The role of Science and Technology in Disaster Reduction

As we have just embarked upon a new century and millennium, natural hazard prevention is set to play a prominent role in global efforts to reduce human suffering and damage to natural and built environments. Disaster reduction is both possible and feasible if the sciences and technologies related to natural hazards are properly applied. The extent to which society puts this knowledge to effective use depends firstly upon the political will of its leaders at all levels. Coping with hazards - whether natural or attributable to human activity - is one of the greatest challenges of the applications of science and technology in the 21st Century.

While we cannot prevent an earthquake or a hurricane from occurring, or a volcano from erupting, we can apply the scientific knowledge and technical know-how that we already have to increase the earthquake- and wind-resistance of houses and bridges, to issue early warnings on volcanoes and cyclones and organize proper community response to such warnings.

Over the last three decades, scientific knowledge of the intensity and distribution in time and space of natural hazards and the technological means of confronting them have expanded greatly. The dramatic advances in the understanding of the causes and parameters of natural phenomena and in the techniques for resisting their forces were presented, in the mid-80s, by Dr Frank Press, a lead scientist, as the rationale which made propitious the launching of the international decade devoted to reduce significantly the consequences of natural hazards. The Resolution of the United Nations General Assembly which proclaimed the International Decade for Natural Disaster Reduction (1990-1999) called for a concerted worldwide effort to use the existing scientific and technical knowledge, adding new knowledge as needed, in order to underpin the adoption and implementation of public policy for disaster prevention. The International Strategy for Disaster Reduction is the successor of the Decade and provides a framework for each nation to fully utilize existing knowledge on the lithosphere, atmosphere, and biosphere and the know-how on disaster protection gained in prior years, and to build effectively and creatively upon past accomplishments so as to meet the projected needs for safer communities.

Progress in the science and technology of natural hazards and of related coping mechanisms have made it possible over the past years to introduce significant changes in the integrated approach to the problematic of natural disasters. Science and technology help us to understand the mechanism of natural hazards of atmospherical, geological, hydrological, and biological origins and to analyze the transformation of these hazards into disasters. Scientific knowledge of the violent forces of nature is made up of an orderly system of facts that have been learned from study, experiments, and observations of floods, severe storms, earthquakes, landslides, volcanic eruptions and tsunamis, and their impacts on humankind and his works. **The scientific and technological disciplines** which are involved include basic and engineering sciences, natural, social and human sciences. They relate to the **hazard environment** (i.e., hydrology, geology, geophysics, seismology, volcanology, meteorology, and biology), to the **built environment** (i.e., engineering, architecture, and materials), and to the **policy environment** (i.e., sociology, humanities, political sciences, and management science). Major progress has been made in the development of global meteorological models and their application to large scale weather prediction. The critical information currently provided on global climate change and its implication on the global environment is the fruit of this progress.

Although earthquake prediction is still not possible, considerable options exist today to make more accurate forecasts and to give warnings of several impending hazard events. Warnings of violent storms and of volcanic eruptions hours and days ahead have saved many lives and prevented significant property losses. Modern technologies have been developed that reduce the exposure to natural hazard of the physical and built environment and other elements of socio-economic life. Owing to progress in design and construction engineering, earthquake-resistant structures, including high-rise buildings, critical lifelines and industrial facilities, are technically feasible and have become a reality. One component of these breakthroughs in disaster reduction, in some instances, has been enhanced capacity to control or modify the disaster events themselves.

Scientific and technological solutions to the complex problems of disasters must be rooted in social realities, in the fullest sense of the term. Science needs to be seen as part of a continuum of action extending from the design of interdisciplinary research to the communication of results to diverse non-specialist user groups. In this vein, scientists will have to share with policy-makers and others, the responsibility for scientifically-sound risk assessment and management.

Without science and technology, and their blending with other disciplines, there can be no world safer from natural disasters. Thanks to science and technology, we already know much about natural hazards and about the ways and means to avoid or reduce many of their effects. Success in significantly reducing disasters is within our reach. Now is the time to act within the International Strategy for Disaster Reduction.

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Examples of Disaster Reduction Initiatives

Technical Secretariats for Disaster Reduction "EDUPLAN hemisférico"

In 1992, the Organization of American States initiated activities on disaster reduction in the education sector troughout the Americas. A broad process of consultation and consensus-building begun by the OAS and supported by international, regional, and national organizations led in 1997 to the adoption of EDUPLAN hemisférico, a Hemispheric Plan of Action for the Reduction of the Vulnerability to Natural Hazards in the Education Sector, under the auspices of the IDNDR.

EDUPLAN hemisférico englobes programmes on the following areas:

Physical Infrastructure: Development of adequate and safe educational buildings resilient to natural hazard events. This component includes strategies such as planning, design, construction, repair, conditioning and maintenance for the management and retrofitting of educational buildings related to vulnerability reduction and safety.

Public Participation: Training and education of the general public for direct participation in preparedness, response, prevention and mitigation of natural hazard impacts on populations and their infrastructure.

Academic Aspects: Changes in the curriculum of primary, secondary, university level education to prepare individuals and groups from various disciplines to work toward measures for disaster reduction.

EDUPLAN hemisférico is implemented through local, national and regional activities supported by technical secretariats, partnering a wide variety of agencies, organizations and educators in collaborative efforts to "voluntarily" reduce vulnerability. Technical secretariats are directly involved with the institutions that operate at the community-level, the educational level, the administrative level or the geographic level. Their actions start locally but offer national, regional and hemispheric application and impact. They work to develop programmes, encourage citizen participation in making schools safer, and network with experts focusing on the schools' infrastructure.

Technical secretariats are emerging throughout the hemisphere with agencies, organizations and institutions willing to commit time, personnel and funds to support mitigation efforts. As of June 2001, eight technical secretariats have been established and the Universidad Nacional de Trujillo in Peru serves as the General Coordinator of EDUPLAN hemisférico in Latin America and the Caribbean:

-Argentina-Universidad Nacional de Cuyo
-Costa Rica-Centro Nacional de Infraestructura Física Educativa (CENIFE)
-Peru-Universidad Nacional de Trujillo
-Trinidad and Tobago-University of the West Indies
-US-Jacksonville State University
-US-University of Louisville
-US-Texas A&M University
-Venezuela-Fundación de Edificaciones y Dotaciones Educativas (FEDE)

Additional technical secretariats are actively sought among all interested institutions in the public and private sectors committed to disaster reduction through the education sector. Or particular importance is the participation of networks of community-based NGOs, professional associations, technical associations and development assistance institutions.

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Examples of Disaster Reduction Initiatives

Successful Application of Information Technology for Disaster Reduction in Vietnam

Vietnam is one of the most disaster-prone countries in the world. The hazards range from floods to typhoons, from drought to landslides, from fires to earthquakes.

Most disasters are water-related, which cause substantial suffering, loss of life and economic damage. Floods, particularly when accompanied by typhoons often cause the worst damages. Typhoons cause sea levels to raise by several meters inundating valuable cropland. On average, 4 to 6 typhoons reach Vietnam each year, killing hundreds of people.

One reason why disasters are so serious is that most of the population lives in areas susceptible to flooding. This is because Vietnam has grown economically by exploiting the low-lying river deltas and coastal lands through wet-rice agriculture. As a result, over 70% of the population of Viet Nam are at risk of water disasters.

Recent UNDP-supported studies estimated that the average annual losses in the Red River Delta and along the Central coast could reach more than $130 million. In a more recent Asian Development Bank study, it was found that the average annual damage from flooding for the area protected by the dyke around Hanoi alone amounted to well over US$50 million per year.

UNDP has for long been the lead agency in providing technical assistance for the Government of Vietnam in disaster management. UNDP supported a Strategy and Action Plan for Water-related Disasters and a number of institutional capacity building activities which have helped the Government reduce disasters since the early 1990s. The UNDP-funded project, Support to the Disaster Management System in Vietnam (DMU project), has been actively contributing to the course of disaster management in Vietnam, especially through the nation-wide information system it has set up. The project, managed from the Ministry of Agriculture and Rural Development (MARD), which assumes the Chairmanship of the Government's main agency for disaster management in Vietnam – the Central Committee for Flood and Storm Control (CCFSC) – has been of support to CCFSC by providing updates on the disaster situation, early warnings and information on damages and needs assessments.

The project set up a computer based information link between CCFSC-DMU and the Hydro-meteorological Services (HMS), connected to the provincial CFSCs of all 61 provinces of Vietnam. The system provides for (1) Forecasting disasters; (2) Warning and responding to disasters; (3) Information on Damages; (4) Rescue and relief; and (5) Restoration and rehabilitation. With information supplied by different sources from HMS, Internet, provinces, CCFSC and MARD, this linkage to provides timely warnings to people, to respond to emergency relief requests, and to disseminate information related to disaster management.

Back-up emergency power supplies have been installed and tested in the disaster mitigation offices of 18 Provincial Flood and Storm Control Committees. By the end of March 2001, disaster mitigation offices in all provinces of Vietnam had been supplied with back-up emergency power systems using gasoline generators.

Additionnally, manuals have been developed and training activities on the usage of the Internet, DMU Intranet, Web, and Email services were carried out for disaster management officials of all 61 provinces. Manuals to establish an effective reporting system of damage assessment, emergency relief needs, and rehabilitation requirements have been published and provided to provinces at the training courses.

From early 2001, with funding from USAID/OFDA, the project has been extended to apply more advanced information technology for disaster reduction in Vietnam. A computer-graphics based weather and natural disaster warning system is being designed for the Vietnam Television to ensure that disaster warning messages are best disseminated to the people. Flood and inundation maps are being established for all Central provinces of Vietnam, using the most up-to-date GIS technology and training is being given on the use of the maps to mitigate loss of life and property damage caused by natural disasters. A river flood alert system is also being designed on the most flash flood prone rivers in the Central Vietnam to give advance warning of impending flooding.

The project has developed a website for disaster management www.undp.vn/dmu

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The World Meteorological Organization on disaster reduction worldwide

Almost three-quarters of all natural disasters – floods, tropical cyclones, droughts, forest fires or epidemics – are weather- and climate-related. The World Meteorological Organization contributes to the mitigation of such disasters through the National Meteorological and Hydrological Services (NMHS's) of its Member countries and the Regional Specialized Meteorological Centres (RSMC's) worldwide through the following programmes:

The World Weather Watch (WWW) contributes to the generation and real time exchange of data, the availability of forecasts, warnings and advisories for the public and the international community.

The Public Weather Services (PWS) supports the National Meteorological and Hydrological Services in disaster reduction activities by coordinating the provision of routine forecasts and information.

The Tropical Cyclone Programme (TCP) ensures capacity building and promotes nationally and regionally coordinated systems to ensure advance and effective preparedness against tropical cyclones and associated phenomena.

The World Climate Programme (WCP) provides through its ***Climate Information and Prediction Services (CLIPS)*** assistance to countries in the application of climate information and knowledge to the prediction and early warnings of climate-related natural disasters.

The World Weather Research Programme (WWRP) is aimed at developing and promoting techniques that are cost-effective and improved to be able to forecast high-impact weather like land-falling cyclones, sand and dust storms and warm season heavy rainfall that can initiate severe flooding.

The Hydrology and Water Resources Programme (HWRP): assists the National Hydrological Services of WMO's Member countries in assessing the risks and forecasts of water-related hazards with a focus on major floods and droughts.

The Regional Specialized Meteorological Centres (RSMC's): centres world-wide designated by WMO to provide weather forecasts, advisories on tropical cyclones and atmospheric transport model products covering the globe to address environmental emergencies such as nuclear facility accidents.

Advances in science and technology have reinforced the early warning capabilities to mitigate natural hazards and disasters over the last decade. The expansion of global communications and new information technologies have increased the availability of information on natural disasters considerably. Nevertheless, sophisticated early warning systems only become effective with free and unrestricted exchange of meteorological data. People at risk must not only receive forecasts and warnings but also understand and assess the provided information, personalize the risks and respond in a timely manner. The exchange and transfer in the application of science and technology to disaster reduction, including technical cooperation supporting developing countries, should be further incorporated in all disaster reduction activities.

Aftermath assessments of meteorological and hydrological disasters point to a number of reasons for the ineffectiveness of some warnings including occasional forecast inaccuracy, miscalculating onset time or the intensity or effects of a natural disaster. Meteorological and hydrological-related hazards constitute a large majority of all natural disasters causing a great number of fatalities and immense socio-economic losses.

As Bangladesh is topping the world ranking of countries most severely hit by cyclones and storm surges in history, the country shows the example of how an appropriate satellite-based early warning system is indispensable for disaster mitigation. The government saw itself in need to develop an early warning system after the killer tropical cyclones of 1971 (300 thousand deaths, 1.3 million people homeless) and 1991 (138 thousand deaths). In 1994, the warning system proved its worth as another devastating cyclone of equivalent intensity struck the archipelago. This cyclone, referenced as 02B, claimed over 250 lives and made nearly half a million people homeless. The ultimate impact of this tropical storm was many times less compared to the disastrous 1971 and 1991 events.

Among the most devastating disasters that occurred lately are the Bay of Bengal tropical cyclone in October 1999 (over ten thousand deaths), droughts in the USA during 1999, flash floods and landslides in Venezuela (December 1999 with 30 thousand deaths), severe winter storms in western Europe in December 1999, the Mozambique floods in 2000, the Great Horn of Africa droughts over 2000-2001, ongoing drought in Central Asia since 1998 and most recently, the severe flooding in western France and in Siberia, Russia.

The recently launched Working Group I report of the WMO/UNEP initiated Intergovernmental Panel on Climate Change (IPCC) stated that 'global changes in tropical storm intensity and frequency are dominated by variations occurring over a period of time of ten years or even over decades, which represent no significant trend over the 20th century'.'However, episodes of the El Niño/Southern Oscillation (shifts in relative air pressure across the Pacific) have been more frequent, persistent and intense since the mid-1970s compared with the previous 100 years', stated the IPCC report. In particular the 1997-1998 El Niño event showed climate anomalies such as suppressed rainfall combined with drought in many parts as well as reduced tropical storm activity over the Western Pacific and the South China Sea. On the other hand, an increased frequency of tropical storms and cyclones was observed east of the International Date Line. The long-term trends in the frequency and intensity of hydro-meteorological hazards (drought, floods and other weather-related disasters) require further study.

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