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UNITED NATIONS

Global Survey of Early Warning Systems

An assessment of capacities, gaps and opportunities toward building a comprehensive global early warning system for all natural hazards

A report prepared at the request of
the Secretary-General of the United Nations

Pre-print version released at the Third International Conference
on Early Warning, Bonn, 27-29 March 2006

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The Global Survey of Early Warning Systems was called for by the Secretary-General of the United Nations in his report of progress toward the implementation of the Millennium Development Goals[1]. Its preparation was coordinated by the International Strategy for Disaster Reduction (ISDR) secretariat through the ISDR Platform for the Promotion of Early Warning (PPEW) in consultation with relevant United Nations organizations.

The Inter-Agency Task Force for Disaster Reduction (IATF/DR), at its 11th Session, May 2005, established a Working Group to support the preparation of the survey. The Working Group was co-chaired by the World Meteorological Organization (WMO) and the Office for the Coordination of Humanitarian Affairs (OCHA) and included the International Telecommunication Union (ITU), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Human Settlements Programme (UN-HABITAT), the United Nations Institute for Training and Research (UNITAR), the United Nations University Institute for Environment and Security (UNU-EHS), the Asian Disaster Preparedness Center (ADPC), the IGAD Climate Prediction and Applications Centre (ICPAC), the Global Fire Monitoring Center (GFMC), and the International Federation of Red Cross and Red Crescent Societies (IFRC).

A number of other organizations contributed to the survey, including: United Nations Children's Fund (UNICEF), the United Nations Convention to Combat Desertification (UNCCD), World Food Programme (WFP), Food and Agriculture Organization (FAO), European Commission Joint Research Centre (EC-JRC), the Asian Disaster Reduction Center (ADRC), ProVention Consortium and South Pacific Applied Geoscience Commission (SOPAC).

A meeting of international experts was held in Bonn, Germany, 12-13 December 2005 to review a consultant's draft report and to provide support for the drafting of the report (the participating experts are identified below by a star).

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[1] In larger freedom: towards development, security and human rights for all, Report of the Secretary-General, 2005, http://www.un.org/largerfreedom/

Executive Summary

If an effective tsunami early warning system had been in place in the Indian Ocean region on 26 December 2004, thousands of lives would have been saved. The same stark lesson can be drawn from other disasters that have killed tens of thousands of people in the past few years. Effective early warning systems not only save lives but also help protect livelihoods and national development gains. Over the last thirty years, deaths from disasters have been declining[2], in part thanks to the role of early warning systems and associated preparedness and response systems.

To be effective, early warning systems must be people-centred and must integrate four elements – (i) a knowledge of the risks faced; (ii) a technical monitoring and warning service; (iii) the dissemination of meaningful warnings to those at risk; and (iv) public awareness and preparedness to act. Failure in any one of these elements can mean failure of the whole early warning system.

With a view to establishing a "worldwide early warning system for all natural hazards building on existing national and regional capacity", United Nations Secretary-General Mr. Kofi Annan in March 2005 requested that a global survey of capacities and gaps for early warning systems be undertaken[3]. The present report synthesizes the findings of this survey, which was carried out by the secretariat of the International Strategy for Disaster Reduction (ISDR) in collaboration with a multi-party working group established at the 11th Session of the Inter-Agency Task Force on Disaster Reduction (IATF/DR) in May 2005.

Information for the survey was gathered from existing sources, including from reports submitted by 122 countries for the World Conference on Disaster Reduction, in 2005, regional reports prepared for the Second International Conference on Early Warning, in 2003, and ISDR publications. Inputs obtained specifically for the survey included updated information from 23 countries and 20 international agencies, and early warning system reports and surveys undertaken by other agencies.

The survey finds that considerable progress has been made in developing the knowledge and technical tools required to assess risks and to generate and communicate predictions and warnings, particularly as a result of growing scientific understanding and the use of modern information and communication technologies. Early warning system technologies are now available for almost all types of hazards and are in operation in at least some parts of the world.

However, the experiences of the Indian Ocean tsunami, the hurricanes in the Gulf of Mexico, and many other recent events such as heat waves, droughts, famine, wildfires, floods and mudflows, point to significant inadequacies in existing early warning systems. In many cases, especially in developing countries, warning systems lack the basic capacities of equipment, skills, and resources. Systems for

2 Centre for Research on the Epidemiology of Disasters (CRED), "Thirty Years of Natural Disasters 1974-2003: The Numbers", Presses Universitaires de Louvain, 2004.

3 *In Larger Freedom: towards development, security and human rights for all* (A/59/2005, paragraph 66), http://www.un.org/largerfreedom.

some hazards, such as tsunamis and landslides, are often absent. The survey concludes that there are many gaps and shortcomings and the world is far from having the global system for all hazards and all communities that the United Nations Secretary-General first called for in January 2005.

Progress on each of the above four components of effective early warning systems is mixed. Even where the capability exists to reliably generate and issue warnings, the other three components are too often absent or weak. Among both developed and developing nations, the weakest elements concern warning dissemination and preparedness to act. Warnings may fail to reach those who must take action, and may not be understood or address their concerns. Root causes appear to be inadequate political commitment, weak coordination among the various actors, and lacks of public awareness and public participation in the development and operation of early warning systems.

However, and more positively, there are many and great capacities and strengths already available upon which a truly effective globally comprehensive early warning system can be built – not as a monolithic centralized system, but as a network of systems, drawing on the expertise and technical capacities of the different hazard fields and the knowledge and insight of relevant social and economic fields. Moreover, what needs to be done to address the shortcomings is not a mystery, but has been already laid out in general terms in a succession of documents and meetings over the last decade, such as the International Conference on Early Warning Systems (EWC'98), Potsdam, Germany, September 1998; Second International Conference on Early Warning (EWC-II), Bonn, Germany, October 2003 (see www.unisdr-earlywarning.org)

The survey makes five main recommendations, as follows:

1. Develop a globally comprehensive early warning system, rooted in existing early warning systems and capacities
   A global early warning system will require long-term sustained action by diverse players, strong political commitment to engender public action and to make early warning a core task of national policy and disaster risk reduction strategy, strong international support and coordination, with clear roles and responsibilities, and wide participation of NGO, private sector and regional organisations.

2. Build national people-centred early warning systems
   Country-based early warning systems are needed for the protection of citizens and also provide the building blocks of the global early warning system. The recommendation includes calls for a national multi-party roundtable on early warning, a national plan based on a survey of capabilities, a warning dissemination strategy, community-based approaches, and public education and exercises.

3. Fill the main gaps in global early warning capacities
   The recommendation highlights gaps and opportunities that deserve immediate concerted action, including for tropical cyclones, floods and tsunamis for the most ill-protected populations, agreements and networking for drought, food security and wildland fire, a global survey and mobile monitoring facility for volcanoes, and a major early warning project in each least-developed country.

4. Strengthen the scientific and data foundations for early warning
   The scientific and technical recommendation seeks action on a long-term global data plan, upgraded telecommunications, an agreement on basin-wide data exchange for floods, a pan-African project to fill major data gaps, improved hazard and vulnerability mapping, an early warning science and technology agenda, and an internet portal for natural hazards, risks and warnings.

5. Develop the institutional foundations for a global early warning system
   This recommendation addresses the needs for underpinning mechanisms of international and regional governance, coordination, and support, starting with a call for the UN system to affirm the goal of a global early warning system, and including requests for various UN and international agencies in technical, humanitarian and development fields to undertake specific governance and support roles.

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Background to the Survey and to Early Warning Systems

1

1.1 Survey Background

In his 2005 report on the implementation of the Millennium Declaration, *In Larger Freedom: towards development, security and human rights for all*, United Nations Secretary-General Mr. Kofi Annan recommended "the establishment of a worldwide early warning system for all natural hazards, building on existing national and regional capacity" to complement broader disaster preparedness and mitigation activities (A/59/2005, paragraph 66). To assist in the system's establishment, Mr. Annan requested the International Strategy for Disaster Reduction (ISDR) secretariat to coordinate a survey of existing capacities and gaps in early warning systems, in cooperation with all United Nations system entities concerned.

The survey and the preparation of the report were undertaken by the ISDR secretariat in collaboration with the Working Group on the Global Survey of Early Warning Systems, which was established during the 11th Session of the Inter-Agency Task Force on Disaster Reduction (IATF/DR) in May 2005, to provide guidance for the effective implementation of the survey and particularly to incorporate information, knowledge and contributions from IATF/DR member agencies. The Working Group was co-chaired by the World Meteorological Organization (WMO) and the Office for the Coordination of Humanitarian Affairs (OCHA).

Information for the survey was gathered from existing sources, as recommended by the IATF/DR Working Group. Such sources include reports submitted by countries to the ISDR secretariat for the World Conference on Disaster Reduction and regional reports prepared for the Second International Conference on Early Warning. Information gathered specifically for the survey included updated information from 23 countries and 20 international agencies involved in early warning systems. Other inputs include ISDR published materials, early warning system reports and surveys undertaken by other agencies such as the Commonwealth Secretariat and the South Pacific Applied Geoscience Commission (SOPAC). Annex I provides a full description of sources and methods for the survey.

The survey report is concerned with early warning systems for natural hazards[4]. These include hydrometeorological hazards, such as floods, mudflows, tropical cyclones, storms, extreme temperatures and droughts; geological hazards, such as earthquakes, tsunamis, volcanic activity and emissions, and mass movements including landslides; as well as biological hazards, such as epidemics, plant and animal contagion and infestations. Environmental degradation processes that contribute to an increase in vulnerability and frequency and intensity of natural hazards, such as desertification and wildland fires, are considered, and also near-Earth space objects. ISDR defines early warning as "the provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response".

1.2 People-Centred Early Warning Systems

The objective of people-centred early warning systems is to empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner so as to reduce the possibility of personal injury, loss of life, damage to property and the environment, and loss of livelihoods.

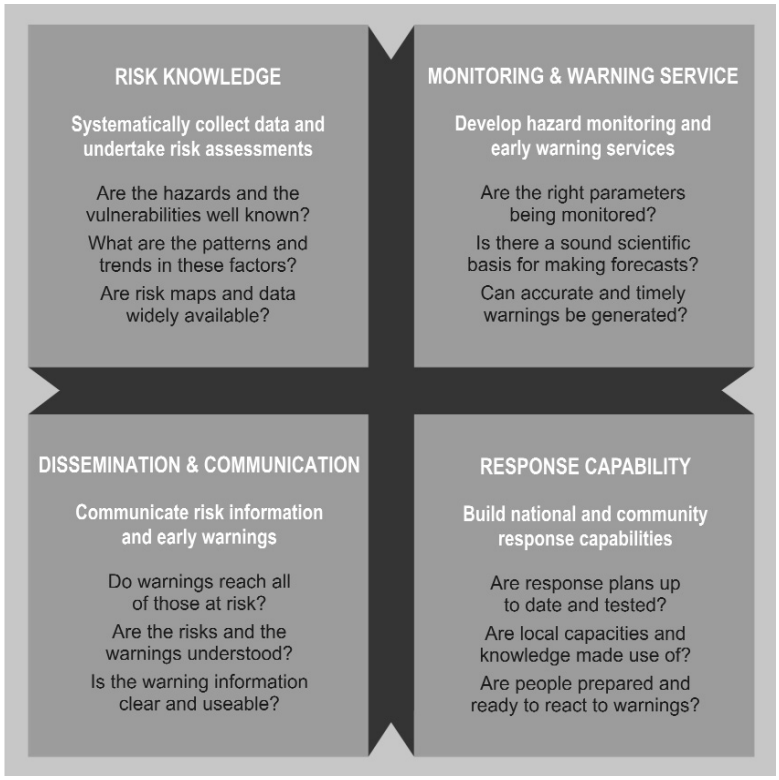
A complete and effective early warning system comprises four inter-related elements: risk knowledge, monitoring and warning service, dissemination and communication, and response capability (see Figure 1). A weakness or failure in any one part could result in failure of the whole system.

Risk Knowledge
Risks arise from the combination of the hazards and the vulnerabilities to hazards that are present. Assessments of risk require systematic collection and analysis of data and should take into account the dynamics and variability of hazards and vulnerabilities that arise from processes such as urbanization, rural land-use change, environmental degradation and climate change. Risk assessments and maps help to motivate people, prioritise early warning system needs and guide preparations for response and disaster prevention activities.

Monitoring and Warning Service
Warning services lie at the core of the system. They must have a sound scientific basis for predicting and forecasting and must reliably operate twenty-four hours a day. Continuous monitoring of hazard parameters and precursors is necessary to generate accurate warnings in a timely fashion. Warning services for the different hazards should be coordinated where possible to gain the benefit of shared institutional, procedural and communication networks.

Dissemination and Communication
Warnings must get to those at risk. For people to understand warnings, they must contain clear, useful information that enables proper responses. Regional, national and community-level communication channels and tools must be pre-identified and one authoritative voice established. The use of multiple communication channels is necessary to ensure everyone is reached and to avoid the failure of any one channel, as well as to reinforce the warning message.

Figure 1:
The four elements of people-centred early warning systems



Source: ISDR Platform for the Promotion of Early Warning.

[4] See http://www.unisdr.org/eng/library/lib-terminology-eng.htm for definition of key terms. ISDR defines a ***hazard*** as "a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation, and ***vulnerability*** as "the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards." Together, hazards and vulnerability give rise to ***risk***: "The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions."

Response Capability
Communities must also respect the warning service and know how to react to warnings. This requires systematic education and preparedness programmes led by disaster management authorities. It is essential that disaster management plans are in place and are well practiced and tested. The community should be well informed on options for safe behaviour and on means to avoid damage and loss of property.

Strong inter-linkages are required between all of the elements, underpinned by effective governance and institutional arrangements, including good communication practices. This requires the involvement of a broad range of actors, some not traditionally identified as dealing with the subject. It also requires linking the subject, perceived as predominantly technical, to sustainable development and community development agendas, and to disaster risk reduction agendas.

An important context to this discussion is the recent international agreement to take concrete action to reduce disasters, namely the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, which was concluded by negotiation among states and organizations at the World Conference on Disaster Reduction (WCDR) in Kobe, Hyogo, Japan, 18-22 January 2005[5]. Its implementation is now the core goal in disaster reduction for the United Nations and the ISDR system. Risk assessment and early warning form one of the Framework's five areas for priority action, with a focus on developing early warning systems that are centred on the needs of people.

Roles and responsibilities
Developing and implementing an effective early warning system requires the contribution and coordination of a wide range of individuals and institutions. Each has a particular function for which it should be responsible and accountable.

Communities, particularly those most vulnerable, are central to people-centred early warning systems. Their input to system design and their ability to respond ultimately determines the extent of risk associated with natural hazards. They should be aware of the hazards and the related effects to which they are exposed and be able to take specific actions to minimize the threat of loss or damage.

Local governments usually have direct responsibilities for citizen safety and considerable knowledge of the hazards to which their communities are exposed. They must be actively involved in the design and maintenance of early warning systems, and understand advisory information received to be able to advise, instruct or engage the local population in a manner that increases their safety and reduces the possible loss of resources on which the community depends.

National governments are responsible for policies and frameworks that facilitate early warning, and usually also for the technical systems for preparing and issuing timely warnings. They have responsibility to ensure that warnings and related responses address all of the population, particularly the most vulnerable. They also provide support to local governments and communities to develop their operational capabilities and to translate early warning knowledge into local risk reduction practices.

Regional institutions and organizations provide specialized knowledge and advice in support of national efforts to develop or sustain operational capabilities of countries that share a common geographical environment. Regional organizations are crucial to linking international capabilities to the particular needs of individual countries and in facilitating effective early warning practices among adjacent countries.

International bodies provide support for national early warning activities and foster the exchange of data and knowledge between individual countries[6]. Support may include the provision of advisory information, technical assistance, and policy and organizational support necessary to ensure the development and operational capabilities of national authorities or agencies responsible for early warning practice.

Non-governmental organisations (NGOs) play a critical role in raising awareness among individuals and organizations involved in early warning and in the implementation of early warning systems, particularly at the community level. In addition, they play an important advocacy role to help ensure that early warning stays on the agenda of government policy makers.

The private sector has a diverse role to play in early warning, including developing early warning capabilities in their own organizations. The media plays an important role in improving the disaster consciousness of the general

5 The Hyogo Framework and the full report of the WCDR are available in several languages at http://www.unisdr.org/eng/hfa/hfa.htm

6 Annex II provides a partial listing of organisations active at the international level.

population and disseminating early warnings. In addition, the private sector has a large untapped potential to help provide skilled services in the form of technical manpower, know-how or donations (in-kind and cash) of goods or services, especially for the communication, dissemination and response elements of early warning.

The science community has a central and critical role in providing specialized scientific and technical input to assist governments and communities in developing early warning systems. Their expertise is fundamental to analysing natural hazard risks facing communities, supporting the design of scientific and systematic monitoring and warning services, supporting data exchange, translating scientific or technical information to comprehensible messages, and to the dissemination of understandable warnings to those at risk.

Natural hazard monitoring and forecasting are carried out by specialized scientific agencies At national level, government agencies, research organizations and universities are usually the main parties involved. At the international level, specialized agencies of the United Nations work extensively with relevant national agencies to coordinate the development of technical capacities for monitoring, detecting, and warnings for a wide range of hazards and their impacts.

The responsibility for organising appropriate responses to warnings usually lies with national disaster management organisations. In developing countries, significant roles are played by emergency response agencies, emergency committees and organizations, NGOs and UN agencies. Integral parts of this task are the preparation of hazard and vulnerability maps and disaster preparedness strategies. Often there are specific political responsibilities for ensuring that warnings are issued and acted upon and that evacuation plans are effective.

Links to disaster risk reduction and development

Early warning systems are recognised in the Hyogo Framework as an important element of disaster risk reduction and hence to the achievement of sustainable development and sustainable livelihoods. Disaster occurrences and impacts (economic losses and number of people affected) are increasing, mainly owing to an increase in the size and vulnerability of exposed populations, but also possibly to increases in the frequency and severity of certain hydrometeorological hazards as a result of climate change. Globally, natural disasters affected an average of 200 million people and claimed 62,000 lives annually during the 1990s.

The economic cost of natural disasters rose 14 fold since the 1950s, reaching USD1 trillion in the last 15 years with such losses doubling every 10 years[7]. Economic losses from disasters can greatly set back hard-won development gains, particularly among the poorest countries.

Regionally, the Asia-Pacific region is the most afflicted by disasters, particularly by flood-related disasters that caused estimated USD 110 billion damages over the last decade[8]. Other major hazards in include cyclones, earthquakes, landslides, tsunamis, droughts, mudflows and tornadoes. But perhaps the situation is graver in Africa: it is the only continent whose share of reported disasters in the world increased over the last decade, as an already low level of development progress is further hampered by major disasters of epidemic, flood, land degradation and drought. Among small island states, natural disasters, especially from hydrometeorological and geological sources, threaten the very existence of nations. Floods, windstorms, heat waves and landslides dominate in Europe, while the major natural disasters in the Americas and Caribbean regions include tropical cyclones and storm surges, floods, windstorms, wildfires, earthquakes, volcanic activity and landslides.

Early warning systems need to be accompanied by efforts to reduce the fundamental sources of vulnerability. In the UNDP report *Reducing Disaster Risk: A Challenge for Development*, developing countries tend to have higher vulnerabilities, which are aggravated by poverty, environmental degradation, population growth and displacement, urban growth, conflicts and weak institutional capacities. Such social vulnerabilities as well as emerging climate variability and change are also threats to developed countries. The recent cases of Hurricane Katrina in the US in 2005 and Hanshin-Awaji Earthquake in Japan in 1994 showed that developed countries are not free from the risk of large disasters.

Early warning helps to reduce economic losses by allowing people to better protect their assets and livelihoods. For example, they can safeguard homes, sell livestock or select appropriate crops for a drought, thus limiting not only the immediate impact of a disaster but also the knock-on effects on assets that can reduce economic well being and increase poverty. Early warning information allows people to make decisions that contribute to their own economic self-sufficiency and their countries' sustainable development. If well integrated into a systematic framework of risk reduction, early warning systems can provide many development benefits.

7 Source: Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT), http://www.em-dat.net/.

8 Source: See CRED EM-DAT, http://www.em-dat.net/

The establishment of early warning systems and associated preparedness and response systems have been an important contributor to the progressive reduction in the number of deaths from disasters over the last several decades[9]. This is true for drought and famine-affected regions, as well as for developed countries where early warning systems, and preparedness, mitigation and risk-transfer measures are generally well developed.

Early warning systems also promote the development and the application of scientific knowledge, including improved science and technology information dissemination. They contribute to the creation of data archives and information bases that are essential to longer-term economic development planning and decision-making, such as in urban design, transport infrastructure and agriculture and water management, and to research on hazards and warning systems. Early warning systems may enhance community capacities through participation processes, public-private partnerships, and recognition of indigenous knowledge and values.

Parallel to developments in early warning for natural disasters, early warning systems for human-made complex political emergencies have gained ground in the past years. The two types of disasters are interlinked. The existence of a political crisis or armed conflict in a country will often indirectly amplify the impact of a natural disaster by exhausting coping mechanisms and response capacities. The occurrence of natural disasters amid complex political emergencies is a widespread phenomenon: over 140 natural disasters have occurred in complex political emergencies in the past five years[10]. Early warning analysis, preparedness and response measures for natural disasters must take into account the socio-political environment and the response capacity of local populations and institutions.

1.3 Early Warning - An Evolving Agenda

One of the most fundamental and widely accepted roles of governments through the ages has been the protection of their people from external threats including those deriving from natural hazards. Over the past century, many countries have developed and integrated early warning capabilities, in particular for meteorological and hydrological events, as an important tool for averting disasters. The need for international coordination of these efforts is well recognised and is generally provided through specialised United Nations entities responsible for geophysical hazards, food security, environmental protection and humanitarian response.

Effective early warning systems for natural hazards are now increasingly perceived as an integral component of disaster risk reduction programmes—involving a broad spectrum of actors. The International Decade for Natural Disaster Reduction (IDNDR, 1990-1999) promoted this concept and worked to raise the profile of early warning accordingly, resulting in the acknowledgement of its crucial importance in the Yokohama Strategy for a Safer World, endorsed at the World Conference on Natural Disaster Reduction in 1994. The International Strategy for Disaster Reduction, the successor to the IDNDR, has introduced a stronger focus on vulnerabilities and has emphasized the need to integrate disaster risk reduction into sustainable development.

The World Conference on Disaster Reduction[11] adopted the *Hyogo Framework for Action 2005-2015: building the resilience of nations and communities to disasters* in which risk assessment and early warning is one of the five themes of disaster reduction. Specific recommendations include the call for countries to develop people-centred early warning systems.

Other relevant development frameworks such as the Agenda 21, the multilateral environmental agreements, the Barbados Plan of Action for Small Island Developing States and the Johannesburg Plan of Implementation have called for actions to expand, deepen and strengthen local, national and international initiatives to develop early warning in particular, and disaster reduction in general, as critical tools for promoting sustainable development and poverty reduction.

Two international conferences on early warning, in 1998 and 2003[12] produced a set of internationally agreed guiding principles for effective early warning systems as well as the outline of an international programme on early warning to reduce disasters[13]. The 1998 Potsdam Conference on Early Warning Systems and the 2003 Second International Conference on Early Warning

9 CRED, "Thirty Years of Natural Disasters 1974-2003: The Numbers", Presses Universitaires de Louvain, 2004. According to CRED, in the second half of the 1970s, the absence of catastrophic famines reduced by half the number of deaths.

10 "Natural Disasters in Complex Political Emergencies", a report on a DfID-funded seminar hosted by the British Red Cross.

11 See Footnote 3.

12 International Conference on Early Warning Systems for the Reduction of Natural Disaster (EWC'98), Potsdam, Germany, September 1998. Second International Conference on Early Warning (EWC-II) - 'integrating natural disaster early warning into public policy', Bonn, Germany, October 2003. The 3rd International Conference on Early Warning (EWC-III) is to be held in Bonn, Germany. 27-29 March 2006. See www.unisdr-earlywarning.org and www.ewc3.org.

addressed technical considerations, strategic issues and institutional requirements and made specific recommendations for strengthening early warning systems, including the incorporation of early warning into policy and development frameworks, a greater emphasis on the social factors in early warning systems, and mechanisms sustaining dialogue and collaborative action among key stakeholders.

13 The International Early Warning Programme entitled "Effective Early Warning to Reduce Disasters: The Need for More Coherent International Action" was launched at the World Conference on Disaster Reduction.

Effectiveness of Early Warning Components: Capacities and Gaps

2

Section 2 describes the existing capacities and gaps revealed by the survey, summarised for each of the four elements of early warning systems. The details of each hazard are captured in specific subsections in the section on monitoring and warning services.

2.1 Risk Knowledge

2.1.1 Practice and Capacities in Risk Knowledge

The development of effective warnings depends on the generation of accurate risk scenarios showing the potential impacts of hazards on vulnerable groups. Warning authorities need to consider acceptable levels of risk to communities as a factor in determining whether and when to warn. Making this determination requires capabilities to analyse not only the hazards, but also the vulnerabilities to the hazards, and the consequential risks.

Risk assessment is a recent practice in disaster risk reduction in many countries but assessment techniques are well developed for some hazards, such as floods, earthquakes and volcanic hazards and can be applied by using standard computers and readily available software. In addition, the application of geographic information systems has expanded the possibilities for risk assessment of single and multiple hazards. The characteristics of risk are usually presented through risk mapping, frequency distributions, scenario plans and exercises, annualised risk mapping and qualitative measures. The use of risk maps is the most widespread.

Many countries, especially high-income countries, prepare risk maps for selective areas and hazards. Harmonized risk maps of national coverage are rare, but Germany provides an example of current efforts to develop harmonized hazard maps for all of its states.

Risk assessment should also consider the cumulative effects of multiple hazards and related vulnerability. At present, there are relatively few truly comprehensive assessments of all risk from potentially damaging natural hazards in a given location. A few countries, including Turkey and Montserrat, have developed multi-hazard maps or expect to have total national coverage of hazard maps as planned by Austria by 2008. In Switzerland, multi-hazard assessments are a requirement for all cantons. The general lack of multi-hazard assessments arises partly because the preparation of hazard maps is rarely a legal requirement.

National capacities for generating knowledge on hazards are determined by country capabilities in science, technology and research, and the availability and sustainability of observation networks. Such capacities are generally rather limited in developing countries. Countries need to have access to high-quality data on the magnitude, duration, location and timing of hazard events and to be able to extract information on hazard frequency and severity from observational data sets. This requires:

- On-going, systematic and consistent observations of hazard-relevant parameters;
- Quality assurance and proper archiving of the data into temporally and geographically referenced and consistently catalogued observational data sets;
- Capacities to locate and retrieve needed data and to freely disseminate data to public users;
- Sufficient dedicated resources to support these activities.

In most countries, institutional arrangements for risk assessment are ad hoc and tend to be developed only after a disaster occurs. Some countries have specialized institutions with the capacity and resources to undertake specific risk profiling. National meteorological and hydrological services usually can provide detailed information, including maps and frequency distributions, on weather-related hazards such as extreme temperature and rainfall, strong wind, and cyclone occurrence.

Risk mapping appears to be least advanced in Africa where only a few countries have prepared risk maps, mainly on drought and floods. The information base published by the Land Degradation Assessment in Drylands programme has produced and compiled a number of vulnerability maps covering risk and desertification in the developing world[14].

International capacities to support risk assessment are largely limited to the hazard component. Major global hazards have been identified and generally well documented through research publications, based on scientific observation programmes, and through hazard impact assessments. Scientific knowledge of hazards and the technological means of managing them have expanded greatly over the last three decades. The role of UN agencies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), WMO and United Nations Environment Programme (UNEP), and the international science NGOs, such as the International Association of Seismology and Physics of the Earth's Interior (IASPEI) and the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), can be noted in this respect. The International Federation of Red Cross and Red Crescent Societies (IFRC) promotes through its many National Societies the conduct of vulnerability and capacity assessments as a basic process to identify the strengths and weaknesses of households, communities, institutions and nations to a specific hazard or shock. A number of regional and national organisations concerned with hazards and vulnerability are also very active internationally.

To facilitate global disaster reduction efforts, it is important to identify countries at risk based on composite indices of disaster risk. Approaches to measuring country disaster risk include the World Bank-supported Natural Hazard Apparent Vulnerability Indicator (NHAVI) for benchmarking countries on a global vulnerability index scale, and the United Nations Development Programme (UNDP) Disaster Risk Index, which indexes countries for each hazard according to their degree of exposure, relative vulnerability, and risk.

International capacities to collect, document and analyse disaster data and trends include the Global Emergency Events Database (EM-DAT) supported by the Centre for Research on the Epidemiology of Disaster (CRED) and the World Health Organization (WHO), the NatCat service of Munich Reinsurance, ReliefWeb operated by OCHA, and the multi-partner Global Disaster Information Network (GDIN). Several organisations have adopted the Global Disaster Identifier Number (GLIDE), which identifies each disaster with a unique number. Hazard-specific networks include the Global Seismographic Network that facilitates global detection of significant earthquakes and the PREVIEW Global Earthquakes Dataset developed by UNEP.

2.1.2 Major Gaps in Risk Knowledge

Inadequate emphasis on social, economic and environmental vulnerability

Risk assessment has been predominantly concerned with hazards, for which there are relatively good data resources and considerable progress, and has been inadequate for the social, economic and environmental factors that increase vulnerability. Social science data can be difficult to obtain and the data that is available remains underutilized for various reasons. More work is needed to make qualitative data and narratives of vulnerability accessible and useable to engineers, planners and policy makers.

Partly as a consequence, populations are often unaware of their vulnerability to specific hazards, and of the how their

14 Please see www.fao.org/ag/agl/agll/drylands/mapsglobal.htm

vulnerability is changing and influenced by policy and practices such as environmental degradation or urbanisation. However, some early warning systems are starting to integrate vulnerability analysis and monitoring, a good example being the famine and food security early warning systems that have introduced an emphasis on vulnerability analysis and livelihood sustainability. Some systems are also integrating information on drought, flood, desertification, famine and food security to provide a more informed basis for decision making. NGOs have taken the lead in this regard.

Need for inclusiveness and public participation in vulnerability assessment

In addition to gathering statistics and mapping populations' risk factors, risk assessments should involve the community to ascertain their perceived risks and concerns, as well as existing coping strategies. People-centred assessment ensures that actions taken by authorities, aid organizations and communities will be more relevant to people's needs and available resources. Moreover, participatory risk assessment allows for the formal integration of valuable traditional knowledge into risk assessments and early warning systems.

Data gaps

Although significant progress has been made in some countries and long historical records do exist in many cases, particularly for hazards, in others data is scarce and there are significant variations in data quality. Inconsistencies in the historical records across national boundaries and over time are common. Data may be inaccessible in non-digital paper form.

At the national level, the main challenges include:
- Establishing and maintaining observing systems and data management systems;
- Maintaining archives, including quality control and digitisation of historical data;
- Obtaining systematic social and environmental data for vulnerability analysis;
- Securing institutional mandates for collection and analysis of vulnerability data.

Difficulty in accessing information

It is human nature to dislike being considered vulnerable and monitored, which makes it difficult to collect accurate data, particularly for variables such as health. Moreover, in some countries, as a result of tightened security, information is increasingly restricted. A particular issue is the unwillingness of some countries to share hazard information with neighbouring countries that are exposed to these hazards, for example rainfall and flood data for major river basins. International and regional policies and agreements are needed to deal with this problem.

Some countries appear to be recognizing the importance of investing in hazard networks and data systems as a national resource, as an investment toward enhanced risk management and socioeconomic development in disaster-prone countries. Unfortunately, data use is often seriously restricted by national or institutional policies that seek to generate revenue from the sale of publicly-funded data resources. In the meteorological community, the basis for the exchange of data is set out in Resolution 40 (WMO Congress-XII, May-June 1995, "WMO Policy and Practice for the Exchange of Meteorological and Related Data and Products including Guidelines on Relationships in Commercial Meteorological Activities").

Lack of early warning indicators

Risk assessment practitioners require indicators that are internationally agreed and locally referenced to measure success and failure of early warning systems and thus improve the basis for collecting and analysing risk data.

Danger of societal memory loss about hazards

In parts of the world threatened with the loss of a whole generation through HIV/AIDS, there is real danger in losing societal memory of past hazards, particularly for infrequent hazards, such as tsunamis. In addition to losing knowledge of hazards, young communities face losing knowledge about how to reduce vulnerability and how to respond to warnings. Disaster museums, such as the earthquake museum in Kobe, Japan, and annual warning-preparedness rehearsals can help maintain awareness.

2.2 Monitoring and Warning Services

2.2.1 Practice and Capacities in Monitoring and Warning Services

There have been marked improvements in the quality, timeliness and lead time of hazard warnings, largely driven by scientific and technological advances, particularly in computer systems and communications technology. There have been continuous improvements in the accuracy and reliability of monitoring instrumentation, and in integrated observation networks particularly through the use of remote sensing techniques. In turn these have supported research on hazard phenomena, modelling and forecasting methods and warning systems.

However, capacities in the monitoring and prediction of hazards vary considerably from one hazard to another, from one country to another, and even within countries depending on prevailing socioeconomic and political conditions. An overview of current capacities for the main hazards follows:

Hydrometeorological Hazards

Disasters of hydrometeorological origin cover a wide range of atmospheric, hydrological and oceanographic phenomena and comprise the majority of disasters. Certain types of extreme events, notably droughts and high rainfall, are projected by the Intergovernmental Panel on Climate Change to increase over time due to the impact of climate change. Reflecting this wide range, early warning systems exist for various hydrometeorological hazards but their status and stage of development vary across hazards and regions.

Capacities to monitor and predict hydrometeorological hazards are relatively more developed than for other types of hazards. National Meteorological and Hydrological Services (NMHSs) are responsible for continuously observing, monitoring, detecting, forecasting and developing hazard warnings for a wide range of weather-, climate- and water-related hazards. International coordination is very well developed through the WMO and its 187 national Members, its 10 Scientific and Technical Programmes, three World Meteorological Centres and 40 Regional Specialized Meteorological Centers (all operated or supported by NMHSs).

The WMO global operational network supports observing, monitoring, detecting and forecasting hazards and the issuing of early warnings for weather-, climate- and water-related hazards, such as extreme temperature, severe storms, tropical cyclones, floods and droughts. The integrated Global Observing System (GOS) enables the systematic observation and collection of weather, climate and water information from around the globe, while the Global Telecommunications System (GTS) provides a network of continuously operating telecommunication facilities and centres connecting countries through their NMHSs. The GTS also supports the global exchange of information for non-hydrometeorological hazards, including tsunami-related ocean data, information and warnings, seismic data and messages related to volcanic ash cloud. Finally, through this network, WMO has developed a Global Data Processing and Forecasting System (GDPFS) providing technical support, analysis, forecasts, alerts and bulletins to the NMHSs of all countries, particularly those with the least resources. Further strengthening of the system, particularly for certain hazards (climate and weather related) and capacities (e.g., upgrading of the GTS where needed) could significantly enhance national early warning capabilities.

Major challenges include: 1) availability of these technical capabilities in a sustainable fashion in all countries, particularly those with the least resources; 2) integration of the existing technical capacities into the disaster risk reduction decision process in a more effective and proactive fashion; and 3) need for improvement of technical warning capabilities for many hazards such as droughts and floods.

Floods:

Some countries monitor flash floods through their NMHSs, while others monitor flash floods and river floods through environmental agencies and hydrology services separately. It is not possible to forecast flash floods but they can be detected as they occur by weather radars if these are present. Most flash floods occur in countries or districts without radar coverage. They are a major killer during tropical cyclone events.

Dedicated systems to monitor and forecast river basin floods are well established in developed countries, where they are operated by a variety of technical organisations. However, such systems are much less widespread in developing countries particularly in Africa, Asia and the Caribbean. In many tropical areas, such as in the Indian Ocean Commission (COI) region, flood monitoring and warning systems are closely linked to tropical cyclone warning systems.

Operational global flood forecasts from specialized warning systems provide three-day warnings but several initiatives are underway to extend the warning range. Most flood warning systems are stand-alone national operations, but warning systems have been developed covering several international rivers, such as those for the Rhine, Danube, Elbe and Mosel in Europe, the Mekong, Indus, and Ganges-Brahmaputra-Meghna basins in Asia, and the Zambezi in Southern Africa. Globally, the Dartmouth Flood Observatory in the United States detects, maps, measures and analyses extreme flood events worldwide. The National Oceanographic & Atmospheric Administration (NOAA) in the United States can provide river-flooding guidance six months in advance based on seasonal forecasts and knowledge of major river catchments.

UNESCO and WMO currently coordinate an operational flood warning system with NMHSs for river flooding. The International Flood Initiative/Programme (IFI/P), launched during the World Conference on Disaster Reduction in January 2005, is a joint programme of UNESCO and WMO to be operated by the International

Centre on Water Hazard and Risk Management (ICHARM), which is hosted by the Public Works Research Institute (PWRI) in Japan. The International Flood Network, through the Global Flood Alert System, provides information on precipitation based on satellite data to global subscribers for free. Such initiatives enhance the services provided by national authorities.

Tropical Cyclones:
Tropical cyclones, also popularly known as hurricanes or typhoons, are globally monitored and forecasted on a daily basis through the WMO Global Tropical Cyclone Warning System. This is a global network for observations, data exchange, and regional forecasting and analysis capabilities, operated by NMHSs, and includes six Regional Specialized Meteorological Centers (RSMCs) that provide around-the-clock forecasts, alerts and bulletins on the severity, project path and estimated land fall to the National Meteorological Services of countries at risk, which then issue the warning for their countries with lead times of at least 24 hours and up to several days. These lead times are sufficient to achieve effective mass evacuations and thereby avoid widespread loss of life. Five Tropical Cyclone Regional Committees (comprising experts in tropical cyclone modelling and forecasting) provide regional coordination including training support.

Severe Storms:
Severe storms comprise several phenomenon types including tornadoes, hailstorms, lightning, flash flood and sand and dust storms. Tornado warning lead time is inherently very short and warning systems are only operational in a few countries at risk, such as the USA, where warning lead time is up to 15-20 minutes. Tornado warnings are most effective in enabling people to seek shelter when they are preceded by alerts, called "tornado watches", which announce to communities at risk the possibility of a tornado outbreak many hours in advance. The number of tornado deaths significantly dropped in the USA during the last century mainly as a result of the Doppler radar network. Similarly, operational systems for hailstorm monitoring are limited at the country level with warning lead time of a few hours. The forecasting of severe storms is challenging as the hazards affect discrete locales. Warnings for sand and dust storms, with a lead time of up to 3 days, are issued through the NMHSs but operational warning systems for many of these hazards are lacking in most countries and regions.

Drought:
Early warning systems for drought are more complex than those for other hydrometeororological hazards and are, consequently, relatively less developed globally. They are heavily reliant on monitoring of observed patterns of monthly and seasonal rainfall, streamflow, ground water levels, snowpack and other parameters, and the use of historical statistical data. Global Circulation Models (GCMs) and associated statistical ensemble methods are being routinely used to provide predictions of upcoming climate anomalies and offer promise for increasingly useful forecasts of the onset, severity and duration of drought for large geographic regions on monthly and seasonal timescales. Requirements for early warning range from a few weeks to several months.

Nonetheless, many countries have developed drought early warning systems capable of integrating information from various sources and providing warnings of the imminent onset of drought. In Africa, regional centres such as the IGAD Climate Prediction and Applications Centre (ICPAC) and the Drought Monitoring Centre (DMC) in Harare, supported by WMO and regional economic commissions, and the Sahara and Sahelian Observatory provide current data, develop climate outlooks, and issue warnings to NMHSs. They organise Regional Climate Outlook Forums comprising national, regional and international experts to review conditions and develop climate outlooks. User representatives from different sectors often participate in the forums. Such forums are also organised in other regions of the world.

When there is evidence of developing El Niño Southern Oscillation (ENSO) conditions, WMO coordinates the development of a global scientific consensus, involving a collaborative process to review best available evidence and predictions. The outcome is the *El Niño Update*, a unified global statement on the expected evolution of ENSO for months ahead, which is issued to NMHSs and to the world at large.

Traditional forecasting remains an important source of climate information in many rural communities. There is growing appreciation that traditional observations and outlook methods may have scientific validity and increased interest in harmonizing traditional and modern scientific methods of climate prediction. Studies have been initiated in some countries, such as Zimbabwe and Kenya, to gain further understanding of traditional forecasting.

Extreme Temperatures:
Extreme temperatures, including both heat waves and cold waves, are a threat to vulnerable populations in both developing and developed countries. In many temperate countries, cold conditions in winter are responsible for exacerbating cardiovascular, cerebrovascular, circulatory and respiratory diseases, which lead to increased mortality, particularly amongst the elderly, and those living in poor housing or without shelter. Cold conditions affect the

human population indirectly as well, when livestock, a vital part of the human food chain, perish because of the weather. In the dzud (bitter cold and snow) of 2000 in Mongolia, livestock froze by the thousands, creating great hardship and food shortages. The extent of this crisis was partially determined by such factors as over-concentration of stock and overgrazing of pastures in some areas.

The 2003 heat wave that affected Europe killed many elderly residents in urban areas, and according to CRED, the impact of extreme temperatures has been rising (during 1995-2004), especially in Europe, where temperature extremes accounted for over 50 percent of total deaths from disasters. The two heat wave events during the 1990s in Chicago, USA, affected mostly poor elderly people living in the inner city.

In some parts of the world, mainly in the USA and in Europe, many cities are served by a new Heat-Health Warning System (HHWS) that provides warnings of thermal and other conditions (night-time humidity, wind patterns, etc) that can lead to excess mortality. The service is organised as a collaboration between meteorological, health and social sector partners. Normally the health sector issues the warning, based on the model run by the meteorological agency. The programme includes outreach and education, and interventions by the health and social sectors to follow up with the most vulnerable groups to help achieve appropriate responses to the warnings. WMO is developing guidelines to help the meteorological and health communities develop such services.

Air Pollution, Haze and Smoke:
Air pollution, haze and smoke are common in both developing and developed countries. Photochemical smog is commonly produced in high economic-activity areas by a combination of automobile use and industry. During the Western European heat wave of 2003, 25 to 40 percent of fatalities were caused by pollution that was exacerbated by the heat. Warning lead time for the risk of air pollution depends on the pollutant and the prediction method and can be about 24 to 48 hours. Regional movements of large pollution plumes such as those associated with wildfires, land-use fires and/or dust storms can be up to 3 to 5 days. In Southeast Asia observations reveal that smoke-haze generated by land-use fires regularly cover the whole region for many weeks or months. Haze and smoke from volcanoes and wildland fires are major threats to aviation, limiting visibility and leading to engine failure (see additional information in the following section on volcanoes.) Satellite observation has been very useful in this respect.

Dust and Sandstorms:
Dust and sandstorms are a consequence of soil erosion by wind. Warning lead times can be up to 3 days and are based on satellite and ground observational data but these capabilities are not yet operational. A number of international efforts including climate modelling and prediction work in China, Japan, Australia and the USA have indicated the importance of up-to-date information on global climate patterns for monitoring of weather conditions conducive to sand-, dust storms and drought (often a precursor to dust events). There is a need for the development of dust and sandstorm warning systems in most countries facing this risk.

Snow Avalanches and Winter Weather Hazards:
Winter hazard warning services are well developed in mountainous countries, such as in Switzerland where the Inter-Cantonal Early Warning and Crisis Information System provides comprehensive warning and response capability development services that were inspired by lessons from the 1999 avalanches. Winter weather, such as blizzards and ice storms, is forecasted as part of operational weather forecasting and warning services. In large cities, blizzards and ice storms can be a major threat particularly if they also lead to failure of national power systems.

Famine:
A common outcome of drought, and sometimes of other weather hazards, is the risk of famine or extreme food insecurity. Early warning systems for food security in many developing countries make use of information from the major international food security monitoring systems. The FAO Global Information and Early Warning System on Food and Agriculture (GIEWS) is the most globally complete system but other systems, including the Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), the WFP Vulnerability Analysis and Mapping (VAM) system, and USAID-sponsored Famine Early Warning Systems Network (FEWS NET), are important. FEWS NET is mainly focused on Africa, where the majority of food security-warning systems operate, but it also covers parts of central Asia and of the Central America/Caribbean area.

Geological Hazards

Geological hazards pose a significant threat to many countries and communities. Great strides have been made through advances in satellite-based observing systems, computing and communications, and fundamental scientific discoveries in earth science and are helping to understand the physics of hazards and promote integrated observation and modelling of the Earth's oceans, landmass, atmosphere,

ice shield, glaciers and of the upper mantle of the Earth's interior. The National Aeronautics and Space Administration (NASA) is partnering with several agencies, including UNESCO, United States Geological Survey (USGS), Committee on Earth Observation Satellites (CEOS), and the space agencies of Japan, Canada and Europe to develop a robust geohazards mitigation programme through application of these developments that supports the goals of the Global Earth Observing System of Systems (GEOSS).

While capabilities exist at the global level to identify areas of occurrence of geological hazards, there is much less certainty in predicting when hazardous events are likely to occur. The signs of an impending volcanic eruption or a landslide can often be detected at an early stage and used for warnings, but the recognition of earthquake precursors is difficult and routine predictions have not been possible.

Earthquakes:
The world's earthquake-prone areas and plate boundaries have been identified and extensively studied. Regional earthquake monitoring systems have been installed in most earthquake-prone regions. Monitoring at the global level is undertaken by the World Wide Standardized Seismograph Network (WWSSN), which is supported by the USGS and now includes 120 stations, as well as by the GEOFON Network, among others.

Prediction capability for earthquakes remains elusive, however, and it must be reiterated that the location, magnitude and time of occurrence of earthquakes cannot be forecasted. In some areas, such as Mexico City and southern California, technical systems exist to identify the first seismic wave following the start of an earthquake that may have happened 100 kilometres away or more. With this information, critical systems such as gas supply lines can be shut down and fire station and ambulance doors opened, before the most severe shaking reaches the location. The warning depends on the distance from the epicentre and the depth of the earthquake, and the lead time may be just a few seconds. The Japan Meteorological Agency (JMA) is planning to establish a network to issue "Nowcast Earthquake Information," to provide this type of early warning to transportation systems. It is possible to act on an initial earthquake shock as a "warning" of possible further shocks and consequential hazard, such as fire or building collapse, for example by quickly shutting off a gas stove and moving to a safer place. A rough estimate of the probability of a tsunami can be made within 10-15 minutes when the hypocentre of the earthquake is located offshore.

Tsunamis:
A tsunami is a series of ocean surface waves that are generated by submarine earthquakes, submarine volcanic eruptions and landslides. Following an offshore earthquake, a rough estimate of the probability of a tsunami can be made within 15 minutes based on the estimation of the earthquake hypocentre using global and regional seismic observations. Once a tsunami is observed, through ocean observing systems, its size, movement and likely arrival time can be calculated accurately enough for warning purposes.

The deadly Indian Ocean tsunami of 26 December 2004 reminded the world of the destructive nature of tsunamis. Although the massive damages to infrastructure were largely unavoidable, thousands of lives might have been spared if a tsunami early warning system had been in place in the region. Currently, there is no global tsunami early warning system, although an ocean-wide warning system under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO has been operational in the Pacific region for more than 40 years. In June 2005 the IOC secretariat was mandated by its member states to coordinate the establishment of tsunami warning systems for the Indian Ocean, the northeast Atlantic and Mediterranean, as well as for the Caribbean Sea. Intergovernmental Coordination Groups (ICG's) for each of these regional systems were established in 2005.

The Pacific Tsunami Warning System (PTWS) is comprised of the Pacific Tsunami Warning Center (PTWC) in Hawaii, the Tsunami Warning Center of the Japan Meteorological Agency (JMA) and the Alaska Tsunami Warning Center, which have been providing ocean-wide timely alerts and warnings to IOC Pacific member states since 1965. Due to the close proximity of a large potential source region, JMA issues tsunami warnings within three minutes of the detection of a submarine earthquake near Japan, based on seismic information only. Experimental warning systems for Europe (in Portugal, France and Greece), national systems, such as the Yuzhno-Sakhalinsk Tsunami Warning Center of Russia and various local systems exist. The initial Indian Ocean Tsunami Warning System (IOTWS) is scheduled to be in place by June 2006 while a system for the northeast Atlantic and Mediterranean is scheduled to be set up by the end of 2007.

The PTWC, IOC's International Tsunami Information Centre in Hawaii, and JMA are currently providing interim tsunami advisory information to Indian Ocean countries. While technical monitoring capacity for tsunami in the region has been improved significantly during the last year, there is still a need to complete the system and to improve associated disaster management capacities, including both structural and non-structural countermeasures for tsunamis. Tsunami risk

assessment must be implemented regionally in tsunami endangered coastal areas, based on solid scientific research and analysis.

During its XXIIIrd session in June 2005 the IOC General Assembly adopted a resolution to establish a global framework for tsunami and other ocean-related hazards early warning system, based on the four regional intergovernmental coordination groups, existing ocean observing and data and information exchange systems, with participation of related UN agencies including WMO and ISDR. At the present time all regional intergovernmental coordination groups on tsunami early warning are in place and the formation of an ad-hoc working group on ocean-related multi-hazard warnings is scheduled for mid 2006.

Volcanoes:
About 50 to 60 terrestrial volcanoes erupt every year and about 3,000 volcanoes worldwide are capable of future eruptions. Prediction of the timing of volcanic eruptions has been accomplished, but the size, duration and climax of a volcanic eruption cannot be predicted. Examples of successful forecasts and effective evacuations include the eruptions of Mount Pinatubo in the Philippines in 1991, Vulcan and Tavurvur in Papua New Guinea in 1994, Montserrat in West Indies in 1995 and 1997, Mt. Usu and Mikaye Island in Japan in 2000, and Merapi in Indonesia in 2001. These successes from around the globe have been largely driven by extensive progress in monitoring changes in seismic activity.

Satellite-based systems for global monitoring of volcanoes has been established jointly by the International Civil Aviation Organization (ICAO) and WMO for the near real-time prediction of the risks and the movement of ash-clouds that can affect air safety, as in the case of the eruptions of the Aleutian Islands and southern Alaska.

The capacity for monitoring volcanoes is variable globally. Some areas are well served by strong national systems (such as USA and Japan) or cooperative regional arrangements (such as for the Pacific Northwest) but large areas of the developing world (such as Africa, central and south Asia) lack the resources to operate seismic monitoring systems.

Landslides:
The timing of landslides can be predicted provided slopes are being monitored, which is often not the case. The 1995 landslide along the Yellow River in China was predicted one day ahead of its occurrence, for example. Advances in monitoring technology, particularly in real-time transmission of information, have enhanced techniques for short-term prediction, but they are only available in a few of the areas subject to landslide risk in the world. Nonetheless, capacities for landslides early warning is expanding. In Central America, where countries are among the most exposed to landslide risks, lessons from hurricane Mitch have contributed to the development of early warning systems for Nicaragua and El Salvador. In China, the early warning system for the Yangtze River valley has so far successfully forecasted 217 landslides, avoiding significant economic losses. In Africa efforts are underway to establish community-based landslide warning systems in Kenya and Uganda.

The International Consortium on Landslides (ICL) was created in 2002 with support from UNESCO, WMO, FAO, UN/ISDR, and the Government of Japan, as well as Kyoto University. It aims at internationally coordinated actions toward landslide risk reduction through project implementation. The February 2006 landslide in Leyte, Philippines, which killed more than 1800 people, is a reminder of the need for further improvement of landslide early warning systems. Landslide early warning systems need to take into account observations of uphill environmental degradation due to deforestation, land-use systems and wildland fires.

Near-Earth Objects:
Natural rock objects (meteorites) in space are very rare but even small objects can have powerful effects on the Earth and its oceans and atmosphere, owing to their high speed and momentum relative to the Earth. Past impacts can be assessed from geological evidence, particularly crater characteristics. If the location and trajectory of a distance object is known, it is readily possible using physics laws to accurately calculate its path and therefore predict if and when it would hit the Earth. Currently a programme is underway using telescopes to map all large objects and to calculate their paths. To date none of the objects measured have been found to be on a path that is dangerous to Earth, although the trajectory of the object NEA Apophis (320 metres in diameter) is reported likely to be very close in 2035.

Biological Hazards

The definition of natural hazard used in the ISDR system includes biological hazards in addition to the more commonly understood meteorological, hydrological and geological hazards. In practice, the biological hazards that are disease-related are typically handled independently by the public health community, with rather limited interaction with the institutions and coordination mechanisms associated with the other natural hazards. To the degree that this arrangement works satisfactorily, it can be accepted without concern, but at the same time it should be noted

that some governments and institutions are taking a more integrated view of all hazards, irrespective of type, and are developing policies that simultaneously address all types of possible risks in a single common framework.

Epidemics:
Epidemics pose significant disaster risk worldwide and undermine global development and security. National surveillance systems for human and animal epidemics and pest infestations exist globally at various stages of development and effectiveness. Comprehensive epidemic early warning systems are undeveloped in several developing countries, although health information systems are in use in epidemiological monitoring and detection.

WHO coordinates international efforts to reduce the risk of transmission of infectious diseases and epidemics. WHO's integrated disease surveillance strategy, based on developing national capacities for participatory and people-targeted surveillance systems is being adapted in the Africa region and applied to monitoring and alert activities in the Eastern Mediterranean region, Europe and South-East Asia. Worldwide, WHO coordinates the Global Outbreak Alert and Response Network (GOARN), a technical collaboration of existing institutions and networks, to undertake rapid identification and confirmation of epidemics. This network is supported by databases, including the Global Public Health Intelligence Network that scans global sources for outbreak-related information. International cooperation also includes the European Centre for Disease Prevention and Control, which promotes cooperation among national disease control agencies and produces the weekly Eurosurveillance journal. The United States' Centers for Disease Control detect and investigate health problems, as well as provide information on epidemics and diseases around the world. In addition, the WMO works closely with WHO to develop monitoring capacities throughout NMHSs for monitoring and detecting meteorological and climatological conditions that favour the development of infectious diseases and epidemics, particularly vector-borne diseases such as malaria.

The need for malaria early warning systems is most pressing in Africa, South East Asia and South America. In Africa, a framework for designing malaria early warning systems has been developed and disseminated as part of the global roll back malaria campaign. Other initiatives include the joint WHO-UNICEF HealthMap initiative, which is being assessed for use in malaria surveillance, and the continent-wide Mapping Malaria Risk in Africa (MARA) project for malaria early warning using GIS, which is underway.

Globalization has widened the scope for early warning on the spread of diseases with disastrous potential, such as HIV/AIDS and SARS. Countries are now on the alert for potential outbreaks of a lethal strain of bird flu, highly pathogenic avian influenza (HPAI), particularly of the H5N1 subtype. Currently, the exact timing, infectious potential and extent of a pandemic is not predictable. A worldwide co-ordinated early warning and alert system is under development for avian influenza. Monitoring programmes aimed at determining the prevalence of avian viruses in domesticated and wild flocks are being undertaken in several countries, and several countries have national avian influenza centres. Currently, it takes several days to characterize avian viruses at the subtype level. Several initiatives to develop more comprehensive and structured early warning systems are underway, including the Task Force on Avian Influenza and Wild Birds and proposals for cooperation between WHO, Food and Agriculture Organization (FAO), World Bank and the World Organization for Animal Health (OIE).

FAO provides early warning of migratory pests and other agricultural pests and diseases through the Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases.

Locust Swarms:
Locust swarms affect Africa, South West Asia, and regions of Australia. Warnings are based on biological models, locust field observations, and meteorological data. Warning lead times range from less than one month for an initial outbreak to 3 to 6 months for a plague. General warning bulletins and advisories are produced mainly through National Locust Control Centres. At the international level, the Desert Locust Information Service of FAO prepares medium and long-term forecasts for all countries and regions. WMO works with NMHSs to enhance their monitoring capacities in support of locust early warning systems.

Environmental Degradation

Desertification:
Desertification develops slowly from mismanagement of land and through the interaction of the natural ecosystem and the human social system. Its assessment and prediction depend on the availability of physical, biological, social and economic information from different sources. Desertification is difficult to predict because of the complexity of the interaction of the multiple driving forces and its long-term nature. There still are knowledge gaps and pending questions on translating broadly accepted principles of early warning into action-oriented modalities

for the United Nations Convention to Combat Desertification (UNCCD) National and Regional Action Programs. As of June 2005, a total of 81 countries affected by desertification, of which 21 are in Africa, had drawn up National Action Programmes. WMO and UNCCD collaborate on these issues.

Wildland Fire:
Wildland fire early warning involves use of fire danger rating to identify in advance critical time periods of extreme fire danger. Fire danger rating (FDR) has long been used as a tool to provide early warning of the potential for serious wildfires and can provide a 4-to-6-hour warning using basic daily weather data. These lead times can be extended to 14 days through the use of forecasted weather data and up to 30 days when calibrated with local data, as developed for South East Asia to indicate the potential for disaster-level haze events from peatland fires. FDR tools for early warning are highly adaptable and have been applied by a wide range of users. Consequently, there are numerous examples of current operational systems, particularly in most industrial countries. However, no internationally accepted fire warning system exists but global and regional collaborative efforts are underway, such as the joint efforts of the World Weather Research Programme (WWRP), the Canadian Forest Service, and Global Observation of Forest and land Dynamics (GOFC-GOLD), as coordinated by the Global Fire Monitoring Center (GFMC), to develop, adapt, standardize and apply fire early warning systems worldwide.

2.2.2 Major Gaps in Monitoring and Warning Service

While very significant progress has been made in many countries on the technical aspects of monitoring and forecasting natural hazards, many major overall gaps exist, particularly in the developing and least developed countries. Key issues include:

- Inadequate coverage and sustainability of observing systems for monitoring of hydro-meteorological hazards,
- Inadequate level of technical capabilities (resources, expertise and operational warning services) in the operational technical agencies responsible for monitoring and forecasting of severe events, such as the NMHSs,
- Lack of systems for many hazards such as dust and sand storms, severe storms, flash floods and storm surges, particularly for at-risk developing and least-developed countries,
- Lack of internationally negotiated data-exchange policies and procedures to share essential data in a timely fashion among countries for the development of modelling and for operational forecasting and warning systems, such as for tsunami and earthquake,
- Inadequate access to information (forecasts and interpreted data) from countries outside of the region affected,
- Insufficient multi-disciplinary, multi-agency coordination and collaboration for improving forecasting tools such as for storm surge and flood forecasting, and for integrating warnings into the disaster risk reduction decision processes in a more effective and proactive fashion,
- Inadequate communication systems to provide timely, accurate and meaningful forecasting and early warning information down to the level of communities.

Overall, systems exist to provide hazard forecasts and warning against impending disasters induced by hydrometeorological hazards, but the scope of hazard coverage at the country level is highly variable and reflects countries' economic development level. The global geographical distribution of hazard forecasting systems is uneven: developed countries and disaster-exposed areas of the developing world operate more hazard forecasting and observing systems than African countries and other developing countries with historically less disaster exposure. For many developing and least developed countries the sustainability of warning systems is a major challenge.

Effective monitoring and forecasting systems are available for most hazards, including for complex hazards like drought, El Nino, food security and desertification. Significant improvements have occurred in tropical cyclone and windstorm warning systems and sub-regional flood warning systems. Systems are less well developed for tsunami, landslides, wildland fires and volcano-related hazards (eruptions and lahars). No scientific basis is currently available for routine earthquake prediction.

Most countries have hazard monitoring and forecasting systems for the dominant hazards that affect them, but in many cases the warning systems do not cover all hazards and all parts of the national territory. Good examples of effective forecasting systems include those for cyclones in Mauritius and storm surges in Bangladesh, and, the new approach to weather warning (Carte de Vigilance) in France. There is need for continued development of operational forecasting and warning systems within the NMHSs, including to provide more effective warnings of severe storms.

Globally, the fastest onset hazard (earthquake) and the slowest (drought) are the most difficult to predict and pose significant challenges to development of early warning systems worldwide. Overall, most early warning systems focus on hazard monitoring and forecasting, excluding vulnerability assessment. Emerging systems for

environmental hazards, such as desertification, are beginning to integrate the vulnerability component. Overall, a major need across the board is for the integration of risk information into hazard warning messages. This would require close collaboration between technical operational agencies such as the NMHSs and national agencies responsible for vulnerability and risk assessment. Capacities for risk assessment need to be developed at national and local levels, on methodologies, hazard and various socioeconomic data. To this end, countries should consider their hazard observing networks as an investment and ensure sustainability of these systems over time.

There is a widespread need for closer collaboration among the meteorological and hydrological agencies and communities at the national and regional levels to ensure enhancement of flood forecasting, modelling and warnings. The five Tropical Cyclone Regional Committees are enhancing forecasting skills for tropical cyclone models but a more integrated approach to the forecasting of tropical cyclones, storm surges and related coastal flooding is needed. While in some countries tropical cyclone warnings are well integrated into disaster preparedness and response planning and activities, in others these linkages remain weak or non-existent. These Committees could potentially provide a regional platform for enhancing capacities for the development of an integrated modelling approach to enhancing hazard warnings in the coastal areas and for strengthening the linkages to the disaster risk management community through joint meetings, training and activities.

Coastal zones are important ecosystems, as well as centres of human population and commerce; however, these are some of the most vulnerable sites to disturbances associated with natural climate variability in conjunction with anthropogenic forcing. Numerous national and international organizations have made efforts to monitor and protect human life and environment in coastal areas from hazards but rarely in a coordinated and efficient manner. Thus, it is crucial to establish a coordinated and integrated mechanism for coastal observations (in-situ and remotely sensed), as well as early warning systems for coastal hazards, including appropriate risk assessment systems to each region's needs. As a first step, it is crucial to identify on a regional basis gaps in geographical monitoring networks of coastal areas, as well as technical gaps in observations, forecasting and warning, and risk assessment.

2.3 Dissemination and Communication

2.3.1 Practice and Capacities in Dissemination and Communication

Dissemination and telecommunication mechanisms must be operational, robust, available every minute of every day, and tailored to the needs of a wide range of different threats and different user communities. The necessary warning response times range from seconds for earthquakes to weeks for droughts. Where common needs exist, it may be possible to make use of the same communications systems for more than one type of warning information.

The dissemination of the information must be based on clear protocols and procedures and supported by an adequate telecommunications infrastructure. At the international and regional level, observations, analysis, bulletins and forecasts must be exchanged among countries in support of development of early warnings, particularly for those hazards whose spatial impacts span more than one country. Dissemination mechanisms must have international capacity to communicate warnings with significant international impacts, such as health and food security warnings. At the national level, effective dissemination and alert mechanisms are required to ensure timely dissemination of information to authorities and people at risk in even the most remote areas of the country. Each area may require different technological infrastructure to allow effective dissemination of messages. To ensure that all systems work smoothly together they should be based on internationally agreed standards.

At the national level, the effectiveness of warnings depends on their timely and effective dissemination to all at risk, particularly through operational telecommunication systems but also through non-technical social networks. The latter are very important in poor communities that lack technological communications. Effective dissemination requires the establishment of a chain of command in advance in order to manage warning issuance and dissemination and ensure that the information provided can be understood by those who need it and reaches all locations affected in the country.

A typical warning dissemination chain involves channelling warnings from technical and scientific sources through government decision makers and the media to multiple receivers who may also function as onward disseminators. Such users include emergency services, security agencies, operators of utilities, information and communication services, other economic service providers, and, vulnerable communities. In countries with integrated disaster management structures, the principal agencies responsible for issuing warnings and the processes for their issuance are established by prior agreement. For example, in the Philippines, the Disaster Coordinating Councils receive, process and rapidly disseminate warnings to threatened communities

while response units are immediately notified and the mass media alerted. Various agents are involved in generating warnings, including the private sector in developed countries and civil defence in others. Some countries operate community-owned alert systems and others decentralized systems that delegate the authority to issue warning to local authorities responsible for the site. To be effective, early warning activities must equally cover all relevant areas in the country.

Countries recognize the need for early warning systems for all relevant hazards but many do not posses the financial and technical resources to establish systems that cover all relevant hazards equally. For example, it is reported that in Jamaica, dissemination of storm and hurricane warning is effective, but flood warnings do not reach all at risk.

In order to reach all those who need to take action, countries are becoming aware of the need to design warnings for particular groups of stakeholders, such as different language groups, people with disabilities, and tourists.

Some OECD countries operate structured systems for dedicated nationwide channels for direct dissemination of warnings, but in other cases warnings are only disseminated through public communication channels, mainly the broadcast and print media. These channels are the primary warning systems for delivering information directly from issuing sources to users in most countries, although the timeliness and reliability of these systems vary considerably among countries. Public broadcast media remains the most widely used mode worldwide, which is appropriate as the best systems for warning dissemination are those used everyday and with which users are most familiar.

A variety of efforts are underway to enhance the participatory and decentralization nature of early warning systems. The role of community-based and grassroots organisations, as well as NGOs and other of actors in disseminating warnings can and has been pivotal, particularly in Africa, Latin America, Russia, central and eastern Europe. Also, some countries, such as Tonga, operate community alert systems while others, such as India, are establishing web-enabled centralized databases for use in issuing warnings.

At the international level, a number of agencies are involved in the dissemination and exchange of data, information and alerts. The WMO GTS, described above, is used to disseminate several types of warning information, while USGS disseminates information for geological hazards, and FAO distributes early warnings on slow and rapid onset food security-related hazards, such as climatic and economic shocks, and pest infestations. WFP provides daily and weekly summaries of food emergency issues, and operates the Humanitarian Early Warning Service (HEWS), which draws on other primary information suppliers. The ITU supports the distribution of early warning and related information through various telecommunication services. UNOCHA and the European Commission support the Global Disaster Alert Coordination System (GDACS) that disseminates alerts to response authorities and the international community.

Technical capacities for disseminating and communicating warnings have advanced, as the past decade has witnessed an explosion in the types, extent and depth of application of information and communication technology (ICT). Current advances in developed countries include short message service (SMS) and video messaging and paging but future warning transmission systems will be more active and will target the warning only at those at risk. The immense need for high bandwidth telecommunications to transmit real-time seismic and sea-level data information all over the globe in support of tsunami warning requires investigation of new technologies and alternative communication systems.

In contrast, progress in enhancing warning and response through application of technology has been relatively slow, particularly at the local level in developed countries and at the national and community levels in developing countries. However, efforts are underway, such as by the Hong Kong Observatory, to test approaches based on personal computer-internet combinations that allow cheap, fast and targeted meteorological forecasts for promotion in developing countries.

The advances in communication technology are blurring the lines between various warning terminology, such as watch, advisory and outlooks. This is because increasing lead times for warnings have made it necessary to provide additional and continuous information once warnings are in effect to allow stakeholders to better assess their risks. However, the multiple messages can have the detrimental effect of overloading the public and leading to confusion or inaction. Therefore, there is a need to standardize and clarify warning terminology, as well as educate the public.

While efforts will continue on improving basic warning message design and dissemination, interest is increasing on how to achieve the multi-organizational change, cooperation and multi-stakeholder interaction needed to engage the recipients in the dissemination process and thereby make warning messages more effective.

2.3.2 Major Gaps and Challenges in Dissemination and Communication

Warning messages do not reach all at risk. In developing countries this is largely a result of the underdeveloped dissemination infrastructure and systems, while in developed countries it is the incomplete coverage of systems. The resource constraints also contribute to the lack of necessary redundancy in services for information in many countries. Other gaps include:

Inadequate institutional arrangements
Warning services are limited in many developing countries because there are no formal institutional structures with requisite political authority to issue warnings. This situation is partly due to limited understanding of the true nature of early warning and reluctance of governments to grant the political authority that goes with warning responsibility. Warning communication often fails as a result of weak inter-personal and inter-agency relationships, including between early warning services and response units and other sectors. There is often a disconnect between key technical agencies and the authorities for effective exchange of technical information and hazard warnings. This reflects a lack of clarity regarding the role played by each agency in the chain of warning dissemination. Agencies may fail to issue warnings when necessary thus losing public trust and leading to lack of response by the public.

Political failure to take action
There are also breaks in the warning-communication chain due to political considerations. Government authorities may choose not to pass on warning information to the public if they feel that doing so poses unacceptable political risks. These include: (a) inappropriate timing of the crisis, (b) lack of resources to assist public preventive actions, evacuation and shelter, (c) unwillingness to cede political authority to warning officials, (d) lack of political strategic importance of the region at risk, (e) inadequate public capacity, (f) fear of litigation in case of economic losses.

Lack of clarity and completeness in warnings issued
Often warnings are incomplete because they do not meet essential requirements for effectiveness including: brevity, clear and uncluttered presentation, use of non-technical language, identification of areas affected, explanation of potential losses and of the chance of the loss occurring within a certain timeframe, as well as instructions to reduce losses through response actions. This is partly because of lack of common standards for developing warning messages within and across countries. It may also be unclear to the public whether the information is a forecast or a warning, as the inherent uncertainty of warnings may not have been appropriately conveyed. Lack of clarity of warning messages is often due to unclear responsibilities about who provides forecasts (of hazards) and who provides warnings (of risks). Often the problem is simply one of insufficient resource and capacity support to mid-level management to provide adequate warnings.

Need to strengthen telecommunication systems and technology, particularly for LDCs
Although at the international level the GTS is already fully operational in many countries, some serious shortcomings exist at the regional and national levels, especially in the developing and least developed countries where there is a need for updating equipment and linkages to the GTS Regional Telecommunication Hubs (RTHs). Furthermore, some of the RTHs connections and capacities need to be enhanced to ensure real-time exchange of some information, particularly for hazards with short lead times, such as tsunamis. There is also a need to upgrade telecommunications facilities, including equipment, service provisioning and operation, to be based on internationally agreed standards for the timely delivery of warnings from authorities to the public.

It should be noted that non-technological systems are in many cases necessary and adequate and are usually tailored to those who use them, ensuring their sustainability. Such can be the case of traditional knowledge and information acquired through educational and awareness-raising programmes, which in the case of the Indian Ocean tsunami of December 2004 enabled a school girl to save vacationers on a beach and the population of Simeulue island in Indonesia to survive the tsunami.

Inadequately standardized nomenclature, protocols and standards nationally and internationally
Another source of confusion in warning dissemination is that different issuers of alerts within a single early warning system may use varying protocols for issuing alerts, resulting in varying standards in language, messages and other aspects of warnings. People may not understand the warning, as warning terminology tends to be confusing. Alert stages, which are often expressed in colours or numbers (such as green, yellow, orange, red or I, II, III, IV), vary by country, leading to problems in translating alert stages across territorial and linguistic boundaries, creating confusion on the level of danger. There is a need for a single, consistent, easily understandable, global nomenclature to be used as a standard by all issuing authorities across all hazards and risk situations. Furthermore, there is need for development of standards, protocols and procedures for exchange of data, bulletins, alerts, etc. for some of the hazards, which traditionally have not been exchanged internationally among countries (e.g., tsunami). WMO, through its GTS and GDPFS has

developed various protocols for exchange of high priority data, alerts and bulletins on the urgency and risk levels of meteorological hazards. This has enabled coordinated and systematic exchange of relevant information among countries. Protocols are critical, particularly when the lead time is short. To facilitate the rapid exchange of tsunami data and alerts on the GTS, protocols are being developed through the Intergovernmental Coordination Groups for Tsunami Warnings in collaboration with WMO.

Failure to address the public's interests and concerns
Perhaps the most important reason for people failing to heed warnings is that the warnings do not address their values, interests and needs. Messages are often not sufficiently targeted to the users and do not reflect an understanding of the decisions stakeholders need to make to respond to the warning. Individuals may perceive the warning as irrelevant or find it impossible to heed, for example because they are reluctant to abandon the assets upon which livelihoods depend, such as livestock, or that have personal importance, such as pets. Furthermore, most warnings are delivered to the whole population through the media, and are not tailored to the needs of individual groups.

Lack of public interest in warnings also occurs because early warning systems only provide information on impending crises. They do not report on positive developments in the system that would engender public confidence and trust in future warnings, such as scientific advances that will enhance the warning services, or positive outcomes of responses to previous warnings. To overcome this obstacle, the public needs to be periodically informed about the hazards and the level of risk they pose, and how this may be changing. This information should not be technical and should remind the population of similar events.

Inadequate understanding of vulnerability
Early warning systems can also underestimate the risks communities face because of inadequate risk assessment for particular target groups. This was illustrated during Hurricane Katrina in respect to inner city residents of New Orleans. There is need for better integration of risk knowledge in the authoritative, official warnings at the national level. This would require closer collaboration between the operational technical agencies that are responsible for warning generation and the agencies and authorities involved in risk assessment and social protection. Due to the historical emphasis on the technological and hazard-related aspects of early warning, there has been inadequate attention to the use of traditional and local knowledge, experience and forecasting practices in considering risk scenarios.

Proliferation of communication technologies and loss of single authoritative voice
The use of the new information and communication technologies, particularly the internet, in disseminating warnings is a useful advance for expanding the coverage and reducing time lags in warning dissemination, yet it is also creating problems of untargeted messages inducing wrong responses due to misinterpretation. This problem is also related to the type of hazard under consideration. For example, while the internet has been a useful communication tool for hurricane warning dissemination in Latin America, the Caribbean and North America, its use in disseminating warnings on El Niño has at least once prompted wrong responses among agricultural operators causing unnecessary losses.

Ineffective engagement of the media and the private sector
Warning dissemination may be inadequate because of ineffective engagement of warning authorities with the media. The media is interested in reporting news and not necessarily in disseminating useful warnings. Thus, conflicts can arise when the media publish inaccurate or misleading information about potential events that contradict the official warning messages. Warning system managers may not be skilled in providing disaster information to the media. Warning messages may not be translated into languages all stakeholders will understand. There is need for the systematic training of technical agencies involved in the development of hazard warnings, such as NMHSs and their stakeholders (e.g., disaster risk managers, media, and the public sector) to ensure that warnings are understood and effective actions can be generated.

Most warning dissemination systems utilize public sector agencies in communicating warnings, though television channels are often privately owned. Given the need to pursue each individual with warning information, there is a need to involve the private sector. For example, participation of networks of tourism institutions in communicating warnings would expand the scope of dissemination.

Ineffective integration of lessons learned from previous warnings
Finally, warning dissemination can be ineffective if there is a lack of feedback on the system and its performance. Serious hazard events are relatively rare at any one location, and experience of an event may be quickly forgotten. Formal feedback processes are needed to ensure that the system continually evolves and improves based on feedback and learning from previous experience.

2.4 Response Capability

2.4.1 Practice and Capacities in Response Capability

Responses to early warnings involve activating coping mechanisms (mainly for orderly movement of people out of harm's way, seeking shelter and safely securing assets) before a disaster strikes. In contrast, post-disaster response implies the wider range of recovery, rehabilitation and reconstruction efforts in the aftermath of disasters. However, both are part of disaster preparedness and employ common emergency procedures. Warnings of hazard events must be issued with clear instructions about the most appropriate actions to take to avoid loss. The success of early warning depends on the extent to which it triggers effective response measures and therefore warning systems should include preparedness strategies and plans to ensure effective response to warning messages.

Most countries have contingency plans, but traditionally these have mainly focused on post-disaster emergency response and recovery. Political momentum is nevertheless being generated at international, regional and national levels to move towards more preventive strategies, as part of the growing awareness of the need to proactively reduce disaster risks. With respect to emergency planning, many developed countries and much of Latin America and the Caribbean operate plans at both national and local levels. In the Pacific Island States, community preparedness is widespread and all countries have and maintain emergency operation centres and pre-positioned emergency stockpiles. In many countries, particularly in Africa, Central Asia, and Central and Eastern Europe, emergency preparedness mechanisms are less developed and public awareness is relatively low. However, progress is ongoing to establish emergency plans in African countries, albeit mainly at national levels.

Warnings trigger a variety of responses from a range of actors at various levels, which must be coordinated. A variety of governmental agencies and institutions are responsible for coordinating disaster preparedness in countries, including various ministries, mainly of the interior, civil defence and protection structures, national disaster management institutions, and, municipal and local administration authorities. In many countries, NGOs, including the Red Cross and Red Crescent Societies, are very active in maintaining contingency plans. International organizations, both from the United Nations system and non-UN and regional disaster organizations, as well as numerous NGOs, promote effective response by supporting capacity development at country and regional levels. For example, OCHA provides a range of services globally, including awareness training for disaster managers and participation in regional simulation exercises to develop preparedness for better response. WMO is initiating education and training programmes for NMHSs and partners and an advocacy campaign on the benefits of weather warning, to support countries to develop their preparedness capabilities for responding to hazards.

Different target groups have different requirements for preparedness measures. Individuals need to assess the level of risk they can endure in balancing whether, when and how to react to warnings. Disaster managers need to address whether, when and how to issue warnings, what warning content to provide, and to ensure warnings reach and are understood by all at risk. Other considerations of warning system managers include determining: how safe and adequate public evacuation and other response facilities are, how to effectively move large numbers of affected people safely, and, how to maintain order and security during evacuations. High-level government officials need to consider making adequate resources available in a timely manner, how to allocate those resources to different areas and response functions, and how to coordinate national and international efforts in responding to the warning.

People are more likely to heed and act upon warnings when they have been educated about their risks and have prepared warning-reaction plans. Experience from successful evacuations, such as from Pinatubo volcano in Philippines, Paez earthquake in Colombia, the eruption of Tavurvur and Vulcano in Rabaul, Papua New Guinea, storm surges in Bangladesh, and hurricanes in Florida, USA, show that as a result of sustained prior public education and community preparedness people will evacuate without waiting for official warnings. Consequently, many developing countries are emphasizing public education in schools and awareness-raising campaigns and have integrated disaster education into school curricula. In some countries, where formal disaster risk education programmes are not part of the educational system, a range of government and non-governmental agencies provide disaster risk information to schools, colleges and the general public.

To develop and strengthen warning and disaster response capabilities at community levels, countries with strong national risk management authorities implement public information campaigns and awareness initiatives, often government-led, and involving various stakeholders and the media. A few countries also promote the use of traditional knowledge in developing community response capabilities.

Lessons learned from past disaster response need to be progressively incorporated into preparedness strategies, but there appear to be many shortcoming in this respect

worldwide. While some countries that frequently experience disasters have put in place mechanisms to enhance their response capabilities, others have not progressed in establishing strong national capabilities for disaster response preparedness. Updating response plans requires the participation of scientific institutions to link technical systems with the requirements of people at risk.

Risks change over time, requiring that preparedness strategies and plans for response to warnings are regularly updated and rehearsed. Many countries are aware of the need for rehearsal of their contingency plans and regularly do so. Ideally, rehearsals are carried out at the municipal, provincial and federal levels and include all agencies, critical facilities, schools, etc.

A strong institutional environment is important to ensuring that warnings are authoritative and trusted by all those at risk. Globally, there has been a growing focus on institutional development under the major international drought and food security warning systems, such as FAO's Global Information and Early Warning System and (GIEWS) and also FEWS NET. Many countries have developed early warning systems, such as those in Central America, and others are making efforts to develop the institutional environment of early warning, as part of designing legal and administrative frameworks for emergency management.

Responding to a warning involves perceiving, understanding, believing, verifying, personalizing the message, deciding on a course of action and taking action. In developed countries, an emerging issue is that people wish to determine for themselves the measures they take to mitigate their risks, which at times may come into conflict with warnings issued by authorities.

International organizations, both from the United Nations systems and non-UN and regional disaster organizations, as well as numerous NGOs, promote effective response by supporting capacity development at country and regional levels. For example, OCHA provides a range of services, including awareness training for disaster managers and participation in regional simulation exercises to develop preparedness for better response globally. WMO in close partnership with other agencies is initiating education and training programmes for NMHSs and their stakeholders and an advocacy campaign on the benefits of early warnings of weather-, climate-, and water-related hazards.

2.4.2 Gaps and Challenges in Respect to Response Capability

The failure to adequately respond to warnings often stems from lacks of planning and coordination at the national and local levels, as well as a lack of understanding by people about their risks. Agencies may not understand their roles and fail to communicate and coordinate effectively. Government may fail to adequately plan for evacuation and emergency shelter for the population. National preparedness plans may not reach the entire population, all of whom need to be aware of their vulnerabilities, ideally having some basic training and rehearsal experience, and the means to take action. Some major gaps and needs include:

Lack of multi-agency collaboration and clarity of roles/responsibilities at national to local levels

Response plans often do not work owing to lack of coordinated reaction among the main actors. The lines of responsibility and authority need to be clear to all to ensure coordination and effective implementation of response plans.

Lack of public awareness and education for early warning response

In many countries, response plans exist but are not known to the public because of weak public information and dissemination capacities. Public awareness is weakened by limited integration of disaster education in school curriculum. In general, the majority of countries do not have school programmes on disaster risk reduction, early warning, preparedness and emergency response. In countries where such programmes exist, they do not always reach all schools and all children.

Lack of simulation exercises and evacuation drills

Few countries regularly practice their preparedness plans. This is one of the priority challenges to enhancing warning effectiveness. It is difficult to maintain the interest and allocation of resources required for the practice of simulation exercises among the public and authorities, particularly for infrequent hazard events. The key is to keep the population aware of disaster risk.

Limited understanding of vulnerabilities and of the public's concerns

Effective community response to warnings is limited by inadequate understanding of risk. Communities may not understand who is vulnerable and may not adequately relate their response needs to their vulnerabilities. Likewise disaster response planners often do not have a detailed understanding of what triggers the community's reaction to warnings. Often there is no clear process for integrating risk information in emergency preparedness and response planning, and

consequently, preparedness plans do not sufficiently take into account peoples' subjective risk perception. If an individual perceives that the cost of heeding a warning outweighs the cost of accepting the risk, the warning is unlikely to induce an effective response. In some situations, it will be unrealistic to rely on people's ability to judge and act to save themselves and therefore necessary to enforce their compliance with regulations in respect to warnings and evacuations.

Need for a participatory approach and inclusion of traditional knowledge

Even where community understanding of risk is widespread, warnings often fail to induce the desired response because the language of the warnings may be too technical or in an inappropriate format to be understood by communities of various backgrounds. This is commonly due to lack of participation of the community, the media and other stakeholders in the planning and development of the warning-response strategy. Through public participation in the development of response strategies, effective traditional knowledge and mechanisms can also be integrated in the formal response strategy, maximizing the chance of compliance. Communities may decide to abandon ineffective traditional practices following such discussions.

Need for long-term risk-reduction strategies

Efforts to mitigate disaster losses through effective response to early warnings are sometimes ineffective because they focus exclusively on warning response rather than inducing long-term risk-reduction behaviour. For example, people living in hazard-prone areas often return after evacuations.

2.5 Cross-Cutting Issues and Gaps

Throughout the previous section, a number of issues have emerged that cut across the four elements of early warning, including:

- Inadequate political commitment to and responsibility for developing integrated early warning systems, lack of legal frameworks for early warning systems, weak integration of early warning issues in national plans and inadequate recognition of the links between disaster risk reduction and development.
- Insufficient investment in early warning capacities, especially in developing countries where disaster vulnerabilities are often highest.
- Insufficient coordination among actors responsible for early warning, for instance between technical warning issuers and government agencies, at all levels from local to international.
- Lack of participatory approaches, with over-reliance on centralised government direction and limited engagement of civil society, NGOs and the private sector.
- Inadequate identification and sharing of methodologies and good practices, as well as cross-discipline collaboration to enhance warning capacities both within and between the different hazard fields.

The first bullet point is the most critical shortcoming as it is largely the source of remaining shortcomings noted. The Hyogo Framework provides the essential critique and roadmap for addressing these core political and institutional problems and its implementation will be an essential foundation for the improvement of early warning capabilities. Equally, the development of better early warning systems will be an essential building block to the achievement of the Hyogo Framework's central goal of reduced disaster risk.

Concerning investment, governments have the sovereign responsibility to protect their people from disasters, and need to examine carefully how well they do so at present. There is ample information available on how to establish good early warning systems. International organisations and donors have considerable capacities to help, if asked, both with technical guidance and with development aid. Investment and capacity building is needed in all components of early warning systems, particularly in preparedness and related institutional development, and not just in technical and infrastructure capacities.

National coordination mechanisms are needed in order to bring the many relevant organisations together to shape and implement effective early warning systems – including the academic community, NGOs and other civil society actors. One option is to set up an early warning standing committee under the auspices of the national disaster reduction platform. Such a committee might be developed along similar lines as, or as an extension of, the tropical cyclone coordinating committees (or similar committees) that many countries already operate.

There are several needs for coordination at the international level. Specific organizations need to be identified to take formal responsibility for fostering and coordinating early warning for specific areas of hazard knowledge. In some cases, such as in meteorology (WMO) and tsunami (UNESCO-IOC), the current responsibilities are clear, but in other cases, such as with water hazards, drought, and food security the responsibilities need to be more clearly

elaborated and may need to be shared. The long experience of WMO in this role should have lessons for other organisations. It is important that such coordinating organizations have governing arrangements linked to governments in order to secure the necessary mandates and resources.

International coordination is also needed to integrate the efforts of the relevant international agencies, such as the development agencies and banks, humanitarian and disaster management organisations, international NGOs, and technical agencies. Most are partners in the ISDR system, which oversees and guides risk reduction and the implementation of the Hyogo Framework, providing the appropriate forum for coordinating the development of broad-based global early warning capacities. The ISDR-fostered International Early Warning Programme provides a vehicle to facilitate cross-cutting activities on technical issues, exchange of experience, monitoring of global progress, and support of capacity building.

A recent crosscutting theme in early warning is the concept of "multi-hazard" or "all-hazard" approaches, which is endorsed in the Hyogo Framework. The exact meaning of these terms remains to be agreed, but the main intention is to improve the effectiveness of early warning systems by seeking synergies of cooperation, such as in data exchange, modelling and analysis, warning communications and public awareness and education. For hazards that occur rarely, such as tsunamis, this approach should help secure the long-term sustainability of the associated warning system. However it is important that steps in this direction are taken carefully and with a firm recognition of the particular technical characteristics of each hazard. For example, tsunami warning systems and drought early warning systems have little in common, with very different science foundations, time frames and target populations, and must each rely on its own specific technical and social mechanisms and constituencies.

Toward a Comprehensive Global Early Warning System

3

3. 1 Overall Conclusions

The successful application of early warning is one of the most cost-effective, practical and effective measures for disaster prevention. Considerable progress has been made in recent decades in developing the knowledge and technical tools to assess risks and to make and communicate predictions and warnings, particularly as a result of enhanced scientific understanding of natural phenomena and the application of modern information and communication technologies. Early warning system technologies are now available for almost all types of hazards and are in operation in some parts of the world. Virtually every country has a national meteorological service that operates continuously.

There has been rapid progress in the identification, monitoring, modelling and prediction phase of early warning systems, involving expanded and automated hazard monitoring systems, better understanding of the physical causes of disasters and improved modelling tools, which has lead to improved provision and accuracy of warnings. In addition, there have been significant advances in communications methods, such as through television, the internet and more recently cell phone technology.

However, the recent experiences of the Indian Ocean tsunami, the hurricanes in the United States, the heat waves, droughts and wildfires in Southern Europe, Asia and North America, the floods in central Europe and China, the famine in Kenya, Niger and the Sudan, snowstorms in Japan and mudflows in the Philippines, all point to inadequacies in early warning systems. In many cases, especially in developing countries, warning systems lack the basic capacities of equipment, skills, and resources. Some of the poorest countries do not have warning systems at all. A great number of countries do not have systems for specific hazards, such as tsunamis and landslides.

Progress in achieving each of the four essential components of effective, systematic and people-centred early warning systems (risk knowledge, monitoring and warning services, dissemination and communication, and response capability) is mixed globally. Even where the capability exists to reliably generate and issue warnings, the other three components are too often absent or weak. The dissemination of understandable warnings and the effective

response of vulnerable communities to them remain the weakest links in warning systems worldwide.

Nevertheless, there has been steady progress in the use of hazard mapping and risk assessment, the involvement of communities, the recognition of indigenous warning knowledge, and increased support for decentralized community-based systems.

In the developed countries, the focus for early warning system development in mainly on issues of institutions and the interfaces between organisations, communities and people, which are best addressed as part of an integrated risk reduction agenda. Progressive upgrading to make use of new technologies is also important. In contrast, in most developing countries, the prime focus remains on the need to develop basic national and regional early warning infrastructures and other capacities.

It is clear that a globally comprehensive early warning system can be built, based on the many existing systems and capacities. This will not be a single, centrally planned and commanded system, but a networked and coordinated assemblage of nationally owned and operated systems. It will make use of existing observation networks, warning centres, modelling and forecasting capacities, telecommunication networks, and preparedness and response capacities. It will also seek to link the various systems for the different hazards, such as through shared use of observation networks, communications and warning centres and the linking of public education and preparedness efforts, in order to improve the coverage of the risks and gain synergies in institutional and operational efficiency and in warning system effectiveness. At the same time, the system must respect the specific risk characteristics and societal impacts of each hazard.

To meet the challenge to build such a system and address the gaps that are currently present will require long-term sustained action and commitment (e.g., political, financial and institutional) from diverse players. The development and sustainability of early warning systems is resource intensive. Political will is needed to engender public action and to make early warning an issue of an enlightened public policy, where warning against impending threats from natural hazards is a core task for national, regional and global safety and development. In turn, this requires strong institutions, nationally and internationally, and sustainable resourcing.

Many challenges on legislative, financial, organisational, technical, operational, training and capacity building aspects remain to ensure that early warning systems are implemented as an integral part of disaster risk reduction strategies within a multi-hazard framework. The tasks involved need to be defined and prioritized and the follow-up actions need to be identified and implemented through close, strategic partnerships among the actors involved in the various aspects of early warning systems at national, regional and international levels.

A globally comprehensive early warning system will require agreement on roles and responsibilities and extensive partnerships, including between the UN system and other key stakeholders, such as NGOs, private sector and sub-regional and regional groupings. Strong governing mechanisms are needed at all levels, especially to secure cooperation and common standards, and to sustain the system over periods of many years. Typically these mechanisms will be hazard oriented at the international level, through the international organizations that have custodial responsibility for specific areas of hazard knowledge and operations. They will be multi-sectoral at the national and local level to orchestrate cooperation among the different national actors such as the technical agencies, the academic community, disaster managers and civil society. In addition, international UN-based mechanisms are needed to facilitate shared endeavour, such as the identification of cross-cutting gaps and needs, motivating strategic partnerships, developing cross-cutting standards, exchanging experience and good practices, monitoring of global progress, and support of capacity building.

3.2 Recommendations for Action

In brief, two main conclusions of the survey provide the basis for the recommendations. The first main conclusion is hardly a surprise – it is that there are many gaps and shortcomings in early warning systems and the world is far from having the global systems for all hazards and all communities that the United Nations Secretary-General envisioned and called for in January 2005.

More positively, the second main conclusion is that there are great capacities and strengths available upon which a truly effective globally comprehensive early warning capacity can be built – not as a monolithic centralized system, but as a network of interacting systems and components, drawing on the expertise and technical capacities of the different hazard fields and the knowledge and insight of the relevant associated social and economic fields. Moreover, what needs to be done

to address the shortcomings is not a mystery, but has been already laid out in general terms in a succession of documents and meetings over the last decade.

Accordingly, the recommendations are as follows.

- Develop a globally comprehensive early warning system, rooted in existing early warning systems and capacities
- Build national people-centred early warning systems
- Fill the main gaps in global early warning capacities
- Strengthen the scientific and data foundations for early warning
- Develop the institutional foundations for a global early warning system

The first of these is the principal recommendation. The remaining four provide the framework for its implementation as well as for the detailed recommendations that are listed below. The recommendations concentrate on the primary areas of need, and where possible on specific concrete actions, rather than providing a comprehensive general programme. They cover the three main themes identified in the survey – technical expertise, societal engagement, and governing institutions – and are mainly aimed at governments, international organizations and authorities responsible for the safety of citizens.

Recommendation 1
Build national people-centred early warning systems

Country-based early warning systems are needed for the protection of the country's citizens and also provide the building blocks of the global early warning system. They involve national, district-level and community-based capacities and are only complete when the necessary capacities for warning dissemination and preparedness and response are in place. The main challenges for countries are firstly, to build or strengthen institutional capacities, and secondly, to effectively engage the affected populations in the system. National action on early warning systems should be incorporated into, and should materially contribute to, the national implementation of the Hyogo Framework for Action 2005-2015: *Building the resilience of nations and communities to disasters*. On this basis, the following tasks are recommended as priorities.

Specific proposed actions

1. Adopt the guiding principle that the country's early warning systems must be people-centred in addition to being technically sound.
2. Establish (or strengthen) a multi-party early warning roundtable, such as a subcommittee of the national platform for disaster reduction, to ensure coordination among the key actors and the integrated implementation of early warning capabilities across all hazards and all user needs.
3. Ensure at national level that the authority and political responsibility for issuing warnings are established in law and are appropriately assumed, and that the chains of command for the dissemination of warnings are clearly established.
4. Undertake a systematic national survey of all early warning system needs, covering hazards and vulnerabilities, institutional and social factors, and existing system capacities, performance and gaps.
5. Develop a long-term national plan for the systematic strengthening of early warning systems, covering technical and social elements, seeking synergies among the different hazard components, and with clear definitions of the targeted populations and the expected performance of the systems.
6. Where appropriate, request the support of the UN Resident Coordinator and the World Bank to support project identification and resourcing, in partnership with other donors, UNDP, relevant UN technical agencies and programmes, and non-governmental organisations.
7. Establish a national strategy and standards for warning dissemination that target stakeholders' needs and interests and reach to local level, and engage both the public and private sectors, especially the media, in their development.
8. Stimulate community-based risk assessment and early warning systems through the assignment of specific responsibilities for risk reduction and emergency management to local bodies, the support of local training and information needs, and the use of traditional knowledge and experience in warning system design.
9. Develop necessary curricula and institute a public education programme that reaches all the population at least once each year to enable them to understand the risks they face, the nature and meaning of warnings and the appropriate responses to take.
10. Undertake annually a well-publicised exercise to demonstrate and test national early warning systems, evacuation plans and public response, preferably involving all or large fractions of the at-risk population.

Recommendation 2
Fill the main gaps in global early warning capacities

There are many gaps to be filled, particularly at national and regional levels, and much work to be done to decide how best to fill them. The development of a globally comprehensive early warning system will require multiple actions at all levels and in all sectors, and covering hundreds of issues and criteria. Nevertheless it is possible to cut through the immensity of the task and to highlight a set of outstanding gaps and opportunities that deserve immediate concerted action. It is recommended that the following tasks be adopted as immediate priorities.

Specific proposed actions:

1. Conduct a detailed survey of gaps and needs in respect to weather-, climate-, water-related extreme hazards, and associated vulnerabilities and warning capabilities, particularly in the developing and least developed countries, and to develop plans for the systematic strengthening of early warning capabilities for these hazards in countries in need.
2. Identify and fill, on a country-by-country basis, the key gaps in operational forecasting and warning systems within each national meteorological and hydrological service, such as for severe storms, flash floods, storm surges, dust and sand storms.
3. Establish, where not already present, a minimum basic meteorological early warning service in all countries affected by tropical cyclones, covering technical needs and linkages to dissemination and preparedness mechanisms.
4. Implement monitoring, forecasting and early warning systems for the 100 flood-prone rivers of the world that most threaten large populations, including multilateral arrangements for monitoring, data sharing and early warnings exchange for basins that span more than one country or territory.
5. Build or strengthen tsunami warning systems in all tsunami-prone basins, as part of a globally coordinated system, through the development of regional intergovernmental coordinating groups, multilateral systems for observational and data systems, networks of national tsunami centres, and national tsunami programmes.
6. Prepare and implement integrated plans for coastal risk warning, mitigation and management systems, covering tropical cyclones, storm surges, and coastal flooding, founded on cross-disciplinary and regional cooperation.
7. Establish a global network of drought monitoring centres for all drought-prone regions, incorporating existing networks, and support them to design and implement a global drought and food security warning and response system, including effective monitoring systems.
8. Devise institutional mechanisms and agreements under UN and regional intergovernmental auspices to solve the problem of repeated failure by governments and international donors to effectively respond to early warnings for food security in Africa.
9. Prepare a global survey of all volcanic risks that threaten significant populations, covering hazards and vulnerabilities, and establish a mobile volcano monitoring capability that can deploy necessary equipment at short notice to emerging volcanic risk areas, supported by a ready-reaction task team of experts.
10. Support the development of the intergovernmental agreements and resourcing necessary to implement a global wildland fire monitoring and early warning system, based on existing initiatives and partnerships.
11. Implement a pilot project on landslide monitoring and early warning in every country that has suffered significant loss of life from landslides in the last decade, harnessing lessons learned from Central American systems developed after Hurricane Mitch and community-based models in Kenya and Uganda.
12. Implement under strong international support one major early warning project in each of the least developed countries, chosen on the basis of an assessment of the country's hazards, vulnerabilities and existing early warning capabilities, and as a first demonstration step of a long term plan toward an integrated national warning system for all hazards.

Recommendation 3

Strengthen the scientific and data foundations for early warning

Scientific and technical expertise and capacity are well recognized as core features of early warning systems, particularly in respect to hazards and to operational systems. However, there are several areas of weakness, such as in knowledge of some hazard processes and risks, lack of hazard and vulnerability mapping, and the limited engagement of relevant social sciences. Observational systems and data exchange arrangements are inadequate is many instances. On the other hand, the increased availability of new information and communications technologies provides opportunities for improved warning systems and for enhancing collaboration among experts worldwide. It is recommended that the global early warning capacity be based on a strong foundation of knowledge and data, and that the following actions be taken as priorities.

Specific proposed actions

1. Establish internationally agreed standard methods for monitoring and mapping natural hazards and related societal vulnerabilities, including hazard-relevant vulnerability indicators and their tracking, and prepare working tools to enable their implementation by countries.
2. Prepare a comprehensive catalogue of information on extreme geological hazards, such as the return periods and scales of future eruptions, the identity of overdue locked-fault segments, and the location and characteristics of areas of unstable terrain prone to landslides.
3. Design and implement a pan-African project to overcome the continent's deficit in hazard monitoring systems and to build related capacity in data analysis, forecasting and warning.
4. Develop through GEO mechanisms a comprehensive long-term globally comprehensive plan for observational and communications requirements to meet the data needs for all early warning system requirements.
5. Upgrade the WMO-coordinated Global Telecommunication System to support high-speed links to all countries and develop its capacity to handle the data streams and warnings communication for all hazards.
6. Identify and implement capacity-building programs needed to establish and maintain the observational and telecommunications infrastructure for reliable and efficient delivery of warnings to populations at risk.
7. Establish an international framework agreement on the regional and basin-wide data exchange necessary for early warning, including standardised nomenclature, through a consultation process among affected countries and building on existing agreements including Resolution 40 (WMO Congress–XII, May-June 1995).
8. Make early warning concerns a priority in the ISDR mechanisms for scientific and technical advice, including through the establishment of a high-level international science panel on extreme and natural hazards to identify and quantify the occurrence and potential impacts of such hazards.
9. Develop an international agenda on science and data-related needs for early warning, as part of the International Early Warning Programme, with the active participation of national scientific groups, including young developing country scientists, and associated training initiatives.
10. Establish an UN-coordinated web-accessible portal that provides access to information on natural hazards and early warnings, including current and emerging risks, as a collaboration of the agencies and institutes already engaged in providing these services.

Recommendation 4

Develop the institutional foundations for a global early warning system

The mechanisms of international and regional governance, coordination and support form one of the two pillars of a globally comprehensive early warning system, the other pillar being the country capacities. These mechanisms provide clarity on the roles and capacities of the relevant organizations, support necessary institutional partnerships, coordinate technical development, and ensure appropriate mechanisms of accountability to governments. The priority tasks are as follows.

Specific proposed actions:

1. Affirm through appropriate UN processes the goal to build a comprehensive global early warning system, rooted in existing early warning systems and capacities, and including necessary supporting governance mechanisms.
2. Request the ISDR system to facilitate the development of the comprehensive global early warning system, guided by the Hyogo Framework, and including overall strategies, clarification and documentation of mandates and responsibilities, definition of standards and terminology, support of capacity building, fostering of partnerships, and the development of an International Early Warning Programme for multi-party action on these issues.
3. Call on regional organisations, including the UN economic and social commissions and organisations concerned with disaster reduction, preparedness and early warning, to foster partnerships and prepare strategies and plans to support the development of early warning systems in their regions.
4. Undertake an assessment of the institutional mechanisms, capacities, and operational experience of WMO, and apply the lessons learned, and where advantageous the available capacities, to the development and operation of early warning systems for hazards not currently mandated to the WMO system.
5. Assign or reaffirm the responsibility for the global governance and coordination of early warning systems for geological hazards to UNESCO, in collaboration with WMO and the ICSU-affiliated science organizations that currently are the main bodies active in geophysical monitoring and warning, and strengthen UNESCO's capacities to effectively meet this responsibility.
6. Confirm the responsibilities for the global governance and coordination of early warning systems of FAO for food production and food security, UNEP for environment status and stress, OCHA for complex emergencies, including WFP and UNICEF's roles in the Inter-Agency Standing Committee for Humanitarian Action, and WHO for health-related aspects of disasters, while recognizing also the related responsibilities and competences of other UN and UN-associated actors, and the need for UN System coordination.
7. Call on the United Nations Office for Outer Space Affairs (UNOOSA) and the Group on Earth Observations (GEO) to coordinate the integration, improvement and sustainability of the observing systems and data exchange policies needed to support the comprehensive global multi-hazard early warning system, and request ITU to incorporate early warning system telecommunications needs into the specifications for the Next Generation Network (NGN).
8. Identify and prioritize the challenges for developing multi-hazard approaches, such as in legislative, organisational, technical and capacity building areas, and develop necessary strategic partnerships with relevant actors at international, regional and national levels and follow-up action plans.
9. Request the World Bank and UNDP to jointly facilitate necessary planning and coordination of, and support for, the inclusion of early warning systems development in national poverty reduction strategies and development plans, and request United Nations Department of Economic and Social Affairs to support the follow up to the WSSD Johannesburg Plan of Implementation on this subject.

Acronyms List

ACMAD	African Centre of Meteorological Applications for Development
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center
CEOS	Committee on Earth Observation Satellites
COI	Indian Ocean Commission
CRED	Centre for Research on the Epidemiology of Disasters
CRID	Regional Disaster Information Center for Latin America and the Caribbean
DMC	Drought Monitoring Centre
DRR	Disaster risk reduction
EC/JRC	European Commission and Joint Research Centre
EM-DAT	Emergency Events Database
EMPRES	Emergency Prevention System
ENSO	El Niño/Southern Oscillation
FAO	Food and Agriculture Organization
FDR	Fire Danger Rating
FEWS NET	Famine Early Warning Systems Network
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
GDACS	Global Disaster Alert Coordination System
GDIN	Global Disaster Information Network
GDPFS	Global Data Processing and Forecasting System
GIEWS	Global Information and Early Warning System on Food and Agriculture
GIS	Geographical Information System
GEO	Group on Earth Observations
GEOFON	GeoForschungsZentrum (GFZ) Potsdam network
GEOSS	Global Earth Observing System of Systems
GCM	Global Circulation Models
GFMC	Global Fire Monitoring Center
GIEWS	Global Information and Early Warning System on Food and Agriculture
GLIDE	Global Unique Disaster Identifier
GTS	Global Telecommunications System
GOARN	Global Outbreak Alert and Response Network
GOFC-GOLD	Global Observation of Forest and land Dynamics
GPS	Global Positioning System
HHWS	Heat Health Warning System
HEWS	Humanitarian Early Warning Service
HPAI	Highly Pathogenic Avian Influenza
IACEI	International Association of Volcanology and Chemistry of the Earth's Interior
IASPEI	International Association of Seismology and Physics of the Earth's Interior
IATF/DR	Inter-Agency Task Force on Disaster Reduction
IAVCEI	International Association of Volcanology and Chemistry of the Earth's Interior
ICAO	International Civil Aviation Organization
ICL	International Consortium on Landslides
ICHARM	International Centre on Water Hazard and Risk Management
ICPAC	IGAD Climate Prediction & Applications Centre, Greater Horn of Africa

ICT	Information and Communication Technology
IDNDR	International Decade for Natural Disaster Reduction
IFI/P	International Flood Initiative/Programme
IFRC	International Federation of Red Cross and Red Crescent Societies
IGAD	Intergovernmental Authority on Development (Eastern Africa)
ISDR	International Strategy for Disaster Reduction
ITU	International Telecommunication Union
ICG	Intergovernmental Coordination Group (for regional tsunami warning systems)
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOTWS	Indian Ocean Tsunami Warning System
JMA	Japan Meteorological Agency
LDCs	Least developed countries
MARA	Mapping Malaria Risk in Africa
NASA	National Aeronautics and Space Administration
NGN	Next Generation Network
NGO	Non-Governmental Organization
NHAVI	Natural Hazard Apparent Vulnerability Indicator
NMHSs	National Meteorological and Hydrological Services
OCHA	Office for the Coordination of Humanitarian Affairs of the United Nations Secretariat
OIE	World Organization for Animal Health
PPEW	Platform for Promotion of Early Warning
PRSP	Poverty Reduction Strategy Paper
PTWC	Pacific Tsunami Warning Center
PTWS	Pacific Tsunami Warning System
PIF	Pacific Islands Forum
PWRI	Public Works Research Institute
RCOFs	Regional Climate Outlook Forums
RSMC	Regional Specialized Meteorological Centers of WMO
RTHs	Regional Telecommunication Hubs
SMS	Short Message Service
SOPAC	South Pacific Applied Geoscience Commission
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	Economic and Social Commission for Asia and the Pacific
UNESCO/IOC	United Nations Educational, Scientific and Cultural Organization & Intergovernmental Oceanographic Commission
UNICEF	United Nations Children's Fund
UN/ISDR	United Nations International Strategy for Disaster Reduction
UN-HABITAT	United Nations Human Settlements Progaramme
UNITAR	United Nations Institute for Training and Research
UNOOSA	United Nations Office for Outer Space Affairs
UNU	United Nations University
UNU-EHS	UNU-Institute for Environment and Human Security
UNV	United Nations Volunteers
USGS	United States Geological Survey
VAM	Vulnerability Analysis and Mapping
WB	World Bank
WCDR	World Conference on Disaster Reduction (18-22 January 2005, Kobe, Hyogo, Japan)
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development
WWRP	World Weather Research Programme

Annex I

Methodology for the Global Survey of Early Warning Systems

Survey Request

Following the Indian Ocean tsunami disaster of December 2004, United Nations Secretary-General Mr. Kofi Annan made the following statement on averting future disasters through early warning systems in his 2005 report on the implementation of the Millennium Declaration, *In Larger Freedom: towards development, security and human rights for all* (A/59/2005, paragraph 66):

> "The countries of the Indian Ocean region, with the help of the United Nations and others, are now taking steps to establish a regional tsunami early warning system. Let us not forget, however, the other hazards that people in all regions of the world are exposed to, including storms, floods, droughts, landslides, heat waves and volcanic eruptions. To complement broader disaster preparedness and mitigation initiatives, I recommend the establishment of a worldwide early warning system for all natural hazards, building on existing national and regional capacity. To assist in its establishment, I shall be requesting the International Strategy for Disaster Reduction secretariat to coordinate a survey of existing capacities and gaps, in cooperation with all United Nations system entities concerned, and I look forward to receiving its findings and recommendations."

The Secretary-General's report on the implementation of decisions from the 2005 World Summit Outcome for Action (A/60/430, paragraph 44) informed on progress as follows: "In that connection, work continues on establishment of a worldwide early warning system for all natural hazards in the context of the implementation of the Hyogo Declaration and Framework for Action. The secretariat for the International Strategy for Disaster Reduction is preparing a survey of the existing capacity and gaps therein. In this it is supported by an ad hoc working group co-chaired by WMO and OCHA. The report of the working group is expected to be discussed at the Third International Conference on Early Warning, to be held in Bonn, Germany, in late March 2006, with publication of the final report in April."

The United Nations General Assembly (A/C.2/60/L.46, paragraph 23) expressed its support of the Secretary-General's request by asking "the inter-agency secretariat for the International Strategy for Disaster Reduction to complete the preparation of the global survey on early warning capacities and gaps, including an account of available technologies for early warning, and invites Member states to provide inputs that may assist the inter-agency secretariat for the ISDR in preparing this survey."

Collaboration on the Survey's Preparation

In fulfilling the Secretary-General's request for a global survey of early warning systems, the ISDR secretariat, through the ISDR Platform for the Promotion of Early Warning (PPEW), established during the 11th Session of the Inter-Agency Task Force on Disaster Reduction (IATF/DR) in May 2005, the IATF/DR Working Group on the Global Survey of Early Warning Systems. The Working Group is co-chaired by the World Meteorological Organization (WMO) and the Office for the

Coordination of Humanitarian Affairs (OCHA) and provides guidance for the effective implementation of the survey and particularly for the incorporation of information, knowledge and contributions from IATF/DR member agencies.

The Working Group members are: International Telecommunication Union (ITU), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Human Settlements Programme (UN-HABITAT), United Nations Institute for Training and Research (UNITAR), United Nations University Institute for Environment and Security (UNU-EHS), Asian Disaster Preparedness Center (ADPC), IGAD Climate Prediction and Applications Centre (ICPAC), the Global Fire Monitoring Center (GFMC), and the International Federation of Red Cross and Red Crescent Societies (IFRC).

A number of other organizations provided information on their roles in early warning systems for the survey, including: United Nations Children's Fund (UNICEF), the United Nations Convention to Combat Desertification (UNCCD), World Food Programme (WFP), Food and Agriculture Organization (FAO), the Asian Disaster Reduction Center (ADRC), ProVention Consortium and South Pacific Applied Geoscience Commission (SOPAC).

Methodology

As a first step in gathering information for the survey, the ISDR secretariat requested information on States' capacities and gaps in early warning through Governments' permanent missions to the United Nations at Geneva. Twenty-three Governments responded, including: Argentina, Azerbaijan, Bangladesh, Bolivia, Canada, China, Cyprus, Egypt, El Salvador, Georgia, Greece, Guatemala, Iran (Islamic Republic of), Jamaica, Jordan, Mauritius, Philippines, Portugal, Serbia-and-Montenegro, Sweden, United Arab Emirates, Yemen and the European Commission.

To involve the relevant United Nations and other organizations in the process, the ISDR secretariat requested information from the IATF/DR member organizations on early warning capacities and gaps, and established the aforementioned IATF/DR Working Group. The Working Group agreed that the survey should be mainly based on existing information and make use of existing resources and organizations. Such sources include reports submitted by countries to the ISDR secretariat for the World Conference on Disaster Reduction (2005). Early warning capacities and gaps were extrapolated from 122 country reports and synthesized in a matrix.

With the guidance of the Working Group chairs, a questionnaire was developed and sent to the Working Group members and other international organizations that expressed interest with the goal of obtaining consistent information on activities and experiences of the Working Group member s and other international agencies involved in different aspects of early warning systems. The completed questionnaires and the results of additional research were compiled and summarized in a matrix reproduced in Annex II. The Working Group met during the 12th session of the IATF/DR to discuss progress on gathering information from organizations.

In addition to new and existing country reports and inputs from international agencies, the survey included the review of regional reports prepared for the Second International Conference on Early Warning and other specialized early warning reports. The survey benefited greatly from surveys produced by the Commonwealth Secretariat and SOPAC on early warning capacities and gaps for the relevant regions.

The information was analysed and synthesized in a draft report that was shared with a small group of experts in Bonn, Germany, 12-13 December 2005. The experts included Alessandro Annunziato, Joint Research Centre, European Commission; Douglas Pattie, Convention on Desertification; David Rogers, former head of UK Met Office; John Scott, Center for Public Service Communications and former consultant with IDNDR; Seth Vordzorgbe, project consultant and writer of synthesis report for the Second Early Warning Conference; and Karl-Otto Zentel, DKKV/Munich Re. The experts identified capacities and gaps for each of the early warning components based on the draft report, the materials reviewed and their expertise. The most salient capacities and gaps were subsequently captured in the survey report.

The consultative draft report was shared with this group of experts and the IATF/DR Working Group. Subsequently, the document was revised and presented at the Third International Conference on Early Warning, Bonn, Germany, 27 to 29 March 2006.

Annex II

Matrix of International Organizations Involved in Early Warning Systems

The following matrix captures information provided by the members of IATF/DR Working Group on the Global Survey of Early Warning Systems on their roles in early warning systems. For each of the four components of early warning, the matrix summarizes organizations' cross cutting activities as well as their roles in providing early warning for specific hazards.

1. RISK KNOWLEDGE

Risk knowledge: sectors of activity through which organizations contributes to enhancing global capacity in risk analysis (systematic evaluation of risks and vulnerabilities) and risk mapping with regard to hazards under their mandate

CROSS-CUTTING ACTIVITIES FOR THE RISK KNOWLEDGE COMPONENT

BHRC – Benfield Hazard Research Centre, University College London. Multidisciplinary academic research centre on hazards and disaster studies.

IFRC – International Federation of Red Cross and Red Crescent Societies utilizes vulnerability and capacity assessments (VCA) to identify the strengths and weaknesses of communities/countries in relation to disaster management.

MUNICH-RE – Undertaking risk analysis and risk assessment.

NOAA - The National Oceanographic & Atmospheric Administration (NOAA) is a federal agency focused on the condition of the oceans and the atmosphere. NOAA supplies information to its customers that pertains to the state of the oceans and the atmosphere. This is clearly manifest in the production of weather warnings and forecasts through the National Weather Service, but NOAA's information products extend to climate, ecosystems and commerce as well. NOAA is a source of accurate and objective scientific information in four particular areas of national and global importance: (1) ensure the sustainable use of resources and balance competing uses of coastal and marine ecosystems, recognizing both their human and natural components; (2) understand changes in climate, including the El Niño phenomenon, to ensure that we can plan and respond properly; (3) provide data and forecasts for weather and water cycle events, including storms, droughts and floods; and (4) provide weather, climate, and ecosystem information to make sure individual and commercial transportation is safe, efficient and environmentally sound.

OCHA - Supporting the conduction of inter-agency assessments promoting recovery activities that minimize risk. Likewise, OCHA supports UNCTs in the development of contingency plans based on disaster/emergency scenarios and risk analysis. OCHA's role in these activities is as support activity. OCHA also assists in the operation of the Humanitarian Early Warning System (HEWS) that serves as a common platform for humanitarian early warnings for natural hazards and socio-political developments worldwide, also under the framework of the IASC. OCHA also promotes risk reduction, through advocacy, linking for example development with the agricultural sector in order to minimize vulnerabilities toward potential drought situations.

ProVention Consortium – Creating global sets of high-quality and accurate risk data and expanding these data sets at regional and national levels; developing and promoting tools for community level risk assessment and combining sets of local assessments to analyse larger patterns of risk and vulnerability; integrate climate change factors into the analysis of risk accumulation patterns and trends.

UNU - Developing methods for measuring, analysing and monitoring vulnerability to different hazards and at different social and geographical scales, including case study verifications and the elaboration of adequate mitigation measures; exploring the linkages between environmental change, hazards, risks and vulnerability, and developing prevention and response strategies within the context of sustainable development.

World Bank - Integrating multi-hazard risk assessment with national poverty analysis systems.

WMO – Coordination of extensive observing systems of the world's National Meteorological and Hydrological Services (NMHS), from 14 satellites, hundreds of ocean buoys, thousands of aircrafts and ships and nearly 10,000 land-based stations. Through establishment of standards, guidelines and procedures for collection, quality control, data formatting and archiving, and data rescue activities, WMO has assisted countries through their NMHS to enhance their capacity in this area. Assists capacity building by providing guidelines and related trainings on requirements for maintenance of high quality archives, methodologies for hydro-meteorological hazard mapping and provision of technical expertise for participation in the risk assessment studies in the countries. Crosscutting programme to enhance NMHS capacity to support hydro-meteorological hazard mapping and risk assessment for disaster risk reduction in their countries.

HAZARD	HAZARD-SPECIFIC ACTIVITIES FOR RISK KNOWLEDGE
Volcanoes	**Smithsonian Institute/USGS** – Hosts extensive searchable database on volcanic activity. **SOPAC** - Provides specialist and technical support to member countries, collation of volcano hazard knowledge and sharing experiences and materials regionally in workshops and conferences (Rabaul Observatory, ORSTOM/IRD, Geoscience Australia, NZ-IGNS and universities). **UNEP** - Developing methodologies and vulnerability assessments as support activities for member states. Data produced: PREVIEW Global Volcanoes Dataset (eruptions 1980-2004, including Volcanic Eruption Index). **UNESCO** - Hazards programme supports research on volcanic risks. In 2006-2007, plans to initiate a number of monitoring and risk awareness activities (e.g., workshops).
Earthquakes	**ISC** - The *International Seismological Centre* is a non-governmental organisation charged with the final collection, analysis and publication of standard earthquake information from all over the world. Earthquake readings are received from almost 3,000 seismograph stations representing every part of the globe. The Centre's main task is to redetermine earthquake locations making use of all available information, and to search for new earthquakes, previously unidentified by individual agencies. **SOPAC** - Seismic hazard and vulnerability assessments, post disaster assessment (IRD, national geological surveys) **UNDP** - Development of the Disaster Risk Index (DRI) Analysis Tool. **UNEP** - Developing methodologies and vulnerability assessments as support activities for member states. Data produced: PREVIEW Global Earthquakes Dataset (earthquakes > 5.5 Richter, 1970 – 2004). UNEP produced physical exposure, risk and vulnerability assessment for UNDP report "Reducing Disaster Risk: A Challenge for Development". UNEP's Awareness and Preparedness for Emergencies at Local Level (APELL) program raises local awareness and preparedness of local communities vulnerable to industrial accidents triggered by accident or by natural disaster (specific brochure on APELL for Earthquake Risk available). UNEP provides support for the development of strategies and technologies to manage disaster waste and debris, strengthening the capacity of environmental authorities to support national and regional multi-hazard warning systems in tsunami-affected countries and adapting environmental assessment instruments to include disaster risk components. **UNESCO** - Through various regional programmes including Mediterranean (RELEMR) and Asian (RELSAR) regions programs, is producing seismicity and active fault maps and is contributing to hazard and risk analysis in more than 30 countries in the extended Mediterranean and South Asia regions. **USGS –** Hosts extensive, searchable global seismic database on earthquake parameters and their effects (available online with a simple File Transfer Protocol or through a browser interface) that serves as a solid foundation for basic and applied earth science research.
Tsunami	**SOPAC** - Capacity building of technical staff, tsunami modelling and animation (ITSU, PDC, PTWC, Geoscience Australia, NZ-IGNS) **UNEP** - UNEP World Conservation Monitoring Center (WCMC) is preparing a publication on the role of coral reefs and mangroves in buffering the impacts of tsunamis. Support of the Flash Appeal 2005 for the Indian Ocean Tsunami and the development of an Indian Ocean Tsunami Early Warning

	System. Recently, UNEP joined the Intergovernmental Coordinating Group for the Tsunami Early Warning and Mitigation System in the Northeastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS). Strengthening the capacity of environmental authorities to support national and regional multi-hazard warning systems in tsunami-affected countries and adapting environmental assessment instruments to include disaster risk components. UNEP's APELL program raises local awareness and preparedness of local communities vulnerable to industrial accidents triggered by accident or by natural disaster – specific brochure on APELL for tsunamis available. **UNESCO/IOC** - Production of tsunami hazard and inundation maps.
Landslides	**ADRC** - Community-based hazard mapping in Asian countries. **SOPAC** - Landslide mapping and training (BGS, Landcare) **UNEP** - Global Landslides Risk mapping along with Norwegian Geotechnical Institute (NGI) for the Disasters Hotspots. (See UNEP PREVIEW project). Strengthening the capacity of environmental authorities to support national and regional multi-hazard warning systems in tsunami-affected countries and adapting environmental assessment instruments to include disaster risk components. Promoting awareness of landslide risk in Pakistan in aftermath of the South Asian Earthquake. **UNESCO –** Supporting risk assessment/mapping activities of the International Consortium on Landslides and the International Programme on Landslides.
Cyclones Hurricanes Storms Temperature Extremes	**ADRC** - Community-based hazard mapping in Asian countries. **SOPAC** - Knowledge transfer for management policies and building codes, vulnerability/asset and post disaster impact assessments. **Tropical Storm Risk/TSR** - Application of seasonal hurricane forecasts in U.S. property catastrophe reinsurance. Through a breakthrough in forecasting US hurricane activity published in Nature, and in collaboration with the Bank Leu, TSR has provided the first direct demonstration of the business relevance of hurricane forecasts for selling and buying (re)insurance cover. **UNDP** - Development of the Disaster Risk Index (DRI) Analysis Tool. **UNEP** - Development of methodologies and vulnerability assessments activities carried out as support activities for national and regional drought monitoring centres. Data on tropical cyclones wind speed profiles can be downloaded (). See project PREVIEW. UNEP prepared physical exposure, risk and vulnerability assessment for UNDP report "Reducing Disaster Risk: A Challenge for Development". UNEP provides support to national and local governments in using environmentally sound technologies for disaster risk reduction and prevention, strengthening the capacity of environmental authorities to support national and regional multi-hazard warning systems in tsunami-affected countries and adapting environmental assessment instruments to include disaster risk components. **WMO** - Developing a standard methodology for cataloguing hydro-meteorological hazards; assistance to countries (through their National Meteorological and hydrological services) to develop and maintain catalogues of weather-, water- and climate-related natural hazards.
Permafrost Snow Avalanches	

Floods Mudflows	**ADRC** – Community-based hazard mapping in Asian countries. **Flood Observatory, Dartmouth University** – Produces the Global Register of Extreme Flood Events, a table detailing information about extreme flood events that occurred during a given year. **SOPAC** - Analysing causes of floods with changing land-use practices. Flood mapping and management for small basins. Capacity building through hydrological training. **UNDP** - Development of the Disaster Risk Index (DRI) Analysis Tool. **UNEP** - Vulnerability assessments as support activities to national and regional drought monitoring centres. Methodology has been developed with the World Bank. UNEP prepared physical exposure, risk and vulnerability assessment for UNDP report "Reducing Disaster Risk: A Challenge for Development". UNEP's APELL program raises local awareness and preparedness of local communities vulnerable to industrial accidents triggered by accident or by natural disaster (specific brochure on APELL for Flood Risk available). Strengthening the capacity of environmental authorities to support national and regional multi-hazard warning systems in tsunami-affected countries and adapting environmental assessment instruments to include disaster risk components. **WMO** - Developing a standard methodology for cataloguing hydro-meteorological hazards; assistance to countries (through their National Meteorological and hydrological services) to develop and maintain catalogues of weather-, water- and climate-related natural hazards.
Drought Desertification	**FAO** - Gathering and analysing information concerning all factors that might influence planted area and yields and integrating it with social, economic and market data at the international, national and sub-national levels. **SOPAC** - Capacity building through hydrological training, Climate Update, guidelines in water harvesting (NIWA). **UNCCD –** Key intergovernmental organization for "Land Degradation Assessment in Drylands" (LADA) project, which is developing methodologies to assess causes, status and impact of land degradation in drylands, and proposing remote sensing applications for early warning for land degradation. **UNEP** - Vulnerability assessments as support activities to national and regional drought monitoring centres. Data: See UNEP project PREVIEW. UNEP prepared physical exposure, risk and vulnerability assessment for UNDP report "Reducing Disaster Risk: A Challenge for Development". **WMO** - Developing a standard methodology for cataloguing hydro-meteorological hazards; assistance to countries (through their National Meteorological and hydrological services) to develop and maintain catalogues of weather-, water- and climate-related natural hazards.
Wildland Fires	**GFMC** - Data supply and analysis: ground-based weather (WMO, BMRC, ECMWF) and satellite fire data (GOFC, UMD); spatial wildland fire risk modelling, scientific calibration to global regions (CFS, BCRC, BMRC); wildland fire risk assessment, map and information dissemination (GFMC, WMO); risk response training (GFMC, UNU, CFS, BCRC, WMO). **UNEP** - Vulnerability assessments as support activities to national and regional drought monitoring centers. Data: see PREVIEW for fires detection (1997-2003).

Locusts	**WMO** - Working with FAO on development of early warning capabilities for locust swarm by providing capacity for monitoring and detecting the climatic and ecological conditions.
Epidemics	**WHO** - Identifying natural and man-made threats to people's health that might develop into crises; building scenarios for possible major incidents, including epidemics, bio-terrorism and their health consequences and making the health system resilient to these threats.
Environmental Degradation	**SOPAC** - Global Environmental Vulnerability Index. **UNEP** - Refining risk/vulnerability assessment indices; Global International Waters Assessment (GIWA); Land Degradation Assessment in Drylands (LADA); Millennium Ecosystem Assessment (MA). DEWA publishes a GEO Year book highlighting the main environmental issues of the year. UNEP's publication: "One Planet Many People: an Atlas of Our Changing Environment".

2. MONITORING AND WARNING SERVICES

Monitoring and warning services: sectors of activity through which organizations contribute to warning services (hazard monitoring, detecting, forecasting and in the development of operational warning) with regard to hazards under their mandate.

CROSS-CUTTING ACTIVITIES
ITU – Normative work and technical assistance in support of (primarily) meteorological services (meteorological aids and meteorological-satellite service) earth exploration-satellite service. Such services are involved in weather and climate prediction, detection and tracking of earthquakes, tsunamis, hurricanes, typhoons, wildland fires, oil leaks and other hazards. **OCHA** - Supports several initiatives aimed at alerting the international community about potential disaster situations. Amongst them, the formulation of Early Warning Early Action reports in the framework of the Inter-agency Standing Committee (IASC). Best practices of monitoring for early action were gained as a result of the Nyragongo volcanic eruption, eastern DRC in 2002. OCHA manages the Global Disaster Alert and Coordination System (GDACS), which disseminates disaster alert notifications to the international disaster response community at the occurrence or at the forecast of significant disaster events. **WMO** - Global coordination of National Meteorological and Hydrological Services (NMHS), consolidation of general requirements for global observations and coordinating the consistent, systematic and on-going collection and archiving of hydro-meteorological and climate observations. WMO Global Data Processing and Forecasting System (GDPFS), includes three World Meteorological Services (WMSs) and 40 Regional Specialized Meteorological Services (RSMCs), and supports global weather modelling and forecasting. Technical training and capacity building including through Regional Meteorological Training Centres (RMTCs).

HAZARD	HAZARD-SPECIFIC ACTIVITIES FOR MONITORING AND WARNING SERVICES
Volcanoes	**Smithsonian Institute/USGS** – Gathering and analysing data from a vast network of volcanological observatories. **SOPAC** - Capacity building at local levels (Massey University, AVI).

Earthquakes	**EMSC** – the European-Mediterranean Seismological Centre operate a system for rapid determination of the European and Mediterranean earthquake epicentres (location of major earthquakes within a delay of approximately one hour). The EMSC, acting as the central authority, is responsible for transmitting these results immediately to the appropriate international authorities and to the members in order to meet the needs of protection of society, scientific progress and general information; to determine the principal parameters (epicentre, depth, magnitude, focal mechanisms...) of major seismic events located within the European-Mediterranean region and dispatch widely the corresponding results; • to collect the data necessary for the operations of the EMSC and make them available to other international, regional or national data centres such as the , the (NEIC); • to encourage scientific cooperation among European and Mediterranean countries in the field of earthquake research, and to develop studies of general interest such as: epicentre location methods, construction of local and regional travel- time tables, magnitude determination; • to promote the exchange of seismological data between laboratories in the European-Mediterranean area; • to satisfy any request related to detailed studies of specific events; to assure the functioning of an European seismological data bank; • a critical examination of the seismological coverage, and to suggest methods for improving the quality of observations and their transmission to the EMSC. **GDACS –** Global Disasters Alerts and Coordination System developed by the European Commission in collaboration with UN-OCHA to alert international organizations of a possible earthquake risk from humanitarian point of view. The objective is the identification of events requiring assistance from the international community. **SOPAC** - Capacity building at local levels (ADRC, UNESCO, NZ-IGNS) **UNESCO –** Assistance to countries in setting up and maintaining monitoring systems; ongoing collaboration with national, regional and global (USGS) seismological networks. **USGS** – Worldwide, real-time monitoring of earthquake activities based on data provided by an extensive network of local, national and regional seismographic systems.
Tsunami	**NOAA –** Pacific Tsunami Warning Center (PTWC) and West Coast & Alaska Warning Center (WC & ATWC) **PTWC** - The Pacific Tsunami Warning Center (PTWC) collects and evaluates data provided by participating countries, and issues appropriate bulletins to both participants and other nations, states or dependencies within or bordering the Pacific Ocean basin regarding the occurrence of a major earthquake and possible or confirmed tsunami generation. **SOPAC** - Capacity building, assist the development of sub-regional South Pacific warning centre. **UNEP** - Support to the implementation of the UN Flash Appeal 2005 for the Indian Ocean Tsunami and the development of an Indian Ocean Tsunami Early Warning System. Recently, UNEP joined the Intergovernmental Coordinating Group for the Tsunami Early Warning and Mitigation System in the Northeastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS). **UNESCO/IOC –** Establishment in1965 of the International Coordination Group (ICG) of the Pacific Tsunami Warning Center (PTWC), which led to a fully operational warning system in the Pacific Ocean. The PTWC and Japan Meterological Agency (JMA) collect and evaluate data provided by participating countries and issue appropriate bulletins to national warning centres, within or bordering

	the Pacific Ocean basin regarding the occurrence of a major earthquake and possible or confirmed tsunami generation. Since the 26 December 2004 tsunami in the Indian Ocean, IOC took lead in establishing additional ICG's for the Indian Ocean, the NE Atlantic/Mediterranean and the Caribbean.
Landslides	**UNEP** - UNEP has the capacity and expertise in-house to train experts in the use of GIS and image processing for landslide analysis and mapping. **UNESCO –** Support to early warning activities of the International Consortium on Landslides and the International Programme on Landslides.
Cyclones Hurricanes Storms Temperature	**ExtremesTropical Storm Risk/TSR** - Tropical Storm Tracker and its forecast wind probabilities and wind fields. The tracker, publicly available on the Internet, provides a sophisticated geographical interface linking to current active systems in the six basins/regions of the world, with forecast on storm-centre positions, recorded and expected wind speeds for up to 93 hours and a full range of satellite images. Also, seasonal probabilistic forecasts of basin and landfalling tropical cyclone activity worldwide. TSR has developed innovative probabilistic models for predicting seasonal basin and seasonal landfalling tropical cyclone activity in the North Atlantic, NW Pacific and Australian regions. These forecasts are updated monthly and provide skilful outlooks for assessing the likelihood of upcoming damage and disruption. **UNEP** - Observation and monitoring both as core activities an as support to national governments. **WMO** - WMO Global Tropical Cyclone Warning System includes six WMO Regional Specialized Meteorological Centers (Nadi, New Dehli, Miami National Hurricane Center, La Reunion, Honolulu, Tokyo Typhoon Center) operated by NMHS, responsible for analysing, developing tropical cyclones and issuance of the bulletins, and forecasts to the NMHSs of the countries at risk. Coordination and capacity building through five Regional Panels and Committees (ESCAP/WMO Typhoon Committee, WMO/ESCAP Panel on Tropical Cyclones, Tropical Cyclone Committee for Southwest Indian Ocean, Hurricane Committee in the Caribbean and North Atlantic, Tropical Cyclone Committee for South pacific and South east Indian Ocean) represented by experts from countries in the region. Support for the development of forecasting capabilities and warnings for a wide range of severe storms related to severe wind and precipitation (rain and snow). Related training and capacity building activities. International research programmes on weather (THORPEX: a Global Atmospheric Research Programme), Hydrological and Water Resources Programme, and Joint Technical Commission on Marine Meteorology (JCOMM) of WMO and UNESCO-IOC aims to enhance storm surge warning systems. Support of monitoring and forecasting of cold spells and heat waves, and related training and capacity building activities.
Permafrost Snow Avalanches	
Floods Mudflows	**Flood Observatory, Dartmouth University** - MODIS Instantaneous Edited Surface Water (individual GIS vector polygons that define the surface water detected by the MODIS 250 m bands); MODIS Maximum Surface Water (GIS vector polygons depicting a multi-temporal composite of the accumulating record of flooded land observed by the MODIS 250 m bands); MODIS Flood Inundation Limits (GIS vector polygons depicting a multi-temporal composite of the accumulating record of flooded land observed by the MODIS 250 m bands for individual flood events); QuikSCAT Weekly Local Flood Detection Displays (raster images produced on a weekly basis); QuikSCAT Regional Flood Detection Displays (raster images produced on a weekly basis); QuikSCAT Wetland Surface Water Status (raster images produced on a weekly basis); QuikSCAT Wetland Water Surface Area Time Series (data are based on the QuikSCAT polarization ratio data which has been processed to determine the surface water status).

	SOPAC - Supports national initiatives on improving hydrological networks and flood warning capabilities (Pacific HYCOS). **UNEP** - Observation and monitoring as support activities to governments. **WMO** - Hydrology and water resources programme works with the National Hydrological Services of the countries on enhancing flood forecasting capacities and the short- and long-term Global Flood Forecasting Project. The Associated Programme on Flood Management (APFM), has been developing strategies for effective community preparedness in several countries. Regional pilot project in Bangladesh, India and Nepal on Community Approach to Flood Management through field activities in selected communities at the sub-district level, with implementation during the recent 2004 floods in some of the villages. Manuals on community approach to flood management have been developed that cover various aspects such as flood preparedness, rescue and relief, agriculture and livelihood planning, health and sanitation, and the role and responsibilities of the communities. The project also addresses issues related to public awareness and capacity development..
Drought Desertification	**FAO –** Integration of market analysis data with vast amount of information provided by third parties on near real-time monitoring of crop conditions. **UNCCD** – China is leading a thematic programme network for Asia on desertification monitoring and assessment linked to WMO. **UNEP** - Observation and monitoring as support activities to governments. **WMO** - Development of new products that provide information with longer lead-times on the state of the climate and natural hazards. Support to Regional Climate Outlook Forums (RCOFs). Working to develop comprehensive Climate Watch programmes in NMHSs around the world, to inform countries whenever significant climate anomalies are foreseen, providing alerts tailored for specific end-users to help them better prepare for the negative impacts of natural hazards.
Wildland Fires	**GFMC** - Collection and analysis of ground-based weather data (WMO, BMRC, ECMWF) and satellite fire data (GOFC-GOLD, UMD); assessment of fire risk information and its end user utilisation (BCRC, CFS); integration of wildland fire danger (or fire hazard) and fire activity as well as implementation in operational warning systems (CFS, BCRC, BMRC). **UNEP** - Support to Global Terrestrial Observing System (GTOS) and its Fire Mapping and Monitoring Theme. Clearing house facility for early warning and on-going fires. Observation and monitoring as support activities to governments.
Locusts	**WMO** - WMO and National Meteorological Services monitor the meteorological conditions favourable for development of locust swarms and provides this information to the National Locust Control Centres.
Epidemics	**WHO** - Regional and country offices, as well as WHO collaborating centres, are among the primary providers of information feeding the Global Outbreak Alert and Response Network; management of Global Public Health Intelligence Network (GPHIN), developed by Health Canada in collaboration with WHO. This is a secure Internet-based multilingual early-warning tool that continuously searches global media sources, such as news wires and web sites, to identify information about disease outbreaks and other events of potential international public health concern. **WMO** - Works closely with WHO on development of monitoring capacities through the NMHSs for monitoring and detecting meteorological and climatological conditions that are favourable for development of infectious diseases and epidemics.

Environmental Degradation	**OCHA**'s Environmental Emergencies Unit provides continuous monitoring and ongoing communication with an international network of contacts and permanent monitoring of news services and web sites, for early notification of environmental occurrences. **UNEP** - Monitors and analysis the state and trends of the global environment and has developed methodologies to assess stressors and pressures on the environment that may lead to environmental degradation. UNEP publishes results and methodologies through a large number of publications (global, regional, national and thematic) as part of the integrated environmental assessment process, and targets environmental managers and policy makers (GEO-Global Environmental Outlook). UNEP also provides capacity development for national and local governments in understanding and developing policies for sound environmental management and disaster risk reduction.

3. DISSEMINATION AND COMMUNICATION

Warning dissemination and communication: sectors of activity through which organizations contribute to enhancing global capacity in the dissemination of understandable warnings with regard to hazards under their mandate.

CROSS-CUTTING ACTIVITIES FOR DISSEMINATION AND COMMUNICATION
GDACS - The Global Disaster Alert and Coordination System is a joint initiative of the United Nations and the European Commission and provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination, including news, maps etc. GDACS is a web-based platform that combines existing web-based disaster information management systems with the aim to alert the international community in case of major sudden-onset disasters and to facilitate the coordination of international response during the relief phase of the disaster. The aim of GDACS is to provide the international disaster response community with a platform to ensure that disaster alerts and information relevant to the international disaster response is exchanged interactively in a structured and predictable manner among all concerned. GDACS will be activated in major natural, technological and environmental disasters, which overwhelm the affected country's response capacity and require international assistance. GDACS will be active from the moment a major disaster is forecasted or has occurred until the end of the relief phase. The relief phase terminates when there is no further requirement for information exchange by responding organisations to coordinate their activities and the focus of international assistance shifts to rehabilitation and reconstructions. The duration of the relief phase can vary in disasters but is usually between three to four weeks. Early warning and rehabilitation/reconstruction will currently not be covered by GDACS. **ITU** - Supports the distribution of early warning-related information through radio amateur services, broadcasting services (terrestrial and satellite), fixed telecommunications services (terrestrial and satellite) and mobile telecommunications services (land, satellite, maritime services, etc.) **MUNICH-RE** – Management of NATHAN, an interactive system for the identification of the natural hazard situation at any point on Earth; publications and online media. **OCHA** - supports the Global Disaster Alert Coordination System (GDACS), which is a web-based platform that combines existing web-based disaster information management systems with the aim to alert the international community in case of major sudden-onset disasters and to facilitate the coordination of international response during the relief phase of the disaster. Pre-positioning of UNDAC teams in case of hazards that allow enough forewarning (hurricanes, volcanic activity) to support response preparedness activities. OCHA manages the Virtual OSOCC web site to disseminate information and facilitate coordination of international disaster responders after the occurrence of sudden on-set disasters. OCHA acts as the Secretariat of the International Search and Rescue Advisory Group and triggers the dispatch of international SAR teams in response to sudden on-set disasters. OCHA is undertaking an

information and awareness campaign for UN Resident Coordinators/UNCTs in countries that are disaster risk prone through series of training initiatives.

UNDP - UNDP's Disaster Risk Index methodology is at the core of the recently published report Reducing Disaster Risk: a Challenge for Development. On top of significant amounts of background scientific and policy-related information, the report includes Disaster Risk Index tables for the period 1980-2000 (Summary, Droughts, Earthquakes, Floods, Tropical Cyclones). In addition to the global report, UNDP's Disaster Reduction Unit publishes regularly the reports of its specific risk assessment activities.

WFP - Daily distribution of Global Early Warnings; monthly summaries of global Early Warning-related developments; contributor to Inter-Agency Early Warnings through the quarterly 'Early Warning-Early Action Report for the IASC WG'; contributor to Inter-Agency and global Early Warnings through the development and maintenance of HEWSweb service.

WMO - WMO Global Telecommunication System (GTS) connects all countries through their National Meteorological and Hydrological Services, and is the backbone of the telecommunication of information, alerts, bulletins and forecasts to multi-hazard warnings related to weather, water and climate-related hazards, as well as data streams for certain other hazards like tsunami. Programmes to enhance the quality of weather, climate- and water-related warnings to ensure that they are understood by stakeholders, such as authorities, the media and the public at risk.

HAZARD	HAZARD-SPECIFIC ACTIVITIES FOR DISSEMINATION AND COMMUNICATION
Volcanoes	**Smithsonian Institute/USGS** – produces the Weekly Volcanic Activity Report. **SOPAC** - Supports countries in simplifying warning messages to meet user needs; strengthening of institutional arrangements and communication equipment. **UNEP** - See Project of Risk Evaluation, Vulnerability, Information & Early Warning-Internet Map Server (PREVIEW-IMS) http://www.grid.unep.ch/activities/earlywarning/preview/ims/data/export.htm
Earthquakes	**GDACS** - The Global Disaster Alert and Coordination System is a joint initiative of the United Nations and the European Commission and provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination, including news, maps etc. **UNEP** - See Project of Risk Evaluation, Vulnerability, Information & Early Warning-Internet Map Server (PREVIEW-IMS) http://www.grid.unep.ch/activities/earlywarning/preview/ims/data/export.htm **USGS** - Automatic Data Request Manager (AutoDRM). Primary data sets include waveform data collected from the US National Seismograph Network (USNSN) and bulletin information derived by the National Earthquake Information Service (NEIS). Includes a sophisticated set of commands allowing users to filter and manage data and is provided free of charge to a broad set of disaster management and research institutions.
Tsunami	**GDACS** - The Global Disaster Alert and Coordination System is a joint initiative of the United Nations and the European Commission and provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination, including news, maps etc. **IMO –** The International Maritime Organization (IMO) disseminates tsunami warnings and other vital information on natural disasters through the World-Wide Navigational Warning Service (WWNWS), not just in the Indian Ocean but in all areas.

	PTWC –The Pacific Tsunami Warning Center (PTWC) issues regional tsunami warning/watch; placing potentially affected countries on tsunami-warning or tsunami-watch status; issues hourly bulletins and cancellation bulletin. **SOPAC** – Supports in-country capacities needs assessment. **UNEP** - See Project of Risk Evaluation, Vulnerability, Information & Early Warning-Internet Map Server (PREVIEW-IMS) http://www.grid.unep.ch/activities/earlywarning/preview/ims/data/export.htm **UNESCO/IOC –** Development of systems for the dissemination of early warning information (last mile) in collaboration with ISDR. Collaboration with WMO GTS as a backbone to disseminate warnings to national warning centres.
Landslides	**UNEP** – Capacities currently under development.
Cyclones Hurricanes Storms Temperature Extremes	**SOPAC** - Support countries in simplifying warning messages to meet user needs, strengthening institutional arrangements and communication equipment.
Tropical Storm	**Risk/TSR –** Provides tropical storm alert feeds. During 2004 Tropical Storm Risk introduced tropical storm alert feeds to Reuters AlertNet, the global humanitarian news portal, and to the United Nations World Food Programme. **UNEP** - Has carried out analysis of damage from cyclones, typhoons and its environmental impacts in several parts of the world (for example Japan, Central American countries affected by Hurricane Mitch, Hurricane Georges in the Caribbean, etc.
Permafrost, Snow Avalanches	
Floods Mudflows	**Flood Observatory, Dartmouth University –** Hosts the Dartmouth Atlas of Global Flood Hazard, presently viewable online by selecting a 10° x 10° tile from the Global Index Map. Individual tiles can be provided on email request at even larger map scales and in tiff (or other raster) format. The flood hazard maps are based on, primarily, MODIS 250 surface water mapping during large flood events (see above data products) but also locally on other satellite sensors such as Radarsat and Landsat. **SOPAC** - Support countries in simplifying warning messages to meet user needs, strengthening institutional arrangements and communication equipment. **UNEP** – Capacities currently under development
Drought Desertification	**FAO –** Global Information Early Warning Service (GIEWS) web-based platform; publications "Food Outlook", "Foodcrops and Shortages" and "Food Supply Situation and Crop Prospects in Sub-Saharan Africa"; numerous Special Alerts and Special Reports are also produced. **UNEP** - Production process and distribution of GEO for desert (organization's core mandate).

Wildland Fires	**GFMC** - Public distribution of fire danger warnings for all countries producing electronic map products on a daily basis via the World Wide Web. CFS and BCRC.
Locusts	
Epidemics	**WHO** - Outbreak Verification List (OVL) reports current outbreaks thought to have a potential for international implication, either verified or under verification; Disease Outbreak News provides public information about officially confirmed outbreaks of international importance; Weekly Epidemiological Record covers epidemiological information on cases and outbreaks of diseases under the International Health Regulations (yellow fever, plague, cholera) and also on other communicable diseases of public health importance.
Environmental Degradation	**UNCCD –** Through National Action Programmes assessment of land degradation are being promoted. **UNEP** - Production process and distribution of the family of UNEP-GEO products; UNEP activities in environmental degradation and policy development, impacts of environmental degradation on societies and economies, strategies for land use management and soil conservation, etc.

4- RESPONSE CAPABILITY

Response capability: sectors of activity through which organizations contribute to enhancing global capacity in response preparedness with regard to hazards under their mandate.

CROSS-CUTTING ACTIVITIES FOR RESPONSE CAPABILITY

IFRC - Readiness to reduce the impact of disasters is central to the work of the International Federation and its member Red Cross and Red Crescent Societies around the world. This is carried out alongside work to help National Societies respond to the consequences of disasters at local, national and international levels. The following four approaches have been identified:

- reducing the vulnerability of households and communities in disaster-prone areas and improving their ability to cope with the effects of disasters,
- strengthening the capacities of National Societies in disaster preparedness and post-disaster response,
- determining a role and mandate for National Societies in national disaster plans, and
- establishing regional networks of National Societies that will strengthen the Federation's collective impact in disaster preparedness and response at the international level.

Vulnerability and Capacity Assessment (VCA) is a basic process used to identify the strengths and weaknesses of communities/ countries in relation to disaster management. A people-centred and community based early warning initiative has very recently been added to IFRC's activities and will increasingly become a major element of disaster risk reduction. Strengthening early warning systems will result in an improved sustainability of development, a major issue with regard to already existing policies and action plans. Local level resilience through effective preparedness for disaster response must be a central element of any early warning system.

ITU - Supports early disaster response action through radio amateur services (assisting in organizing relief operations in isolated or difficult-to- reach areas, especially when other services are still not operational), broadcasting services (support to the coordination of relief activities by disseminating relevant information to the population), Earth exploration satellite services (damage assessment for planning relief activities), and fixed and mobile telecommunications services (exchange of information among disaster responders).

MUNICH-RE – Courses, seminars, participation in experts' committees.

OCHA - Supports UN resident coordinators and UN country teams through network of Regional Disaster Response Advisors in response preparedness activities; provides a range of OCHA's emergency response tools and services; advocates for disaster response preparedness for cyclical events; facilitates/improves linkages in response preparedness with stakeholders in all disaster phases; supports DMTP activities. Supports ISDR in the implementation of cluster V of the Hyogo Framework: 'Preparedness for better response'.

ProVention Consortium – In partnership with the World Bank's Distance Learning Program, ProVention to support learning and innovative practice in community-based disaster preparedness including a flood risk reduction project in Sudan and community risk, vulnerability, and capacity assessment projects in Central America and elsewhere.

UNDP - Provides programme countries with technical assistance and financial support for the design and implementation of disaster reduction strategies and capacity-building programmes addressing a range of relevant issues: the strengthening of administrative and legislative systems; community-based disaster reduction; early warning systems; national disaster reduction plans etc.

UNEP - UNEP's APELL programme raises local awareness and preparedness of local communities vulnerable to industrial accidents triggered by accident or by natural disaster. Prepared to support rapid environmental assessments to identify immediate threats and preliminary environmental assessments for early recovery on request.

UNESCO/IOC – through its International Tsunami Information Centre (ITIC) in Hawaii, IOC develops and provides numerous educative materials on tsunami preparedness at all levels, including school children, disaster managers and political decision makers, for over four decades.

UNU-EHS - Will organize training courses for mid- and high-level decision makers and managers responsible for emergency services, public utilities and natural resources management, land-use planning and land development at national, regional and in particular at the local authority/municipal levels. The initiative aims at incorporating disaster risk reduction in urban development plans and management practices through training programmes, lectures and workshops.

WFP - Capacity building in food-related aspects of emergency preparedness and risk management at the community, national and regional levels.

WMO - WMO is initiating an advocacy campaign, based on a portfolio of good practices, to raise awareness among decision-makers of the benefits of using weather-, climate- and water-related information (e.g., risk identification and early warning, hazard mapping and risk assessment) in policies and planning activities associated with disaster risk prevention, preparedness, response and recovery. WMO is initiating an Education and Training Programmes for the NMHSs to develop educational modules targeted at stakeholders including media, risk management authorities and schools and to implement training for NMHSs to enhance their understanding of and contribution to disaster planning and preparedness activities at the national to local levels.

HAZARD	HAZARD-SPECIFIC ACTIVITIES FOR RESPONSE CAPABILITY
Volcanoes	**ADRC** - Seminars on disaster management for government officials. **SOPAC** - Support and strengthening of National Disaster Management Offices and disaster management arrangements; training of disaster managers. **UNESCO –** Training workshops and evacuation drills.
Earthquakes	

Tsunami	**ADRC** - Development of educational materials; dissemination of tsunami knowledge and awareness raising; education projects in schools; training on early warning systems. **SOPAC** - Tsunami Awareness Kit. **UNEP** - UNEP's Asian Tsunami Disaster Task Force has produced the publication "After the Tsunami: Rapid Environmental Assessment" to identify, and bring to the international community's immediate attention urgent environmental risks and to ensure that the environment is fully integrated into the region's reconstruction and development agenda. Documentation of good practices as support activities to national governments. **UNESCO/IOC –** Collaboration with UNISDR in response-preparedness support programmes.
Landslides	**ADRC** - Seminars on disaster management for government officials. **UNESCO –** Training workshops and evacuation drills.
Cyclones Hurricanes Storms Temperature Extremes	**ADRC** - Seminars on disaster management for government officials. **WMO** - Strengthening the linkages of the hydrometeorological community with the disaster risk management and response communities.
Permafrost Snow Avalanches	**WMO** - Strengthening the linkages of the hydrometeorological community with the disaster risk management and response communities.
Floods Mudflows	**ADRC** - Seminars on disaster management for government officials.
Drought Desertification	**WMO** - Strengthening the linkages of the hydrometeorological community with the disaster risk management and response communities.
Wildland Fires	**GFMC** - Technology transfer and training; cooperation with UN and UNEP / OCHA Environment Unit, supporting the UN with wildland fire early warning information and reconnaissance, especially in wildland fire crises; participation in the Regional Wildland Fire Networks under the umbrella of the UNISDR Global Wildland Fire Network (GWFN).
Locusts	
Epidemics	**WHO** - Convening stakeholders to agree on ways to help cope with and manage threats (evacuation and quarantine procedures, guidelines for the management and triage of mass casualties, prioritising health services); establishing and agreeing on criteria for implementing standard mitigation procedures. Strengthening capacity at all levels to prepare for, mitigate, respond to and recover from disasters, as well as search and rescue operations. Strengthening capacity to establish disease surveillance and control measures in a timely manner; effective coordination before, during and after a crisis.
Environmental Degradation	**UNCCD –** facilitates implementation of methodologies for benchmarks and indicators of land degradation. **UNEP –** UNEP's Division of Technology, Industry and Economics (DTIE) carries out projects in understanding and implementing action on the cyclical links between environmental management and disaster risk reduction.

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