WELCOMING ADDRESS

by

Hernowo Hadiwonggo
Co-Chairman, Conference Organizing Committee

Bapak Sekwilda yang kami hormati, the Secretary of the Special Province of Yogyakarta, honorable guests from ministries and local government officials, police officials, distinguished participants, ladies and gentlemen:

As the Chairman of the Organizing Committee, I would like to convey my sincere welcome to all of you participants of the Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage to Indonesia, particularly to Yogyakarta, which is known as the historical and cultural city. This conference is scheduled to be held until June 26, including a one day field trip to the Merapi area. It is important to mention that about 40 participants of this conference are from the Asia and Pacific countries of South East and East Asia and the U.S. Local participants from Indonesia are officials from various ministries and experts of the universities. According to the list of participants taking part in the conference, we will arrive at convincing results by the end of this conference.

On this opportunity, I would like to express my sincere appreciation to Professor Chiu from the University of Hawaii at Manoa, who is the Chairman of the Steering Committee. He has supported the Organizing Committee with his hard efforts to make this conference possible and well-organized.

I also would like to convey very many thanks to the Secretary of the Special Province of Yogyakarta who shared his valuable contribution and full assistance in facilitating us to make this conference possible. My sincere gratitude goes to the officials of the local government of the various ministries and the honorable guests who are attending the opening session of this conference. Finally, I respectfully ask the Secretary of the Special Province of Yogyakarta, representing on behalf of the government, to deliver his address and to officially open this conference.

Thank you.

WELCOMING REMARKS

by

Albert J. Simone
President, University of Hawaii and
Chancellor, University of Hawaii at Manoa

On behalf of the University of Hawaii, I am very pleased to send a message of welcome to the organizers, participants and distinguished guests in attendance at the Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage.

It seems a very short time ago that I had the pleasure of sending greetings to the first conference, held in Bangkok in 1987. Professor Chiu told me then that if that conference was successful, further conferences would be considered. This second conference pays tribute to the excellence of the first meeting as well as to its timeliness, especially since the United Nations has designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR).

Major earth and climate disturbances have challenged us since 1987. Volcanic eruptions and earthquakes have racked many of us here in the Pacific. The effects of the dramatic explosion of Mount Pinatubo are said to be affecting weather around the world. And the Pacific weather changes that we call El Nino are bringing drought to areas normally wet and heavy rains to areas normally dry. There is still much more for us to learn about the earth and about how to protect ourselves from its less predictable moods.

No nation alone can hope to find the answers we need to mitigate natural hazards. But together, working collaboratively as Pacific and Asian partners, we can help each other to understand past natural events and protect ourselves against them in the future. We need, in particular, to continue to share the engineering expertise to build structures that can withstand the forces unleashed by weather and earthquakes. I am very pleased to note that this conference has attracted even wider geographical participation than the first. This is important, and we hope that the next conference in the series will be even larger.

The University of Hawaii is deeply pleased and honored to have supported both this conference and the one before. We are very pleased that activities stemming from the first conference have been undertaken in the nations represented. We look forward to further accomplishments.

This conference, then, is of vital importance to our region. The faculty, administration and students of the University of Hawaii join me in wishing you a highly successful meeting.

OPENING ADDRESS

by

Sri Paduka Paku Alam VIII,
Governor of the Special Province of Yogyakarta

delivered by
Mr. Suprastowo, The Secretary of the Special Province of Yogyakarta

Ladies and Gentlemen, delegates of the Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage:

Regretfully, I have to inform you that Sri Paduka Paku Alam VIII, Governor of the Special Province of Yogyakarta could not attend the meeting today. He has been called on another assignment outside of Yogyakarta. For this reason we ask for your permission to read his speech on his behalf.

Ladies and Gentlemen:

Today is a very happy day for me because, once again, Yogyakarta has the honorable and pleasant opportunity to host an international conference which will be of considerable importance to human lives. Today marks the opening of the Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage for which I would like to thank and also to welcome the delegates to Yogyakarta.

This meeting has a very important impact on human lives because natural disasters cause great damage, but their occurrences cannot be avoided. Our best effort then is to find ways to avoid a bigger loss, or, forecast what will happen in the future so as to reduce these losses. In this conference, you will discuss many ways to overcome natural disasters such as methods that are now used to protect the earth from soil erosion, flooding and the environment.

The presence of many participants from various countries will provide the delegates the opportunity to discuss many types of natural disasters, and we hope the participants will be able to formulate strategies that are most effective for protecting the environment.

Meanwhile, we hope that the efforts of the deliberations as well as the methods for decreasing natural disaster impacts are not just discussed till the end of the conference. The more important thing is the follow-up ensuring that the results formulated at this conference are implemented in each region for the benefit of human lives.

Good luck with the conference and may God be always with you. Finally with the guidance of Allah Subhannahu Wata'alla, I pronounce the Second U.S.-Asia Engineering for Mitigating Natural Hazards Damage open.

Paku Alam VIII
Governor of the Special Province of Yogyakarta

SUMMARY OF WORKSHOP

The participants were involved in a Workshop during the final two days of the conference program. Five groups were formed, one for each of the conference theme topics. The objective of each of these groups was to develop a report which would identify three or four cooperative research projects of high priority and great interest to participating countries.

The projects identified by the groups have the following common attributes:

- The projects enhance the flow of information and experiences across national and geographic boundaries;
- The projects provide demonstrable results, within the period of performance, that clearly advance engineering understanding and are implementable into practice;
- The projects have a critical mass of investigative capabilities and commitments; and,
- The projects provide an efficient use of local and regional expertise and information bases.

The titles of the projects recommended by the five groups are listed below; the full reports are presented in the following chapters.

EARTHQUAKE HAZARD

1. Seismic Hazard Definition and Zoning
2. Vulnerability and Damage/Loss Information for Risk Management
3. Strategies for Fatality Reduction in Domestic Dwellings
4. Communication of Earthquake Risk Management Issues with Banking and Financial Institutions

FLOOD HAZARD

1. Asian Rim Information Center for Flood Hazard Modeling
2. Evaluation of Flood Forecast, Warning and Response Mechanism
3. Joint Occurrence Probability of Flood and Other Hazards

GROUND-FAILURE HAZARD

1. Relationships Among Precipitation, Pore Pressure and Slope Failure
2. Modeling of Debris/Mud Flows
3. Landslide Mitigation by Biotechnical Methods

VOLCANO HAZARD

1. Collaborative Observation of Selected Volcanoes
2. Exchanges in Hazard and Risk Mapping
3. Topical Research
4. Satellite Observations

EXTREME-WIND HAZARD

1. Improved Design/Construction Provisions for Housing, Shelters and Community Buildings
2. Strong Wind Damage Analysis
3. Development of Building Code and Design Guidelines Related to Severe-Wind Hazard
4. Improved Definition of Wind Characteristics in Severe Storms

ADDITIONAL PROPOSED PROJECT

Establishment of an International Natural Hazard Information Network
(This project cuts across all the hazards and hence is proposed separately from the group reports; it was formulated by the Flood Hazard Group, but it was also endorsed by all participants.)

EARTHQUAKE HAZARD WORKSHOP REPORT

Co-Chairmen: H. Shibata
P.C. Thenhaus
Rapporteurs: A.H-S. Ang
K. Muniandy

The earthquake hazard working group reviewed proposed projects from the initial U.S.-Asia Conference, convened 14-18 December 1987, Bangkok, Thailand. The proposed projects from that conference remain valid and are important topics of research. However, the group's initial concern was to ask why so little progress had been made in implementing the previously proposed research and in reducing the earthquake risk. It is felt that to achieve earthquake related loss (structural, economic, life loss, etc.) reduction, an integrated risk management strategy needs to be developed.

Almost 85 percent of all deaths due to natural disasters occur in Asia and the Southwest Pacific. As the societies develop their economies and urbanization increases, the risk to lives and property continues to increase. Past research has developed a large resource of scientific and technological knowledge but utilization of this knowledge in earthquake hazard mitigation appears to be slow and inefficient. Technological and scientific innovations alone cannot reduce the level of risk. What is needed is a fresh and bold look at an integrated approach to risk management.

Planners, scientists, and engineers have studied and have suggested various solutions for investigating earthquake risk. However, there is relatively very little effort spent on an integrated approach. Such an integrated approach requires a global look at risk management strategies, and application of those strategies in an "appropriate" mix to achieve maximum benefits at minimum cost and time. These strategies span a whole spectrum of disciplines, from engineering to communication, from earth sciences to finance and insurance. Application of any, or a combination of these strategies may bring some benefits. However, to achieve the most efficient global and implementable approach, one needs to look at all the strategies in an integrated manner and to identify barriers that must be addressed to optimize the adoption of scientific and technological approaches. Impact assessment and loss reduction planning are complex issues that require a synergistic and integrated approach. Global management of earthquake risk demands proper understanding of all the risk reduction options and selection of those options in conformance with the socioeconomic, political, technical and scientific environment of the region being considered. These options may be different for various countries depending upon the physical risk, level of economic development, mix and age of constructed facilities and economic institutions involved in development and maintenance of constructed facilities.

Earthquake risk can be managed. The time to understand and implement an integrated approach to risk management is now. In light of this, several study topics are proposed, all of which are intended to generate the necessary technical information that can be directly useful for an integrated risk management of earthquake hazard.

Project 1

Seismic Hazard Definition and Zoning

Regionally uniform assessments of the strong ground-motion hazard from earthquakes is nonexistent in many Asian countries. Assessments that are available and used in some countries are antiquated and in dire need of updating for use in modern engineering design. Primarily responsible for this situation is the lack of expertise in Asian countries in developing such hazard-mitigation products, even though well-defined methodologies have existed and have been widely used in the United States for the past 15 years. The need for training in these standard methodologies is clear.

A short-term goal is to maximize the use of available geological, geophysical and seismological information to produce uniform estimates of the strong ground-motion hazard for applications in modern engineering design and in the implementation of zoning for building code regulations. Because the geologic/tectonic systems that give rise to the seismic hazard in the Asian region cross many countries' borders, international cooperation is required in sharing basic seismological, geological and engineering data used in the development of regional maps.

Longer-term goals are to develop critical databases and instrumentation for refining the predictive capabilities of strong ground-motion. Specifically: 1) assess the technology used for strong ground-motion measurements at the existing instrument stations and upgrade the technology to be capable of measuring broad-band earthquake spectra. 2) Supplement the existing instrumentation so that the database includes a wide range of surficial geologic settings, both in the near- and far-field, to characterize site-response. 3) Develop broad-band, low-maintenance and strong-motion instrumentation that is robust and reliable in the adverse tropical climate.

The tectonic systems in the Asian region are the largest, most complex and most seismically active in the world. Yet, the understanding of the development and the rates of crustal deformation along these systems lags far behind those of Western countries as, for example, the San Andreas fault of western California. Rapid expansion of recently developed techniques of paleoseismological investigation of faults is needed to quantify the rate of deformation and seismic potential along major faults of this region, such as the Sumatra and Philippines fault systems. Refined geodynamic models of plate and microplate interactions are needed to place local fault-deformation rates into a regional geodynamic context. Concomitantly, refined hypocentral locations of earthquakes are required to more clearly define active geologic structure. These integrated studies would lead to a wide range of ground-motion hazard products useful in mitigating earthquake damage to constructed facilities.

Project 2

Vulnerability and Damage/Loss Information for Risk Management

Basic engineering information for risk management must include vulnerability data. These may be developed on the basis of field data from past earthquakes and analytical models of damage and fatality assessment. Different levels of sophistication will be necessary depending on the relative potential consequence of failure -- e.g. in the case of ordinary housing, empirical vulnerability measures may be appropriate, whereas for high-rise buildings, or major industrial facilities and infrastructures, system-specific damage assessment methods may be required to generate the loss information. In the latter cases, condition assessment of existing structures or systems is essential for proper damage evaluation.

To be useful, the generated information must be in a form and based on language easily understood by the financial community. The information should include the economic loss that can be expected (and associated uncertainty or variance) as a function of different earthquake intensities.

The same information may also be generated to show the effectiveness of different degrees of retrofitting or strengthening. The potential benefit from such a study is to provide technical information useful for intelligent decision-making by financial institutions, such as insurance companies and government disaster reduction planning agencies.

Project 3

Strategies for Fatality Reduction in Domestic Dwellings

In many developing countries, domestic dwellings are masonry structures. Furthermore, in some of these countries, like China and Indonesia, there is a move to house people in low-cost, low- to medium-risk reinforced concrete frame apartment blocks. For maximum life-saving potential, it appears necessary that effort has to be directed to make these types of dwellings "earthquake-safe."

Work on this project will involve developing an assessment model for earthquake vulnerability and fatalities from existing dwellings, existing dwellings which are strengthened and dwellings which have earthquake protection incorporated. Efforts towards the development of low-cost methods of strengthening existing domestic dwelling, low- to medium-rise apartment blocks, and incorporation of earthquake protection into the code of practice for low-cost housing are envisioned in this project.

Also, fatality in densely populated areas must consider secondary earthquake effects such as tsunami, landslide, spread of earthquake-induced fire, and other related hazards.

Project 4

Communication of Earthquake Risk Management Issues with Banking and Financial Institutions

Over the past three decades, many engineering and scientific strategies have been developed to mitigate losses due to earthquake. However, implementation of those known strategies have been less than successful. One reason for this less than desirable success has been that knowledge generators and knowledge users are not communicating in the same language. As an example, two important segments of the risk management groups that have not been involved in research or implementation are the financial and the insurance industries. Even though these two sectors deal with the enormous consequences of earthquakes, their expertise, their needs, and their input have not been integrated with other professional and scientific sectors. It is difficult to judge at this time how much more success the earthquake community of knowledge generators would have achieved in mitigating earthquake losses, had they involved the financial and the insurance industry knowledge users, but arguably it can be said that there have been large opportunity losses.

This project will involve working with financial, banking, and insurance/reinsurance industries in Singapore and Indonesia on developing risk management strategies. Such a communication not only will help in articulating the mitigating strategies for economic losses, but will also provide an advocacy group that can help in implementing other structural and nonstructural options for mitigating earthquake risk.

TRAINING

For many parts of the world, including many countries in Asia, the proper implementation of available state-of-the-art knowledge and technology will have the greatest benefit in mitigating potential losses to earthquake hazard. This will necessarily require training of professionals and technicians in the available technology. However, training should also include education and public awareness of the threat of earthquake, and the publication of simple illustrative steps that individuals can undertake in the event of an earthquake.

The four projects described above will require different levels of efforts among research, implementation and training as shown in the following table.

PROJECTED DIVISION OF EFFORTS

Project	Research	Implementation	Training
1	0.1	0.45	0.45
2	0.5	0.25	0.25
3	0.5	0.2	0.3
4	0.1	0.6	0.3

Earthquake Hazard Workshop Participants

A.H-S. Ang
T. Balendra
M.P. Gaus
E. Kertapati
K. Muniandy
T-C. Pan
H.C. Shah
H. Shibata
K. Shiono
P.C. Thenhaus

FLOOD HAZARD WORKSHOP REPORT

Co-Chairmen: A. Nishat
J.M. Wright
Rapporteurs: M.R. Peart
K.L. Hiew

Flood hazard mitigation options include structural measures and nonstructural measures. Structural measures such as dams and reservoirs, dykes, levees and flood walls, flow diversions, flood detention, improvement of channel conveyance, river training, induced groundwater recharge, pumping, afforestation, etc. are aimed at modifying and altering the extent and nature of flooding. Nonstructural measures such as flood plain zoning and other land use controls, watershed management, flood proofing, evacuation and shelter management, flood forecasting and warning, etc. are aimed at reduction of loss of lives and properties due to flooding. Despite these efforts to control flooding and to reduce susceptibility to it, floods occur with serious adverse consequences to individuals and communities. A third strategy of mitigating flood loss is to modify impacts through flood insurance, awareness creation program and post-flood recovery measures.

Floods can result from various factors such as heavy rainfall, dam and levee failures, storm surges and tsunamis, drainage congestion, rising of sea level, etc. Efforts are going on in flood prone regions/countries to mitigate damages through various measures. In recent years approaches in dealing with floods have changed dramatically mainly due to introduction of environmental considerations in planning, better understanding of relationships between flooding and the flood plain and recognition of the need of integrated management of natural and ecological resources. New approaches to flood risk and flood plain management are being formulated and development of the best mix of mitigation measures to be applied to unique local circumstances is being highlighted.

The Workshop participants (list annexed) deliberated and identified the following three priority projects which could be of immediate benefit to participating countries. The main considerations in arriving at the projects include implementability, resources needed and the time frame. It was emphasized that there is a need to exchange experiences on new and innovative steps/approaches on flood hazard management. Effective measures are required to update the level of technological tools such as numerical and hydrodynamic modeling, risk assessment and awareness creation programs, and development of better understanding of the physical phenomena of other hazards related to flood such as river bank erosion, river migration and storm surges, etc. It is felt that the proposed projects will foster and encourage cooperation among participants and support and financing through sponsoring agencies.

Project 1

Asian Rim Information Center For Flood Hazard Modeling

Project Goals

To establish a "clearing house" for collection and dissemination of information on computer models by:

(a) Collecting and updating on a periodic basis, existing models (software) and manuals for flood hazard mitigation studies; and

(b) Providing advice and assistance on application of such models for specific problems of the potential users.

Needs

Computer modeling capacity have been developed in various countries for flood hazard engineering analysis. These knowledge and experience should be shared or disseminated through a Regional Center. Examples of such models are:

(a) Meteorological models - typhoon models, global warming models, intense rainfall models, etc.

(b) Hydrological models - flood frequency models, rainfall- runoff models, radar-rainfall models, GIS models, etc.

(c) River mechanics models - hydrodynamic models, sediment transport models, etc.

(d) Coastal engineering models - sea level rise models, storm surge models, tsunamis models, etc.

Benefits

Technological transfer in the form of:

(a) Supply of information and copies of computer software to potential users in the region

(b) Training on the use of computer models available

(c) Expert advice on the application of these models for specific problem solving

(d) Provide feedback to model developers

Time Requirement

3 years

Possible Project Leaders/Coordinators

R. Harboe, Bangkok
K.L. Hiew, Malaysia

Funding and Collaborating Agencies

DANIDA (Denmark)
JICA (Japan)
GTZ (Germany)
ADB (Manila)
U.S. AID
U.S. Army Corps of Engineers
WMO (HOMS)

Project 2

Evaluation of Flood Forecast, Warning and Response Mechanism

Project Goals

The goals of this project are:

(a) To review the current usage and effectiveness of flood forecast/warning systems and flood risk mapping in participating countries;

(b) To identify improvements to existing flood forecast/warning systems or the design of new systems to maximize hazard mitigation benefits; and

(c) To identify measures to improve public awareness and responsiveness to flood hazards through usage of flood risk maps, effective media communication and citizen participation.

Why Needed

Currently the participating countries are in various stages of technological awareness with regard to flood forecasting/warning systems and flood risk mapping techniques. It has been seen that even when forecasting/warning systems have been operated effectively, the message is not reaching the target group or in a form that elicits the desired response. Similarly, many flood-risk maps have not achieved their planned objectives because of lack of communication between engineers, land use planners, decision makers and the general public.

Benefits

The project will enable participating countries to learn from each others' experience in flood forecasting/warning and flood risk mapping/awareness. It will also contribute to evolution of technology for effective long-term flood plain and coastal management.

Time Requirement

3 years

Possible Project Leaders/Coordinators

A. Nishat, Bangladesh
J.M. Wright, USA

Sponsors

National Science Foundation (USA)
Equivalent organizations in participating countries
Universities
U.S. AID

Project 3

Joint Occurrence Probability of Flood and Other Hazards

Project Goals

The goals of this project are:

(a) To review the use and effectiveness of existing magnitude/frequency models for analysis of flooding due to multiple causes, such as riverine and storm surge flooding; and

(b) To examine whether existing approaches for the management of flood prone areas give sufficient attention to multi-hazards, including sea level rise.

Why Needed

(a) Magnitude/frequency plots may be deficient when more than one extreme event combine to produce a flood, e.g., tsunamis and riverine flooding in Japan. In such cases, magnitude may be underestimated. They are also deficient when an independent event occurs at the same time which exacerbates the flooding.

(b) Non-stationarity consequent upon global warming/sea level change may affect the accuracy and validity of existing magnitude/frequency analysis.

(c) To encourage the consideration of a multi-hazard approach by authorities involved in the management of flood-prone areas.

Benefits

(a) Focus attention on multi-hazards, especially in Southeast Asia.

(b) Evaluate the appropriateness and application of magnitude/frequency hazard models.

(c) Ensure consideration be given to selecting appropriate thresholds for multi-hazard events.

Time Requirement

3 years

Possible Project Leaders/Coordinators

Y. Kawata, Japan

Sponsors

National Science Foundation (USA)
Universities
U.S. AID
Equivalent organizations in participating countries

Project Title

Establishment of an International Natural Hazard Information Network

Project Goals

The goals of this project are:

(a) To establish a formal process to maintain a continual channel of communication regarding activities (projects) proposed by Conference delegates including progress reports and needed follow-up measures; and

(b) To gather information on natural hazard mitigation projects and other activities being carried out by governments/organizations/institutions and individuals that may be of benefit to Conference delegates, sponsors and other users (U.S., Asia and even international).

Why Needed

(a) To establish a mechanism to ensure follow-up of proposals, to assess and measure progress and to determine additional actions needed, including identifying who should carry out required initiatives.

(b) To share experiences and activities with delegates and with the broader network so that interested parties may benefit from state-of-the-art expertise, knowledge, research, programs, policies, etc.

Benefits

(a) Ensures monitoring and follow-up.

(b) Establishes a users network among the U.S., Asia and possibly global applications/uses.

(c) Promotes exchange of information within the discipline.

(d) Promotes inter-disciplinary networking among related hazards.

Time Requirement

Establish by January 1, 1993 and continue to develop until the next Conference (3 years) where the network can be evaluated.

Possible Project Leaders/Coordinators

University of Hawaii (Professor Chiu)
National Science Foundation (USA)
Agencies for International Development
Natural Hazard Research and Application Information Center
(University of Colorado) USA
Other similar centers in sponsoring countries -
- both governmental and academic
UN Scientific Committees

Flood Hazard Workshop Participants

G.T-J. Chen
Y. Fujita
R. Harboe
K.L. Hiew
Y. Kawata
A. Nishat
M.R. Peart
H.E. Rashid
J.M. Wright

GROUND-FAILURE HAZARD WORKSHOP REPORT

Co-Chairmen: B.B. Deoja
R.L. Schuster
Rapporteurs: P. Kumar
T.H. Wu

Definitions

In this report, the term "ground failure" will be restricted to the failure of slopes. Slope failures consist of downward and outward movement of slope materials -- rock, soil, or artificial fill. This movement is triggered by other natural processes, such as heavy precipitation, earthquakes, volcanic activity, or erosion. In some cases, landslides result from the activities of man, typically excavation or irrigation of slopes.

Slope failures range from slumps and slides through falls, avalanches and flows. The general category of slope failure will be referred to by its common term "landslide."

Socio-economic Effects of Landslides

Annual economic losses due to landsliding have been estimated to exceed US$ 1 billion each in India, Japan, Italy and the United States. For example, the U.S. National Academy of Sciences has estimated that landslide losses in the U.S. are US$ 1-2 billion annually (Committee on Ground Failure Hazards, 1985). Landslide losses in most Asian nations are not as well documented as in Japan and India, and are not as large as in those two countries. However, losses in the Himalayan nations, China, Taiwan, the Asian parts of the former Soviet republics, Indonesia, Papua New Guinea and New Zealand are large, with some of them exceeding US$ 100 million per year. In addition, the urban areas of Hong Kong have experienced extremely costly landslides.

Numbers of deaths due to catastrophic landslides are large and have grown in this century because of burgeoning populations. Although data on the precise number of deaths due to landslides are not easy to obtain, during the period 1971-74 nearly 600 people were killed annually by slope failures worldwide (Varnes, 1981). About 90 percent of these deaths occurred in countries in or on the margin of the Pacific basin; a significant proportion of those deaths took place in Asian nations. Data accumulated by the Japan Ministry of Construction (1983) indicate that landslides killed an average of 150 people per year in Japan. In the United States, about 25-50 people are killed annually by slope failure, mainly rockfall and debris/mud flows.

The greatest recorded lost of life in any single group of landslides occurred in Ningxia and Gansu provinces, China, in 1920, when approximately 100,000 people were killed by earthquake-triggered landslides in loess. Another disastrous Asian landslide occurred in 1949, when an earthquake in the Tien Shan Mountains of Soviet Tadzhikistan triggered a series of landslides that buried 33 population centers, killing an estimated 12,000 to 20,000 people. In 1970, 20,000 people were killed by an earthquake-induced rock avalanche in Peru, and in 1985 the eruption of Ruiz Volcano in Colombia resulted in a lahar (debris flow) that killed 22,000 people in the town of Armero.

Among industrialized nations, Japan has suffered the greatest continuing loss of life and property from landslides. Casualties have been particularly great in heavily populated urban areas at the bases of steep mountain slopes. For example, in 1945 in the City of Kure, 1,154 people were killed by debris flows generated by typhoon rains (Nakano et al., 1974).

Organization of Report

The Ground-Failure Hazard Working Group has selected three landslide research projects that it feels have potential of high return and significance in landslide hazard mitigation. The main goal of the proposed projects is to increase the effectiveness of landslide hazard mitigation in Asia and the United States, with particular emphasis on the developing nations of Asia. However, we feel that these projects will provide valuable approaches and results that will be used by natural hazard researchers and managers worldwide. Each of these projects represents one of the following aspects of natural hazard management: (i) failure prediction, (ii) damage prediction, and (iii) mitigation methods.

Project 1

Relationships Among Precipitation, Pore Pressure and Slope Failure

Project Goal

The goal of this project is the development of quantitative relationships among precipitation, pore-pressure generation in geologic materials and landslide initiation.

Background and Justification

Because rainfall-induced landslides are the most frequent mode of slope failure, understanding the mechanism is required for prediction of the occurrences and consequences.

Empirical correlations developed between rainfall and landslides in past studies have tended to be qualitative and specific to particular sites or regions. Real-time pore-pressure measurements can provide a quantitative measure of groundwater response and possibly can improve the accuracy of predictions of slope failure. However, research is needed in various regions and under various conditions of terrain, geology, moisture and groundwater before pore pressure can be used for predicting high-risk and high-frequency landslides.

Strategy

In order to develop the necessary relationships, comprehensive studies involving the following are needed:

- Collection of precipitation data, pore-pressure measurements, and geologic, hydrologic, and geotechnical characteristics from sites in different climatic and geologic environments.

- Measurement of strength and moisture-retention characteristics of geologic materials at instrumented sites, including slope-stability analysis.

- Quantitative evaluation of

  (a) the influence of measured pore-pressure response on slope stability;

  (b) influence of antecedent rainfall on pore-pressure generation and landslide initiation; and,

(c) threshold rainfall levels (i.e., rates/amounts of precipitation at which slope failures are induced) for various geologic and climatic conditions.

Benefits

This research will lead to greater reliability in prediction of high-frequency rainfall-triggered landslides and in assessment of consequential risks.

Time Requirement

3 years

Research Participants

International agencies such as ICIMOD (International Center for Integrated Mountain Development) in collaboration with national organizations, such as the Geotechnical Control Office of Hong Kong or a University, such as Ohio State University, are suggested for implementation of the project. International, regional and local experts are to be hired under short-term contracts by the implementing agency.

Project 2

Modeling of Debris/Mud Flows

Project Goals

The goals of this project are:

(a) To model debris-flow characteristics;

(b) To identify conditions and topographic features conducive to debris flow;

(c) To predict the extent of run-out zone;

(d) To determine risk to population and property; and

(e) To simulate the flow process by a computer model.

Background and Justification

Debris flows (including mud flows) cause significant damage to life and property. Effective protection against such ground failures can be provided if the extent of the run-out zone can be predicted.

In a debris flow, a large bulk of debris is washed down the slope. It mobilizes significant amounts of loose material during its downslope journey. The debris and loose material uproot, bury and destroy everything in their paths. The run-out zone is essentially the region that is covered by a debris flow. Roads, bridges, communication facilities and human settlements may vanish within a matter of seconds. Such failures usually occur during or after heavy precipitation.

Strategy

This study may be conducted either experimentally, for example, through centrifuge modeling or numerically by solving flow equations. The finite-element method of analysis may be employed to solve flow equations.

In the first stage of this study, an extensive literature survey will be done to collect data from reported case histories. This exercise will be used to isolate the variables of significance.

Methods will be developed to model the essential features of slopes and debris. Feedback will be sought from a companion project that seeks to establish relationships among precipitation, pore pressure and slope failure.

Experimental facilities are proposed to be developed to simulate debris flow. A solution of this problem by numerical means appears straightforward as techniques such as finite-element method are well established, and it appears possible to develop the required software.

Extensive graphic support will be needed in a meaningful presentation of the results of analysis.

Benefits

(a) This exercise forms the first step toward risk assessment/management against debris flows. Computer simulation will enable parametric studies by varying critical parameters.

(b) Based on such studies, it should be possible to determine suitable locations of all hill-area developments.

(c) The model may also be used in the development of an effective management/warning system for debris flows.

(d) Although the present study addresses debris flows, the same model (with suitable modifications) can also be applied to study lava flows from volcanic eruptions.

Time Requirement

4 years

Research Participants

International agencies such as ICIMOD (International Centre for Integrated Mountain Development), Nepal; Directorate of Environmental Geology, Bandung, Indonesia; Disaster Prevention Research Institute, Kyoto University, Japan; and the Central Building Research Institute, Roorkee, India

Project 3

Landslide Mitigation by Biotechnical Methods

Project Goal

The object of this study is to establish limits on feasibility of biotechnical stabilization.

Background and Justification

The use of live plants as soil reinforcement to improve slope stability has had a long history. At present, biotechnical slope stabilization is being promoted by soil conservationists and natural-resource people who often fail to consider the engineering principles involved. It is necessary to establish the mechanism of soil-root interaction in order to determine the conditions in which biotechnical construction can be expected to be successful.

Strategy

We propose to conduct pilot projects at two or three sites on natural and/or cut slopes. The most promising local plant species will be used. Instrumentation will be installed in the slopes to observe the physical processes of infiltration of precipitation and of slope movement. The instrumentation at each site will include piezometers, moisture probes, inclinometer tubes and a meteorological station. Observations will be made on slopes with and without biotechnical stabilization to provide data for comparison. We will periodically excavate to determine the growth rate of roots and to measure root depth and diameter.

The results will be used to evaluate the effects of the species on soil infiltration and to determine amounts of plant evapotranspiration. This will be used to predict the effects of plants on pore-water pressures. The measured depth and size of roots will be used to predict the strength of the soil-root system.

Time Requirement

5 years

Research Participants

The International Centre for Integrated Mountain Development (ICIMOD) in Nepal, a scientific consortium of eight Himalayan countries, would be a logical choice to manage the project. ICIMOD is in a position to solicit funds and hire competent researchers for short-term assignments. Ohio State University currently conducts research on biotechnical slope stabilization and can cooperate with ICIMOD. Banaras Hindu University, India, has studied environment regeneration and could serve as advisor on selection of plant species. Other possible participants are Silsoe College (UK) and the Geotechnical Control Office (Hong Kong), both of which have considerable experience in biotechnical slope stabilization.

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Ground-Failure Hazard Workshop Participants

B.B. Deoja
P. Kumar
R.L. Schuster
U. Sudarsono
T.H. Wu

VOLCANO HAZARD WORKSHOP REPORT

Co-Chairmen: B. Voight
S. Bronto
Rapporteurs: A. Nasution
M. Alzwar

More than 1,300 volcanoes are known to have erupted during the past 10,000 years, with about half of these active in recorded history. Two thirds of the active volcanoes are located along the tectonic plate boundaries in the Circum-Pacific.

It is estimated that 360 million people - about ten percent of the world's population - live on or near potentially dangerous volcanoes. With the rapidly expanding world population, mostly in the already densely-populated developing countries, millions of people more will be threatened by volcanic activity in the future. Since the total abandonment of volcanic areas is not realistic, the scientific community and civil authorities face a chronic and increasingly acute problem in coping with hazards from future eruptions.

Volcanic hazards can be substantially mitigated if:

(1) National and local governments are committed to mitigating volcanic hazards and have the will to enact appropriate hazard management decision,

(2) Scientists responsible for such mitigation know how to collect and interpret geological, geophysical, geographical and geochemical data about volcanoes,

(3) sufficient equipment (and maintenance support) for monitoring (and coordinating laboratory work on age dating, etc.) is available to these scientists,

(4) field studies are conducted long before eruptions occur, and

(5) coordination with civil authorities is established before a crisis begins. An existing database and response capability is necessary because of the extremely short lead time often available (about one day in half the cases) between the onset of symptoms warning of volcanic unrest and a dangerous eruption.

Efforts to mitigate hazards in the Asia-Pacific area include some studies of past eruptions; studies of eruption products essential for preparation of volcanic hazards zonation maps and identification of site-specific hazardous processes maps; surveillance of active volcanoes, to warn of increased unrest or imminent eruption; and research on geologic processes, to improve capabilities for eruption prediction/detection or warning, and to improve schemes for hazard mitigation.

Our group considered ideas for cooperative work, some encompassing works already initiated, and others entirely new. The nations having hazardous volcanoes are Indonesia, Philippines, Papua New Guinea (PNG), Japan, Russia (Kamchatka) and the United States (Aleutians). Our group concentrated on areas involving the first three (developing) nations because these nations have needs most closely aligned with the goal of this workshop. Japan, the U.S., France, Australia and New Zealand are nations most likely to provide technology sharing, collaboration and external funding to the developing nations.

Volcanic risk mitigation cooperation between the U.S. and Japan are considered elsewhere under an existing science and technology agreement between those two nations.

General types of cooperative projects include the following:

A. Information Exchange

The obvious goal is to use available expertise and technology in order to gain the greatest impact in risk mitigation.

1. Topical seminars with field visits, e.g., comparisons of similar volcanoes and groups of volcanoes in Asia.

2. Traveling lecturers to universities and government labs, e.g., foreign expert scientists/engineers to Indonesia, Philippines, or PNG, and vice versa. Exchange between the Philippines and Indonesia is funded by UNESCO/ROSTSEA (Jakarta).

3. Exchange of faculty and students for training.

4. Technology sharing:

   a. Sharing designs and prototypes of equipment for use in hazardous locations in less-developed countries. New developments of hardware and software, in seismic, airwave, hydrophonic data acquisition and processing infrasonic monitoring of explosions, radar monitoring of pyroclastic flows, ash clouds and lahars, lightning detectors as indicators of tephra clouds.

B. Collaborative Research Projects

Although it is essential to use existing technologies, this approach alone will not fully solve the problem of high-risk volcanoes. Volcanic processes vital to the prediction and detection of dangerous eruptions are still poorly understood; and thus, research remains an extremely important part of volcano risk mitigation. The existing state-of-the-art is simply not sufficient to provide a truly effective standard-of-practice.

1. Collaborative observations of selected volcanoes:

   a. Intensive multidisciplinary team study of selected active volcanoes for several months, including geologist to identify eruptive history, seismologists, deformation specialists, gas geochemists and others, for documentation and identification of baseline signals and precursors to elevate activity.

   b. Long range multidisciplinary collaborative studies, either by team collaboration, or by data and interpretation sharing between separately-financed and organized groups and agencies. An important goal to work toward is to improve sharing of data and ideas between separate groups; this goal emphasizes the need for "open door" sharing of information, in contrast to the "competitive" attitudes or bureaucratic "vertical structuring" that often impedes working-level cooperation between scientists or engineers. It is vital in the interests of saving lives and mitigating of regional economic losses for us to work together.

c. All volcanoes are candidates for such efforts, but we assigned highest priority to Decade Volcano (IDNDR) in developing countries, emphasizing on-site project training, and improvement in equipment and laboratory analysis capability. Decade Volcanoes for Asia include Merapi (Indonesia), Taal (Philippines), Ulawun (PNG), and Unzen and Sakurajima (Japan).

2. Exchanges in hazard and risk mapping. Assistance with GIS technology to analyze and portray hazard and risk and other state-of-art (SOA) hazard mapping research. Integration of geologic, hydrologic, and geographical and geochemical data. Volcanologists have been slow to take advantage of potential advantages of GIS and other electronic databases.

3. Topical research. A wide variety of projects could be proposed and justified. The list presented here is in random (i.e, non-prioritized) order.

   a. Internal structure and processes of stratovolcanoes, calderas, domes, and hazard implications of each.

   b. Correlation and process implications of continuously recorded (or frequently-monitored) gas emission and other geochemical changes. Use of SOA gas sensing instrumentation. Investigating gas accumulation and release from volcano lakes (Dieng Plateau, etc.); hydrothermal eruptions.

   c. Quantitative characterization of eruptions in progress. What new tools to apply?

   d. Relation of groundwater and crater lake regimes on unrest and eruption processes.

   e. Pyroclastic flow and lahar processes, deposit characterization and relation to process and hazard potential.

   f. Lahar generation from pyroclastic flows; morphology, source characteristics, mobilization, flow characteristics.

   g. Eruption precursors. Models and tests of interpretation and reliability. Study of current activity, review of old data files interpreted using modern concepts. Rates of "false alarms" in relation to pattern recognition of precursors.

   h. Windborne-ash tracking, wind profiling using SOA radar to predict tephra directions and aircraft hazards.

   i. Earthquake source and transmission processes. Distinguish volcanic earthquakes from earthquakes of tectonic character. Influence of source and path on signature. Use of SOA recording and processing, correlation with observed events and other monitoring data.

   j. Tremor and long-period earthquakes as promising long- and short-term precursors to explosive eruptions. Modeling and tests of competing models. Frequency spectrum, correlation with specific events, significance toward eruption prediction, and false alarm statistics. Dense network experiments at selected lively "volcanoes."

k. Fundamental causes, triggers, precursory warnings for collapsing volcanoes (Mount St. Helens-style collapse, eruption). Effect of hydrothermal weakening on volcano stability.

4. Satellite observations

   a. Remote sensing for monitoring (GPS, plume tracking, SO_2 etc.)

   b. Remote sensing for mapping and volcano risk assessments

   c. Data telemetry platforms

5. Prediction experiments, before and during unrest, including:

   a. Instrument development to "catch" precursors.

   b. Testing hypotheses about actual processes and precursors suggesting eruptions.

   c. Possible topics include:

      1. Precursors for reactivation of long-dormant volcanoes, vs. those for "frequently erupting" volcanoes;

      2. Earliest precursors of eruptions (to 10 years before);

      3. Degassing processes preceding eruptions;

      4. Innovative ways to anticipate types and magnitudes of impending eruptions.

In summary, a large number of potential projects and unanswered questions have been identified. Funding seems essential for most of this work. A wide range of projects is proposed, recognizing that not all can be undertaken at once, and opportunities for funding are difficult to predict. Projects have been mentioned for which little or no funding is currently available, in hopes that such projects may be undertaken in the future.

C. IDNDR Decade Volcanoes

Work on the Decade Volcanoes comprises our highest priority, involving one each for the Philippines, Indonesia and Papua New Guinea. These sites are particularly appropriate locations for study of many of the topical research items listed above, and are in addition sites of particularly high risk to local inhabitants.

1. Cooperative investigation at Decade Volcano Merapi, Java.

   a. Goal: to investigate processes and eruption precursors at a highly active explosive volcano; to mitigate risk in a densely populated region.

   b. Why needed: Merapi is one of the world's most dangerous volcanoes. With an eruption occurring once every 3 to 7 years, it ranks 15 on the Yokoyama scale for high-risk volcanoes. The high activity implies that important data are particularly likely to be obtained here, preceding and during periods of explosive volcanism. The lessons learned from these studies can be applied to other volcanoes of similar type worldwide. Many topical subjects previously identified can be studied here.

c. Required Time: Throughout the remainder of the Decade. Subtopics may have specific time limitations as appropriate to justify funding. Combinations of long-term baseline studies and short-term topical investigations.

d. Benefits: Critical information is likely to be obtained on generation of various long-period, tremor, and short-period earthquakes, edifice deformation, gas geochemistry, dome growth (excellent opportunities for terestrial photogrammetry), pyroclastic flow processes, lahar generation, deposition and impact.

The importance of this volcano has led to important prior studies (e.g. carefully-observed eruption history, acquisition of seismic, deformation, and geochemical data bases) that give a strong foundation for future efforts, and increase value of new observations and the likelihood for success of Decade Projects. Investments of funds, equipment and manpower should yield important and cost-effective returns to volcanology and risk mitigation.

e. Potential Collaborating Organizations/Contact Individuals: Volcanological Survey of Indonesia, Bandung, (Dr. Wimpy Tjetjep); Merapi Volcano Observatory (Dr. S. Bronto); Gadjah Mada University, Yogyakarta, Dept. of Physics (Dr. Kirbani); Dept. of Chemistry; Technical Faculty, Geology, Geodesi; Faculty of Geography); Volcanic Sabo Technical Center, Yogyakarta (W. Suharjono); U.S. Geological Survey (T. Casadevall, C.D. Miller) Pennsylvania State University, USA (B. Voight and K. Young); University of Stuttgart, Germany (R. Schick); University of Pembangunan Nasional, Yogyakarta (B. Pratistho); Institute Technology National, Yogyakarta (Ir. Er. Budiadi); French Government Agencies (J-P. Sabroux, P. Allard, M. Kasser); others in Japan, Australia, etc.

2. Cooperative Investigations at Decade Volcano Taal, Philippines.

a. Goal: to investigate process and eruption precursors at an intra-caldera stratovolcano with a crater lake.

b. Why Needed: Taal has had 33 recorded eruptions since its earliest recorded outburst in 1572. Its largest historical eruption killed over 1,300 people, and succeeding eruptions have been extremely violent, including powerful 20-km high eruption columns, fatalities to 10-km radius, and production of laterally expanding ring-like clouds (base surges). It is a Yokoyama scale high-risk volcano.

The volcano is currently experiencing unrest, and thus is most appropriate for Decade study. Results can be applied to local severe risk mitigation at Taal (evacuation of 50,000 in 1965 drained the calamity fund of the national government), and lessons learned applied to crater-lake volcanoes elsewhere.

c. Required Time: Throughout the Decade, combination of long-term baseline studies and short-term topical investigations.

d. Benefits: Critical information on volcano and eruptive process in a crater-lake environment: seismic characterization of precursors, geochemical precursors, volcano topography. Risk reduction to local inhabitants. Training of student/future scientists.

e. Potential Collaborating Organizations/Contact Individuals: Philippines Institute of Volcanology and Seismology (PHIVOLCS), Quezon City (R. Punongbayan), U.S. Geological Survey (C. Newhall, C.D. Miller, T. Casadevall), University of Illinois at Chicago (K. Rodolfo), University of California, Santa Barbara (R.V. Fisher), University of Hong Kong, Dept. of Geography and Geology (Susan Donoghue).

3. Cooperative Investigations at Decade Volcano Ulawun, PNG.

a. Goal: to investigate processes and eruption precursors at an active stratovolcano.

b. Why needed: Ulawun is one of the highest-risk volcanoes in the Bismarck Arc, as rated on the Yokoyama scale (see also Geological Survey PNG, Report 83/13, map scale 1:100,000, C.O. McKee Author, 1983). Justification similar to Merapi but for volcano of different eruptive styles.

c. Required time: Throughout the remainder of Decade.

d. Benefits: Approximately as for Merapi.

e. Potential Collaborating Organizations/Contact Individuals: Geological Survey of PNG, Rabaul Volcano Observatory (B. Talai, C.O. McKee), U.S. Geological Survey (C.D. Miller), Geological Survey of Australia (R.W. Johnson), Macquarie University, North Ryde, Australia (R. Blong); others.

4. Volcanic Hazard Mapping for Quaternary "Dormant" Volcanoes, in Indonesia, Philippines and Papua New Guinea.

a. Goals: To provide:

1. Baseline volcanological data for each volcano, in order to provide the capability for short-term hazard response.

2. Preliminary volcanic hazard zonation maps. The maps are required by scientists and hazard management personnel in time of crisis, and by local governments to guide them to do planning for volcanic areas in advance of crisis.

b. Why Needed : One or several "dormant" volcanoes erupt each year, increasing the number of "known active" volcanoes. Such volcanoes are extremely hazardous, because

   1. They are seldom considered in pre-crisis hazard planning (they may not even be recognized as a volcano).

   2. Typically they have been ignored for basic geologic studies; thus, if hazard maps are suddenly required in time of crisis, no factual basis exists to enable the rapid construction of hazard maps.

   3. A long-repose period is commonly associated with large, highly explosive eruptions. Examples of such devastating eruptions of dormant volcanoes in recent decades include Pinatubo, Philippines, 1991, El Chichon, Mexico, 1982, and Bezymianny, Kamchatka, 1956.

c. Required time: Ten years.

d. Potential Collaborating Organization/Contacts Individuals: Volcanological Survey of Indonesia (Dr. Wimpy Tjetjep); Directorate of Environmental Geology; PHIVOLCS (R. Punongbayan); Rzbaul Volcano Observatory, Geological Survey of PNG (B. Talai); Institute of Indonesian Sciences [LIPI] (Dr. H. Harjono); U.S. Geological Survey (C. Newhall; C.D. Miller); agencies or universities in host countries (e.g. BPPT, University of Gadjah Mada, ITB, UNPAD, University of the Philippines, etc.); others.

Volcano Hazard Workshop Participants

M. Alzwar
S. Bronto
A. Nasution
B. Voight

WIND HAZARD WORKSHOP REPORT

Co-Chairmen: D.C. Perry
A.P. Jeary
Rapporteurs: K. Seetharamulu
T. Maruyama

The group drew from the experience of its members and from the recommendations promulgated at the EMNHD-1 conference held in Bangkok, 14-18 December 1987. Whilst there was a recognition that the engineering aspects were important, there was also an awareness that the dissemination of information to the populace at large, and to the people who make decisions about construction practice is critical for the output from the group.

Concerns were expressed about the ability of the lesser developed communities, and their ability to learn from the experience of the more developed countries, or at least from those whose quality of information could be transferred to other communities.

The group took the view that the development of criteria for the use of builders or specifiers of construction for domestic housing were a primary target group. It was observed that the mitigation of damage to "non-engineered" or "semi-engineered" structures was an area that represents an achievable goal in the medium-term future. Little has been done in this area, and a large impact can be made at little cost.

The group identified four major projects which it deemed of crucial importance. These can be summarized as follows:

1) Residential housing study.

2) Storm damage analysis.

3) Code development.

4) Wind speed assessment.

Specifically, the reasons for an interest in pursuing these areas of study are caused by an appreciation of the following factors relating to each of the proposed projects:

1) The question of the ability of domestic housing to withstand the effects of severe windstorms and tropical cyclone activity is not well treated, neither is it well researched. Entire community viabilities are prejudiced, not by the failure of engineered structures but more by the failure of a community to be able to house its population, or perhaps because of the resultant death of livestock or crop losses on which the communities ability to be self-sufficient is dependent. The additional question of whether shelters should be provided and of where these should be sited is of considerable strategic importance.

   The ability of some areas of the world to pass on relevant experience gained in this consideration is of considerable importance, but has yet to be exploited.

2) It is clear that there is an enormous amount of information which could be garnered were there to be a specific modus operandi available for the systematic collection of data relating to the ability of structures to withstand severe winds (or conversely their failures in this circumstance). The rigorous criteria for such an assessment in the immediate post event scenario would facilitate such an ability. Further, the availability of a team of international

experts who would be prepared at short notice to investigate the post storm damage and meteorological surface data, prepare a report, and quickly make that report available to interested parties is clearly a world resource that should be developed. The data would be used for the establishment of a damage-susceptibility index, which may be implentable through an expert system approach.

3) Considerable difficulties currently exist in the comparison of building codes across national or state boundaries. It is considered that a framework for the passing of information across such boundaries should be established for the region.

   This would involve the parametric comparison of approaches to codification in order that appropriate comparisons can be made and that the experience gained in one region can be usefully translated to another.

4) The development of analytical methods using wind tunnels and super-computers has far outstripped the database's development on which those models have been based. The correlation of wind structure models with the comportment of wind in the real world is therefore of immediate concern and is a database which needs urgent establishment.

   In this case, there is the necessity of an approach which involves both meteorological and wind engineering inputs.

   In particular, the establishment of wind characteristics at cyclone landfall, both in the vertical and the horizontal planes, together with the variations of parameters such as wind speed and turbulence intensity urgently need assessment for the critical landfall situation. The group considered that the methodology is currently available, but the cost is relatively high for some lesser developed regions. The ability to convince organizations that the establishment of such a database is in their best interests is of crucial importance to the success of the project.

Finally, there is a theme that crossed the boundaries of several of the projects introduced above. This theme is that there is an urgent need to disseminate information to the general public so that a greater understanding of the dangers and some of the simple mitigating actions that are available may be appreciated more widely.

The distillation of complex information so as to be easily understood by the intelligent layman is a project which should not be underestimated, and is recommended by the Extreme-Wind Hazard group as a possible subject for inclusion in the next conference. The success of such an approach would be dependent on the interaction of engineers and scientists with sociologists who may be in a better position to advise on efficient methods of putting over such a message.

Project 1

Improved Design/Construction Provisions for Housing, Shelters and Community Buildings

Project Goals

The goal of this project is to save lives and properties of the residents in wind-hazard areas. It is essentially a "region based" exercise. The approach will achieve an integrated planning by suitably combining private houses, shelters and community buildings. Information dissemination is crucial for help and cooperation from government and voluntary agencies. The following are the specific goals:

(a) To develop sheltering for different regions.

(b) To study construction practices (mainly private houses) in respect of

(1) Materials and

(2) Construction techniques.

(c) To collate experiences in different regions and to arrive at suitable design/construction methodologies appropriate to the regions.

(d) To suggest construction guidelines, prepare design/construction manuals for improved housing. For proper dissemination, video explanation may be attempted.

(e) To conduct cost benefit analyses for alternatives.

(f) To plan layout of housings, shelters and community buildings.

(g) To develop evacuation and rehabilitation strategies.

Benefits

(a) Saving lives and minimizing property damage.

(b) Improving building practice appropriate to the regions.

(c) Safeguarding livestock through shelters.

Time Requirement

2-3 years from resourcing

Project Leaders/Communicators

A.P. Jeary, Hong Kong
T. Murayama, Japan
D. Perry, USA
K. Seetharamulu, India
J. Shanmugasundaram, India

Project 2

Strong Wind Damage Analysis

Project Goal

The goal of this project is to develop a strong-wind damage index for a community using currently available data. Strong-wind data obtained from future storms would be used to validate and refine the index. Future projects would correlate the damage index to a measure of wind hazard to complete a strong-wind risk assessment method.

Implementation

The development of a damage index for a specific type of damage and a given community will entail the following tasks:

(a) Investigate structural systems and methods of construction by region.

(b) Study types of loss and damage caused by strong winds.

(c) Document and catalog current knowledge of damage which different types of structures experience when subjected to strong winds.

(d) Model wind-fields which cause the damage.

(e) Identify specific post-disaster local and international team members for post-disaster responsibilities and define their roles. Teams would include:

- Wind Engineer
- Structural Engineer
- Meteorologist
- Hydrologist
- Social Scientist

Benefits

(a) The results will be used as a component of strong-wind risk-assessment systems. These systems are envisioned as using an expert-system approach to evaluate the expected damage which would result from a given strong wind; thus, providing a means of planning for and mitigating damage which would result from future strong-wind storms.

(b) The determination of data that should be and should not be collected in the future to refine damage estimates and risk assessment models.

Time Requirements

- Phase I → 1.5 - 2 years
    - Criteria Development
    - Implementation Plan

- Phase II → 1.5 - 2 years
    - Primary Damage Data Analysis
    - Prototype Risk Assessment System

- Phase III → Ongoing
    - Damage Data Collection
    - Catalog Damage Data
    - Catalog Wind Field Data
    - Creation of an International Library
    - Damage Index Validation