways: Disaster Preparedness; and Disaster Mitigation. Techniques to deal with preparedness are: Scenario (deterministic) simulation of the effects of specific earthquakes; risk (loss) assessment of catastrophic events; preparedness planning; and assessment of catastrophe potential. In working with disaster mitigation, we conduct probabilistic hazard assessments, and associate them with global earthquake mitigation activities.

EARTHQUAKE THREAT AND DEVELOPMENT PROGRAMS

ALCIRA KREIMER
Urban Planner
The World Bank

I would like to address two interrelated aspects of reducing the earthquake threat in the context of earthquakes and development. These aspects are:

1. Disaster mitigation and prevention; and

2. Reconstruction after earthquakes.

I will address reconstruction first, since reconstruction programs have been used as catalysts, or "windows of opportunity," for introducing concerns about earthquake risk reduction and prevention.

Reconstruction

Programs. The World Bank has participated in a number of reconstruction programs as a response to devastation brought about by a range of natural disasters. In total, seventy projects were undertaken for the period 1970-1980, with an average of three projects per year in response to floods, hurricanes, volcanic eruptions, and cyclones. In the specific case of earthquakes, during the period 1970-1988, the World Bank participated in reconstruction activities in Ecuador, El Salvador, Chile, Mexico, Colombia (Popayan), Yugoslavia (Montenegro), Rumania, and Guatemala.

In all the cases mentioned, governments in the affected countries were faced with devastation of staggering magnitude, and needed to respond quickly and decisively. Events of such large magnitude are unusual, so they presented the authorities with a number of difficulties in accommodating the overwhelming demands of the situations. Rapid action was required particularly in the areas of major social and economic need such as housing, health, roads, water, education, and production. Speed was needed not only in relief activities, but also to facilitate the resumption of normal life after the events and to address problems which normally surface immediately after catastrophes and can compound losses. These problems include uncertainties concerning delineation of risk areas; measures to reduce vulnerability; inflation; speculation with the prices of building materials, land, primary need products, moving services, and housing.

Reconstruction after all the earthquakes mentioned above was a challenge of vast dimensions to each affected country. It required the simultaneous management of immediate needs, rapid identification of alternatives and tradeoffs in selecting appropriate rehabilitation strategies, and balancing reconstruction needs with ongoing development projects.

The types of reconstruction programs that were financed by The World Bank included: (1) the one in Yugoslavia, where the objectives were to restore railways and ports and to provide building materials in Montenegro; and (2) the program in Popayan, Colombia, which focused on restoring the basic infrastructure and community facilities, and assisting in the reconstruction of essential public facilities. A reconstruction program currently underway in Mexico addresses housing, community facilities, schools, hospitals and markets, demolition of damaged buildings, and institutional support. In general, reconstruction needs were identified by the local authorities for international financing in different sectors -- urban and rural infrastructure, housing, education, agriculture, industry, power and transport.

Since 1983, a number of concerted efforts by The World Bank have been geared to addressing in a comprehensive fashion the multi-sectoral nature of the losses and to integrating concerns about reducing vulnerability. Thus, while earlier projects sometimes addressed sectoral and discrete needs, such as roads or railways, recent programs have focused mainly on an integrated approach, with substantial emphasis on the institutional aspects of reconstruction. The latter has involved strengthening institutions and coordinating across sectors among implementing agencies. Reconstruction efforts have been placed within each country's development goals at the local, regional, or national level. Reconstruction programs have been defined to consider baseline and pre-disaster information and the assessment of damage and needs conducted immediately after the events. Particular consideration has been given to: (1) the scope of reconstruction; (2) the realistic scaling, scheduling, and phasing of activities; (3) availability of manpower and materials; (4) appropriateness of tasks within the country's institutional framework; (5) economic and financial aspects; and (6) implementation requirements.

Reduction of vulnerability. An important component of the reconstruction programs implemented in the last few years has been the development of measures to reduce vulnerability to disasters. For example, in Mexico the reconstruction program is financing:

- o studies of the administrative, management, and technical experience gained by Popular Housing Reconstruction, the agency in charge of rebuilding 44,000 low-income housing units in densely populated areas in the Federal District;
- o studies for the retrofitting of school buildings;
- o studies required for demolition assessment;
- o studies of soils and subsoils for the development of microzoning regulations;
- o a training program to address the needs of the engineering and architecture professions, including construction supervisors and workers; and
- o 39 studies being coordinated by the Secretary of Finance and the National Council for Science and Technology, which include studies:
  - to define seismic risk
  - of the behavior of structures and foundations
  - of construction materials and building codes and standards.

Coordination and Institutional Organization. In reconstruction, given the large number of sectors and agencies involved, efficient cross-sectoral coordination is critical. This involves:

1. Coordinating different programs and activities included in disaster prevention and reconstruction efforts;

2. Assisting the involved agencies in ensuring the integration of disaster prevention into

overall national economic policies, and the compatibility of reconstruction programs with those economic policies;

3. Advising and supporting the implementing agencies in the identification, preparation, presentation, and execution of projects;

4. Supervising the implementation of programs; and

5. Monitoring and evaluating the completion of tasks in each sector.

Disaster Mitigation and Risk Reduction

A main issue that has achieved recognition as a key aspect of disaster response in developing countries is the importance of an appropriate understanding of development strategies that would promote an optimal utilization of resources while reducing the disruptive impact of disasters. There is, however, a tendency on the part of many governments and populations in disaster-prone countries to resist discussion of potential natural disasters or to allocate more than minimal resources to disaster prevention and preparedness. In certain situations, the relative infrequency of disasters provides convenient grounds for ignoring disaster planning. Investment in disaster prevention and mitigation tends to be viewed as a low-priority part of development programs rather than as an integral component of planning and program development. When confronted with major devastation, such as the events that occurred recently in Latin America, *e.g.*, the earthquakes in Mexico, Ecuador, El Salvador, and Colombia, the main lessons learned are: (1) that risk reduction, disaster prevention, and preparedness are essential components of development; and (2) that well-guided efforts in reconstruction would contribute to the achievement of rehabilitation goals and to the protection of new investments.

Conclusion

The experiences reviewed stress: (1) that reconstruction programs can and should be used as catalysts to develop and implement measures to reduce vulnerability and to mitigate impacts of potential future events; and (2) that disaster vulnerability should be considered in planning new development and in managing, administering, and upgrading existing projects.

The current increased awareness of earthquake risk is encouraging. The study and coordinated action this issue is receiving on the part of both governments in disaster-prone countries and the international community are auspicious. The United Nations' International Decade for Natural Disaster Reduction and the WWERM program initiative by the USAID's Office of U.S. Foreign Disaster Assistance and the U.S. Geological Survey are key activities in this convergence.

(p.43 follows)

REGIONAL DEVELOPMENT: INCORPORATING NATURAL HAZARD MANAGEMENT ISSUES INTO RESPONSE AND RECOVERY PROGRAMS AND PROJECTS

KIRK P. RODGERS
Director
Department of Regional Development
Organization of American States (OAS)

The 1972 Declaration of the United Nations Conference on the Human Environment states:

> *Environmental deficiencies generated by the conditions of under-development and natural disasters pose grave problems and can best be remedied by accelerated development through the transfer of financial and technological assistance as a supplement to the domestic effort of the developing countries* (Principle 9).

It can be argued that such assistance has taken place in the intervening years. The recognition, however, of the relationship between natural hazards and development has not been fully understood, and much development assistance has ignored disaster mitigation.

Specialized conferences have been held on desertification, water, human settlements, *etc.*, and point to the relationship between development and increased disaster vulnerability, particularly of the poor. This increased vulnerability is due in large part, to environmental degradations brought about by development programs.

Planning institutions and regulations governing development should encourage disaster mitigation measures so that infrastructures and people are less vulnerable to natural hazards. But in developing countries, the institutions and public policy mechanisms that would be responsible are often times ineffective. It is in areas such as this where the role of international development assistance agencies can be of critical importance. How, therefore, can the activities of such agencies be most effectively deployed in order to minimize economic and social costs of recurrent natural disasters, particularly in relation to investment projects?

Principles of environmental planning and management should be used in preparing efficient regional development plans and projects. The argument is that by making the best use of natural hazard assessments undertaken at early stages of regional planning, the process of including natural hazard mitigation measures into investment projects is less costly. On the other hand, modifying a project to protect it from a hazard or repairing it after damage has been sustained is often more expensive.

The Department of Regional Development of the OAS is addressing the opportunities and constraints for incorporating natural hazard assessment and mitigation measures into development project preparation and implementation through direct technical assistance, training, and applied research in conjunction with OAS members states. The linkages between natural resource utilization and natural hazards are being emphasized, policies and programs governing the use of natural hazard risk assessment and mitigation information in project planning cycles are being formulated and instituted, and specific proposals for actions are being discussed with members states and corresponding national and international agencies.

The above generalities about the issues surrounding disasters in an international context set the stage for several important, specific points.

- Natural disasters are on the increase worldwide, without qualification. The damage they cause is increasing geometrically in the case of earthquakes.

- The number of people affected is increasing faster than population growth.

- The poorest people are those most affected by disasters, a conclusion that can be drawn from analysis of the facts.

- Misuse of natural resources is a major causal factor in the increase of natural disasters, including floods, landslides, and drought. In fact, landslides following earthquakes are considered in some cases to be caused by poor resource management.

- Unwise development is a major factor in damage from disasters. Planners, developers, and investors especially must look carefully in the mirror to find the sources of development situations that will result in future disasters.

There are three things that can be done to improve the *status quo.*

1. Planners need to "get upstream" in the process of development planning. Too often, the difficulties involved in good resource management are confronted only after a disaster has occurred. One hears many "I told you so" statements; yet, the capacity to repeat the mistakes seems limitless.

2. Development planning should, in current jargon, be multi-sectoral. At the OAS, multi-sectoral development planning is called "regional development." By whatever name, it is a significant tool in designing better investment projects that are economically and environmentally sound, and are subject to less risk from natural disasters.

3. Natural hazard information can be better integrated into development planning. This is a significant method for reducing damage from natural disasters. Presenters at this meeting have spoken about the large amount of scientific and engineering data that is not used by the non-scientific community of disaster professionals. This lack of use of available information underscores the need not for collecting additional material, but of translating that which exists into laymen's language.

The OAS involvement in regional development is to assist countries in the Americas and Caribbean in planning and formulating specific investment projects. Its work over a 15-year period was analyzed. Findings show that the OAS had assisted with projects in operation or in advanced stages of planning having support totaling $4 billion. Many of the international banks had financed projects which the OAS had assisted in developing. It uses an integrated approach, focusing on specific areas or regions, states, or provinces either along border areas or between two or more countries separated by some distance.

The OAS addresses spatial planning concepts, land-use management knowledge, and potential risks in formulating disaster projects that are funded by many multilateral banks.

OAS, with the help of USAID, has developed *Integrated Regional Development Planning*, a set of guidelines and case studies in Latin America and the Caribbean. This exercise was conducted to identify, catalogue, and correct development planning situations that can be improved with new knowledge or by applying existing knowledge. One lesson from developing the guidelines is that when disasters occur, they frequently serve as catalysts to promote integrated approaches to development planning. The question that remains is whether, if integrated planning had been done in the first place, the disaster would have been as devastating. For example, one questions whether so much damage would have occurred in Mexico City if more existing scientific and technical knowledge had been applied in construction practices.

One of the advantage of "getting upstream," or giving early consideration to disaster risks in development planning, is that alternatives can be considered. A specific case regards the pipeline across the Andes in Ecuador. If a careful analysis had been made early in the process of planning for the pipeline, an alternative route may have been selected where the risks of landslides triggered by earthquakes would have been lower. In any event, had alternatives been considered and accepted, less damage would have resulted.

Realities that must be faced in financing any project are those of local political and economic concern. For example, it is counterproductive to try to tell the president of a country not to locate a dam at a particular site when the planning is completed, the architectural drawings are done, and the bank loan is pending. At that point, the president may have his political neck on the line, making the possibility of moving the dam somewhat dim indeed. Funding agencies must be sensitive to the hot spots on which their country colleagues sit; but they can help to eliminate such situations by making it possible to consider alternatives earlier.

Since 1984, the OAS has collaborated with USAID/OFDA on research in Latin America and the Caribbean to do what is discussed above: incorporate disaster management into planning. The studies concentrate on two major issues:

1. The use of hazard management information to promote reduction of disaster vulnerability; and

2. The shared use of natural hazard resource infrastructure and demographic information in mitigation and preparedness activities. This involves mapping, some of which is computer-assisted. The insurance industry, for one example, could be interested in the products from this activity because map information is portrayed in simple, laymen's language, but with sufficient detail to locate projects and relate data with facilities. The research has two sub-projects:

   - Natural hazard information management for disaster preparedness in metropolitan areas of Latin America; and

   - Natural hazard assessment for reduction of vulnerability in the Caribbean Basin.

The success of the project is illustrated by renewed stress on the education of development project designers, and the creation of a training course on the use of natural hazards information. This training course has received a great deal of attention in the Americas and can be applicable elsewhere.

In conclusion, the farsightedness of USAID and OFDA in launching and maintaining the joint research effort is contributing to substantial assistance to development planning in the Americas, and the OAS encourages its replication in other areas of the world.

EARTHQUAKE HAZARD REDUCTION PROGRAM OF THE DEPARTMENT OF STATE

PETER E. GURVIN
Chief, Civil Structural Engineering,
Office of Foreign Buildings
U.S. Department of State

My talk is more esoteric than others you will hear because I speak from the perspective of the Department of State, which owns or leases a large number of buildings throughout the world, some of which are located in areas of high seismic risk. The Department has initiated a seismic hazard reduction program to upgrade the seismic resistance of our buildings through either replacement or retrofit.

(Slide, Office of Foreign Buildings.) The Office of Foreign Buildings Operations (FBO) of the Department of State was created by the Foreign Service Buildings Act of 1926, and is responsible for the design, construction, acquisition, and maintenance of our diplomatic and consular facilities overseas.

Perhaps the most significant aspect of the Department's facility posture is the sheer magnitude of its assets. They total nearly 7,500 buildings in 256 cities in the world. The facilities are worth $10 billion.

(Slide.) Examples of properties we own range from the USIA building in Paris on the Place de Concorde, built in 1759, and located on the Champs Elysee, to the (Slide) American Embassy in New Delhi. That Embassy was designed by Durrell Stone, who also designed the Kennedy Center.

(Slide.) The staff housing in Yemen is another example of the types of buildings with which we deal.

(Slide.) The 1972 earthquake in Managua destroyed the American Embassy. We constructed another building, which is sometimes used for target practice.

(Slide.) The USIA building in Mexico City itself withstood the 1985 earthquake well, but was damaged by the building next door bumping into it.

(Slide.) Another building in Mexico City was our U.S. Department of State Trade Center. The building next door is out of tilt by about 5 degrees toward our building, which is still unoccupied because of the hazard posed by the unsafe adjacent building. Plans are underway to try to straighten the tilted structure, but many engineers question whether it can be done.

(Slide, American Embassy, San Salvador.) As a result of the San Salvador earthquake, a portion of the mezzanine of the American Embassy was damaged by the failure of columns on two sides of the building. (Slide showing damage.) A study done nine months before the event indicated that the sheer wall construction needed to be upgraded. An engineering study was underway at the time of the earthquake to do the upgrade. A building about three times larger that the current one will be constructed elsewhere in San Salvador.

(Slide.) All buildings for which we are responsible, with few exceptions, are designed by United States firms. Our basic structural design guidance, including earthquake-resistance, conforms to the *Uniform Building Code*. Almost 99 percent of our buildings are constructed of reinforced concrete, so the *American Concrete Institute Standards* also constitute a fundamental reference for design. In addition to United States design standards, the construction plans and specifications have to take into consideration the country where the facilities are to be built, locally available materials and levels of construction expertise, and the construction norms of the country.

(Slide - Embassy in Riyadh).

(Slide.) The Tokyo building had to meet stringent Japanese requirements, so we used a Japanese structural engineering firm. This project of about $70 million sits on real estate that may be the most expensive in the world. The price of property in the area where the Embassy is located is about $150 per square *inch*. By that measure, the land on which our building sits is worth about $3 billion.

The Department of State believes that the intent of the National Earthquake Hazard Reduction Program (NEHRP) should be incorporated into the management of its design and construction program even though the National Earthquake Hazards Reduction Act was directed toward stateside agencies. The initial design parameter for overseas buildings, consequently, calls for the FBO to obtain proper zoning, based on the zones used in the *Uniform building Code*, which are graded from 0 through 4. To enable us to accomplish zoning tasks, FBO contracted with the consulting engineering firms of Woodward-Clyde and Dames & Moore to zone all Foreign Service Posts according to the 1976 *Uniform Building Code* format. This global zoning has proved, first, to be very useful in determining the seismic design requirements for buildings in various cities worldwide. (More in-depth seismic zoning may be accomplished on a case by case basis depending on the size of a project). Second, global zoning provides a basis for preliminary recommendations to reduce the vulnerability to earthquake risk of buildings in FBO's inventory.

(Slide.) In Antigua we will use zone 3. There is very little information there.

(Slide.) We recently completed the Embassy in Lisbon, with global zoning by Woodward-Clyde.

(Slide.) As a result of the studies we have done, our office has recommended total replacement of some buildings such as this one in Caracas, which we found to be structurally deficient.

One difficulty FBO faces is the high cost in its embassy construction program of larger sites with better security needed by the embassies. Since funds are limited, the FBO cannot do everything that is desirable to do. (Slides of the damage from the Beirut and Kuwait bombings of 1983, and the Beirut Chancery annex bombing in East Beirut in 1984.) The reasons why we need better security are demonstrated by the results of the Beirut bombings in 1983 and 1984. These activities had a great impact on our construction program, particularly because 87 people were killed in the tragedies.

A decision was made in our hazard reduction program to concentrate on high-occupancy buildings, which usually are the chanceries and office annexes. Since 1982, our office has received a limited amount of funding for preliminary structural evaluation of these buildings. As a result, our office has assigned priorities for seismic strengthening of some buildings, and made recommendations for total replacement of others. Currently, new embassy office buildings are being designed or are under construction for these locations of high seismicity: Caracas, Dacca, La Paz, Nicosia, Osaka-Kobe, Ottawa, Rangoon, San José and Santiago.

(Slide.) I will leave you today with this image: the Taj Mahal has withstood the test of time. It is not in an earthquake-prone area.

(p. 51 follows)

SESSION II -- CLOSING COMMENTS

DWIGHT A. INK
U.S. Agency for International Development
Moderator, Session II

I have tried to estimate how many investment dollars USAID puts into areas at high risk. My guess, although we have never calculated it, is that our own bureau probably contributed something like $.5 billion dollars last year in developmental work in areas that are clearly high-risk. At least that much again, if not more, was invested by other donors in one year. If these estimates are anywhere near accurate, over a period of about six years the amount of development activity at risk which is directly attributable to donors, not counting the spinoffs from donor investments, is enormous.

In closing, let me note that the private sector has not been mentioned in this panel. The private sector, in my experience, is like the donor in investments; but when seeking contracts for development in high-risk areas, it is unlikely that the private sector can be expected to "buy out." We, as public groups, also tend not to bow out. High risk cannot be the only factor in these decisions, but we generally do not give the weight to potential hazards that we should, and we welcome the emphasis being given here to this program.

If USAID can be helpful in any of the pilot projects in Latin America and the Caribbean we will be happy to do so.

(p. 53 follows)

Tuesday, March 8, 1988

KEYNOTE ADDRESS

by

FRANK PRESS
President
National Academy of Sciences

THE INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION

FRANK PRESS
President
National Academy of Sciences

On behalf of the National Research Council, I welcome you to this important meeting, held at the National Academy of Sciences and which the Academy's Division of Natural Hazard Mitigation is co-sponsoring with the Office of U.S. Foreign Disaster Assistance and the U.S. Geological Survey.

I am delighted to speak to you today about the International Decade for Natural Disaster Reduction. It is a program many of you not only have endorsed, but also on which you have been working very closely with us to make a reality. I would like to give you some background on how the idea evolved, how the United Nations Resolution in support of this International Decade was adopted, and what tasks lie ahead in getting it launched in 1990. Moreover, I want to discuss why I believe each of you should participate in making this important effort a successful reality.

Background

Recent Disasters. Obviously, natural disasters do not observe geographic boundaries. On a global scale, they occur almost daily. In fact, I have to change the events I use as examples every time I give a talk. These disasters affect countries large and small, rich and poor, whatever their political persuasion. Just last month, relentless rains in Rio de Janeiro, Brazil, caused floods and mudslides that struck hill-hugging shantytowns and devastated busy neighborhoods below. They caused nearly 300 deaths, injured more than 700, and left homeless more than 25,000 people. Last New Year's Eve, heavy rains in Hawaii caused that State's worst floods and landslides in the past 25 years. In December 1987, the deadliest tornado in history was avoided by only 1,500 feet in West Memphis, Arkansas. It was closing day at the Southland Dog Track in West Memphis, and the large steel-framed stadium was then packed with 9,000 people. Most of the spectators did not realize that a tornado had passed only 1,500 feet away until long afterward. In July 1987, a devastating tornado struck the city of Edmonton, Alberta, Canada, that caused 27 deaths, hundreds of injuries, and property damage in excess of $250 million. Other recent tragedies include the November 1985 Nevado del Ruiz volcanic eruption in Colombia that took over 22,000 lives, and the September 1985 Mexico earthquakes that claimed at least 10,000 lives and caused economic losses in the billions of dollars. Even the moderate Whittier-Narrows earthquake on October 12, 1987, in California, resulted in property losses exceeding $300 million. The list goes on and on.

Rationale for the IDNDR. I have followed the topic of global hazard reduction for many years now, and have viewed it from many different perspectives: as a seismologist conducting research, as a science advisor to the President of the United States, and in my present position with the National Academy of Sciences. Over time, three basic observations have convinced me that a concerted, international effort to reduce hazard-related losses is indeed a critical world need and a scientific and technical possibility.

The first observation is that international collaboration among scientists is a very powerful tool. This idea is not new; but the notion of scientific cross-pollination and interdependence has assumed increasing importance in light of the common threats to life and property, the economic and environmental health of the planet, and the limited financial resources on which we must draw for increasingly costly research.

At the same time, research on natural hazards is entering a new era characterized by large-scale laboratory test facilities, supercomputers and the complex numerical modelling they allow, sophisticated field experiments, and remote sensing and rapid communication through satellites. All of these trends argue for a more international approach to the science underlying hazard mitigation.

The second observation is that the extent of our ability to monitor, analyze, mitigate the effects of, or intervene in the processes of, natural forces has grown markedly in recent decades. Important advances have occurred in theory and application in almost every field of import to hazard mitigation: meteorology, earth sciences, telecommunications, structural engineering, risk analysis, materials sciences, and the social and economic analyses of the hazard mitigation process. We also have successfully demonstrated that we can use this new understanding to fend off disasters.

The third observation supporting an International Decade is the obvious and pressing need for action to reverse the growing impacts of natural hazards on human society. You are well aware of the terrible toll taken by natural disasters each year. Many of you know from firsthand experience that such disasters, beyond the immediate death and injury they bring, can strike at the economic and spiritual heart of the affected community or country, slowing its recovery and setting its progress back for years.

The impact of natural disasters is especially great on developing countries, where burgeoning population growth and the urgent demands of economic development often work at cross purposes to hazard reduction. This can result in the settlement of high-risk areas such as flood plains and unstable slopes, or the inability to replace or upgrade hazardous structures due to limited financial resources. The mudslides in Rio de Janeiro, Brazil, during the past month are a case in point. Most of the victims were forced by their poverty and the absence of coherent land-use planning and development projects, to reside in substandard homes built on unstable hillsides -- a sure recipe for disaster.

A principal goal of the International Decade is to replace the traditional approach to disasters, which calls for responding to the emergency after the hazard has struck, with an anticipatory approach to natural hazards. Although post-disaster relief efforts are necessary components of any hazard-reduction program, it is clearly recognized that their effectiveness in saving lives is limited relative to measures that avoid the hazard.

The Decade: From Concept to Reality. What, exactly, will comprise the International Decade for Natural Disaster Reduction? In July 1984, in a speech before the Eighth World Conference on Earthquake Engineering, I stated that scientific and technical understanding of the causes of natural hazards, and of techniques to reduce both human and property losses, has progressed sufficiently that a concerted effort to assemble, disseminate, and apply current knowledge can result in significant, positive effects. I also suggested that an international program to reduce hazard-related losses be explored seriously. To my great satisfaction, the international disaster community has taken up the challenge of discussing, evaluating, and forging a consensus about the overall structure of this International Decade.

Since 1986, two separate but complementary efforts undertaken within the National Research Council have confirmed the feasibility of a Decade, stated the rationale and focus, outlined potential projects and their benefits, and suggested a framework for organizing and conducting international and national programs. The 1986 effort resulted in an internal document titled *Toward a Less Hazardous World*, which, in turn, served as a reference point for a more definitive 1987 Advisory Committee study chaired by Dr. George Housner. The Advisory Committee was charged to critically assess the desirability and feasibility of, as well as a strategy for, launching an International Decade. The Committee, in its report, *Confronting Natural Disasters*, recommended that the initial emphasis be placed on rapid onset natural hazards such as earthquakes, floods, windstorms, landslides, wildfires, tsunamis, and volcanic eruptions; that an International Decade be established for 1990-2000; and that the United Nations launch, promote, and facilitate the Decade. To participate fully, the Committee recommended that the United States establish its own Decade to better organize United States efforts and to participate in the worldwide activity. The Committee is in the final stages of producing a companion report, *Reducing Disaster's Toll*, which presents the rationale and framework for a United States Decade and for a national committee to plan United States activities and to interface with the international program.

In May 1987, contact was initiated with the U.N. Secretary-General's office to assess what role the United Nations might play and how that role might be implemented. The concept met with considerable interest, and under the initial co-sponsorship of Morocco and Japan, a draft United States resolution calling for an International Decade for Natural Disaster Reduction was introduced before the U.N. General Assembly last fall, gaining a total of 93 co-sponsors. On December 11, the General Assembly adopted the resolution by consensus.

Preparatory work is underway to begin the International Decade in 1990. The U.N. Secretary-General has entrusted Mr. Jean Ripert, Director-General for Development and International Economic Cooperation, with the coordination of the U.N. system's efforts. It is my understanding that the Secretary-General will assemble an international advisory committee of scientific and technological experts to advise him and to assist in preparing for the Decade. The Academy also has offered to assist the United Nations. In this connection, the Academy will host an informal meeting of experts on natural disasters for an exchange of ideas with Mr. Ripert and senior staff of U.N. organizations about how best to plan for the Decade. Dr. Housner is one of the invitees to the meeting, scheduled for March 22 to 24, 1988.

As now envisioned, the International Decade for Natural Disaster Reduction will begin in 1990. Its stated objective is the reduction of catastrophic life loss, of property damage, and of the social and economic disruption caused by rapid-onset natural hazards listed earlier. This objective will be met by a three-pronged approach. First, we should catalog and disseminate widely what we already know about hazard mitigation, and we should identify gaps in that knowledge. In parallel, we should adapt known mitigation and preparedness techniques to each nation's unique circumstances. At the same time, a coordinated research and education program is needed to address the gaps in knowledge and to pioneer improved mitigation practices.

We are speaking about a program of shared knowledge and the shared pursuit of new knowledge. This sharing can take many forms, one of which may consist of bilateral research efforts. Another could be demonstration projects in which one or more nations selects a problem site at which to demonstrate a specific mitigation strategy. This sharing sometimes will involve technical assistance, especially with regard to many developing countries where the need is great, but resources for hazard mitigation are scarce. This technical assistance may involve such activities as adapting building codes or hazard-resistant design provisions to accommodate local materials and construction techniques, or perhaps hydrological models already in use in industrialized nations to anticipate flood timing and volume could be transferred to countries where hydrological planning is just beginning to take shape.

In any case, the IDNDR should not be seen simply as a grand transfer of aid from industrialized countries to developing nations. *It is to be an international partnership in the truest sense*, where exchange is the order of the day and each participating nation comes away more knowledgeable and better prepared to cope with the violent forces of nature. Countries may not begin with equal hazard mitigation experience or financial resources; yet, all nations *can* contribute to the global flow of new data on hazard events, hastening the understanding of natural hazards, and the development of new mitigation strategies.

Although international collaboration is the object of the International Year, IDNDR activities must originate from individual national efforts. This means that the IDNDR will have a "grassroots," or local, quality because each participating country will assess its own needs and priorities and forge its own plan of action on matters of local concern.

The hope of IDNDR is that each nation will declare its own National Decade for Natural Disaster Reduction and establish its own national committee of scientists, engineers, disaster response professionals, and government officials to act on its hazard-reduction plan. Japan already has established its national committee. Scientists and engineers in other countries such as China, Great Britain, and France are very actively engaged in organizing their own committees. Here in the United States, we are pleased to know that Dr. Bill Graham, the Science Advisor to the President, has assigned Dr. Peck, as the Chairman of the Committee on Earth Sciences, to create a dialogue among Federal agencies in the hope that a national committee on the United States Decade will be established shortly.

Role of the Insurance Industry and Financial Community

Finally, let me say a few words about the insurance industry and the financial community's role in the International Decade. No doubt, they must be key participants. Any successful natural hazard management strategy has to conclude that the ability to compensate hazard-induced losses and to maintain sufficient financial stability to allow stricken communities to rebuild their economic base requires that insurance and banking industries be fully conscious of the possible consequences of natural disasters and have adequate resources and flexibility to cope with them.

Financial institutions have only recently begun to fully appreciate the dangers that a catastrophic event might pose. Only in the past few years, for example, have United States insurers made progress in assessing the impact of natural hazards on their own industry. A recent study conducted by the All-Industry Research Advisory Council (AIRAC) found that, in general, the existing insurance system works well in spreading the costs of a major hazard event which causes perhaps $5 to $10 billion in losses. In spreading these losses, however, almost all sectors of the United States insurance industry, as well as a major portion of the international reinsurance industry, are affected. The AIRAC study also demonstrated that the insurance system is limited in its ability to tolerate loss. Although the industry could weather a single $7 billion storm with only moderate damage to its underwriting capability, a second $7 billion storm following closely the first one would damage enough companies to cause major market dislocations. The same study also found that a single $14 billion insured loss, such as might be caused by a major earthquake, would be much more damaging to insurers than the two successive $7 billion losses, since many more companies would exhaust their reinsurance coverage. Clearly, faced with a $60 to $100 billion loss, as could be anticipated from a major earthquake in southern California, the industry's capacity for compensating loss would be quickly exhausted.

The United States insurance industry, specifically, and the financial community in general are not unique in facing a financial threat of such magnitude. These industries in many other countries probably are in worse shape with regard to natural disaster events than are their United States counterparts. This suggests that the insurance industry ultimately will gain from the International Decade activities, because the problems of its own exposure in hazard-prone areas will become better known. This exposure can be expected to catalyze the insurance and financial communities to employ hazard-resistant design and construction practices and to consider the severity and frequency of hazards when selecting building sites for new facilities. In this regard, I am very pleased to know that The World Bank, in its most recent move, has adopted a policy to require natural hazard impact assessments prior to approval of project loan applications.

Insurers also will find rewards in working with other organizations to foster the adoption of better pre-disaster planning, early warning systems, and post-disaster relief efforts. In other words, the insurance and financial communities will prove to be steady contributors to the International Decade, as well as ready customers for the innovations in hazard mitigation and the increase in hazard-consciousness it promotes.

Each one of you can contribute to the IDNDR. I am confident that, by working together, the International Decade can be a success for all its participants. If the highest goal of science and technology is to serve the common good, then the IDNDR is eminently worthy of the support of scientists and engineers. It is a relatively low-cost, high-return endeavor having dividends that can be measured both on material and humanistic grounds.

(p. 61 follows)

KEYNOTE ADDRESS -- Q & A

Q (Julia Taft.) Dr. Press, we in OFDA have been challenged by the foresight of the scientific community, but we are concerned because the so-called "hard" sciences are far ahead of the social sciences. How do you envision a balance between the scientific research interests and the social and political science interests? How can we help to build that balance?

A This is a key issue. Each country's national plan must ensure the involvement of professionals who understand institutions and the nature of institutional change, and how governments work and governmental changes occur. The level of technological understanding will not be adequate without involving those mechanisms. I am pleased to say that we have received expressions of interest from the social science professional organizations, and they, too, are looking at this issue.

Q (?) I am with The World Bank. We are dealing with a policy issue that has not been clarified: how to separate and define slow-onset disasters from rapid-onset ones. If the IDNDR includes the slow-onset disasters, it must also include droughts, AIDS, and so forth. How can the scope be limited?

A If the agenda is too broad, planning cannot be controlled because it will become too political. We should first deal with mitigating rapid-onset disasters. If we can do that successfully, then perhaps our work can serve as a model for slower-onset disasters.

Q (?) How will the momentum that is being generated in the advanced nations be maintained and sustained so that the developing nations can continue their participation, which is essential?

A This is an issue we must address, because the developing nations are affected more by disasters than the advanced nations. The momentum question has to be worked out in allocating resources for maximum impact to help developing countries. We also must work to ensure that communication among all the countries involved remains open. Technology transfer in this program will not be prohibitively expensive for any country.

(p. 63 follows)

Tuesday, March 8, 1988

SESSION III

USING THE EARTHQUAKE-HAZARD KNOWLEDGE BASE

Moderators	Ludovic van Essche, United Nations Disaster Relief Organization; Badaoui M. Rouhban, United Nations Educational, Scientific, and Cultural Organization
Objective	Describe the process underway in selected regions, countries, and urban areas of the world to protect financial investments from earthquake hazards.
Panel Discussion	Examples of actions being taken around the world to protect financial investments.

(p. 65 follows)

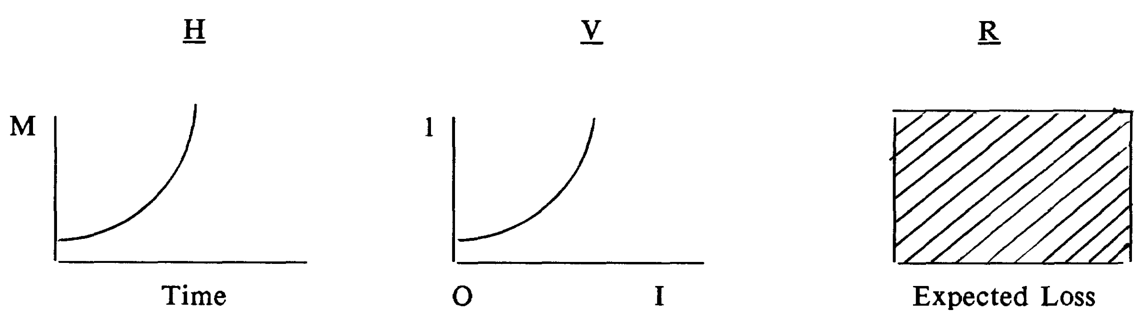
DISCUSSION OF HAZARD, EXPOSURE, VULNERABILITY, AND RISK

LUDOVIC VAN ESSCHE
United Nations Disaster Relief Organization (UNDRO)

At the risk of having too little time to fill in enough details, I would like to talk about methodologies for assessing risk that I have developed, based on an accumulation of about 13 or 14 years of experience in earthquake problems. This experience was gained primarily in the Balkan region and partly the Mediterranean region, and benefitted from enormous international input from distinguished members of the international scientific community.

I will touch also on an approach to project formulation and development. I do not want to repeat earlier statements about implementation and application, although I would like to stress the need for formatting or reformatting scientific and technical data for non-specialists in the hard sciences. As an architect, I am a non-specialist, and am a good subject with a good opportunity for proving to you what I don't know about earthquakes.

The approach I will outline is integrated and, I believe, sensible. It looks at earthquake problems in terms of Hazard, Vulnerability, and Risk. For all of us who wish to plug into the new program initiative and the International Decade, one of the first things we have to do is sort out our terminology. For instance, "risk mapping" to me is something different than, perhaps, to a geologist or an emergency response official. We basically identify the hazard and then look at the vulnerability of structures in the hazard area. The convolution of the two allows us to arrive at an estimate of the risk.



Hazard is a function of magnitude of the event over a period of time. Magnitude over time gives the vulnerability and allows us to map it. As a function of that hazard, we look at the vulnerability of the built environment. We look at the psychology of people exposed to the hazard. We have to be able to get the vulnerability function for specific types of buildings. In carrying out this exercise, the entire process can be combined, and mapping of expected losses can begin (R). An important point about vulnerability is that it is non-site-specific. It is intrinsic to the structure of the building irrespective of where it is located. If exposed to shaking, it will have that specific degree of proportional loss. Repeating the vulnerability exercise over and over again from the beginning through hazard mapping permits identification of the degrees of expected loss.

"R" is your expected loss, but risk assessment is one aspect of that. My time today is far too short to go through this process except to say that structural, non-structural, social, and economic losses have to be integrated into this, or some other kind of system. We are attempting at the moment in the Balkan region to do all of this. We have worked in H, V, and R, but have not been able to integrate the whole.

We are now trying to incorporate into the system an assessment of the danger, level of exposure, and expected losses in the Mediterranean, and have received funds from the Italian Government and UNDRO to structure a program on seismic risk reduction in the Mediterranean region. That region, however, is not particularly exposed to seismic hazard.

In the area of risk reduction, from the physical planning point of view, the language aspect has been underestimated. We also have neglected to focus on the need of the non-specialist to understand how buildings respond to earthquake ground motion, and to understand the phenomenon as a whole. The 1985 Mexico earthquake, for example, was a low frequency one, yet severe damage resulted. This brings up the question of resonance as an important topic for us to study in designing buildings. It is a question related to economy, cost, and the need to be understood by and to understand allied professionals, such as myself, who do not have a full grasp of the entire field.

Another point is the question of response to a major event. Mitigation efforts must address the need to protect the population from an event.

We also have referenced today the question of scenarios. The H/V/R methodology is a scenario in one sense. The physical configuration of the elements can be altered to reflect varying levels and time frames and so forth. In preparedness activities, the science and technology aspects can be integrated. I learned this after the Montenegro earthquake, and gained an appreciation for the importance of the civil defense people. Those people should be exposed to and made more aware of this type of approach.

FORECASTING LARGE AND GREAT EARTHQUAKES

WILLIAM SPENCE
Prepared with Stuart Nishenko
U.S. Geological Survey

While the theory of plate tectonics is now well-established, the associated principles only recently have been used to provide meaningful forecasts of large and great earthquakes at simple plate boundaries. A large earthquake's magnitude (M) is in the range of $7>M\geq7\text{-}3/4$ and a great earthquake's magnitude is larger than M=7-3/4. Typically, an earthquake forecast estimates a future earthquake's magnitude and rupture location and, less accurately, when the event will happen. In contrast, an earthquake prediction attempts to provide accurate estimates of three parameters: size, location, and time of occurrence. At present, seismologists are unable to predict routinely when an earthquake will occur, although recent developments have made it possible for seismologists to estimate the *probability* for an earthquake to occur within a specified time interval, such as the next 10 or 20 years. Probability statements are referred to as long-term, probabilistic earthquake forecasts.

Over geologic time scales, the motions of tectonic plates are fairly constant and range from less than one to ten centimeters per year. Within human time scales, motions at plate boundaries occur episodically as earthquakes. Around the Circum-Pacific region, the interactions of oceanic lithospheres with an island arc (such as Japan) or with continental lithosphere (such as South America) spawn the majority of large and great earthquakes. Tectonic plates continually move away from spreading centers, and already-subducted plates continually sink. Resultant stresses accumulate at a locked subduction boundary until a segment of this boundary ruptures, causing a large or great earthquake. These types of earthquakes have rupture lengths of 100 to 1,000 kilometers, average faulting displacements ranging from one to twenty meters, and recurrence times ranging from thirty to hundreds of years.

At any given time, it is not unusual to find patches or segments of a plate boundary measuring 100 to 300 kilometers or more in length adjacent to zones of recent earthquakes. Because long-term plate motions are continuous, these patches ultimately also must move to maintain continuity of plate motion. The patches can become highly stressed, forming zones of high earthquake expectancy, or "seismic gaps."

Characteristic properties of different segments of the subduction boundary determine how often earthquakes occur along the segments. A critical element of earthquake forecasting is determining the characteristic repeat times for these segments, which is done best by using the historical record of actual past earthquakes. Once the repeat time and its variability are determined for particular seismic gap, it is possible to calculate the probability for the next earthquake to recur in that seismic gap. These probabilities are given over a time interval, typically the next 20 years.

In the last 15 years, more than a dozen known seismic gaps have experienced large and great earthquakes. More recently, the above techniques were used to forecast the 1985 Valparaíso, Chile, earthquake. The U.S. Geological Survey has studies in progress that use the methods described here to forecast probabilities for earthquake occurrence on sections of the San Andreas fault system.

Although complications and difficulties can occur in interpreting the readiness of various seismic gaps to erupt in earthquakes, we are prepared to implement a proven technology, and can develop meaningful forecasts for a number (but not all) of the yet-to-occur destructive earthquakes, worldwide. Armed with the methodology we will use, it will be possible for the first time to develop disaster mitigation programs keyed to specific areas for specific time frames, for many of the Earth's major plate boundaries.

Seismic gaps with very high probability for recurrence of large or great earthquakes within the next 20 years include the west coast of Chile between 26 and 30° South, and 30 and 32°; Nicoya, Costa Rica; western El Salvador; central Guerrero, Mexico; Yakataga, Alaska; the Shumagin Island region of the Aleutian Islands; Tokai, Japan; western New Britain; and San Cristobal, Solomon Islands. These zones deserve high priority for intense study.

We propose to refine and update continuously the long-term, probabilistic forecasts for known seismic gaps at subduction zones of the Circum-Pacific and elsewhere. We propose to employ developing methods to use particular small-to-moderate earthquakes in and around a seismic gap to refine the forecast times for earthquakes pending at seismic gaps. We further propose to develop and test long-term, probabilistic forecasts for other zones that may have the potential to produce great earthquakes, such as the "big bend" of the west coast of South America, the Gulf of Tehuantepec (Mexico), areas of the Caribbean and Mediterranean Seas, the Middle East, and western China.

I would like now to illustrate some interesting earthquakes.

(Slide depicting the eight largest earthquakes since 1904.)

(Slide of the Prince William Sound Alaska earthquake, showing effects caused by clay sensitive to ground shaking.)

(Slide.) This is an example of nearly total destruction from the 1868 earthquake near Guernica.

(Slide of the Great Circum-Pacific tsunamigenic earthquakes that shows evidence of local wave heights of as much as 30 meters.)

(Slide of the effects of tsunami at Port Valdez.)

(Slide of a United States ship grounded from the 1868 earthquake from the Port of Valdez as a result of being caught in the tsunami. This boat had a flat bottom and rode like a surfboard.)

(Slide with questions about causes of large and great earthquakes, seismic gaps, what can be expected from earthquakes.)

(Slide of a model of subduction activity.)

(Slide -- drawing showing rupture at subduction zone.)

(Slide of a map of the east coast of South America which shows the times of occurrence in the area of Valparaíso, Chile.)

(Slide -- "key conceptual slide" that shows recurrences for Valparaíso, Chile, of every 86 years +/- six years. "My coauthor actually forecast the 1985 earthquake.")

(Slide of some "seismic hot spots" throughout the world. The map on the third panel from the end, shows the Circum-Pacific, or Pacific Rim.)

(Slide of conditional probability -- shows one high risk area - southwest New Britain area and the Solomon Islands, San Cristobal.)

(Slide of seismic hot spots for the Alaska-Aleutian area, Shumagin Islands.)

(Slide of a fence diagram showing the probability of recurrence in the San Andreas fault zone, pointing out the location of Parkfield.)

(Slide depicting conditional probability, 1986-1996, in Mexico, and describing how the values were arrived at. "These three gaps all have a high probability..." but will not be of sufficient size to cause as much damage as Mexico City experience. This area is at higher risk from earthquakes than the area in the California slide I showed previously.)

(Slide: What can we expect from future research?)

A. Seismic Gap analysis for the Caribbean region, Mediterranean region, Middle East, and eastern China.

B. Use of new data to tighten (refine) forecast times.

(Slide showing types of long-term probabilistic forecasts.)

(p. 71 follows)

THE GLOBAL EARTHQUAKE THREAT TO FINANCIAL INVESTMENT AND DEVELOPMENT

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Prepared with S.T. Algermissen
Office of U.S. Foreign Disaster Assistance
U.S. Agency for International Development

I consider this meeting to be a major milestone. The maps that we see here around the room reflect only the tip of the vulnerability iceberg, and I am pleased to be taking part in this initiative.

Let me begin today by giving an overview of the OFDA program. The Agency for International Development, Office of U.S. Foreign Disaster Assistance, has supported overseas activities in earthquake hazards reduction in the developing world since 1979. The OFDA disaster preparedness program includes national and regional seismic network development, volcano monitoring and hazards analysis, warning systems, regional earthquake risk mapping, mitigation, and related training. This program reflects the importance USAID places on assisting host countries to achieve greater self-sufficiency in reducing the disaster death toll resulting from geological hazards.

The goal of OFDA's earthquake hazards reduction activities is to reduce probable death and human suffering caused by earthquakes, volcanoes, and tsunamis. This is being accomplished by assisting disaster-prone countries to increase their technical competence and civil preparedness organizational skills. Through disaster avoidance and mitigation strategies, this program can reduce the vulnerability of populations to both primary and secondary disaster impacts.

The following objectives are being realized.

- Increased lead time for seismic-related disaster early warning and contingency planning (that is, earthquake forecasts from probabilistic assessments of seismic potential) for selected countries and regions;

- Integrated early warning systems output with hazard reduction activities, host country civil preparedness, and USAID development objectives for selected countries;

- Upgraded and integrated foreign national and regional geophysical monitoring networks; catalogs of historical seismic data by region; and regional seismic risk maps;

- Evaluation of the relative vulnerability of developing countries to earthquakes; better-developed regional and national mitigation and preparedness strategies in cooperation with participating governments and institutions;

- Strengthened selected Third World seismological institutions; better-informed foreign scientists and emergency management officials on the application of new technologies for disaster mitigation; and

- Wide dissemination of comprehensive earthquake engineering orientation programs in selected high-risk regions.

Results of these activities will continue to be directed toward the establishment of a comprehensive United States strategy for international volcano and earthquake hazards mitigation and disaster preparedness. From fiscal year 1985 to the present, USAID/OFDA has completed the following major activities related to geological-hazard reduction in the developing countries:

- Comprehensive evaluation of the seismic risk in the Tonga-Fiji-Vanuatu region of the Southwest Pacific;

- Installation of the Central Peru automatic earthquake location and strainmeter network for forecast analysis and evacuation planning;

- Installation of a near-shore tsunami warning system for Central Chile, using satellite telemetry;

- Mapping of earthquake risk and neotectonics of the Andean Region for use in comprehensive disaster planning and development;

- Installation of and provision of operational support for national earthquake monitoring systems that complement hazard-reduction activities in Panama, Guatemala, Ecuador, El Salvador, The Dominican Republic, and Costa Rica;

- Installation of volcano monitoring and warning systems in Colombia, Indonesia, Papua New Guinea, the Philippines, and Mexico;

- Establishment of the Volcano Crisis Assistance Team (VCAT) for the Latin America Region, in cooperation with the U.S. Geological Survey;

- Drafting of prototype building codes for wind and seismic effects in the Leeward Islands of the Caribbean;

- Strengthening of national disaster preparedness and emergency management in Indonesia, in cooperation with the U.N. Development Program;

- Conducting the Circum-Pacific comparative earthquake/tsunami probability analysis for use in comprehensive contingency planning;

- Establishment of the Southeast Asia Regional Disaster Management Training Center at the Asian Institute of Technology in Bangkok;

- Development of a comprehensive strategy for an international earthquake hazards mitigation program, in cooperation with the Earthquake Engineering Research Institute, in the framework of the International Decade for Natural Disaster Reduction; and

- Execution of the Natural Hazards Risk Assessment and Disaster Mitigation Pilot Project for Latin America and the Caribbean, in cooperation with the Organization of American States.

These accomplishments briefly sum up OFDA's current projects.

Among other things, we need to inventory the wealth of literature that has been published, and I offer my services in doing that. We need to put together a detailed, annotated bibliography of the relevant literature. This annotated bibliography should be made available to anyone who needs it.

The areas that get primary attention from OFDA are many of those shown in the maps around the room, and include Caracas, Quito, Lima/Chimbote, Arequipa, Valparaíso, Concepción, San Juan/Mendoza, Bogotá, Manila, Tonga/Fiji, Managua, Acupulco, and Mexico City. A quick look at the maps will point out the areas which are at seismic risk.

For the benefit of members of the Task Force, who will talk tomorrow, I would like to raise a few quick questions.

1. What kinds of major economic development investments that are particularly vulnerable to earthquake disasters are being made today in different geographic regions of the world through multilateral and bilateral donors?

2. How vulnerable are current and prior capital investments in LDC infrastructural development and manufacturing facilities, given our current understanding of the earthquake threat? Where have particular investments been made that we now know are vulnerable and are worth protecting?

   I see this question as the crux of what we are trying to do. No one has inventoried where the major dollars are being spent, and we need to solve that problem with the best information covering at least the next two decades.

3. What can we do systematically to pull together specific development/investment portfolio information in different geographic regions from both bilateral and multilateral donors in order to set priorities for mitigation, preparedness, and strategic planning actions during the next decade?

4. What are the approximate number and aggregate value of structures and facilities that host governments and financial institutions have at risk today to earthquake hazards worldwide? What steps are required to obtain these data and organize them systematically so that they can be used?

5. When reviewing major donor portfolios over the past decade, approximately what percentage of their annual budgets has been spent for investment and development in earthquake-prone regions of the world? Can these data be aggregated by industry, sector, or other suitable category?

6. Is a worldwide earthquake ground-shaking hazard map feasible today, given our current state of knowledge and technical development? Assuming such a map could be produced, how can we use it to improve strategic planning and economic development?

If we did not believe that answers to these questions can be found, this meeting would not have been convened. We cannot, however, find them alone. We need your support.

(p. 75 follows)

EARTHQUAKE HAZARD IN VENEZUELA: PROTECTION OF FINANCIAL INVESTMENTS

JOSE GRASES G.
Universidad Central de Venezuela (UCV)
Caracas

While listening to the different talks today, it occurred to me that it would be useful for you to hear about our experiences in Venezuela since 1967. In July of that year, we were subjected to an earthquake. At that time, however, our engineers were not fully aware of what earthquakes can do and, as a result, we recognized suddenly that we had a serious problem: we lacked adequate methods for disseminating knowledge.

To understand that problem fully, it is necessary also to understand the seismic environment of Venezuela. (Slide.) Of Venezuela's 16 million people, about three-fourths live in earthquake-prone areas. We know this because the seismic history of our country goes back to 1530, shortly after its discovery, and we have a relatively good catalog of past events. Of some 2,000 earthquakes, 121 have generated damage to man-made construction at one level or another, and about 40 have reached Mercalli intensities at least equal to VII. These earthquakes are primarily from active fault systems in the Andes, although there are other northwest/southeast faults and those such as El Pilar. (SLIDE.) Seismic zoning maps have been prepared on the bases of observed intensity, as well as probable ground motion. Local risk analyses are performed, using data from seismographic networks and accelerographic and tectonic information. A 70-instrument accelerographic network is maintained, but only a limited number of records are available currently. The maximum recorded ground acceleration is 0.18*g*.

(SLIDE.) The first seismic map was prepared in 1947 of a jungle area where only a few Indians lived at the time. In the same year, seismic regulations were instituted. These have been updated several times: in 1955, 1967, and 1982. Nevertheless, the importance of the threat of natural disasters on engineering works was only recognized after the 1967 Caracas earthquake when several multi-story buildings collapsed. Progressively, seismic actions and dynamic structural response were incorporated into the design of large industrial facilities, new dams, high-voltage equipment and installations, and so on. Now, in addition to building design regulations, code provisions have been developed for the earthquake-resistant design of bridges, offshore structures, and high-voltage sub-stations.

(Slide.) These developments have been fostered, in part, by efforts to enhance the dissemination of knowledge, an important part of which was improving the graduate school engineering curricula. A Master's Degree course was instituted at UCV in 1973, and undergraduate courses have been in place since 1979. These courses provide a continuum for students who are learning to focus on the earthquake problem from the early design stages to completion of structures. When the effort to improve our engineering curriculum began in 1974, we had only two Ph.D. professors, five Masters Degree professors, and six with a Bachelor's Degree. In 1985, we had six Ph.D. professors, and nine M.Sc. professors. In the last 13 years, 39 students have obtained degrees, and 40 more are still matriculating. An interesting side benefit is that the center where this is happening has greatly increased the number of its publications.

Other knowledge dissemination activities also have been, and are being, conducted. Public and professional awareness of the problem has been enhanced by presentations of earthquake case histories from Venezuela's seismic experience. Occasional cooperative efforts in teaching and holding workshops and meetings have had financial support from international organizations. Knowledge is now disseminated in a variety of environments, including post-graduate, undergraduate, the construction industry, and through professional associations such as those for earthquake engineers.

In addition to disseminating knowledge and conducting research, other activities are underway to help reduce earthquake risk. I have divided these into two groups: systematic and isolated. The first consists of the systematic enforcement of *building codes*, which is paramount in effectively reducing risks in densely populated urban areas. Short courses have been developed for building officials to learn how to apply practice codes, and their training includes lectures about the earthquake threat. Isolated activities consist of discrete, dynamic analyses of buildings and installations such as high-rise buildings, dams, and large storage tanks. Another example is the design of base-isolation devices for specific structures.

As a consequence of losses due to recent earthquakes, insurers have revised and updated their premiums, which had been unchanged since 1967. Consideration of new parameters, based on present knowledge, is being given to rate structures, thus relating them more closely to the risk that is insured by the premiums. The total value covered by policies amounts to $2,700,000 U.S., representing 96,159 policies with mean rates of approximately 0.4 percent. Total losses incurred due to earthquakes in 1986 were $2,700,000.

Rough figures of the total investment in protection against earthquake threats, the dissemination of knowledge, and research stands between 21 and 24 million Bolivares (something less than $1 million U.S. at present exchange rates). The distribution is as follows: seismic networks -- 35 percent from the state; hazard evaluation and data collection -- 10 percent from state and private funds; research, teaching, and information dissemination -- 25 percent from universities and professional societies; risk reduction measures -- 10 percent from the state; upgrading of buildings and equipment -- 15 percent from the state and private funds; and recovery programs -- 5 percent from the state.

A systematic effort is needed to identify critical hazardous situations that may lead to catastrophic losses. For instance, we do not know how vulnerable to seismic action are dams near large cities; of Caracas' main water piping system; or of hospitals, bridges, *etc.* Taking into account soil conditions and building characteristics, critical situations similar to those that caused the 1985 Mexico earthquake may have developed in a number of places. Changes over the last three or four decades also are dramatic in the heights and configurations of buildings, many of which now reach 55 stories. These new exposures may have created new hazards never previously tested in urban areas.

(Slide.) In summary, let me leave you with a few final facts:

- o Experience has shown that losses due to seismic events can be very heavy.

- o Material losses in our continent due to destructive earthquakes that have occurred in the last few years exceed $206 million, and have affected bridges, high-rise buildings, harbors, hospitals, pipelines, high-voltage substations, *etc.*

- o New structures built during the last few decades have created some new hazards, which have never been tested previously.

We think that losses similar to those that resulted from the 1985 Mexico earthquakes can occur in Venezuela, particularly along some coastal areas. We are concerned that we are not analyzing and preparing for those potential losses in a systematic way, even though we know that we need to be prepared. We need skilled geologists, earthquake engineers, and architects. We hope that the WWERM initiative will help us in our efforts to address these needs.

(p. 79 follows)

THE MEDITERRANEAN REGION AND THE ARAB WORLD

BADAOUI M. ROUHBAN
United Nations Educational, Scientific, and Cultural Organization (UNESCO)

(Slide.) In the Mediterranean and nearby regions, earthquakes take a serious toll in human life and in the destruction of property. These regions include most of the Arab countries where geological and geophysical observations clearly indicate that earthquakes will continue to occur in the future. Damage from these earthquake will be great, as the Mediterranean is composed of developed industrialized countries of the Balkan region in the north, some of which are highly seismic, and countries in the Arab region, including Israel, Egypt, Morocco, and Tunisia. My talk will focus on the Arab region, and the Balkan region will be covered later by Dr. Algermissen.

(Slide.) The Arab region stretches about 5,000 kilometers from Morocco in the west up to Iraq and Saudi Arabia in the east. It covers almost 10 percent of the world's land area. About 200 million people, representing 4 percent of the world's population, live in the Arab region. The area is characterized by extremely diversified recent deformation belts with which most of the destructive earthquakes in the region are closely associated. The seismicity of the Mediterranean Basin is well known, as many devastating earthquakes have occurred there; however, earthquake preparedness activities are lacking, in part because of the cyclic nature of the events.

(Slide.) The first seismic feature of the area is seen in the continental collision of an area in the northwest of Iraq against the Iranian plateau. In the Persian Gulf, we also have the Arabian plate moving away from the African plate and colliding against the Iranian plateau. There also are anomalies in the region of the Red Sea that have provoked earthquakes in Israel, Jordan, Syria, and Lebanon causing 200,000 deaths. (Slide.) Another example of more complex continental collision exists in the North Africa area as a result of the convergence between the African plate and the Eurasian plate. Events in 1980 and earlier in 1954 were due to this convergence. (Slide.) Finally we observe that earthquakes have occurred in locations remote from major areas of collision, in Sudan and Egypt, for example.

A combination of a lack of earthquake preparedness in the region and the rapid development of settlements in this area magnifies the potential peak impact of a major earthquake and makes the area critically vulnerable to disasters. (Slide.) Look at the City of Jedda, for example. Most of the economy of Saudi Arabia is concentrated here, and it is the center of power. It is built on very soft soil, and one can imagine what the result would be if an earthquake occurred here. An event similar to the 1964 earthquake in Alaska would affect an area extending from the south of Jordan to the northern boundaries of the region. Few buildings in the region are protected against earthquakes, and traditional and modern structures are found side-by-side in urban areas. This is one reason why losses are so high from such disasters.

(Slide.) The 1980 earthquake in El Asnan, Algeria, resulted in the loss of 4,500 lives. A subsequent event in 1982 in North Yemen caused 4,000 deaths. The Agadir earthquake in Morocco caused 12,000 deaths. Total life losses in the Arab countries resulting from earthquakes in the past 300 years is estimated to be about 100,000. (Slide showing the distribution of deaths by country.) In terms of economic losses, the El Asnam earthquake caused losses equal to about 25 percent of Algeria's gross national product, and the North Yemen event caused losses of about 50 percent of its GNP. These losses were incredible setbacks not only to the economic and social development of these two specific countries, but also of the whole Arab region in general.

The Arab region nations took action in response to these events. Prompted by the 1980 El Asnam earthquake in Algeria, the Arab Fund for Economic and Social Development, an intergovernmental development agency, decided that the best plan for effective action to reduce earthquake risk throughout the Arab region was through a long-term preparedness program rather than a temporary relief action. The Fund commissioned the UNESCO to undertake a feasibility study for a multi-disciplinary Program for Assessment and Mitigation of Earthquake Risks in the Arab Region (PAMERAR). This study guided the Fund in allocating $20 million to finance three-year national projects for earthquake risk reduction in seven selected Arab countries. The projects encompass the following common components:

- installation of a seismic network
- installation of a strong motion network
- purchase of special backstopping equipment
- training of personnel in seismology, earthquake engineering and civil defense

Moreover, Algeria will undertake to establish an Institute for Earthquake Engineering and Engineering Seismology which will likely serve as a regional institute.

Whereas the entire responsibility of the execution of the national project lies with each country, UNESCO has been entrusted by the majority of the countries to design and implement the training component. The training programs take place in the respective countries, as well as in specialized institutes throughout the world. Two modes of training are used; individual and group. These training modes will be instituted at the national level by seminars and workshops, and courses will be held in cities and countries such as the United States and Japan. Degree programs will enable professionals in each country to earn doctorates or masters degrees.

PAMERAR funds are allocated by formula and, of course, Algeria has the most because it established an institute of earthquake engineering, and training activities have a high priority in PAMERAR.

A distinctive feature of PAMERAR in developing countries is that it provides a multi-disciplinary, integrated program shared by many professional specialists directly concerned with earthquake risk reduction. In working together, these specialists will undoubtedly contribute to the indigenous protection of the development process in their respective countries and to an eventual decrease of disaster assistance that foreign countries are called upon to provide. Only by developing a skilled cadre of professionals will PAMERER be able to implement the long-term program.

It is anticipated that the initial national implementation of PAMERAR will be followed by strong regional and, to some extent, international cooperation.

In closing, it was written after the North Yemen earthquake that "God gives and God takes and we can do nothing about it." The Arab region, however, is showing that it can help God. Science and mitigation are based on technology. Regional professionals intend to develop the knowledge base that will enable them to hold the keys of success, and to develop professionals and keep the momentum going for them so they will not go to work somewhere else where the wages are better. But that is a problem for another day, another meeting.

(p. 83 follows)

EARTHQUAKE RISK MANAGEMENT IN ALGERIA, ITALY, SPAIN, AND JORDAN

WALTER W. HAYS
U.S. Geological Survey

Mediterranean Seismicity

Algeria, Spain, Italy, and Jordan, four nations that are actively working on earthquake risk management, are located in the Mediterranean Sea region where the seismicity is high. The record of historical seismicity dates back to about 1000 B.C. and shows that many devastating earthquakes have occurred in this region. The collision of the European and African tectonic plates is one of the complex tectonic mechanisms that generates repeated earthquakes throughout the region. Understanding of these mechanisms has improved markedly in the past decade with the acquisition and analysis of seismotectonic data, especially in Algeria, Spain, Italy, and Jordan, where sensitive seismicity arrays are in place and detailed geologic studies have been conducted. Additional instrumentation is placed for all of the Arab States through the PAMERAR. This program is supported by the Arab Fund for Economic and Social Development and the Islamic Development Bank.

Algeria. The Democratic and Popular Republic of Algeria has developed the four basic components of earthquake risk management; (1) hazard mapping, (2) improved practices for design, construction and land use (3) professional skill enhancement, and (4) networking on a global, regional and national scale. With assistance from UNESCO, Algeria's Minstere de L'Urbanisme de la Constrution et de L'Habitat successfully completed a comprehensive seismic microzonation study of the Ech Cheliff region of northern Algeria in 1984. Since the destructive El Asnam earthquake of October 10, 1980, which destroyed almost 80 percent of the city of El Asnam, left 6,000 dead and 8,300 injured, made 300,000 homeless, and caused economic losses that reached $4 billion, Algeria has:

1. produced hazard and seismic microzonation maps for the Ech Cheliff region;
2. improved its national building code;
3. strengthened design, construction and land-use practices;
4. started a long-term training program for professionals;
5. acquired and deployed instruments for a 40-station strong-motion accelerograph array;
6. convened an international conference in seismic microzonation; and
7. established the Institute of Earthquake Engineering and Applied Seismology in Algiers.

Their response demonstrates unequivocally that earthquake risk management can be accomplished, even in a developing nation, in a fairly short time. Leadership is now in place to continue the long-term program of earthquake risk management. At present, work is underway to define the seismogenic zones in the region encompassing Algiers, the first phase of a comprehensive seismic microzonation study of the capital, which was destroyed by a large earthquake in 1716.

Italy. Italy has experienced at least 569,000 casualties from earthquake events in 1169, 1222, 1248, 1352, 1455, 1456, 1626, 1636, 1660, 1661, 1693, 1695, 1703, 1706, 1732, 1757, 1783, 1805, 1819, 1851, 1857, 1908, 1915, 1968, 1967, and 1980. The earthquake of November 23, 1980, in Campania-Basilicata was a major disaster even though it was only a moderate earthquake of magnitude 6.5. It caused an estimated 2,700 deaths and 7,700 injuries, destroyed 250,000 to 300,000 dwellings and caused economic losses estimated at $15 to $20 billion. Italy has embarked on a long-term process to improve its earthquake risk management. Leadership is being provided by several groups, including: Comitato Nazionale per la Ricerca e per lo Svilluppo dell' Energic Nucleare a della Energie Alternativa, Ministero dell' Interno, Politecnico di Milano, and University of Rome. Extensive seismicity and strong-motion instruments have been deployed and are producing data needed for hazard maps. Extensive networks to enhance professional skills and to carry out cooperative programs have been established with many institutions and agencies through the world. An example of a current activity in the Cooperative Program of Seismic Risk Reduction in the Mediterranean Area, a project of the United Nations Development Program and a cooperative program in Earthquake Hazards Mitigation with the University of California, Berkeley.

Spain. Leadership for earthquake risk management in Spain is provided by its Science and Technology Committee. Key Spanish agencies and institutions include the Instituto Geográfico Nacional and the Universidad Complutense de Madrid. A current cooperative five-year program with the United States Geological Survey (directed by Alvaro Espinosa) is designed to:

1. improve the analysis of the seismicity data;
2. conduct paleoseismicity studies;
3. produce seismic hazard and microzonation maps; and
4. enhance the skills of Spain's professionals.

Jordan. Jordan, one of the Arab States participating in PAMERAR, has committed to a long-term earthquake risk management program. Leadership is being provided by the Ministry of Planning, National Resources Authority, and the Royal Scientific Service. Jordan lies adjacent to the seismically active 1,000-kilometer-long Dead Sea rift zone. Paleoseismicity studies conducted in 1981 indicated that two very large earthquakes have occurred on the Jordan fault segment of the rift zone in the past 2000 years, one between 200 B.C. and 200 A.D., and one between 700 A.D. and 900 A.D. Instruments for a 32-station seismicity array and a 40-station strong ground-motion array are being acquired and deployed. An ambitious three-year program to enhance the skills of professionals in Jordan was initiated in 1987 under the guidance of UNESCO. Hazard mapping is beginning, and has a goal of evaluating and improving all aspects of the current design, construction, and land-use practices in Jordan. The national building code is the initial target.

MITIGATION OF EARTHQUAKE HAZARDS IN THE PEOPLE'S REPUBLIC OF CHINA

DAVID P. RUSS
U.S. Geological Survey

In the 20th Century, 104 earthquakes of magnitude 7 or greater have struck 21 of the 30 administrative provinces, autonomous regions, and municipalities of the People's Republic of China (PRC). It is estimated that in the past 37 years alone, earthquakes in China have killed 237,000 people and injured 763,000 others. In an effort to mitigate the effects of these earthquakes, the Chinese government supports an extensive and successful earthquake studies program. Under the leadership of the State Seismological Bureau (SSB), the program is accumulating a modern data base to add to its unequalled 2,000-year historic earthquake catalog.

In the years since the devastating 1976 Tangshan earthquake, the SSB has placed great emphasis on trying to develop the capability to accurately predict damaging earthquakes. Advanced seismic networks and other monitoring instruments have been developed and installed, and the SSB has formed a Center for Analysis and Prediction of Earthquakes. Cooperative international programs, such as the United States-Peoples Republic of China Earthquake Studies Protocol, have been established and modern equipment developed in the United States has been installed in seismically active regions of China.

Although the emphasis on earthquake prediction research in the PRC is, in part, the result of early success in predicting a large earthquake at Haicheng and, in part, due to the extreme difficulty of carrying out an effective land-use program, China has not ignored the importance of earthquake engineering or seismic risk analysis in its mitigation efforts. An Institute of Engineering Mechanics has been in operation at Harbin since 1954, and an Earthquake Resistance Office has been formed in the PRC Ministry of Urban and Rural Construction and Environmental Protection. These organizations have installed strong ground-motion arrays, conducted studies in probabilistic-based design, microzonation, and seismic risk analysis, and developed seismic building codes.

In the past several years, China has increasingly seen the value of addressing the earthquake mitigation problem on a national and global basis. Last year, for example, the SSB, in cooperation with the USGS, completed the installation of a PRC national digital seismic network, and the PRC joined the New Confederation of Broadband Networks. In April, 1987, the SSB sent a large delegation, headed by its director, An Qiyuan, to the International Earthquake Symposium hosted by the City of Los Angeles. They met in Los Angeles with city officials, and with representatives of the USGS and the U.S. Federal Emergency Management Agency. In December of last year, the Chinese hosted an international symposium on microzonation in Guanzhou. A symposium on earthquake countermeasures in the PRC has been approved by the State Council and is scheduled to be held in Beijing in May.

Probably the most ambitious Chinese earthquake mitigation activity currently underway is the establishment of the Chinese National Association for Disaster Prevention. It is composed of more than 100 agencies under the sponsorship of the SSB, and addresses problems caused by earthquakes, floods, fire, landslides, tornadoes, typhoons, and manmade disasters. It is a country-wide association that plans to:

- carry out academic exchanges concerning disaster prevention and countermeasures
- develop disaster response plans
- provide advisory measures for key agencies and activities
- convene workshops and publish a magazine.

In summary, the PRC endeavors to protect financial investments from earthquake hazards through a broad-based program that includes designing and building earthquake-proof structures, predicting damaging earthquakes, educating the public on the hazards of earthquakes, and by developing earthquake preparedness plans.

MITIGATION OF EARTHQUAKE HAZARDS IN JAPAN

RICHARD N. WRIGHT
National Bureau of Standards

It is a pleasure to speak with this group about the earthquake countermeasures in Japan. Their program can be seen as a model of what other countries should do. Other countries can approach the level of preparedness in Japan, given a sustained and broadband effort not only by professionals who work in earthquake-related disciplines, but also by the public at large. Public attitudes are very important in earthquake hazard mitigation. In Japan, a country with a homogeneous society, fewer pockets of differing opinions are found within the population than will occur in the United States. This makes it even more important for us to translate information about known hazards into a form that the public understands. With education about the hazard will come public attitudes that are conducive to support for an effective program. A strong commitment at all levels, in short, is necessary to deal with earthquake hazards.

In the United States, there are some frustrations for those of us in the Federal Government in terms of priorities. Only to a very limited extent do any of our Federal agencies have a mission that allows us to become involved in any real international activity. Even then, we can participate in international activities only to the extent that we can justify that they clearly support the agency's primary mission goals.

For instance, the 20th joint meeting in May (1988) of the U.S.-Japan Panel on Wind and Seismic Effects, which began in 1969, will be attended by representatives from the National Bureau of Standards. It is very easy to justify participation in this activity because information that results from the next earthquake will be available to us in the United States because of the cooperation of participants. The returns will fully pay whatever are the costs of our participation in the program.

I had a little difficulty when Walt asked me to discuss some of the phenomena associated with natural disasters in Japan, such as wind and seismic effects, because those of you who will attend the Ninth World Conference on Earthquake Engineering in August (1988) will get a chance to observe some of these activities yourself, first hand. In 1987, however, the Japanese National Land Agency, a federal government agency, published *Earthquake Disaster Countermeasures in Japan*, which includes a nice treatment of their activities in English. This makes it possible for me to give you a summary of their activities with some confidence.

(Slide.) Japan is located in the Circum-Pacific seismic zone where the crustal movements are the most active. While Japan and the surrounding continental shelves amount to only 0.1 percent of the total area of the world, 10 percent of the world's earthquake energy is emitted there. In Japan, a great earthquake of magnitude about 8 recurs every 10 years and a large earthquake of magnitude about 7 recurs annually.

Major cities in Japan have grown to great size with dense and complicated "lifeline" webs of communications, transportation electricity, water and gas. Cities contain wooden buildings susceptible to fire following earthquakes, mid- and high-rise buildings, and dangerous facilities such as petrochemical complexes, nuclear reactors, and housing areas developed on unstable soils. Despite the susceptibility of their buildings to fire following, however, their fire losses are less than ours. This is due to public attitudes.

The Japanese have had to work very hard to protect their lives and their economy from the threat of earthquakes. We are just beginning to address some questions here in the United States that Japan dealt with many months ago. One of those is what the destruction of lifelines would do to our national defense. Industrial and political resources around the Tokyo bay area are protected to a far greater degree that our own similar installations.

(Slide.) Following enactment of the Disaster Countermeasures Act of 1961, Japanese national policy has integrated countermeasures such as emergency response, hazard assessment, prevention, and restoration. Current annual funding for earthquake disaster countermeasures is about $2 billion. This funding is just for earthquakes. The whole Japanese disaster program is budgeted at about $7 to $10 million. Disaster mitigation clearly is something that they take very seriously.

(Slide.) The framework of earthquake disaster countermeasures includes:

1. Making Cities More Disaster Resistant

   o Securing and equipping evacuation routes and areas

   o Making cities less flammable

   o Upgrading earthquake-resistant standards for buildings

   o Assessing and strengthening existing buildings

   o Making lifelines more disaster resistant

   o Equipping disaster prevention bases

2. Strengthening Disaster Prevention Systems

   o Setting up operational and local plans

   o Setting up radio communication network

   o Securing emergency supplies

   o Disseminating knowledge about earthquake disasters

   o Conducting earthquake disaster countermeasures drills

   o Developing autonomous disaster prevention organizations

3. Promoting Earthquake Prediction

   o Developing an observatory system

   o Researching earthquake prediction.

(Slide showing seismometer.) Japan has installed hundreds of seismometers, one of which is doing quite a dance here...

I am pleased to have had this opportunity to share with you some of the things the Japanese are doing. I think we can look to them as colleagues and to their work as models of some things that other developed countries ought to do.

(p. 91 follows)

YUGOSLAVIA SEISMIC NETWORK PROGRAM

ALBERT M. ROGERS
U.S. Geological Survey

This talk concerns a cooperative project between the USGS, the Earthquake Engineering Research Institute, or IZIIS, and the University Kiril and Metodij in Skopje. Skopje is the major city in the Republic of Macedonia, Yugoslavia. The objective of the project is to install a telemetered short-period seismic network in Macedonia to study low-level seismicity. The project is funded by the Yugoslav-American Joint Board for Science and Technology. The participating scientists are Dr. Dimitar Jurovski, Dr. Dragan Hadzijevski, Mr. Lazo Pekevski, and Ms. Tanja Olumceva. I am the USGS participant.

(Slide, Seismicity of the Mediterranean.) This figure shows all events greater than magnitude 5 in the Mediterranean region. Yugoslavia is shown in blue. Earthquakes in this region occur as a result of complexities in the convergence process between the African and Eurasian plates and the closure of the Mediterranean. Many damaging earthquakes have occurred in Yugoslavia, and this fact piqued interest in seismology and earthquake engineering studies in Yugoslavia very early in the history of seismology. In fact, as an historical aside, one of the most famous seismologists, Andrija Mohorovicic, was from Zagreb. In addition to discovering the thickness of the earth's crust, Mohorovicic, who was a practicing seismologist from the early 1890s, also had a strong interest in earthquake engineering. He was the first to approximate the behavior of buildings by modeling them as inverted pendulums, considering their behavior in response to harmonic motion. Among the conclusions from his studies was that one should avoid building structures on soft or steep ground, and that buildings should be constructed with bearing elements that are tied together. He also noted that, although it may be impossible to build a structure to resist the strongest ground shaking, building safety could be improved with good design and construction practice. These conclusions are still applicable in many parts of the world, including some parts of the United States, to city planning and construction practices to resist earthquake shaking.

(Slide, Seismicity of Yugoslavia.) This figure shows all the seismicity in the vicinity of Yugoslavia. A number of intense zones of seismicity can be seen, including an offshore zone that has produced several earthquakes greater than magnitude 7. The most recent event, in 1979, resulted in the collapse of numerous hotels along the Dalmatian coast. Fortunately, most of these hotels were closed for the winter at the time of the earthquake.

(Slide.) The zone of seismicity in the southern part of Yugoslavia, in Macedonia, is the subject of this cooperative project. The principal earthquake zones in Macedonia occur along a northwest-southeast trend through the center of the Republic, along the western border with Albania, and as a pocket of intense activity on the east near the Bulgarian border.

(Slide, Seismicity of Macedonia.) This map shows the seismicity of Macedonia superimposed on a generalized tectonic map. There are four presumed deep-seated ancient fault zones, but these faults appear to be largely inactive. Seismicity appears to occur most frequently in association with grabens that are superimposed on older structures. These features, which are Neogene and Quaternary in age, exhibit trends striking northwest. Some of these young features, however, also have strikes that are transverse to the main trend.

I want to discuss one earthquake in particular that had a large impact in this area: the Skopje earthquake of July 26, 1963. This earthquake is important because it occurred in a populous industrialized area during a time of rapid growth. The damage had a serious economic impact and resulted in changes in building codes in Yugoslavia.

(Slide, Damaged Highrise.) This slide shows damage from this earthquake to a six-story apartment building with a soft first story. The Skopje earthquake, which was only M=6-6.5, occurred very close to the city, where the Mercalli intensity almost reached the IX level. It was a shallow earthquake, occurring at five kilometers, although no surface rupture was observed. Over 1,000 people were killed and 3,700 were injured. Sixty-five percent of the houses were destroyed or damaged beyond repair, and seventy-five percent of the inhabitants were left homeless. For the most part, tall modern buildings, although not designed to resist earthquake forces, were affected only moderately. This structure was one of the exceptions. The buildings that suffered most heavily were multi-story brick masonry apartments of poor construction. Poor quality mortar, untied cross walls, and stair wells used as bearing walls were some of the contributing factors. These structures were built during a rapid post-war expansion period without the benefit of building codes.

This earthquake had at least two positive after-effects. A year after the earthquake, in 1964, the country established the *National Provisional Engineering Standards for Construction in Seismic Areas*, the Yugoslavians' first building code. Secondly, a UNESCO-sponsored study was conducted. Among many practical recommendations concerning building practices, UNESCO suggested the establishment of an Earthquake Engineering Training School and Research Institute and the establishment of a modern seismic network. The Institute was created a year or two after the earthquake, as IZIIS, the group participating in this cooperative project. This project, hopefully, will fulfill the UNESCO recommendation for a seismic network.

(Slide, Proposed Network.) This map shows the location of a six-station radio telemetered network that we plan to install in Macedonia this summer and fall. The network will have vertical component seismometers, operating at very high magnification to permit the location of all earthquakes in this region greater than about magnitude 1.5-2.0, with the location of some events as small as magnitude zero.

The data from this network will provide earthquake epicenter estimates that are accurate within one to two kilometers. Focal depth estimates will be available for the first time. Focal mechanism determinations also may be possible in this region for the first time. Accurate hypocentral locations and focal mechanisms, which provide information about slip sense on faults and the regional stress field, are critical data in any attempt to understand the tectonics of a region.

Multiple benefits will result from this kind of detailed seismic information. First, it will be possible to begin to establish which faults are active. Second, it will be possible to begin tectonic modeling to explain contemporary deformation processes in this intraplate environment, and this understanding will lead to greater confidence concerning expected active source zones. Third, data on the recurrence of earthquakes in the region may be obtained, and, finally, the attenuation of low-level ground motion can be studied to infer the characteristics of strong shaking.

(Slide, Probabilistic Modeling.) Each of these kinds of information is critical in studies that attempt to define the seismic hazard for a region. In addition to scientific research that will evolve from such studies, the practical benefit of network studies is that they increase the database available to produce realistic estimates of the seismic hazard.

(p.95 follows)

EARTHQUAKE HAZARD ASSESSMENT SOUTHERN EUROPE AND SAUDI ARABIA

S.T. ALGERMISSEN
U.S. Geological Survey

(Slide.) About 1.5 percent of the total energy released per year in earthquakes occurs in Southern Europe, Greece and Turkey. Recent damaging earthquakes in Italy have received widespread public attention; however, damaging shocks are known historically in Italy from at least 63 A.D. Many recent damaging shocks have occurred in Eastern Europe, including the 1977 Romanian earthquake that resulted in heavy damage and 1,000 fatalities in Bucharest. About 2,500 people were killed in the 1966 earthquake in Eastern Turkey near Varto. Skopje, the capital of Macedonia, was severely damaged in 1963 as it had been in 1555 and 518.

(Slide.) There is considerable seismicity in North Africa as well. Earthquakes here tend to be very shallow but, even though not very large, they have resulted in large losses throughout history. In contrast, the losses from many intermediate-depth earthquakes in Greece have been somewhat mitigated.

An excellent database for the evaluation of seismic hazard exists throughout Europe as a result of the work of various scientific groups within each country and through the efforts of various international organizations such as UNESCO, UNDRO, and UNDP. Probabilistic seismic hazard evaluations are available for France, West Germany, and Italy. In 1971, UNDP-UNESCO initiated the project, *Survey of the Seismicity of the Balkan Region*, to develop seismological and seismotectonic data for the evaluation of seismic hazard. This was one of the pioneering studies in earthquake hazard and risk analysis, and the USGS participated in it. The countries that participated were Bulgaria, Greece, Rumania, Turkey, and Yugoslavia. The project developed much useful data, including an earthquake catalog, a series of seismotectonic maps and assessments of earthquake hazards by the various national groups. As part of the project, USGS helped to produce a series of probabilistic ground-motion maps for the entire region of three types: intensity, acceleration, and velocity. The intensity maps were prepared by consultants to the project from the Soviet Union (N.V. Shebalin and others, 1976). The acceleration and velocity maps were prepared by consultants to the project from the United States (Algermissen and others, 1976). Since the conclusion of the project, many other projects supported by UNDP, UNESCO, and UNDRO and the various national groups have extended the work of the original *Survey of the Seismicity of the Balkan Region.*

It is clear that the seismological and geological database available for the European area is quite adequate for the analysis of seismic hazard, and that a number of assessments of seismic hazards are available in the technical literature. Work is needed to reduce these studies to a common base. This is not a trivial job, but it is easier than starting from scratch. A *synthesis* of the databases and the hazard assessments now is needed so that the earthquake hazard can be evaluated comparatively from site to site on a regional basis.

(*Question from Dallas Peck:* What do you mean?

A: Common systematics. Different catalogs have been used, and there are different ideas about how the seismic rays are attenuated. This makes it difficult to compare ground motion in Algeria with that in Yugoslavia. At any rate, if you produce probabilistic hazard maps with a common technique and basis of data, one of the comparisons that can be made is the sort of thing shown in this slide.)

(Slide showing seismic hazard acceleration and exposure time.) Principally as a result of concern over the damaging North Yemen earthquake of 1982, the USGS entered into an agreement with the Kingdom of Saudi Arabia in 1985 to prepare probabilistic ground acceleration and velocity maps of western Saudi Arabia. The principal sources of earthquakes that might affect Saudi Arabia are the Dead Sea and Red Sea rifts, boundaries between the Arabian plate and the Sinai and Nubian plates. There is, however, some historical evidence going back as far as the Middle Ages of damaging shocks on the Arabian peninsula. (Slide showing acceleration in 50 years in western Saudi Arabia.) Maps of the expected maximum horizontal ground acceleration and velocity with a ten percent chance of exceedence in 100 years were prepared for Saudi Arabia (Thenhaus and others, 1987). The results of this investigation show that the earthquake hazard in western Saudi Arabia is fairly low.

Much of East Africa, however, has a substantially high seismic hazard because of the seismicity of the East African Rift. The East African Rift system is a good example of a "pulled apart," or, extensional plate boundary. The rift system is complex with associated earthquake activity extending from Ethiopia to South Africa. As we go further down East Africa, there is considerable seismicity which, so far as I know, has not been much studied. The historical catalog is almost totally restricted to events from 20 to 25 years ago, although we know the large shocks from about 1900. Very little research has been done to define either the seismic hazard or even assemble the seismological and seismotectonic data necessary for an earthquake hazard assessment of East Africa.

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Wednesday, March 9, 1988

SESSION IV

ELEMENTS OF AN INITIATIVE TO PROVIDE THE REQUIRED KNOWLEDGE TO OPTIMIZE STRATEGIC PLANNING AND RISK MANAGEMENT WITH RESPECT TO EARTHQUAKE HAZARD THROUGHOUT THE WORLD

Moderator Frank E. McClure, President, Earthquake Engineering Research Institute

Objective Brief the participants on elements of the OFDA/USGS initiative that will, when implemented, develop networks to assist the strategic planning process of investors, developers, and insurers throughout the world and improve the self-reliance and technical capability of foreign professionals to devise and enact the best risk management procedures for their country to deal with earthquake-related problems.

Panel Discussion The framework of an initiative for enhancing strategic planning and risk management throughout the world to deal with earthquake-related problems.

THE KNOWLEDGE UTILIZATION PROCESS

WALTER W. HAYS
U.S. Geological Survey

INTRODUCTION

An urgent need exists for earthquake risk management on all scales -- global, regional, and national. When maps are superimposed showing: (a) the seismicity; and (b) the location of financial investments and capital improvements that are either being made or planned by individual nations, institutions of the worldwide financial sector, and agencies of the United States Government, it is clear that the economic value of the dwellings, buildings, public and private facilities, and lifeline systems that are at risk from earthquakes is not only very large (trillions of dollars on the global scale), but also that it is growing exponentially with time. **This situation calls for action now!**

ANSWERS TO THE CRITICAL QUESTIONS

To adopt and implement earthquake risk management policies on global, regional, and national scales, answers are needed to three questions:

1. Is the existing base of technical knowledge adequate for defining the spatial and temporal nature of the earthquake hazard in terms that meet the needs of earthquake risk managers of both the nation at risk and of the worldwide financial community?

2. Do we know the most effective way to utilize the existing base of knowledge and the process for transforming that knowledge into practice applications to achieve the goals of risk management?

3. How and where do we start? What do we do first?

The answer to the first question is "yes." The earthquake risk management process is feasible in every nation, starting with the existing knowledge base. We plan to identify 15 countries where we believe the initiative can be the most effective. The selection criteria will be based on factors such as:

1. USAID/OFDA has programs in the country;

2. The worldwide financial community has, or is planning to institute, significant programs in the country; and

3. USGS has access to basic geologic, seismological, and geotechnical data needed for constructing hazard maps in the country and has established interpersonal networks.

The answer to the second question is also "yes." A clear understanding of the knowledge utilization process now exists. After more than 10 years of experience in the United States National Earthquake Hazards Reduction Program and numerous international programs, we know that the process works most effectively by building partnerships on global, regional, and national scales.

Our empirical knowledge about this subject is based on 10 years of experience, working with our partner, FEMA, in transferring information through some 37 workshops.

The National Science Foundation and National Bureau of Standards have been partners in four or five other workshops. **We believe we have identified the key elements.** These elements are the actions that put the information in the right place at the right time, translating the data into non-scientific language, and then communicating that information in a two-way exchange between those that have it and those that need it. The final element is converting the knowledge learned through research into practice through various applications. The latter step enlightens those involved in implementation, serves decisionmaking uses, and effects changes in practice.

Several elements are required to ensure success in transferring information from scientists to the various user groups, regardless of the site where the transfer is taking place. The rules for Algeria are the same as for the United States or some other country, and include:

- the need for information transfer must be identified and understood;
- there must be internal advisors familiar with the subject;
- there must be external champions of the need to transfer information;
- there has to be a credible, user-friendly product;
- the information to be transferred must be politically and economically useful;
- the window of opportunity must be seen and taken.

The knowledge utilization process, as it relates to risk management, has five integrated components that flow in time. They are:

1. **Research** -- studies designed to increase the base of fundamental knowledge;
2. **Dissemination** -- actions that place the research results and products (maps) in the hands of risk managers and key professionals;
3. **Translation** -- actions that give risk managers the answers to four critical questions: *where, when, how bad*, and *how often*;
4. **Communication** -- a two-way exchange of information that increases the likelihood that risk managers will adopt realistic risk management policies; and
5. **Applications** -- actions that enlighten, provide a basis for decisionmaking, and lead to realistic changes in practice.

The risk management process in every nation depends on seven factors:

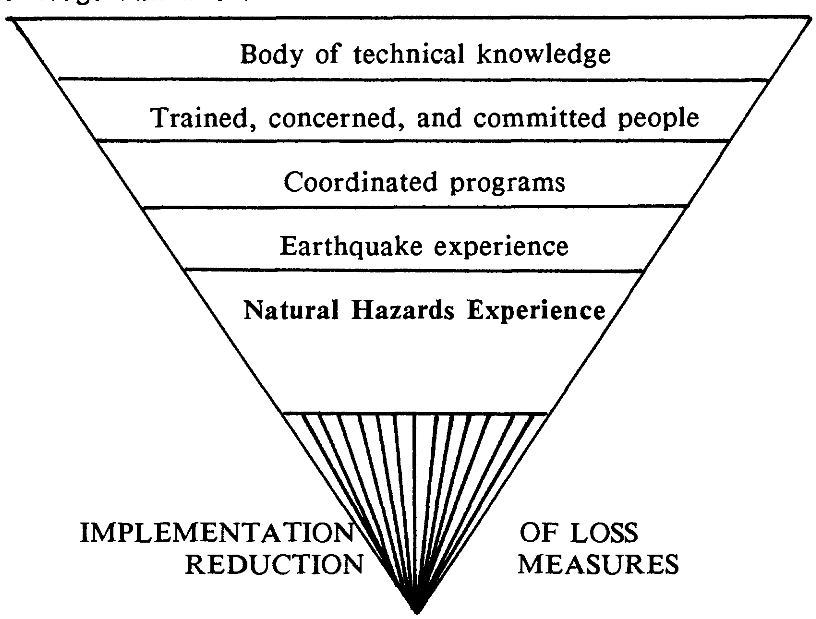
- a perceived need for risk reduction;
- informed internal advisors;
- strong external champions;

- o credible products;
- o user-friendly products;
- o balanced political, legal, and economic considerations; and
- o a window of opportunity.

The lack of any one of these seven elements invites the failure of the program. On the other hand, success is virtually assured when all of these factors are present. The applicable rule is:

> *The probability of success increases in direct proportion to the number of factors present in the process.*

The knowledge utilization pyramid, inverted, helps to visualize one very important aspect of knowledge utilization:



If the people involved in technology transfer are unconcerned and uncommitted, or programs are not coordinated, or there is little actual earthquake experience, the probability for success is low.

Another important aspect of information transfer relates to the stimulus for action. For example, an agency can produce excellent publications; but unless the audience for the publications is motivated to act on the information they contain, the effort will fail even if the documents are leather-bound and gold-embossed. The true test of the effectiveness of a publication is quite simple. It is found in the response to the question, *Did anyone take action as a result of reading this publication?* **The fact is that very little action results from publications by themselves.**

If high-quality publications fail to solve problems of information transfer, then how are they solved? The answer is that a combination of activities must occur to motivate people to take action in response to useable information. One of these activities is to bring people together -- people who have training with those who need their knowledge -- taking advantage of the ability of available experts to serve as advocates and advisors.

Technical lessons have been learned and relearned from past earthquakes and, at a minimum, we should be able to disseminate that knowledge effectively. One report produced by the Earthquake Engineering Research Institute in 1986, for example, synthesizes the information gained from more than 200 earthquakes and post-earthquake investigations since 1964. We *know* what will happen when unreinforced masonry buildings are subjected to strains from ground shaking. Yet, we continue to underestimate the damage they will incur as a result of earthquake ground shaking and to build them in the same way.

Last, we must ensure that information is in a form that the user will understand. Not only must we translate scientific language into laymen's language for the benefit of the non-scientific users, we must do it in whatever language the users understand best, whether it be Spanish, French, or English.

The answer to the third question (*How and when to start and what to do first?*) is that the greatest progress is made when risk managers focus on four basic elements in an earthquake-prone nation, letting all other applications evolve from them. They are:

1. **Hazard Mapping** to provide risk managers with the products they need to make realistic decisions for protecting their investments.

   Hundreds of billions of dollars could be saved in the remainder of the 20th Century and over the 50-year average life of a building if all risk management policies were based on a building code having a uniform world earthquake ground-shaking hazard map.

   In the WWERM program, we expect that 15 selected countries, covering various regions of the world, will be mapped within a five-year period of time, the initial step for a worldwide ground-shaking hazard map (see Appendix 4). The critical regions are:

   a. Central American and the Caribbean Basin,
   b. South America,
   c. The Mediterranean region, and
   d. Southeast Asia.

2. **Improved practices** for design, construction, and land use that are based on realistic procedures for damage and loss control that we have learned and relearned from past earthquakes.

   Hundreds of billions of dollars could be saved by adopting and implementing improved damage and loss control measures.

   The WWERM focus on improved practice will be in the 15 countries that are selected, plus, as appropriate, some of their neighbors.

3. **Professional skill enhancement** to develop greater self-reliance and capability of professionals in earthquake-prone nations to protect lives and property through wiser risk management.

4. **Networking** on global and regional scales that leads to optimal synergism between people and programs.

Initiation and accomplishment of these four actions will greatly enhance earthquake risk management throughout the world.

(*Comment by the Moderator, Mr. Frank McClure*): The two charts showing components of a successful research project and how people learn and become involved are very important (see Appendix 5). They show clearly the challenge we face. Walt has shown us the road map. His work in Algeria, discussed yesterday, has proven that it can be done effectively. We believe that this meeting will be one of the windows of opportunity he discussed.

(p. 105 follows)

A PROGRAM FOR GLOBAL EARTHQUAKE HAZARD ANALYSIS

S. T. ALGERMISSEN
U.S. Geological Survey

Improvements in our ability to mitigate earthquake effects depend upon a better understanding of the hazards associated with earthquakes and the application of that knowledge for better evaluation of the losses associated with earthquakes. Appropriate ranking of risks should lead to the optimization of resources for disaster preparedness, mitigation, land-use planning, insurance, investment, and other important elements of earthquake hazard management and risk assessment.

Both deterministic and probabilistic methods can be used effectively in hazard management and risk assessment. Deterministic, scenario-type simulation of the effects and losses associated with very large earthquakes that may occur are very valuable for disaster-relief planning and determining the catastrophic economic potential that exists in specific areas. Probabilistic seismic hazard and risk assessments are very valuable on a global basis because they establish a quantitative basis for ranking the hazards and risks worldwide. **It is important to understand that a uniform method of probabilistic analysis must be used worldwide in order for the assessments to have the maximum utility.**

In practice, a global probabilistic assessment should provide the basic information for the selection of specific areas of high risk where it may be particularly valuable to prepare a deterministic scenario of possible earthquake effects and losses.

Probabilistic seismic hazard analysis has, within the past 10 years in the United States, become the technique of choice on which to base the earthquake design provisions of building codes. Development of global, uniformly-based, probabilistic ground-motion maps could lead to more effective descriptions of ground motions for those who develop the earthquake-resistant design provisions of building codes worldwide. The basic seismological and geological data for the global assessment of hazards and risks are available, and it is scientifically and technically feasible *now* to undertake this assessment. It is particularly appropriate to so do during the International Decade for Natural Disaster Reduction, since the potential economic benefits and savings in human life through such a global program are very great.

I would like to close my discussion by showing a few slides that illustrate a number of important points related to reducing earthquake losses and the development of a global assessment of hazards and risk.

The first slide shows an important fact: that, **in the aggregate, average annual losses are determined by the repetitive middle-sized earthquakes -- not the very large events.** Although many small losses may occur, and small ones considered together become large, it is a fact that there are more intermediate-size earthquakes than great ones. The curve, however, is affected by the insurance business in the nature of its policies regarding such factors as premium pricing and deductible levels. It is nevertheless important to understand the ground rules about the origin of the losses.

The hazard, the risk, and the losses are tied together. It is possible to measure loss as a function of the distance from the earthquake by class of construction or some other quantity. Several models of hazard and risk assessment, in fact, may be valid and may make it possible to apply realistic generalizations. **It is important for us to be familiar with these models so we can estimate more accurately the hazard and the risk in any given area, and then address the problem in a cost-effective way.**

A good deal of information has already been developed throughout much of the world, and results are now available from large programs funded by USAID/OFDA and those which the USGS has sponsored. The general picture is that we have very good data in South America and in the Far East. Although somewhat less precise in Central America, we have much more high-quality data than we had 20 years ago. I am encouraged by this increase and the potential availability of a global database, the information which will serve as the basis for meaningful risk management policies and practices.

Let me cite an example of one way in which losses can be greatly reduced. A regional, 250-bed hospital in Chile was badly damaged in the March 1985 earthquake. I was there last fall and the hospital was still not in operation, but the structure was being used as a kind of clinic, despite the fact that it is the only hospital within about 100 miles. The hospital building was subjected to very high levels of ground motion, as measured by a strong-motion instrument in operation near this hospital. The point I want to make is that the hospital is located in an area underlain by about 40 meters of beach terrace deposits. **If the hospital were located a mere 200 meters away, it would have been sited on coastal bathylitic material where we know that the ground motions were no more than one-third of what they were at the actual site of the hospital.** This example, I hope, will be a lesson for the future when buildings will not be located on beach sands, negating the expenditure of a great deal of money to ensure an adequate design in terms of the seismic threat and the importance of the facility.

Finally, a model strategy for mitigating earthquake effects involves disaster preparedness as one goal and disaster mitigation as the other. Products of interest to investors, the insurance industry, preparedness and response personnel, and others can be packaged to make a sizeable contribution to both of these goals.

THE NSF KNOWLEDGE UTILIZATION STUDY

Extemporaneous remarks of

WILLIAM A. ANDERSON
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Division of Fundamental, Emerging, and Critical Engineering Systems
National Science Foundation

The research the National Science Foundation has sponsored to identify elements of effective knowledge utilization tells us is that a great deal of interaction between producers and users of information is necessary, and that the rapidity with which new information is disseminated is a factor in how effectively the information is used. We have concluded that researchers and producers of information need to identify their target audience quickly and involve that audience in the research activity as soon as possible, because useful research results can begin emerging very early in the process. Ways in which the users can be involved include service on advisory committees and in discussion groups to identify user needs for research. The target audience also needs to be involved at intermediate levels and at the end of the research project, not only in terms of receiving documents, but also in terms of interaction. It is particularly important that users have opportunities to provide feedback to the research community.

Real social interaction results in information utilization when there also is a significant effort to get the message to the user community. Utilization does not occur with a one-time interaction. Written documents, conferences, workshops and other, multiple opportunities for interaction centered around the same body of knowledge are necessary, as is evaluation. Evaluation of the information transfer process makes it possible to refine the dissemination/knowledge transfer process to its most effective level. This, in a nutshell, is what we have learned.

In closing, I would like to say that we have identified various windows of opportunity in the process of researching this topic.

Q (Art Zeizel): Now that the National Science Foundation staff knows how the knowledge utilization transfer process works, could you tell us how NSF is applying it to their research programs?

We are doing a number of things:

1. We are making our findings available to the research community.

2. We are making our results available to people in our sister agencies. At FEMA, for example, there has been significant improvement in information transfer, in part because of the NSF research program results that we shared with that agency. The recent activity by the Building Seismic Safety Council (BSSC) is a good example. The new *1985 NEHRP Recommended Provisions of the Development of Seismic Regulations for New Buildings* (the "Provisions" or "Recommended Provisions") have been developed. Not only did BSSC develop these, but they also spelled out the social context in which the Recommended Provisions will have to be presented to communities around the country. One of the documents FEMA produced dealt with the social and economic factors that must be dealt with in utilizing the Provisions; it will facilitate that utilization.

3. Finally, we are working with USGS and FEMA in developing effective workshops. In 1987, we looked at how research results have been used around the country in various regions of the United States, and reached some interesting conclusions. Within a few weeks, USGS will document these conclusions in a publication for use in important activities at NSF, NBS, USGS, and FEMA, and will indicate to what degree and why the results of those activities are being utilized around the country. We expect to learn important lessons from this project.

IMPROVED PRACTICES IN DESIGN AND CONSTRUCTION: CODES

EDGAR V. LEYENDECKER
U.S. Geological Survey
Golden, Colorado

Major earthquake losses may occur in a single event, such as in Mexico City in 1985 (M_S=8.1 on September 19 followed by a M_S=7.3 aftershock on September 20), or the losses may accumulate into major amounts with a series of relatively minor earthquakes, such as the 1987 Whittier Narrows Earthquake (M_L=5.9 on October 1). In certain areas, accumulated losses due to a series of relatively small earthquakes may be a bigger problem than a single large event. There are things that can be done today to mitigate against these losses. We can always do better tomorrow by using knowledge gained yesterday. We do not have to wait to gain immediate benefits; **we can use what we know now to make substantial reductions in the potential losses.**

Major potential for loss lies with existing construction that has not been designed to incorporate earthquake resistance. This danger has been recognized in some areas and retrofit programs have been initiated. The City of Los Angeles, for example, has had such a program for strengthening unreinforced masonry structures for a number of years. This is a difficult problem, and considerable research has been conducted to address it. The fact that there exists underdesigned construction need not preclude our taking action on new construction. **There is no need to add to an inventory of underdesigned structures.**

Although knowledge is incomplete, considerable relevant information is available about vulnerability of different types of construction, such as masonry, timber, concrete, etc. Knowing this, design guides have evolved that give credit to the materials that are the best performers and try to correct or adjust for the others. Guides also prescribe construction practices, such as minimum amounts of reinforcing steel in concrete construction, that are to be used regardless of level of ground shaking.

Design guides also translate ground motion from seismic maps into appropriate levels of earthquake design requirements for structures. This information allows proper consideration of ground motion at a site. In some cases these data may indicate that a site is very expensive to develop, or that it should be avoided. Both deterministic and probabilistic techniques provide an objective, uniform comparison of the hazard at many locations. This is an important factor when potential impacts of the earthquake hazard are being evaluated worldwide. More and more modern design guides are either using or moving toward using probabilistic techniques.

New knowledge will continue to be developed and work its way into practice. Mexico City illustrated in a tragic way the need to consider site amplification and the effect that distant earthquakes can have on tall buildings when sited on the wrong types of soil deposits. While these effects were not unknown, this earthquake demonstrated their destructive potential and pointed to the need for appropriate future consideration of such effects. The same earthquake served as a grim reminder of the risk to life and investment involved in the failure of a single multi-story building. **This reminder is very important as increasing land prices and population density push the heights of buildings upward.**

There are various kinds of documents available as guides for earthquake design of structures. The documents may be called by different names depending on the type of structure, *e.g.*, building or bridge; or the level of enforcement, *e.g.*, a specific job or a legal jurisdiction. A building code, for example, is a document containing legal requirements for design of buildings in a specific jurisdiction. Specifications and standards are names of other kinds of design documents. The term "codes" is used loosely in this presentation to include all of these documents.

A number of codes are available that might be suitable models for use in earthquake design. Perhaps the *Uniform Building Code* published by the International Conference of Building Offices (1988 is the most recent edition) is one of the best known. The 1985 *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings* is also a good reference document and is being revised for a 1988 edition. Importantly, the NEHRP Provisions incorporate probabilistic ground motion into design procedures. The proposed revision also includes a convenient relationship for translating data contained in seismic maps directly into design requirements. The effects of distant earthquakes also are considered explicitly.

How much will it cost? This important question is difficult to answer precisely; however, limited comparative studies have been made using the 1985 NEHRP Provisions. These studies indicate that there is little difference in cost when compared to a code such as the *Uniform Building Code* in an area currently enforcing such a code. Depending on the structure, costs may be slightly higher or lower. These same studies indicate that cost increases may be significant, perhaps 15 or 20 percent higher, when a seismic code such as the NEHRP Provisions or the *Uniform Building Code* is implemented in an area where the hazard is high (accelerations on the order of 30 percent of gravity) but no seismic code is being used. One has only to look at a few recent earthquakes such as those affected Mexico City (at least $4.0 billion in primary losses to buildings and at least 8,000 fatalities) or Managua (about $850 million, 1972 dollars, in primary losses to buildings and 9,000 to 10,000 fatalities) to see that a reduction of only a few percent in the losses in those cities would have had enormous benefits. Introduction and enforcement of a modern code would certainly contribute to reducing such losses and would not appear to be an excessively costly mitigation measure to implement.

Codes can provide considerable guidance to the designer of a structure. While they will not eliminate all failures, they will reduce the risk. Knowledge of earthquake design and good judgment in applying this knowledge are critical. The need for that knowledge is one reason why professional skill enhancement and networking are so important. With the tools under development, maps, and the available current code documents, we can proceed to manage risk, in part, through improved design and construction practices.

Although it will take time to institute modern codes over the globe, **there are some things that can be done *now*** with or without building codes. Some of these are:

- A program to help the business community look at siting issues more carefully would be very worthwhile. The insurance and financial communities, rather than advising investors against locating structures in areas where code enforcement is expensive (thus driving the investors into an area with less stringent construction requirements), should be educated to take a more positive view. After all, investors logically should *want* to locate structures where they are protected by the best available building codes.

- We should proceed quickly to use existing documents that contain information that is ready for transfer to practice standards. There is a tendency to want to wait for the perfect document which, of course, does not exist. We should reorder our thinking and proceed to transfer existing knowledge *now*, as has been done in the three "model" codes that are currently in use in the United States (illustrated by slide).

- More attention than ever before is now being paid to the contents of buildings. Managers of very expensive computer facilities, for example, must be cognizant of the consequences of earthquake damage. They ask themselves *How long are the computers likely to be non-functional? What alternative measures can we take to ensure that critical operations can continue unabated or at minimally acceptable levels?* When these questions are addressed, managers may decide to upgrade existing levels of earthquake resistance. The knowledge to do so exists *now*.

- The capability exists *now* to assess seismic risk, estimate ground motion, and translate the results into provisions of building codes. (Slide.) This gives you an idea of how this is done throughout the United States. Referring to the September 19, 1985, Mexico earthquake, (slide), we see that the vertical axis represents the force being imposed on buildings; the horizontal axis, the height of the building; and the time period is 10 percent. This slide depicts a building of about 20 stories. The yellow curve is the design curve required in Mexico City prior to the 1985 earthquake. The blue line shows the kinds of damaging forces to which the buildings were subjected. Damage was a function of height; buildings in the 15-to-20-story range incurred the most damage. These illustrations show how ground motions can be predicted at particular sites. (A slide representing estimated ground motions in California was shown to compare and contrast its estimates with those in Mexico City.)

- A good, sound building code can be implemented *now* on the basis of existing knowledge, and understanding that it takes between 10 and 15 years to change a code. (Slide depicting a hospital in the San Fernando earthquake where the first story was partially collapsed because existing knowledge had not been applied in designing and constructing the structure.) One of the best things that can be done *now* for new buildings is to improve the codes right away.

- Although existing buildings are a problem, we have a responsibility not to add to that problem by building new structures not designed on the basis of currently available knowledge. (Slide showing a school building in California that has been retrofitted.) We also can encourage the application of knowledge to retrofit programs.

In our efforts to institute immediate mitigation measures, it is important that we remember to include bridges and other structures as well as buildings.

Finally, before picking up a building code and trying to adapt it for local use, a number of questions should be addressed. Among the most important are: *What is the local building philosophy? What types and levels of damage are acceptable in this community?* Although some concerned observers would hope that no damage is ever acceptable, the costs involved in implementing mitigation measures at maximum levels present an obstacle that must be balanced against the acceptability factor. Thus, compiling a code could be considered a matter of economics. For example, limited damage will be tolerated in major earthquakes, whereas the collapse of structures will not. Less damage would be accepted in moderate earthquakes. A careful look at the local building code will uncover the applicable building philosophy being practiced.

(p. 113 follows)

NETWORKING THE WORLDWIDE EARTHQUAKE RISK MANAGEMENT PROJECT

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U.S. Geological Survey
Department of the Interior

FRED M. COLE
Office of U.S. Foreign Disaster Assistance
Agency for International Development

REMARKS OF MR. SHEARER

Available research makes clear several points about how to effectively transfer technology and information to individuals in government, business, industry, and the public sector. Among them are:

- Persistent social interaction between researchers and potential users of their research leads to a "marketplace of ideas." In contrast, utilization of research is impaired when conducted in a more traditional manner, *i.e.*, removed from the potential users.

- An advisor may have to repeatedly explain, defend, and modify his proposal.

- Communication is a process, not an act.

- Technology transfer is enhanced greatly when there are internal champions, *i.e.*, those in a position to defend, redefine, and promote agendas from within an organization.

The Worldwide Earthquake Risk Management project is designed to take advantage of these findings, considering that the process has been demonstrated to be effective both in the United States (*e.g.*, Los Angeles) and abroad (*e.g.*, Algeria).

Many individuals involved in the WWERM project also participate in well-established networks that will be useful in this endeavor. One goal of the WWERM initiative is to build upon these networks. For each of the 15 countries selected to be in the project, a network will be created of scientists, financiers, government officials, and others whose constant interaction will generate a synergism of ideas, products, and advocacy useful in earthquake risk management activities. This synergism and network-building begins with this executive briefing. We hope that participants will reflect upon the issues and the proposal and work with the Worldwide Earthquake Risk Management project.

Panel C has offered suggestions and names of organizations that will help the WWERM project managers reach their goals. We solicit ideas, names of organizations and representatives that can help us and provide assistance over the next five years. Worldwide Earthquake Risk Management project managers will work continuously with network members, and meet yearly with selected participants to review progress and negotiate needed mid-course changes, particularly when a significant opportunity to accelerate the transfer of technology presents itself.

REMARKS OF MR. COLE

The most important benefits of my work for Mrs. Julia Taft are the opportunities I have for networking. In my 14 years at OFDA, I have been to the four corners of the earth and met with people such as those here today. I have shelves loaded with conference proceedings, Christmas cards, and hundreds of names and faces in my head. These are extremely valuable to me. This is networking -- and it works.

Some kinds of networking are qualitative and *ad hoc*, as this slide shows (slide). Going into the International Decade brings home in a particularly striking way the fact that demands for information dissemination are satisfied by networking.

We are supposed to make sure that all the knowledge we possess gets to the communities that want to use that knowledge. Consequently, we have to help those communities define their own problems in ways that permit us to help them find solutions.

Diversity is one of the elements with which we must deal as we begin working on WWERM and the IDNDR. There is a great deal of knowledge available, but it is categorized in different ways. The social beings that Dr. Press referred to yesterday are involved in various ways and at various times of the disaster cycle. Some of us work within disciplines; others sell technologies. What we must do in the International Decade is to devise ways and create opportunities in which individuals and activities over the entire spectrum can be brought together and viewed as a continuum. We see this as a task of the IDNDR committees -- the Danish National Committee and the Japanese National Committee, as well as the United States National Committee. (If I begin talking about "we" and "they," I do so in terms of "we" who have the information and "they" who use the information; so "we" at times will become "they.") We expect that the United States National Committee will devise a format and define the content of information to give to the users.

Perhaps the greatest and most difficult task will be to respond to the United Nations Secretary General's offer to the world that information will be processed for universal application. Some entities at the United Nations are prepared to support this activity, and our office has decided to look at how this can be accomplished. It will be a tremendous job for all who become involved.

It seems to me (and this admittedly may be a personal bias) that it is particularly important to filter information and package it so that individuals in various regions of the world can understand it. Each of us who has worked abroad can see similarities that lend themselves to particular approaches to problems among contiguous countries in various geographical regions. Nevertheless, it will be extremely difficult to determine how India, for example, could use a particular body of knowledge, or what regional peculiarities must be considered in preparing information for the Subcontinent. This concept fits with the Secretary General's idea that there should be regional collaborating agencies, and that we should determine how those agencies are constituted.

We also must be acutely sensitive to the fact that the approach which works in one region of the world will not always work in another. My own interest in the area around Bangkok leads me to believe that it is one area that meets the criteria under discussion for countries that will be included in the WWERM.

I would like to reiterate the importance of translating information not only from Spanish to English, for example, and vice versa, but also translating ideas through the barriers of cultural differences. Without attention to that element, we cannot expect to be successful.

The Asia Institute of Technology (AIT) is an institution that deals primarily with educational matters. It has worked through the years with virtually all the countries of Asia and the South Pacific, and their needs affect the composition of the AIT faculty. At a recent meeting at AIT, we discussed its new education program, which focuses on disaster relief management and has been enormously effective. To date, 150 people have completed the management course. These 150 are prime networking examples. The AIT staff report that, once the management course is completed, the participants keep coming back to Bangkok, asking questions and discussing their activities with the staff. Perhaps the AIT model can serve, at least in part, as an answer to the need for establishing regional centers where people who require information can go to get it.

ADDITIONAL REMARKS OF MR. SHEARER

Much has been said during the past two days. Rather than repeat it, I will simply say that I am encouraged by the fact that many speakers have reinforced my own ideas, and I will try to tie together some of the elements of networking that have been discussed.

A question of one speaker comes quickly to mind: *Do we know how to transform our basic knowledge into applications?* This question is based on our national experience, including the NEHRP and local activities such as the Southern California Earthquake Preparedness Project (SCEPP). Then we heard from Kirk Rodgers of the OAS and Alcira Kreimer of the World Bank that the social scientists have been talking for many years about this same issue in terms of key elements of research utilization.

I will show some slide that will help to illustrate three of the elements we accept as necessary to successfully impart knowledge about the results of scientific investigation to end users in the communities of disaster mitigation and response.

1. The first point, a key element, is that a "marketplace of ideas" must be created, as modeled by this book marketplace in France, where researchers and users frequently come together. Perhaps such a marketplace will be helpful in developing a better design for the Worldwide Earthquake Risk Management Project, and thus help the project get off to a good start.

2. The second point relates to the role of outside advisors. It is difficult and time-consuming to assemble a qualified, effective, and willing cadre of advisors. One reason is that each member of the group must be educated about all aspects of the program on which advice is needed.

3. The third point concerns internal champions. Internal champions are needed to give direction and leadership to our efforts to improve earthquake risk management.

I also would like to add a few words about another essential component of information transfer: networking. As shown in this slide, the Worldwide Earthquake Risk Management project will have global, regional, and national components, carried out by four different groups: country organizations, government agencies, researchers, and regional organizations. No matter how much emphasis has been, or will be, given to networking, **the structure of the WWERM program initiative makes clear the belief that WWERM will fail without efficient, long-term networking.**

How will we accomplish this networking? This briefing is the first of many convenings where risk management information will be exchanged from several perspectives. Each meeting has its own special advantages. For instance, in this briefing I have learned about The World Bank projects, the insurance industry, the "get upstream" concept of the Organization of American States (OAS), and a few planning projects that are underway. Because of its value, this same process will be used in our networking. The Worldwide Earthquake Risk Management program initiative has built-in opportunities to meet, review programs, and learn from people having different backgrounds about the things they consider to be really important so we can develop a better product. We plan to have annual meetings to update our knowledge and evaluate investment strategies. We want to be located in the most propitious places for meeting our goals to save lives and money. We will need to meet occasionally just to be sure we are on the right track. There will be unplanned chances to meet and advance program goals, and we will take full advantage of these as windows of opportunity.

During the course of the WWERM program initiative, there probably will be one or more damaging earthquakes. We will want to know how The World Bank helps with reconstruction, or how participants in the International Decade from the affected area respond to the disaster. (Slide.) By reaching out and getting a broad network of people to fill out this networking chart we will find the internal champions here to help the project take advantage of the windows of opportunity. I hope all of the people here today will take the initiative to bring to our attention any matter of concern that we can address as the WWERM initiative goes forward.

All of this -- the marketplace of ideas, persistent advisors, and internal champions -- adds up to a synergism of labor, of thought, and needs not just a little serendipity.

ENHANCING EARTHQUAKE RISK MANAGEMENT THROUGH THE USE OF INTERACTIVE WORKSHOPS

PAULA L. GORI
U.S. Geological Survey

Interactive workshops are critically important to effective earthquake risk management because they increase the communication between scientists and practitioners by:

1. Enhancing professional skills of local scientists, design professionals, and public officials to understand and practice damage and loss control;

2. Increasing the level of understanding by scientists of local needs which, in turn, is reflected in focused scientific research and usable products; and

3. Fostering long-term networking between individuals who gather earthquake risk information and those who use earthquake risk information at all levels of government and within the private sector.

Small, interactive workshops encourage networking and learning, two essential ingredients of successful earthquake risk management. Their primary value is in serving as a forum for familiarizing ultimate users of information with research findings and processes, and in bringing them together with important suppliers and other users of information about earthquake risks at all stages of a given project. Lines of communication develop quickly among workshop participants and become stronger as the projects on which they collaborate go forward. This networking process also contributes to the development of bonds among workshop participants by making visible the stake each one has in the ultimate success of the project.

Interactive workshops also, in some cases, serve as a catalyst for enhancing the operations of local programs. The USGS experience in Utah is a good example of this. Since 1983, the USGS has sponsored a program there to assess earthquake hazards and risks. When the program began, the state agency having responsibility for emergency management did not work closely with the agency that collects risk management information; the geologists communicated little, if at all, with the engineers; and the engineers lacked good communications with construction professionals. The USGS' own scientists were lax in disseminating information about their activities. Turf disputes and pockets of distrust among agencies also were evident. Yet, some good things were going on. Key people did meet at conferences and read each others' journals; but the kinds of personal interaction that networking encourages were absent. As a result, very little information filtered down to the end users; and although quite a bit of information in Utah had been published, very little of it was being used to implement earthquake hazard reduction activities.

This was the general atmosphere at the time the USGS program was instituted. We began conducting, each year, one large and many small workshops where users and generators of applicable information came together to share findings and results of experiences to implement damage and loss control measures. Things then changed. People began to meet, trust, and work together. The heads of the Geological and Mineral Survey in Utah and the State Division of Comprehensive Emergency Management now held regular meetings to see what each agency can do to help the other and cooperate in earthquake simulations. As scientists began to understand the operations of the emergency management people, and they, in turn, began to understand the research agenda, roles became clearer, turf disputes were alleviated, and personal relationships began to form. The increase in the scientists' levels of understanding of local needs is reflected in more focused scientific research and usable products. Seeing the value of their changed outlook, Utah is now fostering networking through all levels of government and with the private sector.

Utah now has a unique capability to implement earthquake hazard reduction measures because key individuals are working together to solve problems.

Workshops also increase the likelihood that risk information developed during a project will be used, because the workshops provide users with a role in guiding the research and developing advocates for use of the products of the research. The ultimate effect of interactive workshops and their by-product, networking, will be to enable the end users of risk information to understand and embrace improved risk management practices and products which will be formulated during execution of the Worldwide Earthquake Risk Management program initiative. This result fosters increased self-reliance to deal with the earthquake threat.

Implementing new ideas is one of the most difficult tasks facing government agencies and design professionals, scientists, bankers, and others involved in one or more aspects of earthquake risk management. These are busy individuals, whose day-to-day responsibilities, in general, are already quite heavy. Enhancing the skills of these public officials and professionals thus becomes important in enabling them to accelerate the adoption and implementation of damage and loss control measures.

As this slide on professional skill enhancement shows, we have a choice. We can work to increase skills of professionals or we can ignore the problem. Success will be assured if we follow the process of information reception and integration depicted in this communications model: (1) one hears the information; (2) learns to understand it; (3) eventually believes it; (4) personalizes it; and, finally, (5) acts on it. By addressing the problem of enhancing professional skills, we will help professionals achieve their goal of minimizing damage. If we ignore the problem, unnecessary losses will result. Interactive workshops using this communication model will facilitate the transfer of information about damage and loss control measures. On the other hand, projects that fail to provide opportunities for users to communicate with those who are producing research are apt to end up with products that will not be utilized.

The WWERM program initiative will do everything possible to enhance professional skills.

SESSION IV -- Q & A

Q (John Wiggins.) Paula Gori mentioned the good things in Utah. I was involved, however, in a survey of building officials and inspectors in Utah. None of them could administer the *Uniform Building Code.* Not one designer in the cities surveyed understood and applied the code. So I have a problem with those who think that the code, alone, fixes things. We also must have people who understand and can apply the code.

A (Walter Hayes.) That situation was true, but it now has been corrected in Utah, in part through special classes conducted for inspectors by the Utah Seismic Safety Advisory Council and others. A new course has now been developed for Californians through the Seismic Safety Commission, and we intend to implement it through WWERM and other programs.

(Frank McClure.) I would like to add that eight of us spoke for eight hours in the class mentioned by Walter Hays and took plan checkers step-by-step, in great detail, through the items they should check. At the end of the class, everyone understood exactly what should be reviewed in each plan. Furthermore, the information they had learned by the close of the course on Friday was applied when they went to work the following Monday.

Q (Nora Sabadell) With regard to networking, everything that I have heard this morning could be applied not only to earthquakes, but also to all other natural hazards such as floods and tornados. I would like to hear that this network will be enhanced in the next decade to include other hazards to which communities are subjected. Many of the techniques we already have to deal with earthquakes are the same as those used to deal with other hazards, and many committed people would be interested in working on other hazards as well. Also in the groups that you talked about, researchers are the ones with whom the most intense work to improve communication is needed. After all, research is where new and improved knowledge is created. Researchers have been almost insulated from the real world for many years, and we have to work hard to bring them together with users. We at NSF are trying to do that and to ensure that the same is done in the other natural hazards programs.

A (Badaoui Rouhban): The developing countries, because of limited resources, must concentrate them in the most effective way. Consequently, it is entirely appropriate that they focus initially on earthquake risk management activities, and ensure that these are in place and are effective. Then the various countries will deal with other hazards if national support with which to expand the program is identified. The developing countries of the world simply cannot establish a separate national committee for each natural hazard; so it is conceivable that the national committee on earthquakes also will play a key role in management of all the hazards emphasized later in the Decade.

(Michael Gaus): One other aspect of networking is that, in general, people act like people. In periods of time when no disaster-causing events occur, people are uninterested in risk management. When an event occurs, interest rises sharply. The network has to be in place to take advantage of the interest generated by these events.

(Ludovic van Essche): There are two levels of networking. My diagrams of yesterday reflect the results of an interdisciplinary form of networking which provides the mechanism for formatting information for use by the lay public. The other type, interactive networking, allows the conversion of the technical network into the human network.

Wednesday, March 9, 1988

DISCUSSION BY TASK FORCE AND PANEL D

Moderator Frank E. McClure, President, Earthquake Engineering Institute

Objective Respond to the proposed initiative with comments, suggestions, and recommendations, identifying the contributions to WWERM that may be possible from their organizational units.

Discussants were encouraged, if possible, to respond on behalf of the agencies and organizations they represent to the WWERM initiative (see Appendix 3). Key questions included:

1. Is there a need for the OFDA/USGS WWERM initiative?
2. What countries do you recommend for the five-year program?
3. Are the goals and scope of the initiative realistic?
4. What are the most critical initial steps? Why?

Participants Members of the WWERM management team, and a Task Force comprised of ten experts presented information and views about the WWERM initiative.

(p. 123 follows)

RILEY M. CHUNG

Director, Division of Natural Hazard Mitigation
National Research Council

As a staff member of the National Academy of Sciences, I appreciate the opportunity to play a part in organizing this important briefing.

The Academy's Division of Natural Hazard Mitigation, for which I am responsible and which is working closely with many of you in the audience, has a number of activities in the natural hazard area. They are:

- o The Committee on Earthquake Engineering.

  Chaired by Professor George Housner, this Committee is addressing the nation's earthquake engineering issues with an integrated systems approach.

- o The Committee on Natural Disasters.

  This group has the primary responsibility for the third activity of the WWERM initiative: transferring lessons learned from past earthquakes. The committee also addresses issues in other types of natural hazards. It conducts post-disaster studies for natural hazard events both in the United States and overseas.

- o The International Decade for National Disaster Reduction.

  The origins and development of the International Decade were explained by Dr. Press yesterday in his luncheon address.

I would like to comment on the WWERM initiative from the broad perspective of opportunities that the IDNDR would offer in reducing natural hazards on a worldwide basis.

1. *Is there a need for the OFDA/USGS WWERM initiative?*

   The answer is "yes," especially considering that a great deal of work has been either conducted or sponsored by OFDA, the four principal agencies (USGS, FEMA, NSF, and NBS) that are responsible for the United States' National Earthquake Hazard Reduction Program, and many colleagues in various parts of the world. It is time now for us to make the best use of the information that has become available to us on a global basis.

2. *What countries do I recommend for the five-year program?*

   This is not an easy question to answer. One would like to see an opportunity for all earthquake-prone countries to participate. The selection process outlined in the background paper is quite thorough. To begin with, however, the following two additional selection parameters could be considered:

   - o Balance between countries that have mature earthquake mitigation programs and those that have just begun their earthquake mitigation activities. This balance would offer the best opportunity to develop the true partnership that Dr. Press alluded to in his speech.

- o Balance between the three regions (Americas, Asia/Pacific Rim, and Africa/Europe) as given in Table 1 of the program initiative briefing booklet. This would offer the best opportunity to examine differences in practices so that methodologies for uniform data recording, reduction, and reporting could be developed expeditiously.

3. *Are the goals and scope of the initiative realistic?*

The answer is a conditional "Yes," the condition being that the initiative focus on the development of preliminary risk maps for the 15 countries selected for the first five-year program. The goals would probably be too difficult to accomplish if the design, construction, and retrofit of structures and social, economic, and political issues are included. By the way, the proposed initiative does not make it clear whether these elements will be addressed as part of the program.

I would like to suggest the following:

1. The management team is an excellent assemblage of experts, but it is too USGS/OFDA-focused, granting that it is an OFDA/USGS initiative. I would suggest that individuals be included from other Federal agencies, such as NSF, FEMA, and NBS, that have the expertise relevant to this important task.

2. One of the most critical initial tasks of the initiative should be the establishment of the network to enhance communication. In this regard, I support Fred Cole's idea of centers of excellence.

3. To facilitate communication, methodologies for uniform data gathering, reduction, and reporting have to be developed.

4. We should immediately begin the task of developing an inventory of what is quantitatively available, as Paul Krumpe pointed out yesterday, in bibliographic form, as the basis from which a uniform data base can be developed.

5. Finally, I congratulate the earthquake profession for being the first one to initiate such an international program. For this reason, I would like to see the management team invite some individuals who are working in other areas of natural hazards to observe the process of this program initiative so that they will be able to translate this experience while tackling issues in their respective areas of interest.

This program initiative also can provide an additional impetus to the fifteen selected countries to establish their own national committees for the International Decade for Natural Disaster Reduction. Thank you.

MICHAEL P. GAUS

Deputy Director
Division of Fundamental Research in Critical Engineering Systems
National Science Foundation

The WWERM effort, personally speaking, is welcome. In fact, any activity is welcome that helps us to identify levels of risk, potential losses, and approaches that facilitate working together to mitigate those losses.

I would like to make this point with regard to the WWERM initiative: although professionals in earthquake-related disciplines are taking the lead in the initiative, the WWERM program ultimately should take a multi-hazards approach.

Let me take this time to describe NSF's functions with regard to research, which can be a foundation for WWERM. There is an ongoing team effort within the Federal Government to conduct useful research. Several agencies work together, and each has separate and specific functions. By and large, this team effort works well, but it seems to me that NSF's role with regard to research is not as well understood as it might be. NSF is not an operating agency; rather, it supports researchers who develop knowledge in various areas.

NSF attempts to develop methodologies to help determine the risk to the built environment. Our staff works with seismologists and geologists, for example, in using their data to establish and map the levels of risk. NSF also is concerned with how to cope with local anomalies, such as those identified in microzonation studies, which may not show up in global assessments.

Another aspect of risk management in which NSF is interested is to identify appropriate approaches for existing vs. new facilities. The major current risk is from existing buildings which were constructed without benefit or application of current knowledge about seismic safety construction techniques. From both the research and financial points of view, NSF is interested in identifying strategies for low- vs. high-frequency seismic events. The strategies might be quite different. In some cases, life safety is of primary concern, whereas economic losses may take precedence in others.

NSF also is interested in:

- estimating losses, particularly in the problems of analyzing the vulnerability of lifeline facilities to damage from hazardous events, and designing strategies to alleviate such damage.

- developing information to improve codes and standards -- not in an operating role, but simply in making scientific information available to those who develop, implement, and monitor the application of codes and standards.

- providing analysis and design tools, such as computer software, and new methodologies to make it more practical for engineers and architects to design better and safer buildings.

- improving structural materials by making available to manufacturers information about new techniques that might be utilized.

- o developing improved planning and response procedures.
- o learning from natural disasters that occur.

From a research perspective, the items discussed above are those in which NSF is interested.

ALBERTO M. GIESECKE

Director
Centro Regional de Sismología para América del Sur (CERESIS)

The developing countries that suffer very severe losses generally have mitigation policies in place, although these may seem to have a relatively low priority because of the critical day-to-day hazards they face. For example, drug traffic and foreign debt are quite real hazards that must be managed daily in some developing countries and, when considered in comparison to the occasional threat from a severe natural hazard, it is easy to see why the priorities are as they are. The same reasoning applies as well in understanding the funding appropriation levels for research in developing countries.

Let me take a moment to discuss CERESIS, which has 11 member states in South America and Spain. **Our organization has come of age.** As a successful experiment in international cooperation in earthquake risk reduction, CERESIS coordinates ongoing research into various aspects of seismic risk in South America, has sponsored a series of regional projects to monitor and assess seismic hazards, and conducts an earthquake mitigation project in the Andean region which has already resulted in the publication of hypocenter and intensity data catalogs, a neotectonic map, maximum observed intensity maps, and two epicenter maps of South America.

I would like, in the limited time available, to address the question of countries to be included in the WWERM initiative, and to propose that consideration be given to areas rather than strictly to countries. For example, the entire Andean region should be included. It should be treated as a unit with the parts of the west coast of South America and the entire area that corresponds to the plate boundaries included in any seismic risk maps that may come out of the WWERM project.

The OFDA and USGS recognized the value in treating the latter area as a unit at a 1980 meeting at which we discussed techniques for mitigating earthquake effects. That meeting covered all the seismic and geological information necessary to undertake a seismic risk study, which was financed by OFDA with $1 million over a six-year period. The study, "Earthquake Hazard Mitigation in the Andean Region," produced two very important results. The primary result was a series of publications, one of which is an evaluation of economic effects of earthquakes, that was produced totally by the work of 200 South American people. We were assisted in this effort by Ted Algermissen, who gave considerable support. The second important result was the establishment of a solid network between the 200 South American people with our United States colleagues in all related disciplines. It was clear that every participant was dedicated to and concerned with mitigation of earthquake effects.

I relate this activity to illustrate that a region, particularly in South America, can respond as a whole to the challenge WWERM presents. In fact, when CERESIS was created in the mid-1960s, it was based, in part, on the premise that earthquake risk problems would be treated on a regional basis.

We at CERESIS were especially interested to note the emphasis on seismic risk maps when this WWERM initiative first came to our attention. One of the strategies suggested for mapping was to utilize and capitalize on the resources available from similar projects completed by other groups. This was considered important with regard to necessary linkages, and it presumes that those involved in similar projects should be invited to be part of the networking process. CERESIS completed the first maximum earthquake intensity map, based on research covering seismic events over five centuries, of the entire continent of South America in 1983. This activity was supported by USGS, OFDA/USAID, the U.S. Department of State, and nine participating countries.

It is notable, too, that a number of Latin American organizations can be influential in bringing pressure to bear on potential sources of funds for support of WWERM activities. Ongoing hazard reduction projects in Latin America, one of which has formed a regional center for coordination of work toward natural hazards risk reduction financed by the Swedes, have information of value to contribute to the WWERM network. The entire list of these organizations should be carefully analyzed and evaluated to determine how they can help as strategic planning begins for the WWERM initiative.

JULIO V. GRIECO

Area Officer
Regional Bureau for Latin American and the Caribbean
United Nations Development Program (UNDP)

My predecessor gave the first part of my presentation when he discussed the low priority assigned to mitigation efforts in Latin America and elsewhere in the developing countries of the world. Without reiterating that information, there are five points I would like to recommend that the WWERM management team consider.

1. It is important to stress the direct relationship between projects to implement earthquake risk management and development programs. Studies show that the overwhelming costs of recovery from recent damaging events to countries such as Mexico can be reduced if some mitigation measures are in place. With these cost savings, the overall impact of damaging earthquakes can be reduced as well.

2. The second point concerns the WWERM initiative which, from the perspective of earthquake-prone areas of Latin American and the Caribbean, is very valid. This initiative appears not only to be an academic exercise, but also it brings together the academic community, user groups, disaster management personnel, and participants from the private sector. It is important that the initiative address the issue of substantive interchange in many directions -- south/south and south/north, for example -- as a critical component of cooperation in sharing expertise.

3. In the United Nations system that deals with multi-sectoral technologies, there is a programmatic basis of sufficient scope to address the exchange of expertise anticipated by the initiative; therefore, there is a likelihood of a positive United Nations reception to the concept, which will need to be included in plans for future activities.

4. There seems to be little focus in the materials I have seen on the operational level of risk management as it relates to the economic impact of disasters. In the United Nations system, which may be unique in multilateral organizations, a methodology has been developed for assessing the impact, in terms of costs, of a disaster such as an earthquake. I would like to suggest that my colleague who works in this area be included in some appropriate context in WWERM activities, perhaps in constructing scenarios in the pre-disaster phase. I have with me examples of work in this area in the form of two reports on the impacts in 1985 and 1986 of the earthquakes in Mexico and El Salvador. They were produced in a short period of time and are very good.

5. It would be helpful to see more information on how the initiative will move forward. First, I am particularly interested in the mechanism by which activities will be carried out, and the institutional structures and mechanisms that are contemplated. Second, if United States organizations are to participate in this effort, we will need to know what types and levels of resources are planned to be allocated globally so we can address proposed United Nations participation in an appropriate context.

(p. 131 follows)

ALCIRA G. KREIMER

Urban Planner
The World Bank

The initiative proposed by the OFDA and the USGS comes at a propitious time, and we look forward to utilizing the momentum created to date. My predecessor mentioned the likelihood that the initiative will be well received in New York, and I believe that it will be well received in my office as well.

In response to the question asking whether I think the initiative is important, I can say, "certainly, it is." There are a few comments, however, that I would like to make.

- The linkages between this initiative and the IDNDR have been clarified during this briefing.

- The United Nations has participated in and sponsored other "decades," such as the World Sanitation Decade. The WWERM initiative should take stock of the experiences of those prior activities and learn from them.

- It would be appropriate to define more clearly the advantages of the initiative, particularly in terms of collaboration. Describe how north/south and south/north interaction will take place and what this interaction is expected to produce. Also describe more clearly the relationships among the different countries in the south, and the connections between the private and public sectors. The engineers are an important group to be included.

- Of great importance is how the needs of the people who suffer the most in earthquakes (the poor) will be addressed. We must consider their needs in programs implemented at the United Nations, as well as in preparing whatever publications, or training and education materials we contemplate.

In organizing United Nations activities, the roles of the technical advisor and committee, defined in such a manner as to reflect the anticipated linkages, would be very auspicious, as would information about activities that could be implemented rapidly. Some of these might include:

1. Transmission of knowledge in a two-way process that can be set up immediately and will extend to and from numerous countries;

2. Retrieval of information already available;

3. Inclusion of the United States in the list of areas at high seismic risk to help illustrate its involvement in the two-way communication (one document that divides the world into three seismic areas does not make it clear that the United States is included);

4. Focus on translating information into different languages, including Spanish and French, at a minimum;

5. Encourage the institution of appropriate building codes, perhaps going so far as to

make program financing conditional on the institution of such codes by a specified date;

Finally, demonstrate attention to programs already underway, such as the reconstruction program in Mexico supported by the World Bank with counterpart funding from the NSF. This is one way to institute the collaboration that the initiative contemplates, and the development agencies will look favorably on activities that take advantage of opportunities and avenues for cooperation.

These are ways in which I can recommend that the WWERM program proceed.

JELENA PANTELIC

Assistant Director
National Center for Earthquake Engineering Research

Thank you for this opportunity to present some of the opinions of the National Center for Earthquake Engineering Research ("NCEER" or "the Center").

NCEER was created two years ago to foster all aspects of earthquake-related research -- social, economic, geophysical, and others. It was established under a $5 million grant from NSF, with equal funding from the state of New York for an initial period of five years. Additional funding also has been obtained from other sources.

The Center was not conceived as a geographic entity, but as a managerial unit working with several core institutions. This consortium of institutions of higher education includes Columbia, Cornell, Lehigh, Lamont-Doherty, and Rensselaer Polytechnic Institute, as well as SUNY-Buffalo where the Center's offices are situated. The Center supports research at each of these institutions and elsewhere. NCEER does not attempt to emulate the NSF. On the contrary, it has adopted an interdisciplinary approach to research.

I would like to address four points that will lead to understanding NCEER's response to the two key questions regarding the WWERM initiative. I hope to make clear what NCEER can offer to the initiative and the IDNDR, and vice versa.

1. The Center relies on support from the public sector, but it obtains funding from other sources, principally in the private sector, as well. NCEER and its director, Dr. Robert Ketter, firmly believe that only through forging links and closely cooperating with the private sector can the Center become self-reliant and, thus, more resilient.

   In addition to nurturing these constructive relationships through mutual projects, NCEER is aware that moderate earthquakes can obstruct the functioning of the private sector; consequently, researchers are looking at the reasons why the business community is so affected and how it deals with recovery.

2. Technology transfer, information dissemination, and education are key foci of the Center's program. Only through well-informed members of the private and public sectors, key decisionmakers, and professionals can we hope to reduce the earthquake threat in this country and abroad. To accomplish that goal, the Center is organizing a number of meetings, workshops, conferences, and other activities where research findings will be transmitted to the users of that knowledge. Our last major conference was held in New York City about 10 days ago and dealt with seismicity in the eastern United States.

3. The Center emphasizes implementation of research results, and has been successful in connecting scientists with end users.

4. There is an international program at NCEER. Our experience has shown that assistance is a two-way street; by cooperating with other countries and with our colleagues in universities and state departments around the world, we help each other. We conduct tests and monitor seismicity in several countries in ways that we cannot use in the United States. Attempts are made to cooperate not only with our neighboring

countries, but also with such faraway places as China, Turkey, Japan, Taiwan, and Spain.

In conclusion, we at the Center see the International Decade and WWERM as very important and needed activities, and believe that the NCEER can play a role in the preparatory stages of the program and in the activities as they develop. For both of these activities to have a successful outcome, there must be consensus on the programmatic strategies and funding levels and mechanisms. Meetings such as this one will make it easier for us to achieve that consensus.

RICHARD J. ROTH, JR.

Assistant Administrator
California Department of Insurance

I have only three points to present at this time in response to the WWERM proposal.

1. It is important to recognize the relationship between insurance and activities to promote hazard mitigation. After the October 1, 1987, Whittier earthquake, the insurance industry paid $72 million in loss claims. Insurance is a very efficient payment mechanism since it promotes mitigation through its pricing structure, deductibles, and underwriting. On the other hand, federal and state governments paid out $102 million. That is counter-productive in terms of mitigation, although it is productive in terms of human welfare. It is easy to understand the attitude of some individuals in high-risk areas who ask themselves, *Why should I reinforce my building and spend my money for other mitigation measures when the federal and state governments are going to help if an earthquake occurs?* The use of insurance, therefore, is the preferable source of reconstruction funds from a mitigation standpoint.

2. Only about 20 percent of homes and businesses are insured for earthquake damage. Having insured that 20 percent, the insurance industry probably has exceeded its capacity to assume risk. Even so, I am not saying that all federal or state aid is necessarily bad; the flood insurance program, for example, is entirely federally funded and is a good program. All flood insurance has to be purchased by the Federal Government, but the mitigation factor is there: the government will only sell the insurance in areas where a flood-plain mitigation program exists. That kind of encouragement for earthquake mitigation also can be incorporated into a federal insurance program.

3. Earthquake recovery depends greatly on the status of international relations. If a major earthquake occurs in California, approximately half the losses will be reimbursed by insurance companies not domiciled in the United States. The insurance mechanism is not used very much in other countries of the world, so they rely to a lesser extent than the United States on international financial arrangements. New Zealand, for example, has an earthquake damage commission with a fund of $1 million U.S. to compensate for hazard losses, but this amount could easily be inadequate. Recognizing this, officials in New Zealand have expressed a desire for mutual aid agreements with other countries in the Pacific rim. This is not only desirable, but probably will be a necessity. Other countries that have had major earthquakes, such as Ecuador and Mexico, certainly recognize the need to rely on and cooperate with other countries to pay for earthquake damages.

Therefore, an initiative such as WWERM which promotes the dissemination of technical knowledge is absolutely necessary to promote the use of insurance and international agreements.

(p. 137 follows)

BADAOUI M. ROUHBAN

Program Specialist
Earth Sciences Division
United Nations Education, Scientific, and Cultural Organization (UNESCO)

My answer to the first question, regarding the need for a program initiative such as WWERM, is "Yes." As internationalists, we at UNESCO favor all cooperative international programs having mutual assistance aims. UNESCO was one of the first agencies to deal with earthquake risk, having begun to do so 25 years ago. The reasons we support this initiative are as follows.

1. Observation of seismic activity should be international.

2. Lessons learned from past earthquakes are applicable to all nations. The lessons from Chile, for example, are being used by the scientific community in the United States.

3. Losses resulting from earthquakes are shared throughout the world by insurance, by relief measures -- and force the necessity to backstop and strengthen ongoing risk management projects in various countries. One has only to look at the recovery processes and economic impacts of past earthquakes to recognize the importance of the proposed OFDA/USGS mission.

What countries should be included in the five-year program? Countries where a risk management program already exists, and where financing for the international effort can be obtained should be included.

Are the goals realistic? Yes, they are. In my opinion, however, several key factors will be necessary to improve the chances of success. In priority order, these are:

1. Assured financing should be secured; not necessarily huge amounts -- just seed monies. Experience shows that careful use of even a little budget can lead to big achievements.

2. A strong and sustaining commitment on the part of industrialized countries -- the United States, Japan, European countries -- should be made to this mission. This commitment should not be used as a mechanism for creating "south" vs. "north" situations; rather, a sustained effort is needed to ensure the transfer of technology from the industrialized world and, in return, the industrialized world will benefit from the two-way communication process that is established. For example, if Western firms are to design important structures in the developing world, it is critical that they be aware of, and have access to, regional hazard maps. Investors, too, need this information from the developing country.

3. Strong links should be established with the International Decade. If implemented, WWERM will be one of the most important vehicles for the IDNDR in establishing intergovernmental mechanisms.

4. Strong national teams should be established in the various countries that will be concerned with this initiative. Perhaps a twin mechanism is necessary -- government-to-government and between the academic community -- in each country.

5. Emphasize as strongly as possible the need to transfer technology. The external advisors we have heard about cannot expect to go to a country, give a one-time speech, and expect it to result in the country taking action. It is important to maintain contact, to network, and to take advantage of every available opportunity to make known the existence of technology and its applications.

LUDOVIC VAN ESSCHE

Senior Coordination Officer
Division of Prevention and Support Services
United Nations Disaster Relief Organization (UNDRO)

The title of this panel asks us to respond to the proposed initiative. I would like first to select what seem to me to be the most important points in the OFDA/USGS position paper, then make suggestions, then respond to the questions.

First, we saw that preparedness and disaster mitigation are distinct but related fields. We reaffirmed that these cannot be separated in the process of addressing risk management issues. We saw the strength of the need for hazard mapping and seismic risk assessment.

Second, we looked at the lessons learned from past seismic events. This is very important. An enormous amount of knowledge is gathered by the USGS, OFDA, NSF, other international organizations, the private sector, the insurance industry, and other groups and individuals. It is critical that this information be compiled, systemized, and made available around the world.

Third, there is a need to accelerate the application of research results to implementation tasks. **Research produces knowledge, and knowledge is fundamentally necessary; but it becomes useful only when it is applied to support the processes of implementation.**

A related issue is reformatting scientific data into laymen's language and making it available to the entire community of professionals that deal with risk management. This activity is fundamental to the networking process and to implementation. A distinction also should be made between information which is useful to technicians and that which is useful to the decisionmaker. An office such as OFDA should be particularly sensitive to this need because of the special nature of disaster preparedness.

The WWERM strategy was divided into several phases. The first two phases were designed to identify the knowledge base and proceed to mapping, training, assessing, and so on. After this should come better codes and better-prepared professionals. The role of the non-specialist should be strengthened, as should self-reliance among participating countries. Again, if one accepts that mitigation and preparedness are equal but separate units in the risk management continuum, the socio-economic aspects of recovery should be strengthened in the program initiative.

Collaboration on methodology is an element of cooperation that could perhaps be strengthened. We have talked about the needs for conceptual consensus and agreement on techniques; but without the same concurrence on methodology, we are unlikely to make much progress. Success depends, at least in part, on an interdisciplinary approach.

I can only repeat that we at UNDRO wish to cooperate with the United States in all of its disaster management programs at federal, state, and private-sector levels. We are extremely interested in the networking component. Although the idea of networking always has existed, the word itself has now assumed a new dimension. Today it includes the concepts of networking institutions as well as people and, at the human level, of creating trust among each other. The networking of disciplines also is a very important concept for large regional projects in surveying the state-of-the-art in various disciplines, and within the countries of the region. Training as a vehicle for networking is also important in creating self-sustaining mechanisms in various countries, so that at the end of our WWERM involvement they can, in turn, export the knowledge they gained from their own WWERM involvement.

Last, I will address the question of money. I hope that when I go back to UNDRO my directors will treat me kindly. I have managed to raise money in UNDRO for other projects, and hope we can work together. From the point of view of the United Nations, I don't think we should rely on the very large donors. The smaller countries will participate in the benefits of the initiative, and can and should contribute resources. This is what will make it self-sustaining.

In closing, I would like to quickly answer some of the questions on the *Participant Response* sheet (see Appendix 6). Yes, we will participate in annual meetings. Yes, we will utilize technical products and maps prepared with other organizations. Yes, we will participate in networking with other organizations. UNDRO can do these thing for you/with you. Yes, we will participate in funding the initiative and in meetings with co-sponsors for further discussions on how we can best contribute to the effort. Certainly, we would like more information.

RICHARD N. WRIGHT

Director, Center for Building Technology
National Bureau of Standards

I concur, generally, with the initiative presented to us this morning. It recognizes that earthquakes are not inevitable disasters. Earthquakes are inevitable hazards, but practical, economical, effective practices are available for achieving safe performance of structures in earthquakes. This was exhibited in the 1976 Guatemala earthquake. Guatemala City is located with respect to the fault responsible for that earthquake similarly to Los Angeles relative to the southern San Andreas fault. Modern, well-designed and well-constructed multi-story buildings performed successfully in the Guatemala earthquake. Although effective practices are available for earthquake hazard mitigation, education is needed at all levels, from policymakers to carpenters, so that each participant in the building process understands how his or her decisions affect earthquake safety, and takes actions to achieve earthquake safety.

Consistent earthquake hazard mapping is vital to international sharing of earthquake hazard mitigation activities. Otherwise, the experiences and practices in one locality cannot be quantitatively adapted to another. The proposed cooperative international activities give us an opportunity to challenge "Steinbrugge's Law," paraphrased from our distinguished colleague and briefing participant: "No United States policymaker will learn anything from a foreign earthquake."

Useful earthquake hazard mapping and design and construction practices are presently available, but research must continue. For instance, we still lack a good measure of earthquake intensity for hazard mapping. Modified Mercalli intensity is based on the performance of unreinforced masonry structures. This intensity was low in downtown Mexico City, where low-rise, unreinforced masonry buildings were undamaged while tall, reinforced concrete and steel buildings collapsed.

The participation of insurance and financial organizations is vital to the initiative. Their participation is needed to provide incentives for the worldwide use of earthquake hazard maps and modern seismic design and construction practices. Here, I can quote "Ehrenkrantz's Law," paraphrased from Ezra Ehrenkrantz, a distinguished, innovative architect: "No architect will learn a new technology unless it is needed to get a commission." I suspect this also is true for most engineers.

The emphasis in the initiative on networking is most appropriate. I call to your attention the opportunity to mobilize the participation of international professional organizations such as the International Council for Building Research, Studies, and Documentation; and the International Association of Bridge and Structural Engineers. These organizations have technical committees, with members drawn from organizations such as my own, working on improving building practices. Support from the United Nations and international development organizations for participation of professions from the developing countries in these international activities will provide an effective means for transferring technology to practice in the Third World.

Finally, I wish to express the interest of the Center for Building Technology and the Center for Fire Research at the National Bureau of Standards in participating in the initiative. Although our basic mission is domestic, with support from USAID or other organizations with an international mission, we can provide substantial technical support to the initiative.

(p. 143 follows)

TASK FORCE -- Q & A

Q (Karl Steinbrugge): In response to what Dick (Wright) said, we had a "peanut" earthquake in California. The number of resulting deaths can be counted on your hand, yet the California Legislature went into special session to deal with it. Contrast this to many places elsewhere in the world, where thousands of lives can be lost in a major event such as that which occurred in Chile. My point is that Steinbrugge's law is only too true; public policymakers pay attention to some earthquakes, particularly those that occur here in the United States, but not to others. I wish that law would be violated.

(p. 145 follows)

Wednesday, March 9, 1988

CLOSING REMARKS

DALLAS L. PECK

Director
U.S. Geological Survey

This has been a very productive meeting. I congratulate the organizers. They have conceived a good program, and set up a good meeting having a good mix of people within a good, sound educational format.

I particularly enjoyed the last panel discussion and the suggestions of the Task Force. It appears that we are off to a good start on a program for which the time is right. **The needs have been recognized, and the initiative propitiously comes together at a good time to mesh with the International Decade for Natural Disaster Reduction.**

Finally, let me reiterate that our network will have many more opportunities to work -- we won't let it drop here.

I look forward with pleasant anticipation to the concrete actions that will result from the Worldwide Earthquake Risk Management initiative.

(p. 149 follows)

JULIA V. TAFT

Director
Office of U.S. Foreign Disaster Assistance
U.S. Agency for International Development

These remarks are not really a closing -- rather, they are an opening. Much of the future of this initiative, the IDNDR, and the networking will hinge on what one person, Michael Gaus of NSF, said: "people will be people." We are dealing with many cultures, motivations, and concerns. Yet, what has happened, or rather *not* happened during this briefing, is very exciting. I did not hear about "professional imperialism" or about "regional differences" or other elements that tend to divide us. **Our theme was unity; and that was the theme we wanted to convey. This is a partnership!**

As we go forward, we must do so on an equal basis. A great deal of giving and a lot of learning yet to come make this program exciting. I anticipate the application to this initiative of some USAID resources other than those at OFDA, because investments in the developing world are being threatened as a result of inattention to hazards and hazard mitigation. I am very pleased that representatives of USAID are part of this process.

One recommendation I had hoped for did not come out of this meeting: to change the acronym. It appears that we are stuck with WWERM!

I would like to thank a number of people, particularly the presenters and my staff, Paul Krumpe and Fred Cole. They are the catalysts and the prodders who, in spite of everything that draws my attention and energy, keep things in perspective. I also found in this room many people I have known because they have sat on the horseshoe at the OFDA Operations Center trying to figure out how to respond to whatever disaster may have occurred. This partnership we have enjoyed in looking at disaster relief gives us a sound basis on which to proceed to work on the mitigation side. I would like to thank Riley Chung and all of his associates at the Academy who were helpful in putting this meeting together, and all of you who came to spend your time with us. I hope you take away as much as you have given.

I look forward with pleasure to our next networking opportunity.

APPENDICES

APPENDIX 1

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APPENDIX 2

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CHUNG, Riley M. Dr. Chung is Director of the Division of Natural Hazard Mitigation of the National Research Council. Among his responsibilities are the Committee on Natural Disasters, Committee on Earthquake Engineering, and the Advisory Committee on the International Decade for Natural Disaster Reduction.

COLE, Frederick M. Mr. Cole is currently Assistant Director for the Asia and Pacific Division of the Agency for International Development's Office of U.S. Foreign Disaster Assistance. He established the Asia Disaster Preparedness Center at the Asian Institute of Technology in 1985. This center, the only regional institution of its kind, provides specialized training in disaster management. Mr. Cole also managed United States disaster relief response during the Lebanon crisis, and the food relief distribution during the famine in Ethiopia.

COUVILLON, Stanley J. Currently Assistant Vice President of Loss Prevention at Industrial Risk Insurers (IRI), Hartford, Connecticut, Mr. Couvillon is a loss-prevention engineer by training and an industrial engineer by education. During his 21+ years with IRI, he has worked in virtually all aspects of loss prevention including field surveys, managing field servicing operations (domestic and international), developing protection guidelines, analyzing losses, and estimating losses for catastrophic natural phenomena such as floods, hurricanes and earthquakes. For the last five years, he has been refining IRI's methodology to evaluate the catastrophic impact of earthquake as it relates to the industrial class of business.

EHLERT, Darrell W. Mr. Ehlert is currently Assistant Vice President at Allstate Insurance Company. Within the Corporate Planning Department, he manages the environmental analysis group, the industry and competitor analysis group, and the financial analysis group. Beginning his career in the Property and Casualty Actuarial Department, he became director of the department in 1966. During his 31 years with Allstate, he has held a variety of other positions, including five years in International Operations with tours of duty in Japan and England. He has served on numerous industry committees and is a fellow of the Casualty Actuarial Committee and a member of the American Academy of Actuaries.

GAUS, Michael P. Dr. Gaus is director of the Critical Engineering Systems Division (CES) of the National Science Foundation (NSF). The CES Division, which contains the Earthquake Engineering activities of NSF, is organized into four programs: Siting and Geotechnical Systems; Structural Systems; Architectural and Mechanical Systems; and Earthquake Systems Integration. These programs provide individual grant support for development of research facilities and equipment and support for the National Center for Earthquake Engineering Research administered through the State University of New York at Buffalo. Support also is provided for the National Information Service for Earthquake Engineering, University of California at Berkeley, and for the Natural Hazard Information Center, University of Colorado, Boulder.

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van ESSCHE, Ludovic. Dr. van Essche is Senior Coordination Officer in the Division of Prevention and Support Services of the United Nations Disaster Relief Organization (UNDRO). His broad responsibilities include assessment and mitigation of the economic impacts of natural hazards.

WOODS, Alan. Appointed Administrator of the United States Agency for International Development in November, 1987, Ambassador Woods directs U.S. economic and humanitarian assistance programs in more than 70 developing countries. From 1985 until this appointment, he was Deputy United States Trade Representative. He also has served as Assistant Secretary of Defense, President of International Services Corporation, and Vice President for Technology at Sears World Trade.

WRIGHT, Richard W. Currently Director, Center for Building Technology, at the U.S. National Bureau of Standards, Dr. Wright has 15 years' experience in research and teaching in structural engineering at the University of Illinois at Urbana-Champaign, and 16 years in building research at NBS. His expertise lies in structural systems behavior, structural dynamics, formulation and use of design criteria, and research management. He is chairman of the Interagency Committee on Seismic Safety in Construction of the National Earthquake Hazards Reduction Program, and United States Chairman of the U.S.-Japan Panel on Wind and Seismic Effects.

APPENDIX 3

INFORMATION REQUESTED OF PANEL D, THE TASK FORCE

The following guidance was given to each member of the Task Force approximately one month before the Executive Briefing.

This letter provides additional clarification of your role in the Executive Briefing as indicated on the enclosed preliminary program and background information on the new OFDA/USGS cooperative program initiative (tentatively called WWERM). This background information will facilitate the preparation of your comments and suggestions on the program initiative, which will be given orally on March 9, the second day of the Executive Briefing. . .

1. Is there a need for the OFDA/USGS program initiative (WWERM)?

2. What countries do you recommend for the five-year program?

3. Are the goals and scope of the initiative realistic? If yes, what are the keys for success in your opinion? If no, what changes would you suggest?

4. Do you know of investors, developers, insurers, and professionals who should be invited to be a part of the networking process of WWERM? Please name them.

5. Do you know of other regional and global international programs that have potential synergism with WWERM? Please name them and the people to contact.

Your oral comments should be given from the perspective of the network(s) of people and programs associated with you and your organizational unit. In short, we are requesting that you think as if you were a potential "partner" and provide us with constructive advice, identifying:

1. What your network(s) can bring to the proposed OFDA/USGS Worldwide Earthquake Risk Management Program (WWERM).

2. What the WWERM initiative can do for your program.

Thank you for your support in the Executive Briefing. I am looking forward to seeing you in March.

Sincerely yours,

/S/

Walter W. Hays
Deputy for Research Applications
Office of Earthquakes, Volcanoes,
and Engineering

APPENDIX 4

COUNTRIES LOCATED IN EARTHQUAKE-PRONE REGIONS OF THE WORLD

(A representative list)

Americas	Africa and Europe	Asia and Pacific
Argentina	Algeria	Australia
Bolivia	Bulgaria	China
Brazil	Greece	India
Canada	Iran	Indonesia
Chile	Italy	Japan
Colombia	Jordan	Korea
Costa Rica	Morocco	Nepal
Dominican Republic	Portugal	New Zealand
Ecuador	Rumania	Pakistan
El Salvador	South Africa	Philippines
Guatemala	Spain	Soviet Union
Honduras	Syria	Taiwan
Jamaica	Tunisia	Thailand
Mexico	Turkey	
Nicaragua	Yugoslavia	
Panama		
Peru		
United States		
Venezuela		

APPENDIX 5

KEY ILLUSTRATIONS

Figure 1 **WORLDWIDE EARTHQUAKE RISK MANAGEMENT PROGRAM.** Strategies of the Worldwide Earthquake Risk Management Program initiative.

Figure 2 **NETWORKING.** Schematic illustration of networking, a long-term process that brings people and programs together in a way that benefits everyone.

Figure 3 **STRATEGIC PLANNING FOR EARTHQUAKE HAZARD REDUCTION: Options for Risk Management.** Hazard mapping is an effective initial step in earthquake risk management because it provides a foundation for other loss-reduction measures.

Figure 4 **IMPLEMENTATION OF LOSS-REDUCTION MEASURES.** Schematic illustration of the overall process leading to adoption and implementation of loss-reduction measures. Integration of hazard, exposure, vulnerability, and risk is the ultimate goal of risk management.

Figure 5 **KNOWLEDGE UTILIZATION PYRAMID.** Schematic illustration of key elements in the knowledge utilization process.

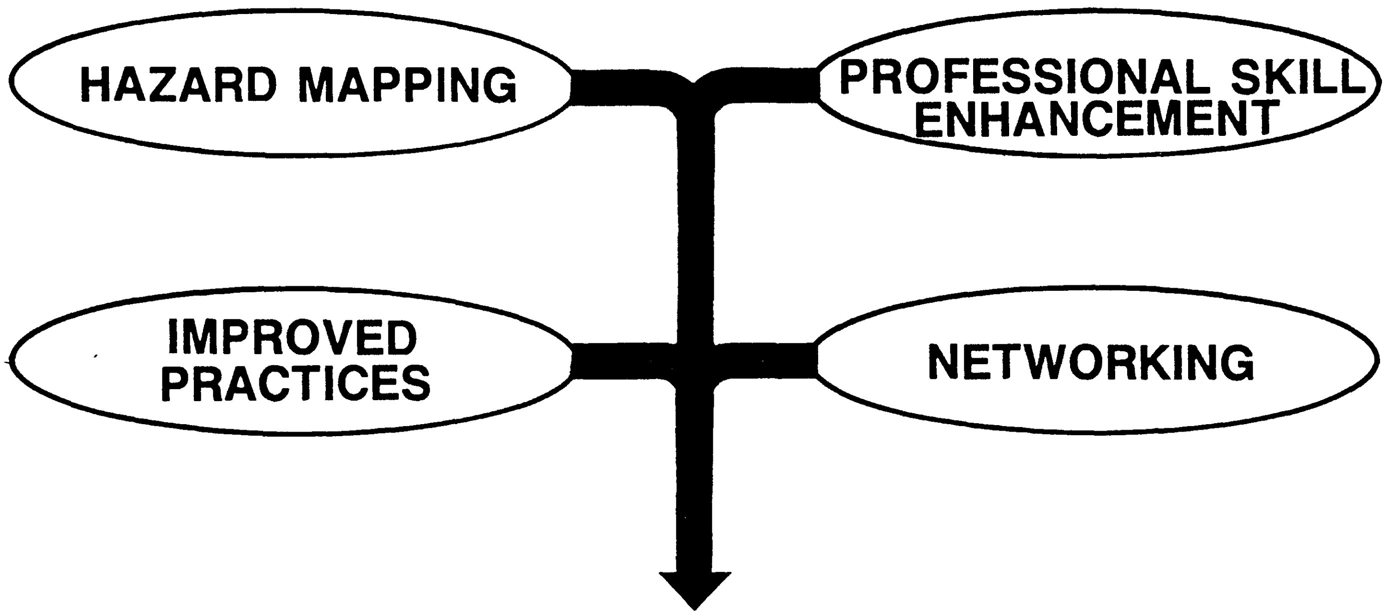
Figure 6 **THE RESEARCH APPLICATIONS PROCESS.** Successful applications of knowledge produced in research depends on:

a. a perceived need;
b. internal advisors;
c. external champions;
d. credible products;
e. user-friendly products;
f. balanced political, legal, and economic considerations; and
g. a window of opportunity.

Figure 7 **STIMULI FOR ACTION.** Illustration showing the various influences on decisions to adopt and implement risk management policies and practices. On-the-job training and experience are the major influences on both the action taken and the advocate/advisor from whom assistance is sought. Technical publications by themselves have little influence.

WORLDWIDE EARTHQUAKE RISK MANAGEMENT PROGRAM

EARTHQUAKE-PRONE COUNTRY



GOAL: ENHANCED EARTHQUAKE RISK MANAGEMENT

FIGURE 1

NETWORKING

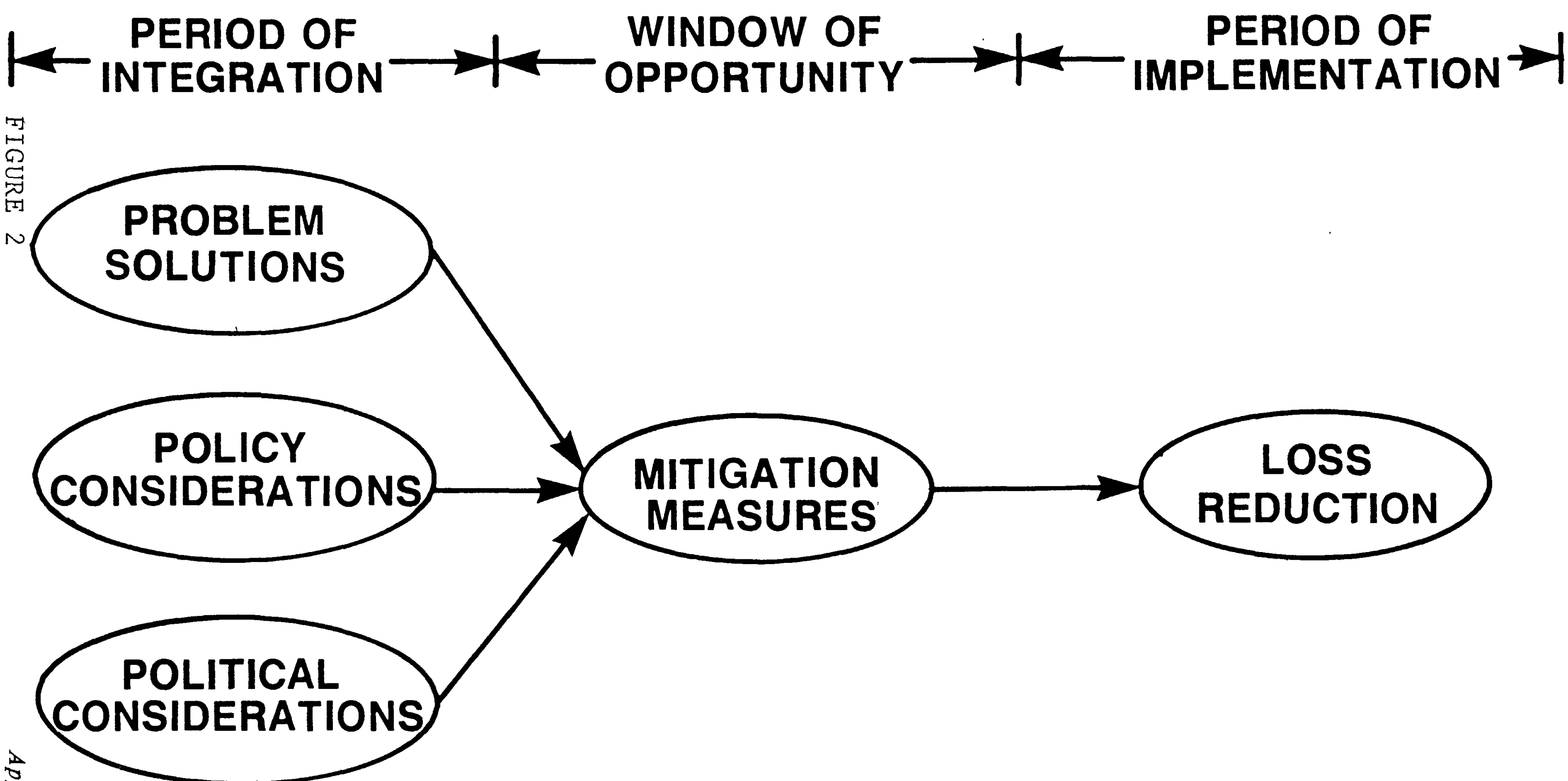


FIGURE 2

STRATEGIC PLANNING FOR EARTHQUAKE HAZARD REDUCTION

OPTIONS FOR RISK MANAGEMENT

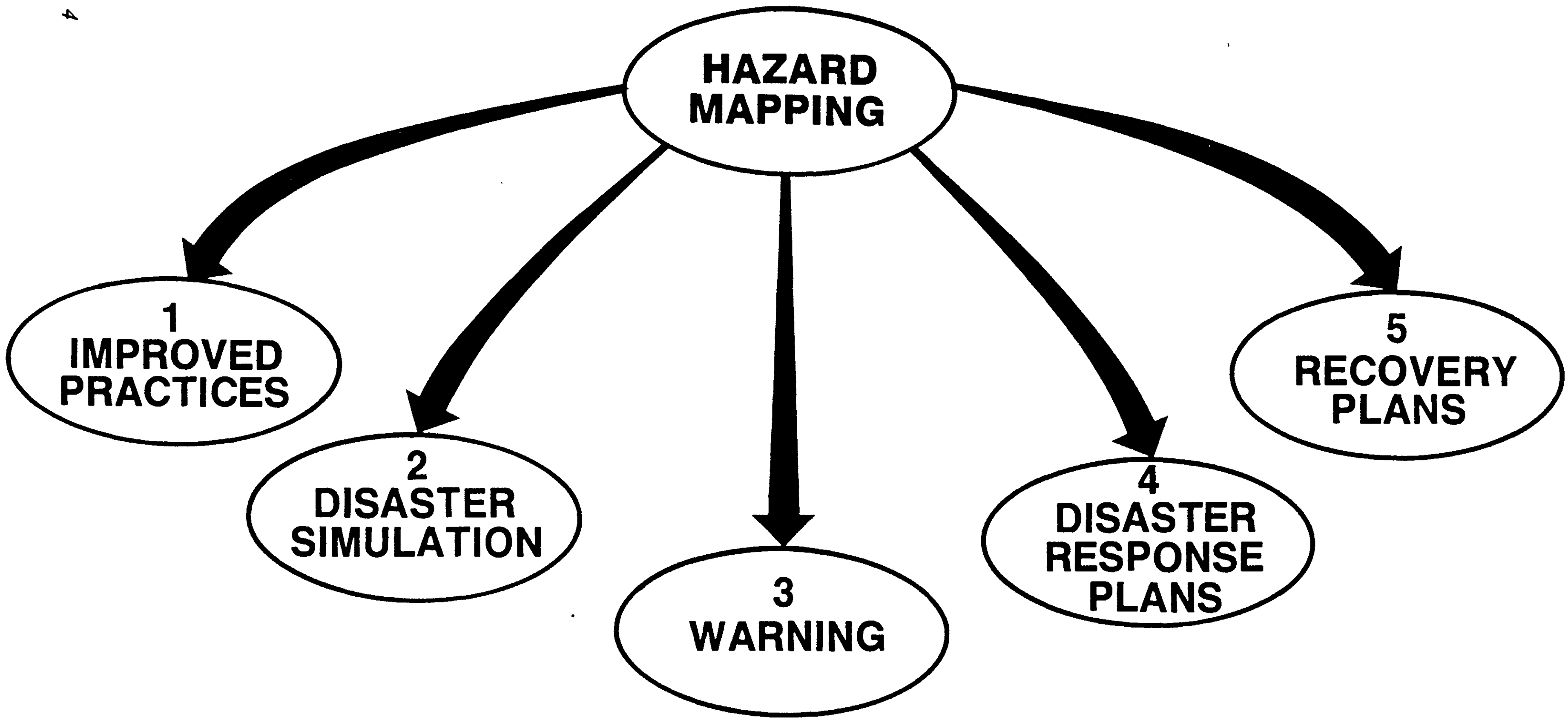


FIGURE 3

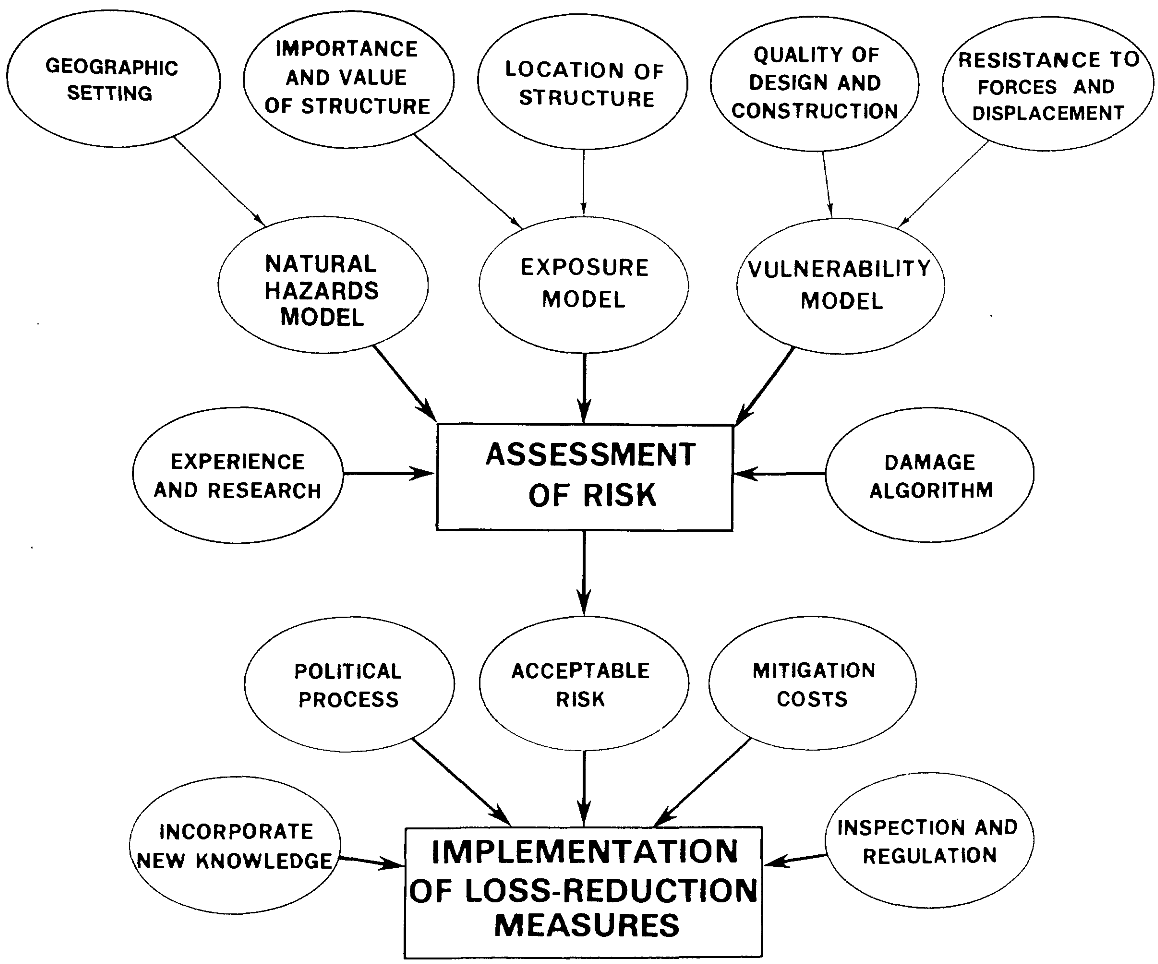

GEOGRAPHIC SETTING
IMPORTANCE AND VALUE OF STRUCTURE
LOCATION OF STRUCTURE
QUALITY OF DESIGN AND CONSTRUCTION
RESISTANCE TO FORCES AND DISPLACEMENT
NATURAL HAZARDS MODEL
EXPOSURE MODEL
VULNERABILITY MODEL
EXPERIENCE AND RESEARCH
ASSESSMENT OF RISK
DAMAGE ALGORITHM
POLITICAL PROCESS
ACCEPTABLE RISK
MITIGATION COSTS
INCORPORATE NEW KNOWLEDGE
IMPLEMENTATION OF LOSS-REDUCTION MEASURES
INSPECTION AND REGULATION

FIGURE 4

Knowledge Utilization Pyramid

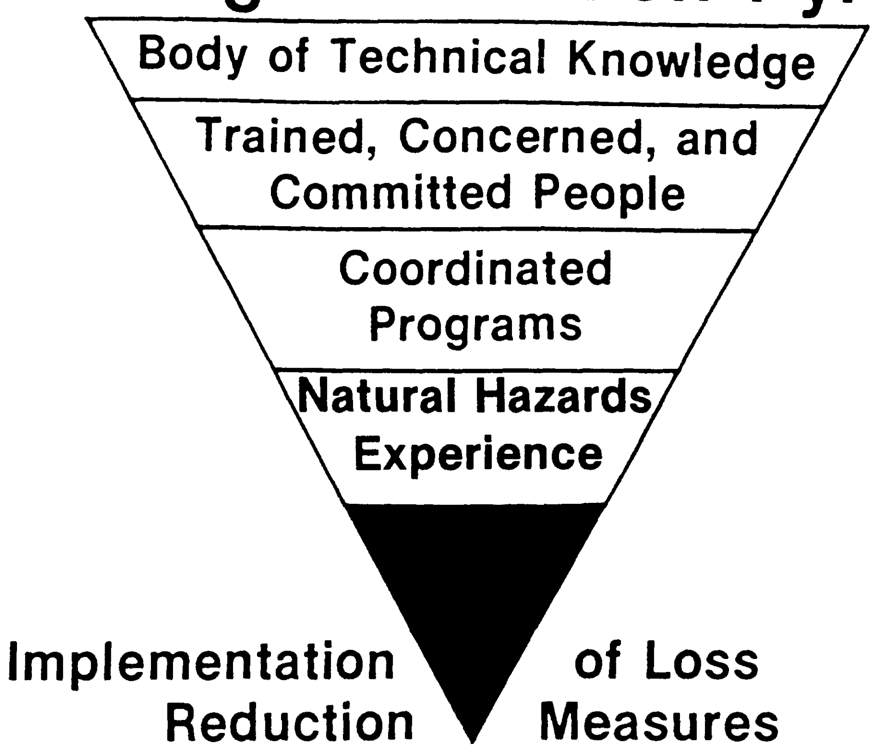


FIGURE 5

THE RESEARCH APPLICATIONS PROCESS

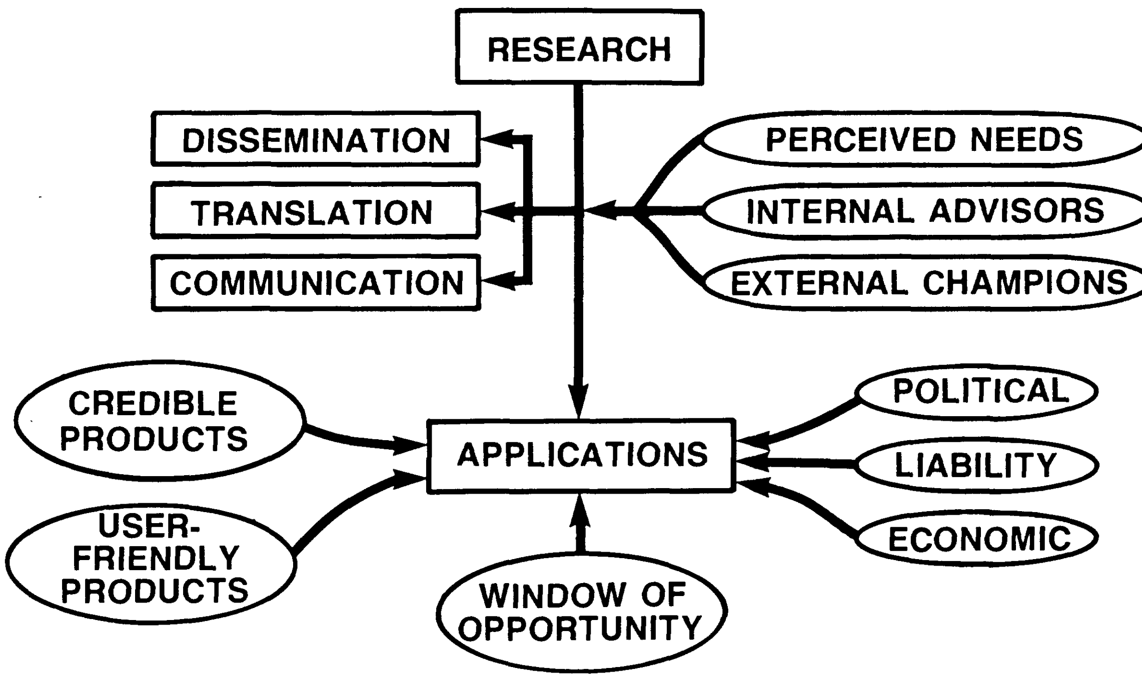


FIGURE 6

STIMULI FOR ACTION

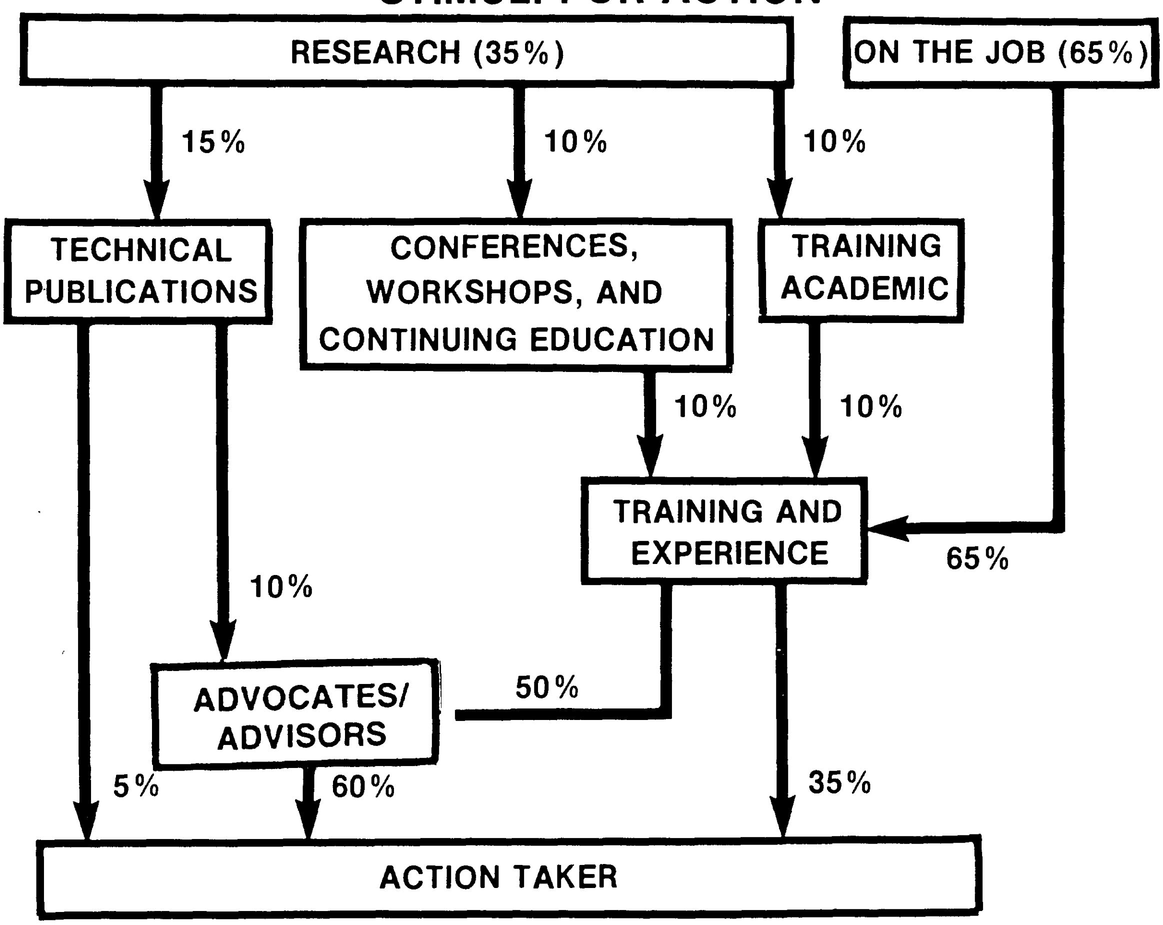


FIGURE 7

APPENDIX 6

PARTICIPANT RESPONSE SHEET

A sheet containing the information below was given to each participant in the Executive Briefing.

Subject: Partnership in the Worldwide Earthquake Risk Management (WWERM) Program Initiative

In response to the invitation of Mrs. Julia V. Taft, Director of the Office of U.S. Foreign Disaster Assistance, and Dr. Dallas L. Peck, Director of the U.S. Geological Survey, to be a "partner" in the WWERM initiative, our organization is willing to consider doing the following:

- [ ] Participate in annual planning meetings.
- [ ] Utilize technical products and maps prepared as a result of the initiative.
- [ ] Participate in networking with other organizations to increase the benefits of all concerned.
- [ ] Incorporate appropriate earthquake damage and loss control measures in project activities under my purview at the regional and host country levels.
- [ ] Co-fund professional skill enhancement activities in targeted countries.
- [ ] Meet with co-sponsors of the initiative for further discussions on how my agency or organization can best contribute to the overall effort.
- [ ] Would you like more information regarding the WWERM, *etc.*?

____
Name *(please print)*

____
Organization

____
Address

____
City, State, Country

____
Telephone

____
Telex

____
Date