PROGRAMME FOR THE FUTURE - CLOSING CEREMONY

Task manager: United Nations Scientific and Technical Committee (STC) on Natural Disaster Reduction
Moderator: Mr. R. Mountain, Director, Office for the Coordination of Humanitarian Affairs (OCHA), Geneva
Rapporteur: Mr. R. Hamilton, Rapporteur General of the Programme Forum
Speakers: Rapporteur General and Special Rapporteurs

General Conclusions and Recommendations by the Rapporteur General of the Programme Forum:

Poverty: The people that are most vulnerable to natural disasters are the poor, who have very limited resources for avoiding losses. Environmental degradation resulting from poverty exacerbates disaster impacts. Without greater attention from policy makers and more support from donor agencies for disaster prevention action, many developing countries, particularly in Africa, will not be able to escape from this situation. Innovative approaches are needed; emphasis should be given to the programmes to promote community-based approaches.

Megacities and urban areas: Concentrations of population in major urban centres (megacities), many of which are located in hazard-prone areas and in developing countries, are highly vulnerable to natural and technological hazards due to dependence on complex infrastructures and occupation of marginal land. Greater attention should be given to developing resilient and redundant infrastructures through regional and land-use planning.

Communities: Most disaster prevention and mitigation actions require community acceptance and initiative, which must be based on a credible assessment of risks and realistic estimates of costs and benefits. Communities are generally knowledgeable about their own environments and coping mechanisms, and often of ways to reduce vulnerabilities. Community leadership also enhances independence and self-reliance. National, regional and international efforts towards disaster prevention and mitigation are essential, but should be seen as supportive of community-based actions.

Awareness: Public awareness of natural hazards and risks, the driving force for prevention action, should be solidly grounded in the best scientific and technological information and methodology. The IDNDR has promoted this goal and is seen as a key factor in increasing political sensitivities towards the need for disaster reduction measures and policies.

Warnings: Warnings for some types of hazards have saved many lives and are steadily improving, which is a major achievement during recent years. This has been made possible by improvements in monitoring, analytical, and communications systems. Nevertheless, further advances are possible and should be pursued. Warnings can be used to avoid disasters rather than just respond to them. Special attention should be given to delivering the right message to the right place at the right time.

Information: Advances in information technology in recent years now provide enormous resources for decision makers. However, efforts are needed to distill this information into products that are tailored for the specific needs and delivered in a timely manner. Advances in communications technology make possible integration of real-time and archival data for emergency situations.

Education and training: Education and training for disaster reduction is a key, cross-cutting issue that must be an integral part of all programs. Creative use of films and videos, as well as of modern dissemination means, can be especially effective. Information must be seen as authoritative and credible, which can be achieved by linking experts with community leaders.

Education resources provided by regional and international organisations, including NGOs, can be particularly helpful.

Partnerships: Partnerships involving public and private organisations can be particularly effective in linking stakeholders and implementing plans. The private sector may be able to promote mitigation by providing incentives, for example, by ensuring compliance to building codes that would reduce insurance premiums as a condition for coverage.

Risk management: Risk management should be better integrated into overall developmental and environmental planning. Cost effectiveness of proposed action is an essential consideration. Post-disaster recovery and reconstruction provide the opportunity and resources to implement natural disaster reduction as an essential element of sustainable development. Improvements have been made in recent years in risk assessment and loss estimation methodology.

Health: Natural disasters require close collaboration between scientists and decision-makers to assure that authoritative information on potential or actual health problems is communicated. It is often difficult to achieve this goal in the face of uncertain and/or sustained situations. Effects of climate variability on health are of growing interest.

Climate variability: The successful prediction of the El Nino phenomena during 1997-98 signalled an improving capability for forecasting climate variability. As climate variation affects the occurrence of natural hazards, such as drought, heavy rainfall with floods and landslides, and tropical cyclones, this development carries great implications for natural disaster reduction. In advance of El Nino, some communities took preventive action that significantly reduced potential impacts.

Environment and ecosystems: Natural hazards impact the environment and environmental degradation can exacerbate disasters. Small Island States and mountain communities can be especially vulnerable. Hazard and risk assessments should be improved to guide prevention and mitigation measures, for protecting the environment.

Research: Substantive progress has been achieved in understanding the cause and effects of natural hazards. Nevertheless, further efforts are needed, especially with respect to risk assessment and warnings. Multi-disciplinary efforts are needed for many problems, especially to better integrate physical and social sciences.

Building codes and practices: In many cases, rather simple modifications to current building practices could greatly improve performance under hazard-induced stress. Retrofitting existing structures, however, poses a challenge due to cost Emphasis is now being given to overall building performance, moving beyond the previous focus on life safety. Methods have been advanced for better housing construction using local materials, which should be more broadly communicated.

Loss data: Reliable data on natural disaster losses, other than human casualties, are very limited. Standard methods should be employed for collecting such data. National statistics on losses could be used to measure progress on disaster reduction.

Framework: The international and regional framework provided by the IDNDR has greatly assisted many nations in focusing attention on the threat posed by natural hazards and the means for mitigating their impacts. Of great importance, through the IDNDR many high-level decision-makers have become aware of the vulnerabilities and the opportunities to reduce them. It is of the utmost importance that such a framework is provided in the future beyond the decade.

STRATEGY: A SAFER WORLD in the 21st CENTURY
Disaster and Risk Reduction
IDNDR Programme Forum, Geneva, July 1999

INTRODUCTION

While hazards are inevitable, and the elimination of all risk is impossible, there are many technical measures, traditional practices, and public experience that can reduce the extent or severity of economic and social disasters. Hazards and emergency requirements are a part of living with nature, but human behaviour can be changed. In the words of the Secretary General,

"We must, above all, shift from a culture of reaction to a culture of prevention. Prevention is not only more humane than cure; it is also much cheaper... Above all, let us not forget that disaster prevention is a moral imperative, no less than reducing the risks of war".

VISION

To enable all communities to become resilient to the effects of natural, technological and environmental hazards, reducing the compound risks they pose to social and economic vulnerabilities within modern societies.

To proceed from protection against hazards to the management of risk through the integration of risk prevention into sustainable development.

GOALS

I. Increase public awareness of the risks that natural, technological and environmental hazards pose to modern societies.

II. Obtain commitment by public authorities to reduce risks to people, their livelihoods, social and economic infrastructure, and environmental resources.

III. Engage public participation at all levels of implementation to create disaster-resistant communities through increased partnership and expanded risk reduction networks at all levels.

IV Reduce the economic and social losses of disasters as measured, for example, by Gross Domestic Product.

OBJECTIVES

1. Stimulate research and application, provide knowledge, convey experience, build capabilities and allocate necessary resources for reducing or preventing severe and recurrent impacts of hazards, for those people most vulnerable.

2. Increase opportunities for organizations and multi-disciplinary relationships to foster more scientific and technical contributions to the public decision-making process in matters of hazard, risk and disaster prevention.

3. Develop a more proactive interface between management of natural resources and risk reduction practices.

4. Form a global community dedicated to making risk and disaster prevention a public value.

5. Link risk prevention and economic competitiveness issues to enhance opportunities for greater economic partnerships.

6. Complete comprehensive risk assessments and integrate them within development plans.

7. Develop and apply risk reduction strategies and mitigation measures with supporting arrangements and resources for disaster prevention at all levels of activity.

8. Identify and engage designated authorities, professionals drawn from the widest possible range of expertise, and community leaders to develop increased partnership activities.

9 Establish risk monitoring capabilities, and early warning systems as integrated processes, with particular attention being given to emerging hazards with global implications such as those related to climate variation and change, at all levels of responsibility.

10. Develop sustained programmes of public information and institutionalized educational components pertaining to hazards and their effects, risk management practices and disaster prevention activities, for all ages.

11. Establish internationally and professionally agreed standards / methodologies for the analysis and expression of the socio-economic impacts of disasters on societies.

12. Seek innovative funding mechanisms dedicated to sustained risk and disaster prevention activities.

IMPLEMENTATION

Conduct a national audit or assessment process of existing functions necessary for a comprehensive and integrated national strategy of hazard, risk and disaster prevention, projected over 5-10 and 20 year time periods.

Conduct dynamic risk analysis with specific consideration of demographics, urban growth, and the interaction or compound relationships between natural, technological and environmental factors

Build, or where existing, strengthen regional/sub-regional, national and international approaches, and collaborative organizational arrangements that can increase hazard, risk and disaster prevention capabilities and activities.

Establish coordination mechanisms for greater coherence and improved effectiveness of combined hazard, risk and disaster prevention strategies at all levels of responsibility.

Promote and encourage know-how transfer through partnership and among countries with particular attention given in the transfer of experience amongst those countries most exposed to risks.

Establish national, regional/sub-regional, and global information exchanges, facilities, or websites dedicated to hazard, risk and disaster prevention, linked by agreed communication standards and protocols to facilitate interchange.

Link efforts of hazard, risk and disaster prevention more closely with the Agenda 21 implementation process for enhanced synergy with environmental and sustainable development issues

Focus multi-year risk reduction strategies on urban concentration and mega-city environments.

Institute comprehensive application of land-use planning and programmes in hazard prone-environments.

Develop and apply standard forms of statistical recording of risk factors, disaster occurrences and their consequences to enable more consistent comparisons.

Undertake periodic reviews of accomplishments in hazard, risk and disaster reduction efforts at all levels of engagement and responsibility.

Study feasibility of specific alternative funding and resource allocation modalities that can ensure continued commitment to sustained risk and disaster prevention strategies.

RESPONSIBLE PARTIES

Governments have the primary responsibility for protecting citizens from risks and disaster, however, local communities and elements of civil society most threatened by hazards emerge as key initiators of important risk and disaster prevention actions. They must work through partnership, and together, receive necessary encouragement and support to realize the vision of disaster resilience.

Regional/sub-regional and international collaboration is essential, especially with regard to the dissemination of experience and information, scientific and technical applications, continual advocacy and the coordination of strategies to assist in the development of national capabilities.

The United Nations system has a special leadership role in global risk and disaster reduction by its universal character, inter-disciplinary and multi-sectoral scope, and role as a forum for global dialogue. It should address global risk issues, ensure coherence among humanitarian aid, disaster prevention and development, and promote collaboration among countries.

REVIEW

The strategy, A Safer World in the 21st Century: Risk and Disaster Reduction, should be closely monitored by the risk and disaster reduction community, and a global review of progress and accomplishments should be undertaken by all concerned parties within a period of five years.

PRESENTATION OF THE CONFERENCE STATEMENT

International Decade for Natural Disaster Reduction
IDNDR International Programme Forum
5-9 July 1999

The Geneva Mandate On Disaster Reduction

We, participants in the IDNDR International Programme Forum - Towards Partnerships for Disaster Reduction in the 21st Century, - recognise that the world is increasingly being threatened by large scale disasters triggered by hazards, which will have long term negative social, economic, and environmental consequences on our societies and hamper our capacity to ensure sustainable development and investment, particularly in developing countries.

We have to act decisively now, to guarantee a safer world for future generations. We must build on progress achieved during the IDNDR, so that risk management and disaster reduction become essential elements of government policies. The Yokohama Strategy (1994) and the strategy "A Safer World in the 21st Century: Risk and Disaster Reduction" (1999) chart the course. Political will is essential to ensure that appropriate policies and institutional arrangements foster a culture of prevention at all levels of our societies.

We shall adopt and implement policy measures at the international, regional, sub-regional, national and local levels aimed at reducing the vulnerability of our societies to both natural and technological hazards through proactive rather than reactive approaches. These measures shall have as main objectives the establishment of hazard-resilient communities and the protection of people from the threat of disasters. They shall also contribute to safeguarding our natural and economic resources, and our social wellbeing and livelihoods.

Furthermore, scientific, social and economic research, and technological and planning applications will be required at all levels and from a wide range of disciplines in order to support risk management and effective reduction of our vulnerabilities. In this connection, there is need for increased information exchange, improved early warning capacities, technology transfer and technical co-operation among all countries, paying particular attention to the most vulnerable and affected.

These last ten years have shown the multisectoral, interdisciplinary and cross-cutting nature of broad risk management and its contribution to disaster reduction. Continued interaction and co-operation on the above basis, among all disciplines and institutions concerned, are considered essential to accomplish commonly agreed objectives and priorities. This interaction shall be based on the strengthening of co-operation and partnerships engendered by the IDNDR Programme.

We stress the importance of developing and strengthening regional approaches dedicated to disaster reduction in order to take account of local specificity and needs. We emphasise in this respect, the need to support institutional initiatives and mechanisms for strengthening regional, sub-regional national and local capabilities, coordination, and applied research. We recognise the particular need for establishing an institutional arrangement to coordinate disaster reduction in Africa, and in this regard, invite existing and evolving mechanisms for inter-regional co-operation to accord priority to these concerns.

Appropriate financial resources will be needed to ensure the development and implementation of prevention and mitigation policies and programmes in all countries particularly developing countries. Innovative approaches should be explored including the funding of international initiatives. However, full use should be made of existing regional and national financial mechanisms involving those communities most directly exposed to risks. All bilateral and multilateral development assistance should include disaster reduction components.

We recommend to the international community and to the United Nations that, based on the proven success of the functional responsibilities and organizational arrangements during the IDNDR, the international co-operative framework for disaster reduction be maintained and strengthened. This framework should ensure partnership and synergy among all elements of risk management and disaster reduction, and promote a shift from a mentality of reaction to a culture of prevention. The growing threat of political, social and economic disruption caused by natural and technological disasters calls for bold action from member States of the United Nations in this regard.

WMO/UNESCO SUB-FORUM ON SCIENCE AND TECHNOLOGY

The complete procedings of the WMO/UNESCO *Sub-Forum have been published in a separate document by the concerned Organizations*

(reference: 1999, WMO, ISBN 92-63-10914-1)

STATEMENT FROM THE WMO/UNESCO

SUB-FORUM ON SCIENCE AND TECHNOLOGY IN SUPPORT OF NATURAL DISASTER REDUCTION
(Geneva, 6-8 July 1999)

One of the outstanding achievements of the International Decade for Natural Disaster Reduction (IDNDR) has been its major contribution to increased interaction and cooperation between the natural and social science communities working in disaster reduction and hence to enhanced application of science and technology to reducing the large and growing social and economic cost of natural disasters around the world.

Though science and technology have already contributed much to saving human life and reducing property loss and environmental damage from most forms of natural hazard of meteorological, hydrological, oceanographic and geological origin, their potential contribution over the next decade is even greater. But only if they are systematically and wisely applied within the broader social context of an integrated approach to natural disaster reduction which is the principal legacy and proudest achievement of the IDNDR.

In order to assist the global community to build most effectively on the foundation provided by the IDNDR, the World Meteorological Organization (WMO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), as the two principal United Nations (UN) agencies concerned with the scientific and technological aspects of disaster reduction, convened a "Sub-Forum on Science and Technology in Support of Natural Disaster Reduction" as a special contribution to the UN IDNDR Programme Forum 1999 "Partnerships for a Safer World in the 21st Century".

The Sub-Forum reviewed the various ways in which science and technology contribute to the disaster reduction process including, in particular, through:

- assessment of vulnerability and enhancement of community awareness of the nature of the risk;
- operation of integrated warning systems; and
- preparedness and education programs.

In its review, the Sub-Forum took stock of recent progress and future prospects in each of these three aspects of the application of science and technology to reduction of the impacts of tropical cyclones, extra-tropical storms, storm surges, severe local storms and tornadoes, sand and dust storms, drought, extreme and persistent temperatures, fire weather, floods, landslides, avalanches, volcanoes, earthquakes and tsunamis. A synopsis of this review is contained in the Annex to this statement.

The participants in the Sub-Forum, who came from both the natural and social sciences and with both research and operational backgrounds in developing and developed countries were concerned that more could have been achieved during the "decade" if the channels of communication and mutual trust that have now been achieved could have been established earlier. They were also concerned at the substantial gap that still exists between the disaster reduction capabilities of the developed and developing countries. They believe, however, that the achievements of the past decade have provided a sound foundation on which to build an effective global strategy for natural disaster reduction in the 21st century.

Major Achievements

Many of the most significant achievements in natural disaster reduction during the 1990s were largely a result of science and technology. Accuracy and timeliness of early warnings for many natural hazards have been improved. The ability to provide forecast time and location of landfall of tropical cyclones has been improved by 24 hours so that the accuracy of the 24-hour forecast in 1990 has been increased in 1999 to 48 hours in advance. The warning time for tornadoes in 1990 was around 8 or 9 minutes and this has nearly doubled to over 17 minutes by the end of the decade. During the "decade", information and understanding on specific natural hazards such as earthquakes and cyclones has, along with increased confidence of design engineers and insurance corporations, permitted improvements in building codes and standards in many parts of the world. A related achievement has been the significant increase of available maps of risk for many countries based on scientific studies and analyses of the climatology of natural hazards.

Perhaps the most visible achievement in the 1990s has been the creation of new disaster management bodies at all levels of government that now include scientists and engineers involved in the study and prediction of natural hazards. One of the major meteorological concerns of the 1990s has related to the longer time scales associated with seasonal to interannual climate variability and human-induced change While the capacity to forecast these changes is still limited, the implications for natural disaster reduction are extremely significant with just a very small improvement in forecast skill likely to lead to major benefits for communities and national economies.

Another notable achievement of the decade has been the ability, through satellites, to detect, track and assess the intensity of tropical cyclones and major storm systems. It is almost a certainty that all tropical cyclones can now be detected at or before their development as a natural hazard.

Significant improvements have been made during the decade in the global observation system of the World Weather Watch (WWW) and the Integrated Global Ocean Services System (IGOSS). For example, the polar and geostationary satellite systems have been enhanced and the experimental buoy network in the tropical Pacific Ocean has been made operational providing essential observations for early detection of intense El Niño and subsequent La Niña phenomena. This achievement permitted prediction of drought and above normal precipitation several months in advance in Eastern Africa, and prediction of heavy rain in California in the United States These predictions also led to special preparedness actions resulting in significant reduction in the losses from the associated flooding.

Overall, the achievements in scientific understanding and its application during the 1990s have provided significant increases in evacuation times, better building standards, and improved risk assessment.

Vulnerability and Awareness

The Sub-Forum agreed that vulnerability assessment and reduction should form an integral part of the follow-up to the IDNDR. This should be achieved through use of advances in engineering as well as in the natural, social and human sciences.

Awareness raising on all types of natural disasters forms an essential element in early warning

systems, particularly also where warning periods are short. It encompasses the affected population as well as the political authorities concerned. Therefore, education and training of communities at large, the involvement of media and continuous interaction between scientists, sociologists, technologists and decision-makers and governmental authorities are indispensable vehicles for effective implementation. The partnership of scientific and technical practitioners with those working in social and humanitarian fields is essential notably in urban areas, involving the local population as well as tourists

In developed countries, it has been clearly demonstrated in recent years that the vulnerability of communities to natural hazards can be greatly reduced by the use of modern building standards in conjunction with risk zoning based on scientific and technical knowledge of the various hazards and their impact on the built environment. Indeed it is through such standards and risk zoning that much of the scientific and technical knowledge of the various hazard mitigation is applied in the community In the building and construction area these standards are being developed by the International Standards Organization (ISO). These standards have the potential to greatly reduce community vulnerability to a number of major hazards in the long term but this will require that the development of these new international standards be given higher priority than the revision and upgrading of their individual national standards.

A related, but separate need is the development of cost efficient means of reducing the vulnerability of existing buildings and infrastructure and the financing of activities. This is required to address the reduction of vulnerability in the short to medium term A high level of technical skills will be required to determine economic means of reducing the vulnerability, and high level of scientific and engineering expertise will be required for the innovative methods of risk financing that will be needed to securitise the investment in reducing the vulnerability.

Integrated Warning Systems

Early warnings are an extremely important link in the chain of actions required to reduce the social and economic impact of natural hazards. Warnings of a natural hazard such as a flood delivered in a timely and clear manner to individuals or communities prepared to take action reduces the impact of the hazard.

All sectors must be involved in the warning process and serve population needs, environment and other national resources. Effective early warnings require unrestricted access to data that is freely available for exchange and they must emanate from a single officially designated authority.

Advances in science and technology during the last decade have demonstrated enhanced warning capabilities for many natural hazards in many parts of the world For example, warnings of drought have been issued several months in advance which proved of great value for alleviating the impacts of the drought and food supplies The forecast accuracy of tracks of tropical cyclones has shown significant improvement and average forecast lead times for tornadoes and flash floods have been substantially increased which reduces the loss of life

Provided adequate assistance is available, many opportunities now exist to transfer these warning capabilities to all areas affected by the natural hazard especially in developing countries during the next decade

The warning process is underpinned internationally by the World Weather Watch and IGOSS, the Tsunami Warning System and associated research particularly the World Weather Research Program. At the national level this process includes local and regional observational systems such as coordinated hydrological networks and radar, data processing capability and most importantly it depends on well-trained meteorologists to prepare forecasts and warnings and interact with media and emergency management officials.

Preparedness and Education

A wide range of activities and bodies is encompassed by the terms "preparedness" and "education". They extend from the grass roots to the governmental level and involve individuals, families and communities at one extreme, and universities, ministries and government as a whole at the other. They take in classes, seminars, schools, links of various sorts such as between the forecasters and the audience for their forecasts; and they include research, not only into forecasting but also into the delivery and dissemination of forecasts and warnings and the responses, perception and reactions to them.

Developed and some developing countries have extended their preparedness and the meteorological, hydrological and other geoscience products supporting it into new areas during the "decade". They have forged closer dialogue between the scientific community and stakeholders in various areas of endeavour, such as agriculture, health and transport. They have made good progress with dialogue with social scientists, but this area still needs more attention. Catering for preparedness of the disadvantaged and disabled has also not progressed to the desired extent and greater use of plain and meaningful language is seen as highly advantageous in the better communication of forecasts and warnings. Indeed the language of preparedness measures and forecasts determine the way these messages are accepted In many cases the use of a dialect could improve effectiveness and credibility. Confirmation of such messages is also an important consideration. Using mobile phones and pagers to propagate these messages and means other than radio and television have distinct benefits. Education and training applied in the direction of those scientists building the preparedness measures as well as those they are designed for. Indian experience of workshops between forecasters and the users of their forecasts pointed to the value of such exchanges. However, there are differences when carrying the message to adults as opposed to children

There are advantages attached to the education of school children in disaster preparedness - their parents benefit as well and this has been made evident during the IDNDR. Developing countries trying to build their preparedness face enormous costs and also the much greater costs of reconstruction in the wake of a disaster.

Future Actions

The Sub-Forum recognized that, as a result of population increase and concentration and other factors, our societies are becoming more and more vulnerable and that our protective systems are not necessarily adapted to cope. Furthermore, considering that a disaster strategy which puts emphasis solely on relief and response is short-sighted and not cost-effective, the participants agreed on the need for greater emphasis on prevention across the whole continuum of hazards faced by humanity.

The Sub-Forum recalled that the 1994 Yokohoma World Conference on Natural Disaster Reduction called for a construction of a "Culture of Prevention" which should be based on improved short-term and long-term monitoring mechanisms Mitigation, preparedness and prevention measures must be proactive rather than reactive; they must provide the correct treatment while there is still time. Prevention must be rooted ultimately in culture and education which finds its expression in our everyday social behaviour. Hence, the threat of potentially irreversible events includes an ethical dimension which should be reflected in training, organization and motivation of communities at risk

Capacity building and education at all levels have an important role to play in the development of a culture of prevention by ensuring a two-way flow of information between decision-makers and communities at risk.

The Sub-Forum emphasized the need for capacity building in vulnerability and risk assessment, early warning of both short-lived natural disasters and long-term hazards associated with environmental change, improved preparedness, adaptation, mitigation of their adverse effects and the integration of disaster management into overall national socio-economic development planning.

The participants agreed that a focused ongoing coordination structure is needed within the UN system in order to strengthen further the already close cooperation among intergovernmental and non-governmental scientific and technical bodies committed to natural disaster reduction. Such a mechanism is necessary to foster and sustain the vital international and national effort on the application of the natural and social sciences and technology in support of natural disaster reduction, particularly through the implementation of the relevant programmes of UNESCO and WMO.

EXTRATROPICAL STORMS

Speaker: Mr. W. Appleby, Environment Canada, Atmospheric Environment, Canada

Large-scale, mid-latitude, storms are the main cause of blizzards, freezing rain and heavy snowfall in winter and can also cause intense rainfall, hailstorms, or spawn tornado families. The 1990s have seen an increase in the cost of natural disasters resulting from these storms. During 1989-90, a series of intense winter storms struck northern Europe causing over 200 deaths and billions of dollars in damage. In July 1996, a low pressure system dumped 200mm of rain in the Saguenay River region of Quebec in Canada and the resulting flash floods killed at least 10 people, 16,000 people had to be evacuated and losses were over US$ 500 million. The 1998 flooding of the Yangtze River in China was the most costly disaster of the year, claiming 4,150 lives, affecting 223 million people and causing $30 billion in damage.

Significant achievements during the Decade include improved forecast accuracy, resulting from improvements in numerical models, supported by enhanced observational systems and increased emphasis on user requirements and effective messaging. Using computer models, many extratropical storms can now be predicted well ahead of time and the timely issue of early warnings helps to mitigate their impacts.

For the future, it is critical that investments continue in surface and space-based observational networks, telecommunications and computer systems and numerical weather prediction along with related research and development. Since more people are living in vulnerable areas and, in many instances, they are taking inadequate precautions against extratropical storms, it is equally vital that emphasis continue to be placed on enhancing public awareness and understanding of hazards, early warnings and mitigation and preparedness actions.

SEVERE LOCAL STORMS AND TORNADOES

Speaker: Dr. H. Brooks, NOAA/National Severe Storms Laboratory, USA

Severe convective weather such as tornadoes, hail, damaging wind gusts and flash floods presents a serious threat to life and property in many parts of the world. Destructive tornadoes have been observed in all continents except Antarctica and their occurrence is, probably, vastly under-reported In the Pacific and the Carribean, landfalling tropical cyclones often spawn tornadoes. During the past 20 years, devastating tornado occurrences have resulted in hundreds of fatalities in places as far apart as Moscow and Bangladesh. Severe hailstorms, flash floods and dangerous wind gusts are also very widely experienced and damage from these non-tornadic events can also be catastrophic. In the last 15 years, hailstorms have caused damage in excess of US$500 million from Munich, Germany to Denver, USA and Sydney, Australia. A flash flood recently killed over 80 people at Biescas in the Spanish Pyrenees. Around the world, press reports are common of damage to buildings, aircraft, trees and crops caused by strong convective gusts.

Significant progress has been made in understanding and modelling severe convective storms. Though increasing numbers of tornadoes have been reported in the US and property damage has increased in recent years, the annual death toll has dropped significantly. The decrease in fatalities is due to improvements in scientific understanding of severe storm formation, in observing technology and in the preparation and communication of warnings along with aggressive and successful public awareness and preparedness programs. Notable accomplishments include more widespread application of weather radars, particularly Doppler, leading to significantly increased lead times for tornado warnings and improved detection of heavy precipitation, enhanced observational coverage through automatic weather stations, improved tools such as workstations, advances in numerical models and improved public awareness of severe weather, particularly tornadoes. This has already led to a doubling of warning times, jumping from about nine minutes in 1990 to over 17 minutes in 1999.

The success of the above integrated approach combining improved storm detection, forecasting and warnings delivery with enhanced public awareness and education and well-exercised preparedness and response measures, makes it clear that this strategy should be transferred to all regions at risk. Particular issues for the future also include the need to: improve climatological estimates of the threats presented by severe weather; address probable under-reporting of severe weather occurrences; transfer research results and advanced forecast techniques; and to lessen the vulnerability of buildings and structures to severe weather phenomena.

DROUGHT

Speaker: Prof. L. A Ogallo, Department of Meteorology, University of Nairobi, Kenya

Droughts are normal components of climate variability though their effects are, all too frequently, seriously exacerbated by human factors such as population growth, inappropriate agricultural and forestry practices, poor or no planning and war. The adverse impacts of severe droughts are well known - forced migrations of people and animals, shortages of food, water, energy and other basic necessities, environmental degradation and disastrous mass starvation necessitating the mobilization of huge international relief efforts. Developing countries, particularly in Africa, continue to be both particularly vulnerable and limited in their ability to implement costly mitigation and preparedness measures.

In most developed countries, a reduction in vulnerability to drought has been achieved through the ongoing application of scientific and technological capacity. Related measures include the use of historical climate records and scientific and technical knowledge as a basis for risk assessment and zoning, land use planning, selection of appropriate agricultural practices, design of water storage and delivery systems and the development of insurance schemes and other realistic disaster preparedness policies. More immediate mitigation and preparedness measures build upon systematic monitoring of climatic and hydrological systems to provide early warning of developing droughts.

These approaches are being transferred to developing countries through initiatives such as the establishment of Drought Monitoring Centres. The Centre in Nairobi, for example, has achieved commendable results in drought monitoring, seasonal weather forecasting and capacity building in the Eastern Africa sub-region. Its products are disseminated widely and used for agricultural and water resources management and form a crucial component of early warning systems for food security in the sub-region.

During the next century, an increase in vulnerability to drought may be expected as a result of development pressures and population increases. Global warming may, in addition, increase the frequency of recurrence of drought-producing weather conditions in some regions. It is vital, therefore, that very high priority continues to be given to programs aimed at reducing global and regional vulnerability to drought. Key challenges to be faced include the development of the essential scientific and technical capacity in vulnerable regions, the establishment and maintenance of adequate meteorological and hydrological monitoring networks, improving seasonal and inter-annual prediction, implementing effective public education and disaster prevention and preparedness policies and ensuring ongoing technology transfer. The Drought Monitoring Centres, in particular, need to be strengthened and their computing and modelling capabilities enhanced along with improving real-time transfer of data and products throughout the sub-region(s).

FOREST FIRES

Speaker: Mr. B. Sol, Météo-France, Bureau Etudes et Développement, Direction interrégionale sud-est, France

Fighting forest and bush fires involves very large expenditures by communities and governments and the after-effects of large fires are generally felt for many years. Wild fires result in extensive damage to vegetation, human settlements and industries, along with closures of roads, railways and airports, evacuations of people, disruption or death of domestic animals and wildlife and occasional loss of human life. They can also create significant regional problems such as occurred in 1994 when fire razed over five million hectares of bush, plantation and forest in Indonesia, generating thick haze which severely affected Malaysia, Singapore and Brunei Darussalam. At times visibility was reduced to as low as 500 meters, disrupting air transport, causing poor air quality and an increase in eye irritation and respiratory problems.

Early identification of high fire hazard enables preventive or mitigating measures to be taken. As a result of research conducted over the past several decades, reliable techniques now exist for estimating the probability of forest fire outbreaks on the basis of meteorological conditions. Forecasts of high forest fire risk, made a day or two in advance, are of great value in initiating preventive measures such as forest closures, restrictions on logging and banning of open-air burning as well as in alerting and pre-positioning fire fighting personnel and warning the population. During active fires, wind, precipitation and humidity forecasts for fire sites enable fire-fighting crews to anticipate fire movement and behaviour, thereby increasing their efficiency and effectiveness and reducing overall costs.

The provision of timely early warnings of high fire risk and short range predictions of fire behaviour is critically dependent on the existence of adequate surface and space-based observational networks, reliable telecommunications and well-trained meteorological and forestry specialists The establishment and maintenance of a close, ongoing, relationship between National Meteorological Services and forest fire agencies and the conduct of effective public education and awareness campaigns are also essential ingredients in achieving optimum effectiveness in fire prevention, preparedness and mitigation. Consequently, future efforts to reduce forest fires disasters should focus on the development of observational and communications infrastructure, specialized professional expertise, inter-agency liaison and coordination, skills in the conduct of public awareness campaigns and facilitate the transfer and implementation of operationally proven fire risk assessment techniques.

EXTREME TEMPERATURES

Speaker: Dr. G. Jendritsky, German Meteorological Service, Freiburg, Germany

Many deaths result from cold waves and damage to crops, livestock, power supplies, transportation and other components of infrastructure can be enormous. Around 275 people died during the 1992 cold wave in India while similar conditions resulted in 298 deaths in central and eastern Europe during November and December 1998. Over 1 million farm animals died in China in 1986; extreme cold in late April 1991 destroyed the grape harvest in much of France and 40% of the Brazilian coffee harvest was destroyed in June-July 1994. Low temperatures alone, however, rarely cause disaster and other compounding factors are usually involved, such as freezing rain, heavy snowfall or high winds. For example, the 5 - 10 January 1998 Ice Storm, the worst in Canadian history, resulted from a prolonged period of freezing rain and left 4 million people without power, necessitated the evacuation of over 100,000, caused over US$2.5 billion damage in Canada and the neighbouring US and took 23 lives.

Prolonged heatwaves also impose severe stresses on people and economies. About 1,500 lives were lost in China in 1988, over 2,000 died in Greece in 1997 and, in 1998, a record 3,028 people died in a heat wave in India. Economic damages in the Mexican event of 1966 were over US$1.2 billion, reached US$13 billion in the 1988 US drought/heat wave and exceeded US$1 billion in 1992 in southern Africa. Urban populations, particularly the poor and elderly, are especially vulnerable as the heat island effect prevents nightime temperatures from dropping sufficiently to provide relief.

Mitigation and preparedness for cold and heat waves requires the assessment of historical climate records, planning and design to accommodate extreme temperatures (especially in densely settled areas), implementation of early warning systems and ongoing dissemination of advice to the public. National Meteorological Services already contribute significantly by issuing early warnings of extreme winter weather and heat waves and supplying climatic analyses. An integrated heat watch/warning system, currently being extended internationally at the initiative of WMO, WHO and UNEP, is an example of technology transfer which will further assist in preparedness when tailored to local conditions.

To prevent further disasters, efforts must continue to enhance national and regional capacities to prepare for, warn of and withstand temperature extremes and related weather phenomena. In particular, heat watch/warning systems adapted to local conditions should be established in the most vulnerable megacities around the world.

DUST AND SAND STORMS

Speaker: Dr. A. A. Hassan, Meteorological Authority, Cairo, Egypt

Sand and dust storms are natural events which occur widely around the world, in arid and semi- arid regions, temperate, tropical and sub-tropical latitudes. They are one of the most unpleasant weather phenomena and can be hazardous to transportation and navigation and for human health. Severe or prolonged dust and sand storms also result in major disasters. A dust storm which lasted for 5 hours near Jingchang, China caused 640 million yuan in economic damage over a wide area and injured and killed upwards of 300 people. In mid-March 1998, the Middle East was hit by choking sandstorms, claiming four lives, leaving 29 people injured, forcing the Suez canal, airports and seaports to close and bathing the region in an eerie yellow light.

The arid region around the Arabian Sea experiences the highest frequency of dust storms with over 30 per year occurring in the area joining Iran, Afghanistan and Pakistan. In Egypt, sandstorms -- called "khamsin (fifty)" for the number of days on which they can occur -- are a seasonal hazard and in 1997, 18 people died when that country was hit by the worst sandstorm in 30 years. Dust storms occur on a variety of spatial scales from mesoscale/regional to continental and remove large quantities of surface sediments and topsoil along with nutrients and seeds.

Timely early warnings of impending sand and dust storms are critical to preparedness for these, at times, disastrous events. National Meteorological Services in affected countries now prepare and issue such warnings when expected weather conditions favour their development. Longer-term mitigative measures are also being pursued such as the planting of trees and vegetation cover, modification of agricultural practices and public education initiatives.

For the future, efforts must continue to increase our understanding of duststorms and the factors which influence their development, movement and decay to improve our ability to provide early warnings of these events. In addition, longer term mitigative measures aimed at increasing awareness and reducing vulnerability and exposure must continue to be pursued.

EARTHQUAKES

Speaker: Dr. A. Green, Institute of Geophysics, Zürich, Switzerland
Speaker: Dr. W. Hays, United States Geological Survey, USA

Earthquakes are amongst the most damaging natural phenomena to affect the earth. Over 1.6 million people have died in earthquakes during the 20th century while huge economic losses have been incurred. The moderate (Richter scale 6.9) 1995 earthquake in Kobe, Japan, for example, produced direct economic losses reaching a new record of over $140 billion! Earthquake damage is, in general, related to the magnitude of the event, the quality of buildings and structures and the nature of the ground and secondary effects such as fires, landslides and tsunamis frequently contribute substantially. In 1960, a magnitude 5.9 earthquake caused approximately 12,500 deaths in Agadir, Moroccan where traditional stone and brick houses were situated on loosely consolidated sediments. In contrast, a magnitude 6 earthquake in the Canadian Shield in 1988 caused no deaths in a region where houses are usually wood framed with relatively light roofs. Unfortunately, around the world, earthquake vulnerability is increasing rapidly as a result of flaws in planning, siting, design, construction and use of buildings, dams, transportation links and other infrastructure. Seismologists consider that very strong (Richter >8) earthquakes will eventually occur in several areas of high population and development density, possibly producing losses up to an astounding $2,000 billion! This provides a wake-up call for responsible risk management.

Earthquakes will, inevitably, continue to occur, particularly along the boundaries of tectonic plates, but we cannot predict exactly where, when or what will be their magnitude. In a few regions, however, useful early warning systems are possible for approaching seismic waves from distant earthquakes and such systems have been implemented in a few locations. Their effectiveness is dependent on very fast seismographic and computer-communications infrastructure capable of disseminating information in advance of the arrival of dangerous shear and surface waves (i.e. within seconds to a minute or so).

For the future, since every dollar spent on mitigation and preparedness is estimated to save ten dollars in recovery and reconstruction costs, continued emphasis on earthquake mitigation and preparedness makes economic sense. The basic scientific and technical information required to characterize earthquake hazard and community vulnerability is now readily available in all countries. The general level of seismicity across broad areas can be forecast for the next tens to hundreds of years and nearly all countries now have regional seismic hazard maps. The next step towards preparedness is to conduct detailed vulnerability studies.

As a result of the IDNDR, several major projects are underway aimed at improving worldwide earthquake mitigation and preparedness, such as the World Seismic Safety Initiative, RADIUS project and the Earthquake and Megacities Initiative.

For the future, reduction of vulnerability to earthquakes is, clearly, an urgent goal for the coming decades. It is, moreover, one that is realizable as policy makers and stakeholders now have many earthquake mitigation options available. These include insurance, construction codes and standards, remediation and retrofit, demolition of hazardous structures, relocations, siting and land-use criteria, training and exercises. The key to success will be to integrate risk assessment and risk management as an ongoing strategy aimed at avoidance of flaws in planning, design, siting, construction and use which create or increase vulnerability.

LANDSLIDES

Speaker: Dr. P. Canuti, Earth Science Department, University of Firenze, Italy

Landslides occur in all regions of the world when masses of rock, earth, mine waste or debris move down slopes and result from rainstorms, earthquakes, volcanic eruptions and various human activities. They usually strike without warning destroying landscapes, buildings and homes, breaking electrical, water, gas, and sewage lines and disrupting roads and railways. Landslides and disastrous mudflows during the 1997 and 1998 hurricane seasons in Central America and the Caribbean caused untold damage and the tragic loss of thousands of lives in vulnerable communities. Landslides in the United States alone are estimated to cause an annual loss of about $1.5 billion and at least 25 fatalities and many areas of the globe are even more vulnerable.

Mitigation of the impacts of landslides requires hazard and vulnerability assessments and the implementation of risk management policies and strategies including public awareness campaigns, planning and development regulations, and construction codes and standards. Landslide, mudflow and debris-flow problems are often caused by mismanagement including unwise land-use practices on ground of questionable stability, particularly in mountain, canyon, and coastal regions. Significant progress has been made in that geotechnical experts can identify areas vulnerable to land slippage and provide early warnings of landslide hazards and advice on preparedness measures, such as evacuations. Land-use zoning, in partnership with professional inspections and proper design, can alleviate many of the problems associated with landslide hazards. Additional disaster mitigation measures include planting ground cover on slopes, installing flexible pipe fittings to avoid gas or water leaks and building channels, deflection walls to redirect the flow and insurance.

For the future, achievement of a reduction in the tragic consequences of severe landslides and mudflows around the world requires continued emphasis on risk assessment and risk management, utilizing increasing scientific understanding of the factors which lead to landslides to develop and implement policies which will reduce exposure and vulnerability to these hazards.

AVALANCHES

Speaker: Dr. P Föhn, Swiss Federal Institute for Snow and Avalanche Research, Switzerland

Avalanches are a major hazard in many mountainous countries. They result in substantial loss of life, such as the 75 fatalities recorded in the European Alps during January-February 1999. Avalanche damage can also be very substantial, reaching 1 billion Swiss francs in Switzerland during the past winter, for example. Around the world, vulnerability to avalanches will continue to increase as winter recreational activities and facilities expand in mountainous regions.

Effective long term preventive measures to reduce avalanche vulnerability include hazard mapping, land use planning, development of protective forests and installation of protective structures. Short-term measures include avalanche forecasting, the issue of avalanche warnings, artificial releases of snow masses, road and rail closures and evacuations. Some governments already invest heavily in such avalanche protection measures because of their demonstrated cost effectiveness Over the past 50 years, for example, about 1.5 billion Swiss francs has been invested in protective structures in Switzerland, in addition to the resources devoted to forecasting, hazard zoning and protective forests.

For the future, implementation of avalanche risk assessment and risk management is fundamental to the achievement of reductions in vulnerability. While this approach already in place in some countries, it needs to be extended to other vulnerable regions. In order to improve its application, needs also exist for continued research into snow pack physical processes, improved avalanche forecast and hazard mapping techniques, better technical and construction measures and enhanced risk management methods.

TSUNAMIS

Speaker: Dr. C. McCreery, Pacific Tsunami Warning Center, USA

Earthquakes, volcanic eruptions or shifts in the sea bottom generate very large, fast-moving waves known as "tsunamis". These huge waves travel at speeds in excess of 1000 km/hr on the open sea but are of such long wavelength as to be barely noticeable. When they reach coastlines and, particularly, bays or inlets, however, they interact with the sea floor, reduce speed and build up to tremendous heights, presenting a major threat to people, animals and structures along the shoreline. Tsunamis have resulted in catastrophic natural disasters and the coastlines around the Pacific Ocean are particularly vulnerable.

Mitigation and preparedness efforts for tsunamis focus on the provision of timely early warnings combined with ongoing public awareness and education programs. The need to enhance mitigation and preparedness, led UNESCO's IOC to establish, in 1968, an International Coordination Group for the Tsunami Warning System In the Pacific. The Pacific Tsunami Warning Centre (PTWC) in Honolulu is the headquarters of the International Tsunami Warning System and works with regional and national centers in monitoring seismological and tidal stations around the Pacific Ocean to evaluate earthquakes for their potential to generate tsunamis. IOC also maintains an International Tsunami Information Center (ITIC) which is responsible for monitoring warning programs, recommending improvements, assisting Member States to establish national warning systems, fostering research and improving preparedness throughout the Pacific Ocean.

The Decade has seen numerous improvements in tsunami mitigation. Numerical modelling techniques have been improved and are now applied to runup mapping for hazard assessment and to forecasting. Historical data bases have been electronically archived and made readily accessible. New techniques have been developed for assessing the tsunamigenic potential of large earthquakes and improved observational instrumentation has been developed and deployed. Rapid telecommunications systems have been installed and educational materials prepared and disseminated.

For the future, progress needs to continue in all of the above areas. New local and regional warning systems should be established in the Pacific and other ocean basins that are without warning coverage. In particular, a more coordinated approach to the provision of warnings would be of benefit in the Mediterranean, the Caribbean and the Atlantic Ocean. Low cost automated techniques need to be developed for warning against local tsunamis and installed in regions at risk. Coastal regions at risk from landslide/submarine slump induced tsunamis need to be identified and strategies devised to help protect their communities. In addition, tsunami education needs to be institutionalized to maintain adequate awareness over the long time periods between destructive events.

STORM SURGES

Speaker: Dr. T.S. Murty, Senior Scientist, Canada

The combination of strong onshore winds, low atmospheric pressure and high astronomical tides can result in exceptionally high water levels known as storm surges. Around the world, storm surges present a major natural hazard in many vulnerable coastal and island regions. Large storm surges, with amplitudes up to several meters, are generated by tropical cyclones and regularly cause great destruction in the Pacific, Atlantic and Indian Oceans, the Bay of Bengal and the Gulf of Mexico. In 1970, a tropical cyclone induced storm surge sweeping over the coastal wetlands resulted in catastrophic damage and the deaths of 300,000 people in Bangladesh while a similar tragedy in 1991 killed over 100,000. Storm surges caused by extra-tropical storms sometimes also result in deaths and in catastrophic damage, as experienced by low-lying countries around the North Sea on a number of occasions during the past several decades. In the future, sea level rise associated with global warming and land subsidence along vulnerable coastlines may increase the amplitude of storm surges and increase vulnerability to them. Concern also exists that a rise in sea surface temperatures may increase the percentage of tropical cyclones which reach coastlines, leading to an increase in the frequency of damaging surges.

Mitigation and preparedness for storm surges involves a combination of measures including risk assessments, vulnerability reducing initiatives, provision of early warnings of impending surge events and evacuation planning to remove people from exposed, low-lying, areas. Efforts to reduce vulnerability encompass structural measures, such as sea walls, barrages and dykes and risk zoning, land use and development planning. The provision of timely early warnings of storm surges combined with solid evacuation plans is, however, critical to disaster reduction in the face of these most dangerous events.

During the Decade, great progress has been made in implementing early warning systems and in timely dissemination of warnings to the public as well as in public awareness and education. This is reflected in the dramatic decline in deaths due to storm surges from thousands each year to a few hundred annually.

For the future, a major challenge for the early warning community is to reduce the number of "false alarms" which cause unnecessary evacuations in the most vulnerable regions. Furthermore, the predicted location and magnitude of surges must be pinpointed with much greater accuracy. Achievement of these improvements will require substantial investment in research directed towards improving the prediction methods. In addition, public awareness and education efforts must continue to be supported as essential components of preparedness and mitigation.

VOLCANOES

Speaker: Mr. S. Malling, UNESCO, On behalf of Dr. R. Punongbayan, Philippines

As dramatically demonstrated by the violent eruptions of Mount St. Helens in 1980, Pinatubo in 1991 and more recent catastrophic events in the Caribbean and elsewhere, volcanoes can wreak great havoc and devastation in the short term. They can also produce serious impacts over the medium and longer term, forcing evacuations, interfering with transport, increasing the acidity of precipitation and cooling global temperatures. Submarine volcanoes are also common features on certain zones of the ocean floor and some are active, occasionally blasting steam and rock-debris above the surface of the sea or generating dangerous tsunami waves.

In the face of these hazards, the challenge to policy makers and scientists is, therefore, to mitigate the adverse impacts of volcanic eruptions so that society may continue to benefit from products of volcanism such as fertile soils, access to geothermal energy and industrial raw materials. Mitigation of the adverse impacts of volcanic eruptions requires that we improve the capability for predicting these events and providing early warnings of potentially disastrous events. It also requires that decision makers and the general public are provided with the best possible information on high-risk volcanoes, to underpin sound decisions on land-use planning and public safety.

Considerable advances have been made in recent decades and scientists have the ability to predict their future behaviour. During the Decade, predictive ability has improved and hardware such as single component disposable seismometers has become more accessible. Capacity has been enhanced in developing countries but further work is needed. In the aviation context, mention must also be made of the ICAO/WMO Volcanic Ash Advisory Centres which now issue forecasts of the trajectories of volcanic plumes as a contribution to flight safety.

For the future, emphasis needs to continue on preventive and preparedness measures which have been initiated but are still embryonic in most developing countries. Similarly, efforts to raise awareness have begun in selected countries and locations but much more work is needed in the years to come.

TROPICAL CYCLONES

Speaker: Dr. G. Holland, Bureau of Meteorology Research Centre, Melbourne, Australia

Tropical cyclones are rightly feared as being amongst the most dangerous of the natural hazards. They are potentially the most destructive of all systems that affect coastal communities in tropical and subtropical countries. Increasing population and development density in such communities will continue to result in increased economic and social disruption from tropical cyclones

Scientific research and technical development have generated remarkable improvements in tropical cyclone forecasting and community response during the IDNDR. Contributing factors include continuing research emphasis on tropical cyclones, increases in computing power and the skill of numerical models, improving observational and communications capability and a growing recognition of the vital importance of public education and community preparedness in the face of these devastating storms.

At the end of the Decade, we have a strong community across all related disciplines, research meteorologists, forecasters and social scientists, applied to the reduction of tropical cyclone impacts. It is imperative that this be expanded and applied to further improving the safety and reducing the economic losses of affected communities.

In this context, the recent establishment of the WWRP is welcomed and their emphasis on high impact weather is strongly endorsed. Their establishment of a tropical cyclone landfall program is seen as a logical vehicle for carrying the research and development initiatives into the 21st century. The WWRP approach of taking research and development programs through to the forecast demonstration stage ensures a strong operational perspective It is pleasing that the WMO/ICSU development, under the IDNDR, of a pilotless aircraft to improve the observations of tropical cyclones has reached the stage of the aircraft moving to operational use

Provided that the impetus generated during the IDNDR can be maintained, the outlook is optimistic for substantial improvements in tropical cyclone forecast accuracy leading to more accurate and timely early warnings and enhanced preparedness for cyclone landfalls. Serious concern remains that the budgetary pressures being felt by governments may further undercut weather observing networks and forecasting and communications systems which are essential to the realization of these improvements.

FLOODS

Speaker: Dr. T.A. Khan, Bangladesh

Huge economic and social losses result from flooding in river floodplains and coastal regions subject to storm-surges and vulnerability is increasing in parallel with economic development. Floods continue to kill vast numbers of people, particularly in developing countries though the toll has declined significantly due to advances in early warning combined with planned evacuation to safe areas. In the future, climate change may compound the problem through sea-level rise, resulting in regrading of river-beds and more frequent overtopping of banks and levees. It may also enable an increasing percentage of tropical cyclones to reach coastlines, one study suggests an increase of about 30% is likely in the number of tropical cyclones which make landfall.

Substantial progress has been made in preparedness for flooding, issuance of timely early warnings and organized evacuations. Around the world, basin-wide land and water management is increasingly being used to mitigate floods and reduce vulnerability to them. Flood-protection structures provide real benefits but can also increase vulnerability by encouraging unwise developments. During floods, the greatest contribution that governments can make is often, however, to enable people to save their lives by warning them and facilitating their evacuation to safe areas. Consequently, provision of timely early warnings of flood events is a fundamental contribution to preparedness and mitigation and has resulted in saving many lives during the Decade.

For the future, risk assessment remains critically important in mitigating the effects of flooding. There is a need for continuing research and capacity building efforts to improve preparedness and strengthen early warning and other mitigation aspects. Structural measures, land use and planning approaches, forecasting and warning systems, identification or construction of safe havens and public education and awareness initiatives all play vital roles in achieving these objectives. In developing countries, investment is required in capacity building to keep floods away from people and keep people away from floods as well as in the more readily-funded "clean up afterwards" option.