INCEDE: At the End of a Decade
- Summarizing its 8-year activities -

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Abstract

United Nations (UN) declared 1990-2000 as the International Decade for Natural Disaster Reduction (IDNDR). The International Center for Disaster-Mitigation Engineering (INCEDE) was established in April 1991, within a year after the UN declaration, as a national contribution of Japan towards UN initiative of natural disaster reduction. The center was established in a university environment at Institute of Industrial Science (IIS) of the University of Tokyo with the objectives of doing fundamental research on various aspects of disaster reduction and tackling problems in disaster mitigation through synthesizing information and methodologies from different fields, mainly from earthquake, water induced disasters, remote sensing and GIS fields. Now, IDNDR is almost at the end of its official period, less than a year to go. Reaching the final stage of this disaster reduction decade, we review overall activities of INCEDE, what had been done so far, how much have been achieved and what will be the goals for the future, through this report. This report summarizes the last 8-year activities of INCEDE and its prospective in the new millenium after the IDNDR.

1. INTRODUCTION

Due to the permanent increase of natural disasters in the last few decades, a resolution of the United Nations (UN) in December 22, 1989 declared the 90's as "The International Decade for Natural Disaster Reduction (IDNDR)". The main goal of the IDNDR was the use of specialists and technical equipment to count the losses of human lives, properties and destruction of socio-economic bases, which frequently result from natural catastrophes. Along with many other activities of Japanese Government to support UN initiatives for natural disaster reduction, the International Center for Disaster-Mitigation Engineering (INCEDE) was formed in April 1991 at the Institute of Industrial Science (IIS) of the University of Tokyo, as a national contribution of Japan towards IDNDR for promoting fundamental research on disaster mitigation and information dissemination from an international and university researchers' view point. In general, as a country most vulnerable to various types of natural disaster, importance of disaster mitigation is always realized in Japan. However, Kobe earthquake of 1995 made this realization much stronger among the various levels of society from researchers to decision makers by shattering the general perception that Japan possessed the required technology for disaster mitigation. For INCEDE, it was realized that establishment of the center was timely to carry out fundamental research and increase awareness of public for disaster mitigation issues at national as well as international levels.

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Now, IDNDR has reached almost its final stage, only a year to go before it would officially end. This year, many workshops and meetings are taking place in different continents to evaluate IDNDR activities and achievements and to device strategies for the next decade. Reaching the end of this decade for disaster reduction, we have realized that we need to review our almost a decade long activities. In this report, we summarize various activities of INCEDE during the last 8-year period and possible directions of INCEDE for the post-IDNDR decade.

2. OBJECTIVES OF INCEDE[1)]

Objectives of the INCEDE are to promote fundamental researches for disaster mitigation and information dissemination from an international and university researchers' point of view. INCEDE synthesizes information and methodologies from different fields, mainly from earthquake, water induced disasters, RS/GIS fields, to tackle the problems in disaster mitigation. At present, INCEDE specializes mainly in the disciplines of urban earthquake disaster-mitigation engineering, hydrology/water resources, and RS/GIS.

When the INCEDE was established, the following proposals were presented:

1) Recent changes surrounding a city such as increase population, expansion of the city, and concentration of industries and social capitals in the disaster prone areas, are making the city weak against natural hazards. As for the kinds of disasters, they are shifting from the structural oriented to information or system oriented, with an increase of potential risk of damage to city functions. Fundamental research to reduce the vulnerability to disasters is necessary for minimizing the damage.
2) If a large natural hazard like an earthquake or a flood occurs, damage would be huge and might cover many countries. Without international cooperation, a country struck by such a disaster finds it difficult to respond on its own. This fact highlights the importance of international cooperation in minimizing the effects of a disaster.
3) From these view points, promotion of the fundamental research for developing new technology to make the effects of natural disasters clear and mitigating them becomes very important.
4) For this purpose, we need to establish a research center, which promotes fundamental research as well as develop new technology in order to contribute to international cooperation through joint research with overseas organizations.
5) In addition, establishment of such a center can be Japan's national contribution for the activities of IDNDR.

3. DISASTER MITIGATION RESEACH IN THE UNIVERSITY AND INCEDE

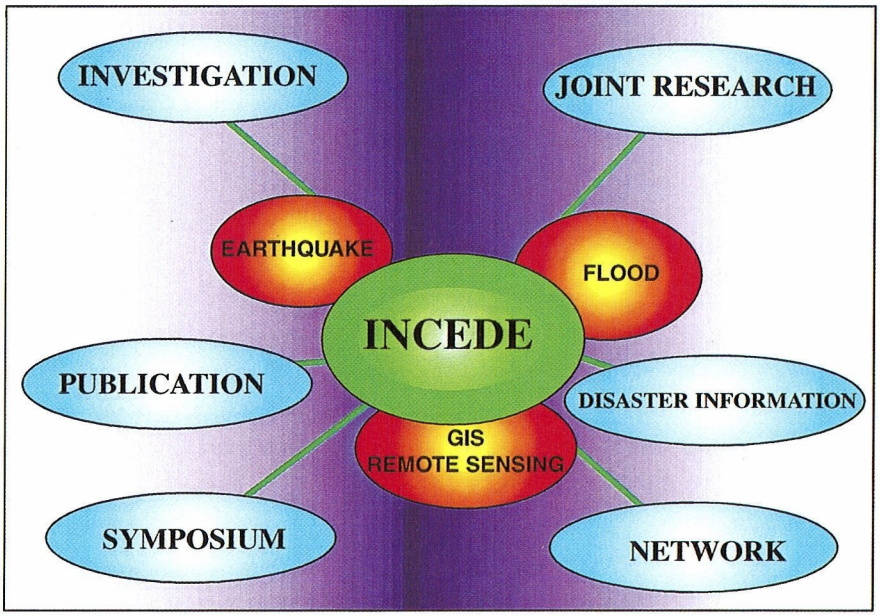
3-1 University Institutes in Disaster Reduction

The special role of the university institutes is the promotion of both fundamental and applied research that should be carried out in a long time span. University institutes have the advantage to continue the research from a neutral position spending a long time. This point is very important in the field of disaster mitigation, as it requires long term research.

Research with results not so valuable in near future but which will be of great value in years to come, and research which is of great importance but no visible solutions or time limitations are also problems which

should be tackled by the university institutes. Applied research by university institutes should be ones whose fields cover several academic societies. The research for standardization of earthquake resistant design code, and returning the results of their fundamental research to the society can be pointed out as examples. Another important role of university researchers may be to act as good public translators of the knowledge on disasters using easy terms.

In addition to these, university has a very important role as an educational organization. Universities are expected to provide human resources and to conduct research. University institutes, therefore, should actively



INCEDE Organization

INCEDE staff together with the Director of IDNDR Secretariat
Dr. Philip Boulle (1st from the left in the front row) during his visit to INCEDE

educate practitioners and officials based on the fact that cooperation between researches and practitioners, and that between institutes and governmental disaster related organizations are very important for disaster mitigation. In addition, university institutes have to play a role as an information dissemination center for international societies.

3-2 Other Institutes in Disaster Reduction

Ministry of Construction, Ministry of Transportation and Science and Technology Agency also have institutes for disaster mitigation. Most institutes listed above, however, are requested to respond to the current problems in a very short time and/or to carry out research only along the guideline of the government. Institutes under governmental organizations cannot carry out research on the topics whose fields cover several academic societies as they sometimes have very strict sectionalism. It is very difficult to expect the institutes belonging to governments to train the people in order to make them specialists in the field.

4. INCEDE ACTIVITIES DURING LAST 8 YEARS[2),3)]

INCEDE was established with four full time staff, a professor, a visiting foreign professor, an associate professor and a research associate. During the last 8-year period, INCEDE has extended its strength from four full time staff to a total of 13 members, which includes 9 part-time research assistants. Also, time to time, INCEDE has been accommodating visiting researchers from different organizations within Japan and abroad. INCEDE has established three research laboratories, which function under the supervision of three faculty members of the center. In addition, eight laboratories of IIS act as cooperative members of INCEDE.

With this limited but dedicated work force, INCEDE has covered a wide range of activities from fundamental research to international cooperation in disaster mitigation. At present, INCEDE activities can be broadly divided into four groups as follows;

1) Research for disaster mitigation technology,
2) Reinforcing disaster related community network,
3) Disaster information dissemination, and
4) Reconnaissance surveys on natural disasters.

The main contents of different activities of these four groups are listed in the righthand side table.

INCEDE Activities

1) Research for Disaster Mitigation Technology
   - *Fundamental Research*
   - *Collaborative Research*

2) Reinforcing the network of disaster related communities
   - *Development of INCEDE Network*
   - *Exchange of MOU*
   - *Joint Research Projects*

3) Disaster information dissemination
   - *World Wide Web*
   - *INCEDE Publications*
   - *International Symposia/Workshops*
   - *INCEDE Open Lectures*

4) Reconnaissance Surveys on Natural Disasters
   - *Earthquakes, Floods, and Volcanic Disasters, etc.*

4-1 Research for Disaster Mitigation Technology

One of the main objectives of INCEDE is fundamental research and development of new technology contributing to international cooperation through joint research with foreign researchers. INCEDE has covered three areas of research, which are as follows;

a) Urban earthquake mitigation engineering
b) Hydrology and water resources engineering
c) Application of RS/GIS to disaster mitigation research

With the above three areas, research activities of INCEDE can be broadly realized in two kinds; namely, Fundamental research and Collaborative research.

4-1-1 Fundamental Research

For conducting fundamental research and development of new technology on the three areas of research as mentioned above, INCEDE has established three research laboratories, which are headed by three professors of the Center. These three laboratories have their own students and researchers for conducting research works. The three laboratories and their major research areas are listed in the righthand side table.

Major Research Themses of INCEDE

Research Laboratory 1: Disaster Mitigation Strategies
- *Natural hazard risk analysis of developing world*
- *Geo-scientific and socio-economic origins of natural disaster*
- *International cooperation for natural disaster mitigation*
- *Disaster mitigation programs and knowledge transfer for developing world*

Research Laboratory 2: Hydrological Disaster Mitigation Engineering
- *Distributed hydrologic modeling*
- *Hydrologic disasters in Asian region*
- *Urban flood mitigation measures*
- *Hydrologic information system on disasters*

Research Laboratory 3: Urban Earthquake Disaster Mitigation Engineering
- *Real time control of large lifeline systems during earthquake*
- *Microscopic seismic risk assessment in urban areas*
- *Simulation of collapse process of structures due to an earthquake*
- *Human evacuation behavior analysis using virtual reality and computer model*
- *Dynamic behavior of interior objects during an earthquake, etc.*

Research Laboratory 1: Disaster Mitigation Strategies

There are 36 research centers affiliated to universities in the field of natural disaster in Japan. Only three of them are dealing with "international aspects" of the natural disasters. However two are oriented to socio-economic research. Thus it is the only research laboratory that studies natural disaster in terms of scientific and engineering and in the global aspect. There are very few such research organizations in the developed countries that focus on reduction of natural disasters in the developing world. The major research fields of this laboratory are explained below.

i) Natural Disaster Risk Analysis of Developing World

Most disaster prone countries in the developing world are making hard efforts to identify natural disaster risk with very limited resources. This laboratory studies how researchers in the developed countries can help in the identification and in putting identified issues into practice. As part of this study, the laboratory is deeply involved in the RADIUS project. It is an undertaking by the IDNDR Secretariat of the United Nations aiming to make risk assessment of urban areas in the developing world against earthquake disaster. INCEDE is carrying

out risk assessment of the Tashkent City, Uzbekistan Republic. In this work, we have paid our attention to the facts that most deaths have taken place at houses where people are living in most earthquake disasters such as Spitak earthquake of 1989, the Kobe earthquake of 1995 and Sakhalin earthquake of 1995. Based on the facts, peak ground motion on dwelling areas in Tashkent was estimated, based on the realistic rupture dynamics of the two faults, which run beneath the Tashkent City. The estimation has revealed that the near fields terms would made the ground motion larger than the estimation conventionally made.

ii) Geo-scientific and Socio-economic Origins of Natural Disaster

Earthquake, volcanic eruption, tsunami, floods, cyclones, and landslides are natural phenomena on the earth. Physical processes within or over the earth cause them. The energy released from these processes is so large that we can not prevent their occurence. These natural phenomena can affect human society adversely in some particular cases. It is the process that natural hazard becomes a natural disaster.

What are these particular cases? The quation in the righthand side explains the cases. The laboratory studies factors in the eqauation. These factors will be expressed in terms of scientific, engneering and socio-economics.

Equation expressing disaster in terms of scientific, engneering and socio-economics

$$D(t) = M\int_{\sum} \frac{G(\vec{r})}{E(\vec{r})S(\vec{r})} X(p)d\vec{r}$$

Where,
D = disaster measured by death toll, affected people and economic loss,
M = magnitude of hazard source
G = geo - scientific response
$\vec{r}$ = location coordinate,
$\sum$ = area where society is built
E = engineering capacity,
S = society capacity
X = societal system, and
P = set of parameters, pk = f(D(t - τ))

iii) International Cooperation for Natural Disaster Mitigation

More than 70 countries in the world suffer earthquake disaster. More than 120 countries in the world suffer flood disasters. There are many similar experiences among these countries and a lot of lessons to be shared by them. The laboratory studies these experiences and lessons to identify research issues for further reduction of natural disasters and to find problems to be solved in the scientific and engineering aspects. In this context, the laboratory is concerned about what gap exists in sharing the technologies and knowledges in the international aid communities, such as JICA, GTZ, USAID, etc.

iv) Disaster Mitigation Programs and Knowledge Transfer for Developing World

There are a couple of international initiatives toward global earthquake disaster reduction with emphasis on the developing world. One is World Seismic Safety Intiative (WSSI) an intitiative by International Association of Earthquake Engineering, IAEE. One of the objectives of WSSI is to increase the awareness of high-level decision-makers about earthquake disaster in earthquake prone countries. It is crucial to mobilize all resources for disaster redcution. Decision-makers should play a key-role. The laboratory studies how to stimulate or encourage such high-level people to take necessary actions toward earthquake disaster reduction. As part of this research, we are going to study cost benefit analysis of measures against disasters.

Research Laboratory 2: Hydrological Disaster Mitigation Engineering

Floods and water related disasters are the main causes of deaths due to natural disasters in the Asian region[4]. As a disaster category, they inflict the highest economic damage among all natural disasters in the region. Flood damage mitigation should be carried out either by control of the water through structural measures such as dam construction, river improvement, through non structural measures by providing space for water and ensuring that human activities do not exacerbate the flood hazards, or ideally, by a combination of the two. One pre-requisite for such flood disaster mitigation activities is the understanding of physical hydrological processes and the ability to anticipate the hydrologic response under various scenarios. This is especially difficult in the Asian region where long term observations of hydrological phenomena, necessary for the calibration of conventional mathematical models are few. For this purpose, the laboratory emphasizes on the development of numerical models based on the governing equations of water movement in all phases. They directly utilize physical catchment properties that are necessary when catchment characteristics change, either under human activities or natural phenomena. The models are applied for flood forecasting, damage estimation, flood reduction measures, water resources planning, coupling with climatic models, etc.

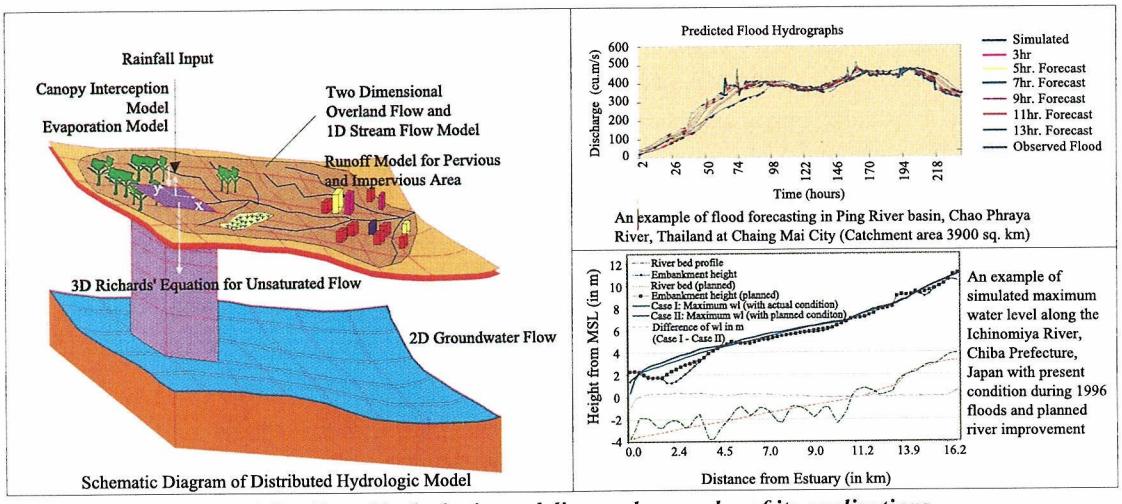
i) Distributed Hydrologic Modeling[5), 6), 7)]

Over the years, three different distributed mathematical models have been developed for applications to different sizes of catchments. They are, 1) A complete distributed mathematical model, which treats the water pressure as the state variable coupling interception, evapotranspiration, sub-surface flow, surface flow, groundwater flow and river network solutions, which has been applied in catchments ranging from 10 sq. km order with 50 m resolution data to 70,000 sq. km with 2 km grid resolution in Japan, Thailand and Philippines. 2) A model treating storage as the state variable that can simulate both natural as well as human water usage including water supply, drainage and irrigation has been applied in dense urban catchments with high spatial data resolutions. 3) A geomorphology based distributed model for application in very large catchments of order 100,000 sq. km which discretizes the catchments to slopes and river network using geomorphologic properties of the catchment. It has been applied in several river basins in Japan and Thailand and in the Mekong basin covering up to 400,000 sq. km in extent.

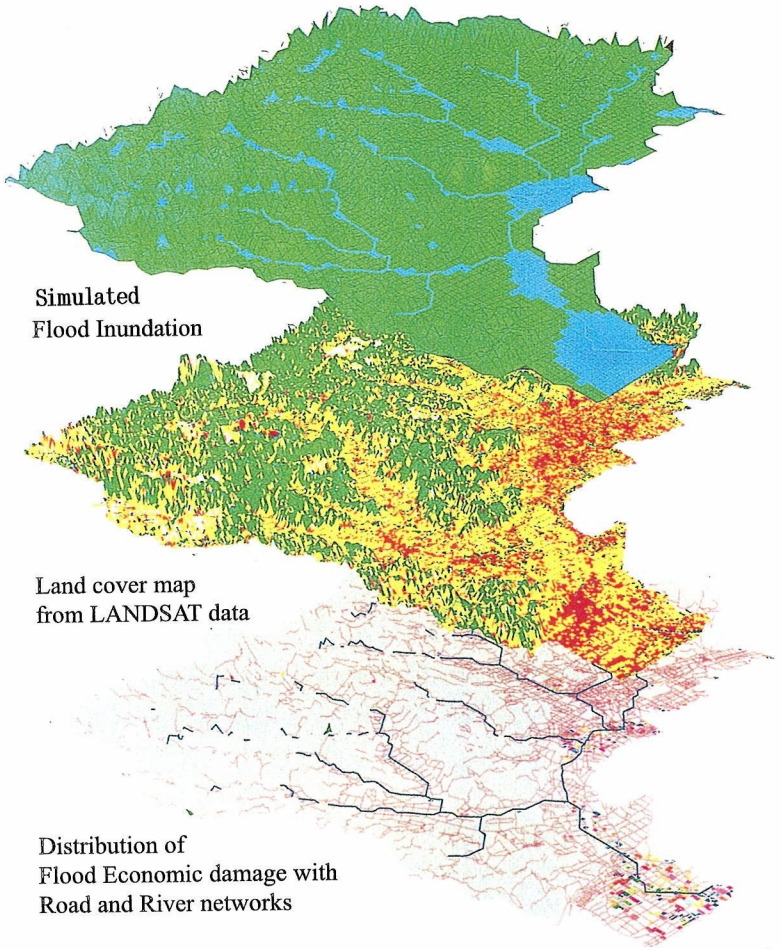
ii) Flood Modeling and Mitigation[8), 9)]

Mathematical models for flood inundation simulation and damage assessment are being developed. The second figure in the next page shows an application in Ichinomiya River basin, Chiba Prefecture, Japan, where the top figure shows the inundation simulation of a 1996 flood. The assets within the catchment, such as commercial and private buildings, industry, agriculture are spatially distributed utilizing remote sensing land classification. The 3rd layer shows economic damage distribution of residential buildings expressed in terms of million-yen per 50 m square grid area. Economic damage is estimated using depth-damage functions for different types of assets.

Another area of research is the utilization of infiltration facilities, such as trenches and wells to minimize direct surface runoff and increase ground water which in turn enhance the river base flows leading to better riparian environment. Optimum distribution of such on-site measures are investigated using distributed catchment models coupled to infiltration facility models in study catchments.



Concept of distributed hydrologic modeling and examples of its applications



Application of integrated flood simulation and damage estimation model in a Japanese river basin

iii) Hydrologic Information Exchange

Difficulties in applying distributed hydrological models to practical problems are the model complexity, large volume data and processing needs and training for proper use of such models. Internet based decision support system development is being carried out to enable remote users to use mathematical models available at INCEDE for flood forecasting and to visualize impacts of different decisions made. The system is developed on a central database, which stores hydrological data as well as knowledge for model execution and result analysis.

In addition to the above mention research topics, the researchers of the laboratory have been involved with many collaborative research projects. GAME and AP-FRIEND are two major on-going global research projects, where the laboratory members are activity involved. GAME (GEWEX Asian Monsoon Experiment) and GEWEX (Global Energy and Water Cycle Experiment) are ambitious programs designed to increase our understanding of global water and energy circulation in all its phases which would ultimately make it possible for long-term weather forecasts, to assess the human influence on global climate and to provide insight to moderate and control climatic variability and change. This laboratory is mainly involved in the hydrologic modeling research activities of the GAME project.

AP-FRIEND (Asian Pacific FRIEND) is responsible for the Asia-Pacific region of the FRIEND (Flow Regimes from International Experimental and Network Data) research program, an international collaborative study into regional hydrology with support of UNESCO. The primary objective of the FRIEND project has been to improve the understanding of hydrological science and to find solutions to practical water related problems.

Research Laboratory 3: Urban Earthquake Disaster Mitigation Engineering

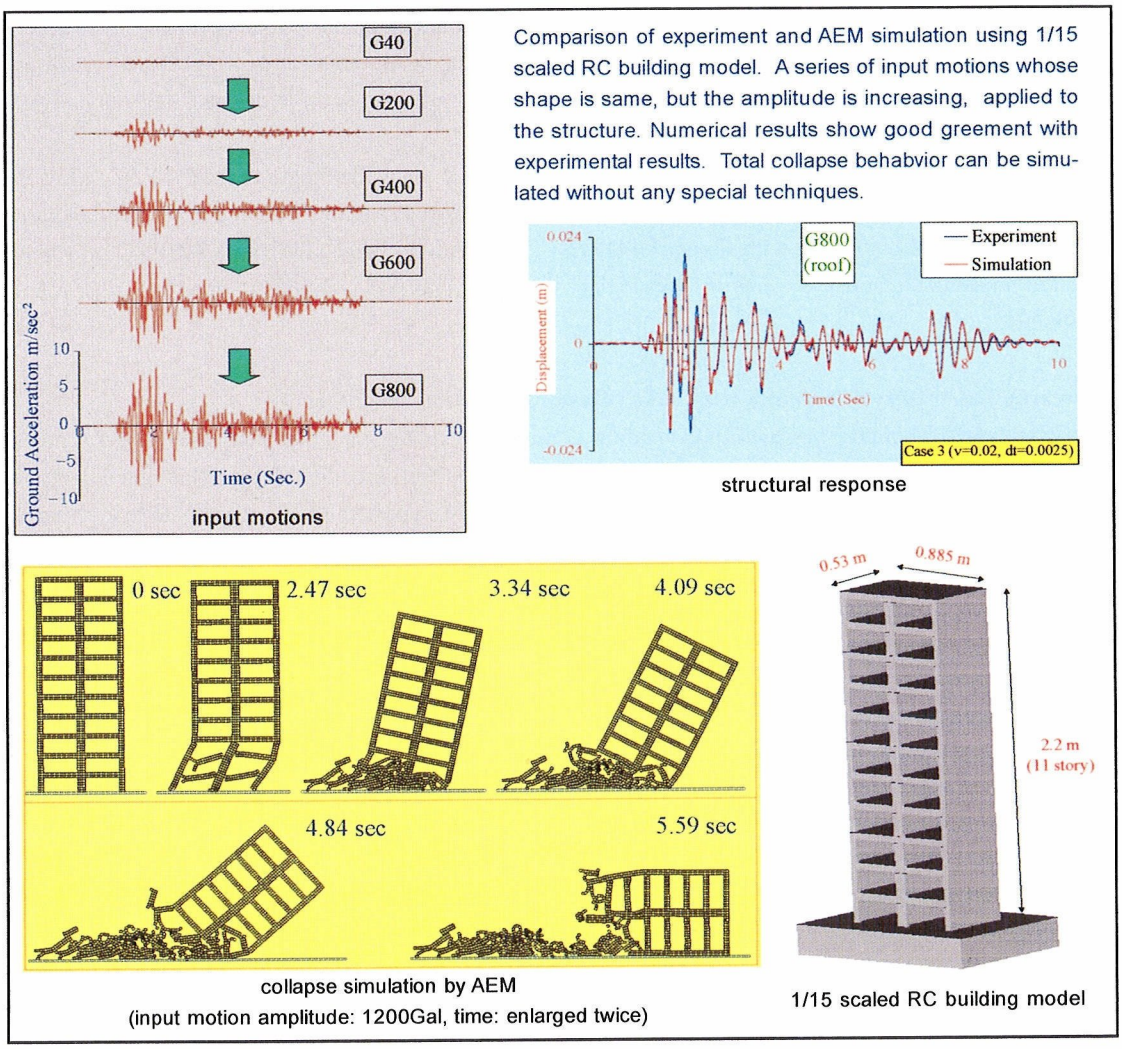
This research laboratory has been studying disaster mitigation strategy in urban areas due to hazards mainly by an earthquake. The objective of the research is to minimize human casualties and social ill function by well balanced countermeasures of hardware and software. The most important lesson we should learn from the 1995 Kobe earthquake is that the most important issues like human life and/or important information can be protected only by hardware measures, while minimization of social ill function and quick recovery/reconstruction from the damage should be implemented by real-time disaster mitigation systems and optimum recovery/reconstruction strategy. Based on these points, this laboratory has been tackling many research topics. Some selected research topics are only introduced here due to space limitation.

i) Development of New Model for Failure Analysis of Structures

To reduce human casualties, it is essential to understand the mechanism to collapse of structures. However, there is no simulation tool by which total collapse behavior can be simulated accurately. With the Applied Element Method (AEM), developed by Meguro and Hatem[10),11)] mechanism of structural damage to buildings and infrastructure is studied. Unlike the finite element method (FEM), with the AEM, there is no need to assume the location and direction of a crack before analysis. Cracks can initiate at any location and propagate to any direction based on stress conditions. This model overcomes the problems of the FEM as mentioned above and also the problems of distinct element method (DEM) such as difficulty of application of static problems and effect due to the shape and arrangement of elements and long CPU time.

ii) Urban Space Design and Safety Evaluation from the Viewpoint of Evacuation Behavior of Users

Issues on structural behavior and/or physical strength of the structures have been main topic in construction of safe urban facilities. With the improvement of engineering technologies and construction materials, strength of the structures, especially in developed countries, has been getting better and better. (Of course, still, we have big problems on pre-code revision structures.) However, to build really safe urban spaces, it is very important to pay attention to the human evacuation behavior as well as structural problems[12]. Especially, when users aren't familiar with the space, its importance becomes much higher. Therefore, the space plan of urban facilities should be designed with proper consideration of users' evacuation safety and efficient evacuation guidance should be provided. To discuss the human behavior, we developed a new computer simulation model in which human evacuation behavior of a lot of evacuees in huge-sized facility or space can be easily simulated and



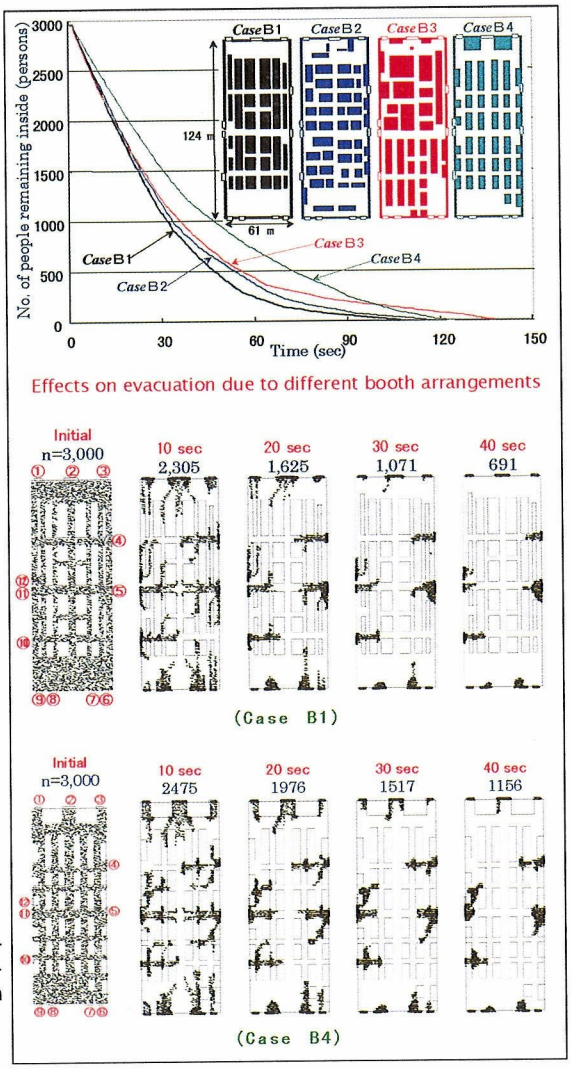
Applied Element Method: a newly developed model to simulate collapse process of structures accurately with reasonable CPU time

situation in disaster and individual personal characteristics of every evacuee can also be considered. In this study, we propose a new philosophy of designing structures, in which urban spaces are designed from the viewpoint of safety of users considering their evacuation behavior. When we apply the proposed model to any existing space, the safety of the space can be evaluated from the viewpoint of human behavior, and also, optimum evacuation guidance can be discussed based on the computer simulation of human evacuation.

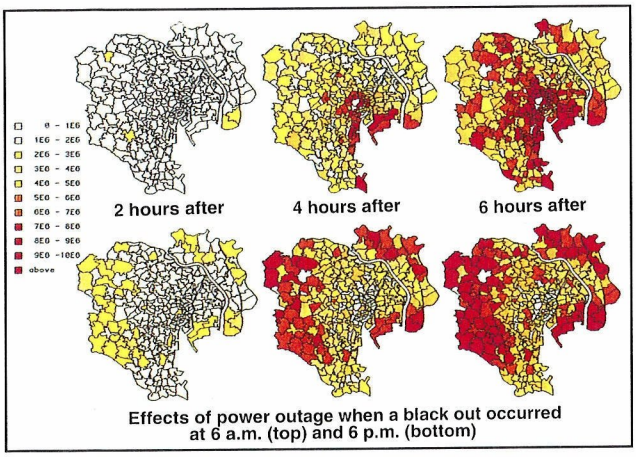
iii) Disaster Mitigation Countermeasures for Lifeline Systems in Urban Areas

Impact to the society due to damage to lifeline systems by a hazard like an earthquake or a typhoon is studied. Especially, taking the electric power whose ill function affects the other life line systems and also many social functions, we have proposed the method for quantitative evaluation of power outage considering regional characteristics, occurrence time and duration of outage[13]. Based on the results, we have also proposed a method for proper counter measures against blackout.

Simulation of Human Evacuation Behavior:
We discuss the effects of arrangement of booth in exhibition hall on human evacuation behavior. Each dot represents a person trying to evacuate frominside an exhibition hall. The value of 'n' is the total number of people remaining inside the hall.



Effects on evacuation due to different booth arrangements



Effects of power outage when a black out occurred at 6 a.m. (top) and 6 p.m. (bottom)

Estimation of Effects due to Power Outage in Urban Area foe Optimum Measures:
Our modern societies heavily rely on electric power and suffer functional damage due to power outage when natural disasters such as earthquakes and typhoons strike. To develop a new methodology for estimating the effects of power outage on city functions considering the characteristics of the area, occurrence time and duration of outage, a database is developed which consists of regional characteristics and electric power demand in Tokyo using geographic information system. Using the database, a new methodology to estimate the effects of power outage is proposed which can be used for optimum disaster mitigation measures before and after an accident.

From the experiences of the 1995 Kobe earthquake disaster, we have been discussing the optimum recovery/ reconstruction strategy of lifeline systems considering interactions between their activities. Because we observed many interactions between different lifeline systems which hindered the recovery activities of each other. Each of the organization or company did its best to recover the its own services, however, from the viewpoint of whole lifeline systems, it was not the best way. We can modify the recovery/reconstruction procedures for getting global maximum. This is a main concept of this study.

4-1-2 Collaborative Research

For international cooperation, INCEDE has been collaborating with different research organizations and researchers around the world for carrying out meaningful and productive research works in regional or global level. In such collaborative works with foreign researchers, three laboratories of INCEDE work together toward creating a multidisciplinary research environment for complex problems of disaster mitigation. In addition to this joint collaboration, three laboratories individually coordinate research projects with different national and international organizations on specific research topics of interest. Out of the various collaborative projects that INCEDE has been conducting, three major projects are listed below;

Flood Forecasting Modeling in the Philippines

This was a three-year joint research project from 1994 to 1996 on flood forecasting and warning systems between INCEDE and the research institutions in the Philippines. The counterparts in the Philippines were the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the National Hydraulic Research Center (NHRC) of the University of Philippines, and the National Mapping & Resource Information Authority (NAMRIA). Ministry of Education, Culture, and Sports of Japan supported the project. In this project, an extensive GIS data base of the Agno River basin of the Philippines and a flood forecasting model for the Agno River were developed.

Post-earthquake Reconstruction Strategy

This project was a Center-to-Center Project between INCEDE and National Center for Earthquake Engineering Research (NCEER, later changed to MCEER- Multi Disciplinary Center for Earthquake Engineering Research), State University of New York, Buffalo on post-earthquake reconstruction and rehabilitation strategy. The Japan Society for Promotion of Science (JSPS) and the US National Science Foundation (NSF) jointly supported the project. The three-year project was initiated in October 1995 and ended in September 1998. The main objectives of this joint project were,

- to carry out a comprehensive comparative study of recent earthquake experiences in Northridge (USA) and Kobe (Japan) in order to identify generic issues for post-disaster reconstruction.
- to conduct case studies and to identify exemplary technical, societal and financial strategies for the retrofitting and post-earthquake repair and restoration of the built environment in an optimal fashion.
- to carry out individual disciplinary-oriented research to fill knowledge gaps and simultaneously, to formulate one or more strategies for recovery using a system-integrated team approach involving multi-disciplinary experts.
- to exchange visiting researchers and students and to share experiences to enhance the spirit and substance of IDNDR

- to encourage and facilitate additional cooperative research efforts among earthquake engineers in Japan and US and to establish further joint efforts with other centers/research groups in both countries.

Under this project, six technical workshops were held among the researchers and practitioners from Japan and USA. The project had two valuable products as the outcome of the three-year joint research. First is a series of technical reports, which have documented the outcomes of various research activities of the participant researchers on Northridge and Kobe earthquakes. The second product was a digital source book, which includes lessons learnt from Northridge and Kobe earthquakes for an effective countermeasure for the recovery due to an earthquake, which can strike not only Japan or USA but, any urbanized area in the world in the future.

RADIUS Project

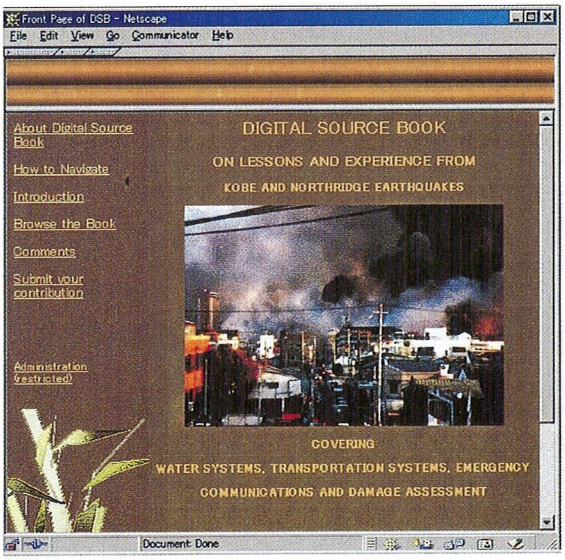
This is an on-going project started as the initiative of IDNDR Secretariat. Looking at the growing risk of earthquakes, the IDNDR Secretariat of the United Nations, launched the RADIUS project (Risk Assessment

DR. Pineda of PAGASA shows receiving of telemetric gauging stations datato INCEDE team

Philippine researchers survey river protection works, Japan

First US-Japan meeting on C-to-C project at INCEDE, December, 1995

RADIUS project workshop in Tashkent, 1997



Front page of the Digital Source Book (DSB) browsed in WWW through dynamic interaction with oracle database

Tools for Diagnosis of Urban Areas against Seismic Disasters) with assistance of the Japanese Government to promote worldwide activities for reduction of earthquake disasters in urban areas, particularly in developing countries. The project aims at developing practical tools for seismic risk assessment of the urban areas based on the analysis of case studies. The case studies are to prepare earthquake damage scenarios in several cities around the world with the financial support and technical assistance from the IDNDR Secretariat. These practical tools will be developed for seismic risk assessment of the urban areas, in order to raise the awareness of decision makers, government officials, business leaders, communities and citizens of the importance of disaster mitigation measures and to provide them with directions for disaster mitigation. Through the project, it is expected that state-of-the-art studies and technologies for seismic disaster mitigation will be incorporated into appropriate tools available to the whole world. These tools will be developed based on the analysis of case studies, which will be carried out in nine cities around the world.

The IDNDR Secretariat selected 9 case study cities, to which the IDNDR Secretariat offer technical and financial assistance. The case studies have started in February 1998 and will end in July, 1999. INCEDE is one of the three international institutes that IDNDR Secretariat has selected to participate in the project. INCEDE is responsible for conducting case studies in Asian cities.

INCEDE has been observing, since its inception of 1991, that it is difficult for many disaster prone countries to divert large amount of resources to disaster reduction measures. However, through INCEDE Networking activities, we have made an observation that a very few money allocation to disaster measures could function efficiently in disaster reduction, if all resources available are fully brought together. INCEDE thinks that the RADIUS project is a good and timely opportunity to demonstrate disaster prone countries/cities this fact. Actually, all the case-study cities are such cities mentioned above. INCEDE is convinced that successful case studies in these cities will encourage rest of earthquake prone cities to take actions and stimulate. International donor agencies will be encouraged, as well.

4-2 Reinforcing the network of disaster related communities

Disasters have no boundaries, a major disaster in a region can cover many countries. Many issues of disaster mitigation are common to all countries around the world and often a country alone can not fight against a major disaster with limited resources. To strengthen our ability to flight against disaster, a strong global network among disaster related communities are utmost important. From the very beginning, INCEDE realized this fact and has dedicated its time and effort in reinforcing the network of disaster related global communities through various activities as follows;

4-2-1 Development of INCEDE Network[14]

INCEDE has been developing a network called the INCEDE Network composed of disaster-related persons and organizations in the world. Major reasons for development of INCEDE Network composed of researchers and practitioners in disaster reduction are written in the righthand side table.

Major reasons for development of INCEDE Network

- *To preserve the important information on disasters (Knowledge of specialists),*
- *For useful assistance from outside,*
- *To record disaster information in the world (Disaster struck countries sometimes cannot afford to record the information)*
- *To share methodologies and experiences*
- *For better damage investigation taking care of the damaged sites, and*
- *To establish and maintain the good cooperation structure, etc.*

Many researchers working in the area of disaster in developing countries face the problem of acquiring enough

information on both the occurrence of disasters all over the world and, especially, new knowledge of the recent research activities in the field. Therefore, INCEDE Network has caught much attention.

We consider the activities related to the formation of the INCEDE Network to be of utmost importance, because the interaction between information generators and users/receivers must be two-way. The INCEDE Network was established so that all the members can be the generators as well as the receivers of information. Recently we have been hearing from our members on the disasters that had taken place in their regions, opinions and evaluations of mitigation activities. In compiling disaster-related information, various sources are available. On-line news services provide access to news wires from sources such as Reuters, AP, UPI, etc., and reports prepared by UN organizations such as DHA. It is often found that there are conflicting statistics depending on the sources and the timing of these summary reports. One very important expectation we have of network members is to clarify these conflicting reports and authenticate information, so that a reliable archive of disaster related information can be constructed and maintained.

At present, there are about 1,000 members of the INCEDE Network representing 100 countries. Including the network members, we also have a contact list of over 3,000 disaster-related persons and organizations from 150 countries. Any interested person can become a network member by filling up a form sent available INCEDE Newsletter or the on-line form in WWW INCEDE Home page (http://incede.iis.u-tokyo.ac.jp). The network members are obliged to be information providers as well as receivers, to receive help from other members in investigating a particular topic related to disasters as well as help another network member in his/her study related to the member's region or field.

4-2-2 Exchanging MOU with Institutes

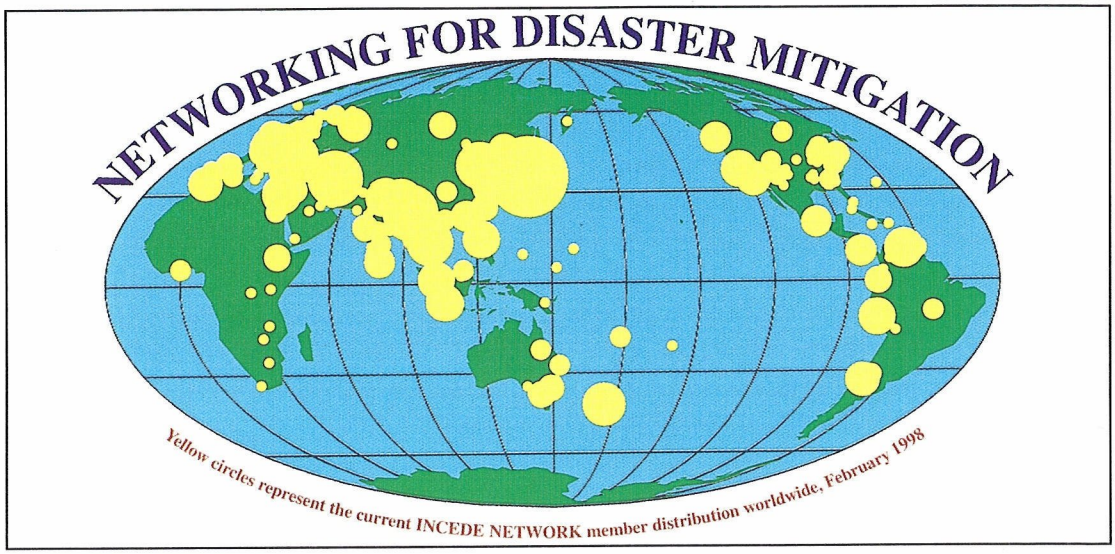
INCEDE exchanges Memorandum of Understanding (MOU) with different organizations and institutes of similar research and work interest around the world to reinforce bilateral relationship in carrying out various research work in collaboration and sharing information. So far, INCEDE has exchanged MOU with eight institutes in four countries and one international organization as listed in the table below. Also, INCEDE is the process of exchanging MOU with the Asian Center for Research on Remote Sensing (ACRoRS) located at the Asian Institute of Technology (AIT), Bangkok, Thailand.

4-2-3 Joint Projects

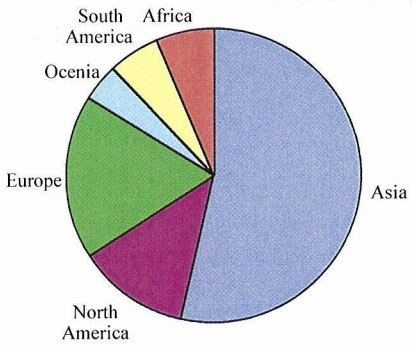
Joint projects with organizations of different countries are another policy of INCEDE towards establishing strong international network. During the last 8-year period, it has established many collaborative projects ranging from fundamental research to practical implementation of available tools for disaster reduction with various organizations around the world, especially, with the institutes that it has exchanged MOU. Some of the major research projects of this kind are already mentioned in the section 'Collaborative research'. Another very important joint research

International Institutes having MOU with INCEDE

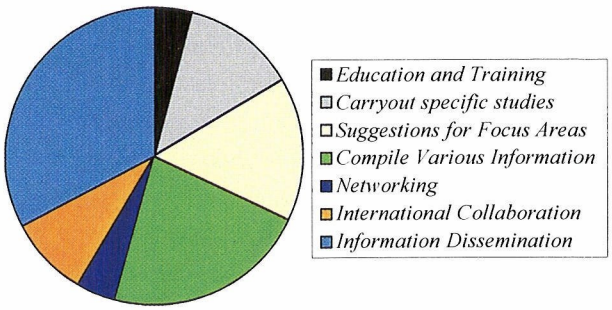
- *California Universities for Research in Earthquake Engineering (CUREe), USA, 1992.12.22*
- *National Center for Earthquake Engineering Research (NCEER), USA, 1993.2.22*
- *Department of Civil Engineering, Stanford University, USA, 1993.9.9*
- *Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Philippines, 1994.2.9*
- *National Hydraulic Research Center (NHRC), University of Philippines, Philippines, 1994.3.30*
- *The Kamchatka Center of Earthquake Engineering and Natural Disaster Mitigation, Russia, 1994.6.2*
- *Venezuelan Foundation for Seismological Research (FUNVISIS), Venezuela, 1996.6.13*
- *United Nations University (UNU), Tokyo, 1996.11.22*



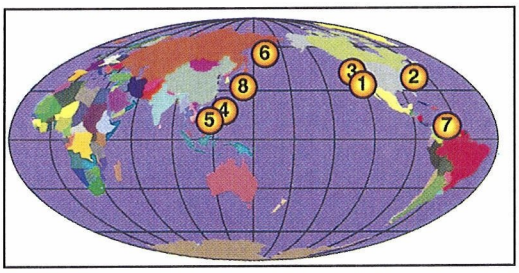
Distribution of INCEDE Network members



Regional distribution of Network members



Expectation of Network members from INCEDE



Distribution of INCEDE MOU Institutes

Directors of INCEDE and Kamchatka Center sign MOU between the two centers

project was development of disaster information network called GLO-DISNET. INCEDE, Stanford University and United Nations University jointly carried out this project.

4-3 Disaster Information Dissemination[14)]

One of the important roles of INCEDE is to work as a clearinghouse of disaster information, especially in the Asian Region. INCEDE activities for this purpose are discussed in the sub-sections.

4-3-1 Information Dissemination Through Internet

Since the disaster information network known as GLO-DISNET is developed in cooperation with INCEDE, Stanford University, and United Nations University; the field of disaster information network became an additional new research topic of the INCEDE. INCEDE opened INCEDE Home Page on World Wide Web (WWW), Internet, and started to disseminate disaster information collected and generated by INCEDE. INCEDE publications have been made available through INCEDE web page.

4-3-2 INCEDE Publications

INCEDE has two major publications, one is a quarterly newsletter known as "INCEDE Newsletter" and another is "INCEDE Report". The following sections explain about these two publications.

INCEDE Newsletter

INCEDE Newsletter is published quarterly and sent to over 3000 persons and organizations in the world. The newsletters are distributed free of charge to all the INCEDE Network members. The newsletter is addressed to a general audience and carries articles by prominent engineers on general topics related to disaster-mitigation, reports on recent natural disasters and publishes current activities of INCEDE and its network members. The newsletters in the past carried reports on post disaster investigations, conducted either by INCEDE staff or the network members. So far, we have published 28 INCEDE Newsletters. Twenty four regular issues and four special issues on major earthquakes occurred in Japan amounting to a total of 292 pages, with the cooperation and assistance from all those related to our activities, especially, INCEDE Network members. As the first report written by Japanese specialists in English soon after the Kobe earthquake, the special issue entitled 'The first 55 Hours, Great Hanshin Earthquake, January 17, 1995' was published. They were distributed to more than 4,000 researchers and organizations in over 140 countries, resulting in gaining a very high reputation from all over the world for its quick publication and excellent quality.

INCEDE Report

Nine INCEDE Reports have been published and several reports are in final stage of compilation. Immediately after publication, every time, about 700 copies of INCEDE Report are sent to selected INCEDE Network members. Titles of the published reports are listed in the righthand side table.

Published INCEDE Reports

- *INCEDE Report 1: INCEDE Looking Ahead (by T. Katayama, M.A.H. Pramanik, A.S. Herath and K. Meguro), 50 pages.*
- *INCEDE Report 2: Aftermath of the Loma Prieta Earthquake - How Radio Responded to the Disaster - (by T. Katayama), 96 pages.*
- *INCEDE Report 3: Impacts of Disasters on Environment and Development - International Cooperation - (by M.A.H. Pramanik), 45 pages.*
- *INCEDE Report 4: Towards Natural Disaster Reduction - Proceedings of VII PSA Workshop - (edited by A.S. Herath and T. Katayama), 195 pages.*
- *INCEDE Report 5: Seismic Risk of the Asia Pacific Region -Proceedings of the WSSI Workshop - (edited by K. Meguro and T. Katayama), 192 pages.*
- *INCEDE Report 6: Space Technology for Disaster Monitoring and Mitigation in India (by R.B. Singh), 58 pages.*
- *INCEDE Report 7: Disaster Mitigation Strategies in Bangladesh (by M.A.H. Pramanik), 30 pages.*
- *INCEDE Report No. 8: Harnessing the Communication Revolution - Creation of a Global Disaster Information Network - (edited by S. Herath),*
- *INCEDE Report No.9: Earthquake Engineering Frontiers in Transportation Facilities - Proceedings of the Center-to-Center Project Workshop - (edited by George C. Lee and Ian M. Friedland), 504 pages.*

4-3-3 International symposia/workshops which INCEDE held and/or organized

INCEDE has held and/or organized 30 international symposia and workshops in 15 countries. Some of those are listed in the next page.

Some of the international symposia/workshops organized by INCEDE

- *'Seismic Risk Management for Countries of the Asia Pacific Region,' (1993.2.8-11), Bangkok, Thailand*
- *'Towards Natural Disaster Reduction,' VII Pacific Science Inter Congress, (1993.6.27-7.3), Okinawa, Japan*
- *'Recent Research Topics in Hydrology,' The Seminar (Philippines Project), (1993.10.18), Tokyo, Japan*
- *'Role of Engineers in Mitigation of Disasters,' The Seminar, 1994.4.7, Kandy, Sri Lanka*
- *'Mitigation of Earthquake Risks - Needs and Resources of European Countries,' (1994.9.1), Vienna, Austria*
- *'Geo-Related Risk in Sri Lanka,' (1994.12.9), Colombo, Sri Lanka*
- *'Great Hanshin-Awaji Earthquake Disaster,' Public Seminar, (1995.2.6), Manila, Philippines*
- *'Catastrophic Risk Management for the Insurance and Reinsurance Industries,' (1995.5.16-18), Singapore*
- *'Harnessing the Communication Revolution -Towards a Global Disaster Network,' VIII Pacific Science Congress, (1995.6.10-11), Beijing, China*
- *'Post-Earthquake Reconstruction Strategies: First Center-to-Center Project Workshop,' (1996.2.2-3), Honolulu, USA*
- *'Water-Lifelines: Fourth Center-to-Center Project Workshop,' (1997.12.8-9), California, USA*
- *'The International Symposium on Information Technology Tools for Natural Disaster Risk Management,' (1998.2.4-6), Bangkok, Thailand*
- *'Seismic Risk Management for Countries of the Asia Pacific Region,' Second WSSI Asia Pacific Workshop, (1999.1.18-20), Bangkok, Thailand*

Titles and names of the speakers at INCEDE Open Lectures

1st, 'Recent Natural Disasters,' (1992.5.13) Profs. S. Herath, K. Meguro (INCEDE), and Y. Nakano (IIS)

2nd, 'Efforts for disaster mitigation -on commemoration of IDNDR day-,' (1992.10.14), Profs. T. Katayama and M.A.H. Pramanik (INCEDE), Dr. A. Hamamori, and Prof. H.C. Shah (Stanford University)

3rd, 'IDNDR,' (1993.10.13), Prof. T. Katayama (INCEDE)

4th, 'Quick Report on Northridge Earthquake and Mt. Pinatubo Eruption,' (1994.2.2), Profs. T. Katayama (INCEDE) and Y. Nakano (IIS), Mr. P. Castro (NHRC, UP)

5th, 'Report on Lahar Flow Disaster due to Mt. Pinatubo Eruption,' (1994.3.7), Profs. Liongson (NHRC, UP) and Lopez (UP), and Dr. N. Hirose (Nippon Koei)

6th, '1989 Newcastle Earthquake -Australia's Most Devastating Earthquake and Responses to It,' (1994.5.19), Dr. J. Rynn (CERA, Australia)

7th, 'Why is Global Earthquake Risk Increasing,' (1994.10.12), Prof. H.C. Shah (Stanford University)

8th, 'Urban Earthquake Risk Management, -Preparing for the Big One in Tokyo,' (1995.9.27), Prof. T. Katayama (INCEDE), Mr. P. Hatfield (Journalist), Prof. B. Wisner (Hampshire College), Prof. H.C. Shah and Mr. A. Kakhandiki (Stanford University)

9th, 'Safety and Medical Issues during Disasters,' (1995.12.5), Dr. H. Yamamoto of Association of Medical Doctors of Asia (AMDA), Dr. S. Hanayasu (Institute for Industrial Safety, Ministry of Labor) and Dr. M. Nishimura (Medical Examiner of Hyogo Prefecture)

10th, 'Disaster Mitigation Science as Viewed from Its Origin,' (1996.2.16), Prof. K. Takahashi (Nagasaki University), Prof. Y. Kawata (Disaster Prevention Research Inst., Kyoto University), and Prof. Y. Ota (Yamaguchi University)

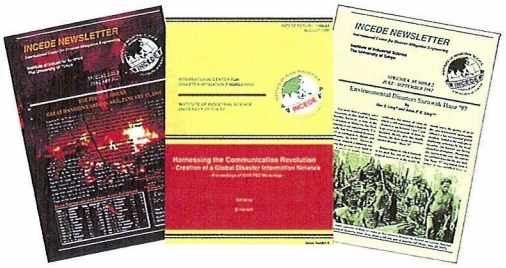
11th, 'Earthquake Engineering in Last Three Decades,' (1996.8.27), Profs. T. Katayama, K. Sudo (INCEDE) and H.C. Shah (Stanford University)

12th, 'Earthquake Disaster Management: A Global Priority,' (1997.5.22), Dr. A. Besrat (UNU), Profs. K. Sudo (INCEDE), T. Okada (Shibaura Inst. of Tech.) and K. Mogi (Nihon University)

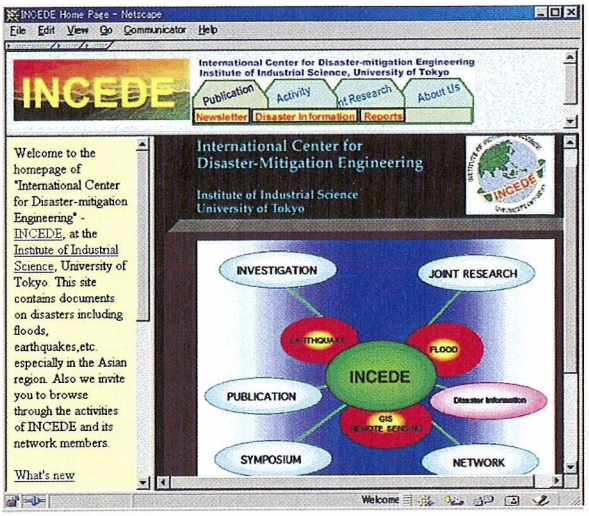
13th, 'Water: Too much... too little... ,' (1997.10.7), Profs. S. Ikebuchi (Kyoto University), K. Musiake (IIS, University of Tokyo) and Dr. M. Watanabe (JICA)

14th, 'Disaster due to Volcanic Eruption: Proper Relation among Government, Researchers, Practitioners and Citizens,' (1998.3.9), Dr. D. Shimozuru (Ex-Chairman of Volcanic Eruption Prediction Committee of Japan), Mr. K. Kanegae (Ex-Mayor of Shimabara City), Mr. M. Matsui (Ex-Head of the Office of Unzen Fugen Reconstruction, Ministry of Construction)

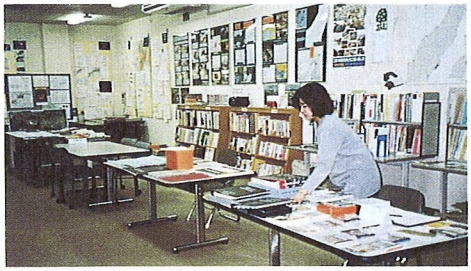
15th, 'Information: Too much... too little... Role of Communication Media in Disaster Reduction,' (1998.10.8-9), Prof. K. Sudo (INCEDE), Dr. J. Uitto (UNU), Prof. H. Shah (Stanford University), Mr. Y. Fujiyoshi (NHK), Mr. H. Hashimoto (NTT), Prof. O. Hiroi (University of Tokyo), Dr. T. Katayama (Director General, NIED), Ms. T. Nonaka (Journalist), Mr. J. Tomari (Asahi News Paper), Mr. K. Yamamoto (JMA), Y. Ishikawa (Governor, Shizoka Prefecture) and Prof. K. Meguro (INCEDE).



INCEDE Newsletter and Report



INCEDE home page



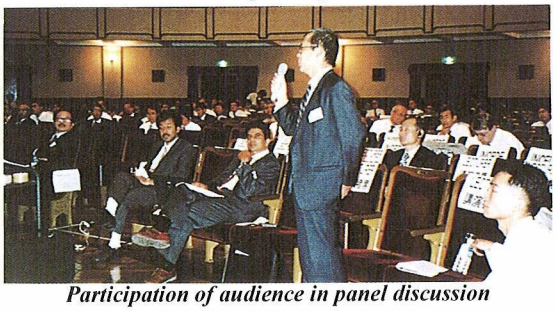
Information exhibition room of KOBEnet- IIS

C-to-C project workshop, Delaware, USA, Sept., 1997

PSA workshop, Beijing, China, Jun., 1995

WSSI workshop, Bangkok, Jan., 1999

INCEDE-UNU symposium, AIT, Bangkok, Feb., 1998



Participation of audience in panel discussion at 15th INCEDE Open Lecture

Participants at 10th INCEDE Open Lecture

4-3-4 INCEDE Open Lectures

INCEDE also holds open forums several times a year. Because we believe that for disaster mitigation, it is very important for the general public as well as specialists to get exact knowledge on disasters and understand what happens during and after hazards.

So far, we have held 15 INCEDE Open Lectures. The 3rd, 7th, 8th, 12th, 13th and 15th were co-organized by INCEDE and the United Nations University and the 10th was held in cooperation with the Earthquake Resistant Structure Research Group (ERS) in IIS, KOBEnet and INCEDE. Themes and speakers of the INCEDE Open Lectures are listed in the previous page.

4-4 Reconnaissance Surveys on Natural Disasters

As the most fundamental research for disaster mitigation, we have carried out site investigations after the disasters. With the limited staff available, INCEDE has been able to carry out studies on only a few numbers of disasters[15), 16), 17), 18)]. However, the emphasis was placed on making these studies as complete as possible. The archives on these disasters such as reports, local publications and other data are available on the WWW INCEDE Home Page (http://incede.iis.u-tokyo.ac.jp/). Followings are natural disasters that INCEDE investigated.

With regards to floods, so far,

Typhoon No.19, Japan (1991), Saiko lake high water, Japan (1991), Flood in Leyte island, Philippines (1991), Flood in Hong Kong (1992), Flood in Colombo, Sri Lanka (1992), Flood in Mississippi and Missouri valleys, USA (1993), Flood in the Tokyo Metropolitan District, Japan (1993), Flood in Nagano and Niigata, Japan (1995), Floods in Oder river basin (Germany, Poland and Chez Republic) (1997), and Floods in Fukushima, Japan (1998).

With the collaboration of INCEDE network members

Floods in China (1991), Pakistan (1992), Nepal (1993), India (1993), Thailand (1995), Earthquake in China (1996, 1998), Cyclone in India (1998).

Earthquake reconnaissance Surveys

Erzincan earthquake, Turkey (1992), Kushiro-Oki earthquake, Japan (1993), Hokkaido-Nansei-Oki earthquake, Japan (1993), Latur earthquake, India (1993), Northridge earthquake, USA (1994), Hokkaido-Toho-Oki earthquake, Japan (1994), Sanriku-Haruka-Oki earthquake, Japan (1994), Hyogo-Ken-Nanbu (Kobe) earthquake, Japan (1995), Qayen earthquake, Iran (1997)

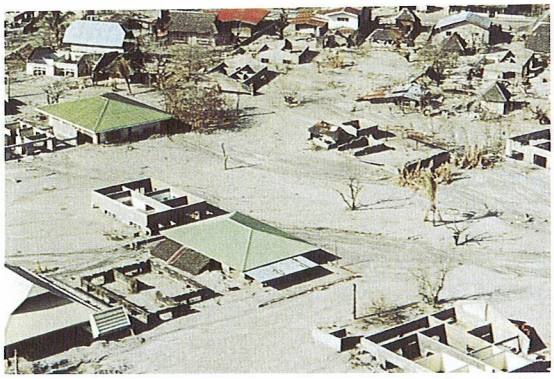
Disaster due to volcanic eruption,

INCEDE has investigated lahar disaster due to the Mt. Pinatubo, the Philippines (1993), and debris flow at the Mt. Fugen, Unzen, Japan (1994).

5. INCEDE ACHIEVEMENTS

Achievements are something that can be better judged from outsides. Being insiders, as staff members, it would not be wise to judge INCEDE by us. For us, INCEDE activities itself reflect its achievements. Here, we would like to focus on a very few points from our own realizations from years' of experiences in the center.

When INCEDE was established, one of its prime objectives was to establish a strong network of disaster related societies. During the 8-year period, INCEDE has been aggressively working towards establishing a strong INCEDE network, and now the result of this effort can be felt with about 1,000 active members or



Damage due to lahar from Pinatubo erruption, 1992 (Philippines)

Northridge earthquake, 1994 (USA)

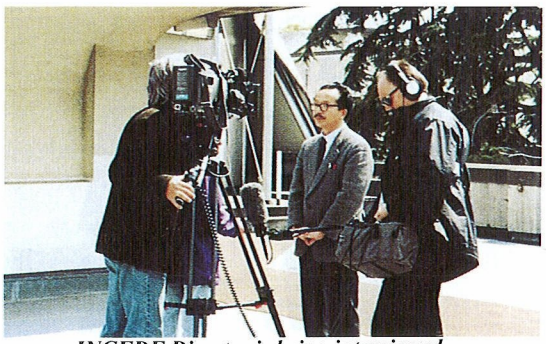
Kobe earthquake, 1995 (Japan)

Qayen earthquake, 1997 (Iran)

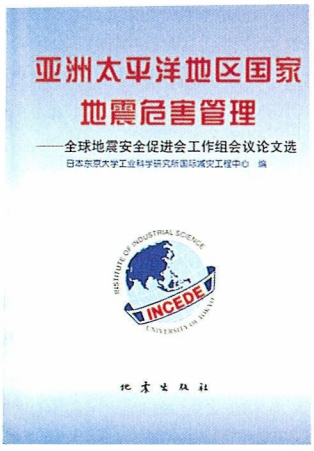
Floods in Europe, 1997

Floods in Fukushima, 1998 (Japan)

Disaster Investigations by INCEDE Staff



INCEDE Director is being interviewed for German TV



INCEDE report translated to Chinese language

organizations from about 100 countries. INCEDE supports the network members many different ways in their activities from providing information, to inviting them to participate in various INCEDE activities such as joint research activities, disaster related workshops, open lectures, forums organized by INCEDE, etc. In return, the network members help INCEDE getting more and more information about their countries. When a disaster strikes in a country, local INCEDE network members are very prompt in sending first hand information to INCEDE and these information are distributed to other members of INCEDE network through WWW or newsletters and that have benefited many interested people in getting proper information in right time. Network has established a strong task force in increasing the awareness against disaster in different countries around the world.

INCEDE publications are well received around the world. It is noteworthy to mention about the special issue of INCEDE newsletter aftermath of Kobe earthquake. As the first report written by Japanese specialists in English soon after the Kobe earthquake, the special issue entitled 'The first 55 Hours, Great Hanshin Earthquake, January 17, 1995' was published. They were distributed to more than 4,000 researchers and organizations in over 140 countries, resulting in gaining a very high reputation from all over the world for its quick publication and excellent quality. In the last few years, many disaster related organizations in different countries have been taking initiative in translating INCEDE newsletters and reports to their own languages, e.g., INCEDE reports and newsletters are already published in Chinese, Persian, etc.

As an organization from university environment, we have enjoyed the freedom of conducting fundamental research along with our other activities. During 8-year period research activities in the three laboratories of INCEDE have reached high spectra. Especially, these three laboratories have strongly contributed in advancement of research works in the fields of distributed hydrologic modeling for flood simulation, integrated database for hydrologic analysis, discrete element or applied element simulation for building collapse behavior and real time evacuation simulation, and have come out with their own models for practical applications toward disaster reduction.

Recently, established many centers or organizations in the same areas of interest, have followed the footstep of INCEDE activities and many have come to us to get suggestions for their new plans or proposals.

6. INCEDE FUTURE

Disaster-mitigation is a complex issue and solutions, if there are any, require a large amount of resources and years of dedicated involvement. Since the inception of INCEDE, our activities were focused on achieving maximum results in the disaster-mitigation field through the optimum use of available resources by limiting the focus both geographically and subject matter, considering what INCEDE could do best as a University organization. As mentioned beforehand, these activities included training, workshops, seminars, lectures, joint research projects and basic research on selected subject areas. This has produced results that are useful and contributed new knowledge in the areas of interest.

With the experience and learning of the past 8 years, and the network of disaster-mitigation specialists, we should re-organize and refocus in order to serve the society better, keeping in mind these new strengths. As an organization affiliated to the engineering department of a university, INCEDE should focus on the engineering aspects of disaster-mitigation as it had done so far. However, in order to make engineering solutions serve society better, these contributions should be motivated by the needs and the capabilities of each society. There-

fore firstly, we need to have a continuous dialogue with researchers in the social and medical fields to find out how and what types of engineering solutions are needed so that societies can cope with disasters better. Secondly, disaster-mitigation should be actively promoted as part of the development process to ensure sustainable prosperity. Looking at experiences of different countries at different levels of economic development, it is necessary to identify the engineering strategies that promote sustainable development. Fusing these new criteria to the present activities, INCEDE should re-organize and focus in four main areas; (a) Disaster-mitigation technologies, for reducing the impact of disasters, including harnessing new technologies (b) Monitoring and response systems, for reducing the losses after the disaster, (c) Engineering strategies for disaster-mitigation, to identify optimum disaster-mitigation policies in harmony with national development planning and (e) Interfacing actively with social and medical disciplines to serve the society better. We believe that such an approach of looking at the total process of disasters and their impacts on society would help us prepare and manage disaster impacts better in the coming millennium.

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3) T. Katayama, M. A. H. Pramanik, S. Herath and K. Meguro, *INCEDE Activities Expand*, Bulletin of Earthquake Resistant Structure Research Center, No. 26, pp. 3-11, March 1994.

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6) R. Jha, S. Herath and K. Musiake, *Development of IIS Distributed Hydrologic Model (IISDHM) and its Application to Chao Phraya River Basin*, Thailand, Annual Journal of Hydraulic Engineering, JSCE, Vol. 41, pp. 227-232, 1997.

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9) D. Dutta, S. Herath and K. Musiake, *Distributed Hydrologic Model for Flood Inundation Simulation*, Annual Journal of Hydraulic Engineering, JSCE, Vol. 43, pp. 25-30, 1999.

10) K. Meguro and H. Tagel-Din, *An Efficient Technique for Fracture Analysis of Structures*, Bulletin of Earthquake Resistant Structure Research Center, Institute of Industrial Science, University of Tokyo, No. 30, pp.103-116, March 1997.

11) K. Meguro and H. Tagel-Din, *A New Simplified and Efficient Technique for Fracture Behavior Analysis of Concrete Structures*, Proceedings of the Third International Conference on Fracture Mechanics of Concrete

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12) K. Meguro and M. Harada, *Urban Space Design and Safety Evaluation from the Viewpoint of Evacuation Behavior of Users*, (8 Pages), Bulletin of Earthquake Resistant Structure Research Center, No. 32, March 1999.

13) K. Meguro, F. Yamazaki and T. Katayama, *Estimation of Effects due to Power Outage in Urban Area for Optimum Measures*, Proceedings of the World Urban-Earthquake Conference, Fukui, Japan, pp.113-120, June 1998.