Background Paper for the

Foresight Project-State of Science:

Early Warning in the context of Environmental Shocks:

Demographic Change, Dynamic Exposure to Hazards, and the Role of EWS in Migration Flows and Human Displacement

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4th August2011

Contents

SUMMARY

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Many institutions, organizations, experts and social groups are engaged at various levels in running components and different types of Early Warning Systems (EWS). At the global and UN level, WMO and IOC-UNESCO are important institutions working with a number of partners and stakeholders at various levels to run, for example, the tropical cyclone and tsunami warning system and programs in different ocean basins. Compared to early warning systems for rapid-onset hazards (floods, cyclones, tsunamis etc.), warning and response systems for creeping and slow-onset hazards have received less attention and are less advanced. Also, the systematic integration of issues regarding migration has not yet been achieved within the context of EWS for natural hazards and related disasters.

In general, EWS aim to inform people and to influence their decisions and behaviour in times of adverse conditions and crises. Thus EWS should not solely function as technical systems for hazard detection, but should also provide incentives and appropriate information to trigger and influence actions and the behaviour of social agents at various levels so that they can prepare for hazard events and disaster situations. Until now, most EWS have focused mainly on the immediate warning and evacuation processes, thus on the function of saving lives in the context of an extreme event or its adverse consequences; however, in the light of climate change more attention must also be paid to the question of how EWS can improve their warning and thus improve livelihood security.

This means that EWS must not be improved solely in terms of the detection of different hazards and their characteristics, such as wave height, drought intensity and earthquake intensity, to name just a few, but rather EWS must also address the challenges linked to the so-called Last Mile. The notion of the Last Mile originated from the need that EWS have to reach people at the local and community level with appropriate information in order to ensure that anticipated responses at the Last Mile can take place (Shah 2006). In this context, the issues of the Last Mile and preparedness strategies indicate that EWS need to pay more attention to risk knowledge, response capabilities, and vulnerabilities of communities, including aspects of temporary migration.

Additionally, a key subject identified in the study is Early Warning Governance. In order to build up effective and people-centred EWS, improved coordination and information chains are needed that also include local communication and risk management structures. Hence, it is important to have effective and decentralized governance systems and structures that are characterized by strong links between the national and the local levels. Thus EWS have to ensure and establish a kind of dialogue structure in order to ensure that local and national perspectives are considered. In this regard, community-based

approaches, multi-stakeholder participation, and multi-disciplinary approaches are also essential for sustainable EWS that are developed for and with the community and people at risk.

EWS are also important tools to bridge and link Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) (see Birkmann and Teichman 2010). Early Warning and preparedness strategies form a key pillar of enhanced and adaptive Disaster Risk Management (Birkmann, Chang Seng, Suarez 2011). A gap that has to be addressed is information constraints for the establishment of effective and forward-looking EWS. For example, many EWS might account for climate change and physical and biogeochemical climate scenarios, but less knowledge is available on scenarios for vulnerability and exposure. For a city and its respective EWS it makes a great difference if the population of today has to be warned and evacuated or whether a further increase in urbanization might mean that twice the number of people need to be warned.

Furthermore, EWS need to deal with the challenges of complexity and uncertainty in the light of climate change and socio-economic changes, including migration. Particularly in the light of complexity and uncertainty, EWS need to pay more attention to issues such as effective and transparent communication strategies, and risk perceptions at the Last Mile in order to better account for the specific challenges linked to climate change. Various cases and disasters – such as Hurricane Katrina in the United States – have shown that once the trust in the EWS and its institutions is lost, most systems fail to provide an effective response mechanism to deal with environmental shocks and appropriate human responses.

In this context, EWS should be based on inclusive and good governance concepts, and should encourage actors and people at risk to exercise agency, particularly where and when the state actors are unable to do so. Many countries that are highly vulnerable to environmental shocks and climate change also have serious problems in terms of governance. Countries such as Somalia, which is currently seriously affected by a drought disaster, are even classified as failed states (Fund for Peace 2011). Thus in these failed states, the capacity of state institutions to provide support for coping in times of adverse consequences is normally non-existent or very limited. Thus, if the performance at the national level is very weak there might be no other alternative than to introduce EWS and preparedness concepts at the local level.

Furthermore, the study also shows that many EWS still dominantly focus on one hazard only. While there is a clear need to strengthen multi-hazard assessment, the study underscores that we need to move beyond this. What is needed are EWS and preparedness strategies that account for multi-risk management. Only if the daily risks and issues at the Last Mile are also sufficiently considered, can a warning system be described as people-centred. Other pressing challenges are linked to the issue of Last Mile and legitimacy. In many cases, decentralisation is either flawed in the concept or poorly supported due to the absence of an institutional financial mechanism and adequate resources at multiple levels. Although there are attempts to develop and recognize local approaches, the key difficulty is improving the legitimacy of these mixed EWS approaches. EWS in general are still often top-down expert systems that do not sufficiently link national and local institutions and interests.

Moreover, population growth, urbanisation, and migration are important factors that will modify and in most cases increase exposure and in some cases increase vulnerability, e.g. through a higher number of people in urban areas having access to basic infrastructures or warning information, but being exposed to coastal or other hazards. In this regard, EWS and preparedness concepts need to give more attention to the dynamics of exposure and vulnerability as well as issues of mobility, temporal migration and displacement. Mobility is a particularly important aspect of people's exposure and their adaptive capacity.

Information on exposure provides knowledge about the distribution of the population or elements at risk and serves as a basic consideration in EWS and disaster risk reduction in general. However, in nearly all EWS analyzed within this study, migration has not been systematically included as an indicator or data set. Migration can be an important indicator that a destabilization process might take place. On the other hand, particularly people that are on the move or in temporary camps need early warning information about new hazards, since most of them are not familiar with the environment they are living in. Also, examples show that health risk related EWS are needed for those who are migrating into a new environment and therefore are not prepared for such diseases. Additionally, in some cases migrant populations are blamed for transporting new diseases to other regions, and consequently there are sometimes conflicts between host and guest communities. In this regard, more transparent and available information about health risks from independent EWS would probably improve the situation. On the other hand, the EWS dilemma must also be addressed, namely that in some cases people might not be interested in monitoring and disseminating risk information especially if they might face economic losses, for example in terms of trade restrictions due to livestock diseases.

At present, EWS – even those of humanitarian organizations, such as the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) - monitor socio-political development threats as part of the process of early actions. However, this information about socio-political developments is often not a systematic integration of these aspects into EWS. Only very few EWS and projects – such as the Global Pulse Project of the UN – focus on migration as one indicator of instability.

Finally, it is important to note that early warnings and alert messages can lead to migration and even forced migration, such as in the case of Hurricane Katrina or in the context of the Japan earthquake and tsunami in 2011. Often these warnings are also constraint by limits of knowledge, e.g. in terms of the further development of the crisis. On the other hand, forced migration might increase if no warnings are issued and trust is lost in state and governmental institutions at local and national levels.

The study concludes that more attention should be paid to critical thresholds, potential tipping points in social-ecological systems, dynamic exposure, and response capabilities of communities at the so-called Last Mile.

So far, most EWS have been successful in providing information especially regarding short-term evacuation processes. Some EWS also take into consideration medium and long-term trends, particularly linked to droughts. However, most EWS do not really monitor trends in risk development. Also, initial steps have been undertaken to integrate and consider daily mobility patterns in an early warning and evacuation process (e.g. the city of Padang / Indonesia); however, what is still missing is a more systematic inclusion of migration issues and displacement processes in early warning. This means that push and pull factors for migration – including the issue of potential and actual tipping points - should play a stronger role in EWS, especially linked to creeping changes. EWS also need to take account of potential migration flows in the light of climate change, especially sea level rise. This might mean that specific preparedness concepts are needed that provide first answers on where people can go in the case of a major extreme event, such as a tropical cyclone, which, linked with sea level rise would impact coastal communities, for example in small island states. Finally, the role of EWS for migration and displaced population groups has not been sufficiently documented and evaluated. The further enhancement of EWS in terms of dealing with migration issues also requires new approaches to early warning governance. Key criteria for effective and sustainable early warning governance have been outlined and need to be transferred to institutions that deal with voluntary and forced migration in the light of environmental and socio-economic change.

1.0 Introduction

By Denis Chang Seng and Jörn Birkmann

1.1 Objectives and Scope of the Study

The aim of this study is firstly to review and identify the key institutions and stakeholders running various EWS. Secondly, it examines and discusses EWS in the context of the Last Mile and preparedness, and governance aspects of different EWS in the context of environmental shocks. Thirdly, the study examines and explores the role of EWS in regard to migration and displacement, particularly because vulnerable migrant groups often have less local knowledge, and have a special need to receive early warning information in case they are exposed to a hazard event, including epidemics and other health-associated risks. Fourthly, we highlight the key policy-relevant lessons learnt, and underscore the new challenges of EWS pertaining to new environmental shocks and in the light of migration and human displacement. Lastly, recommendations are proposed for improving EWS and preparedness, particularly regarding the improved consideration of migration and human displacement in EWS.

The specific objectives include understanding:

i. The key institutions and stakeholders running various EWS, focusing on both rapid and slow onset hazards/impacts;
ii. The role of EWS in the context of the Last Mile and preparedness, and in terms of not only saving lives and reducing property damage but also addressing livelihood issues;
iii. Governance and measures which make EWS successful in terms of preparing for environmental shocks;
iv. The role and challenges of EWS in migration and human displacement;
v. Policy-relevant lessons learnt and the key challenges in terms of new hazards or environmental shocks in the Last Mile and in the light of migration and human displacement;
vi. The progress needed in order to improve people-centred EWS and their preparedness function for local communities at risk in the light of migration and human displacement;

1.2 Early Warning Systems (EWS)

Firstly, it is important to understand what EWS are and to examine their purposes. According to UN-ISDR, 'early warning' is defined 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' (ISDR 2004). EWS are a major element of disaster reduction. They should empower societies and communities to prepare for and confront the power and the uncertainties of both natural and climate change-driven hazards. EWS provide resilience to natural hazards, and protect economic assets and development gains (IEWP 2006). EWS exist for natural geophysical and biological hazards, complex socio-political emergencies, industrial hazards, personal health risks and many other risks.

The traditional framework of EWS is composed of three phases: monitoring of precursors, forecasting of a probable event, and the notification of a warning or an alert should an event of catastrophic proportions take place (Villagran 2006). It is essentially, a linear, top-down warning chain that is expert-driven and hazard-focused from observation through to warning generation and transmission to users (Basher 2006). An improved four-phase EWS framework is currently being promoted by the International Strategy for Disaster Risk Reduction (ISDR) and partners (Figure 1). ISDR underlines that for an EWS to be effective it must be people-centred and should integrate and include four elements as defined by the ISDR model, namely: (i) knowledge of the risks faced; (ii) a technical monitoring and warning service; (iii) the dissemination of meaningful warnings to those at risk; and (iv) responses which depend on public awareness and preparedness. While this set of four elements appears to have a logical sequence, in fact each element has a direct, two-way linkage and interaction with each of the other elements. New concepts and strategies on how to improve and extend frameworks for institutional and governance issues in Early Warning Systems have been developed by Chang Seng (2010).

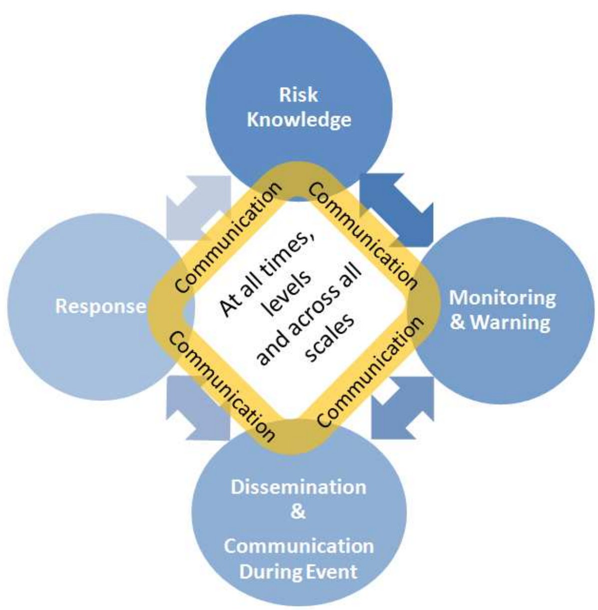

Figure 1: The four elements of an effective EWS framework
Source: International Early Warning Programme 2006, Modified version by Chang Seng 2010

Rapid/sudden-onset and slow-onset events have different lead time prediction. EWS are capable of issuing warnings of tens of seconds for earthquakes, minutes for tornadoes, minutes to hours for tsunamis, hours to days for volcanic eruptions, or hours to weeks in the case of tropical cyclones. EWS for drought as a slow–onset event can have in the range of weeks to months of lead time. For climate variability-related signals (El Niño, La Niña) warning time provided by warning systems increases to years or even decades of lead time since these are slow-onset threats (i.e. global warming).

2.0 EWS Institutions and Case Studies

There are many institutions, organizations and agencies that specialize in or are concerned with natural hazards. Globally, many countries are striving to improve their EWS. However, EWS often lack one or more elements. On the other hand, various institutions, organizations and stakeholders operate individual components of the complete EWS. Some institutions are engaged only in monitoring and forecasting while others are involved in dissemination, communication and response to targeted users (local early warning applications) or broadly to communities, regions or to media (regional or global early warning applications). Very recently, Grasso (2011) conducted an extensive inventory of existing alert warning/monitoring systems detailing the key institutions and actors running these systems. The systems were classified as rapid-sudden onset hazards (wild fires, earthquakes, tsunamis, volcanic eruptions, severe weather, storms, tropical cyclones and epidemics) and slow-onset creeping threats (air quality, desertification, droughts, impacts of climate variability). The table in the Annex shows a selected list of institutions operating alert and warning systems. In the following section, we examine key institutions and stakeholders operating systems related to EW. We focus on selected examples of institutions and stakeholders operating rapid-sudden onset hazards (i.e. tropical cyclones, tsunamis) in contrast to slow-creeping hazards (i.e. desertification and drought).

2.1 EWS for Sudden-Onset Hazards

2.1.1 Storms and Tropical Cyclones

The World Meteorological Organisation (**WMO**), World Weather Watch (WWW) and Hydrology and Water Resources Programmes coordinate and provide global collection, analysis and distribution of weather observations, forecasts and warnings. The WWW is an integral part of the Global Observing System (GOS), which provides the observed meteorological data. The WMO Global Telecommunications System (GTS) facilitates the exchange of reports, observations, forecasts and other products, while the Global Data Processing System (GDPS) provides weather analyses, forecasts and other information. It is an ideal, efficient model of an operational framework of coordinated national systems, operated by national governments. The World Climate Programme

(WCP) and the Tropical Cyclone Programme (TCP) provide access to climate data and applications, and are responsible for issuing tropical cyclone and hurricane forecasts, warnings and advisories.

Region	Description	Links to Centres (RSMC and TCWC)
I-II	Atlantic and Eastern Pacific	National Hurricane Centre (RSMC Miami)
III	Central Pacific	Central Pacific Hurricane Centre (RSMC Honolulu)
IV	North-West Pacific	Japan Meteorological Agency (RSMC Tokyo)
V	North Indian Ocean	India Meteorological Department (RSMC New Delhi)
VI	South-West Indian Ocean	Météo France (RSMC La Réunion) *en Français*
VII-X	South-West Pacific and South-East Indian Ocean	Australian Bureau of Meteorology (TCWC Perth) Australian Bureau of Meteorology (TCWC Darwin) Papua New Guinea (TCWC Port Moresby) Australian Bureau of Meteorology (TCWC Brisbane)
XI-XII	South Pacific	Fiji Meteorological Service (RSMC Nadi) Meteorological Service of New Zealand, Ltd. (TCWC Wellington)

Table 1: Regional Tropical Cyclone Centres, Source: WMO

For instance, at the global level, WMO-TCP seeks to promote and coordinate efforts to mitigate risks associated with tropical cyclones. TCP has established tropical cyclone committees that extend across the regional bodies (Regional Specialized Meteorological Centres (RSMC) and which, together with National Meteorological and Hydrological Services (NMHSs), monitor tropical cyclones globally and issue official warnings to the Regional Meteorological Services of countries at risk. Table 1 lists the key institutions, regional Specialized Meteorology Centres (RSMC) and Tropical Cyclone Warning Centres (TCWC) participating in the WMO Tropical Cyclone Programme. For example, Météo France is the mandated Regional Tropical Cyclone Centre based at La Réunion for region VI in the South-West Indian Ocean. Some of the national member countries involved in the South-West Indian Ocean tropical cyclone programme include, Mauritius, Madagascar, Seychelles, Comoros, Tanzania, Kenya, Mozambique, Australia etc. Individual countries are responsible for their own national tropical cyclone programme and EWS. The member countries have adopted standardized WMO-TCP operational plans and manuals that are updated on a regular basis. According to Grasso, the University of Hawaii collects information from WMO and provides online information on cyclone category, wind speed, and current and predicted courses.

Figure 2: Environmental damage and destruction to the manager’s office at Providence Island in the Seychelles, caused in December 2006 by an intense cyclone of a strength never observed or experienced before. EWS played a key role in safeguarding the lives of the inhabitants
Source: DRM, 2007

2.1.2 Tsunami

Global Tsunami EWS

A global tsunami warning system similar to that of the WMO tropical cyclone warning system is gradually emerging under the leadership of IOC-UNESCO. The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) received a mandate from the international community to coordinate the establishment of the tsunami EWS system during the course of several international and regional meetings, including the World Conference on Disaster Reduction (Kobe, Japan, 18 – 22 January 2005). The IOC General Assembly XXIII in Paris, 21-30 June 2005 adopted resolutions to create three[1] new (apart from the existing Pacific TEWS) regional Intergovernmental Coordination Groups (ICGs) for tsunami EWS for the (1) Indian Ocean, (2) the North-East Atlantic, and (3) Mediterranean as well as the Caribbean to establish a basin-wide TWS (Figure 3). Together with the existing system for the Pacific and other relevant UN bodies they will also contribute to the work of a global coordination group on tsunamis and other sea level-related hazard warning systems.

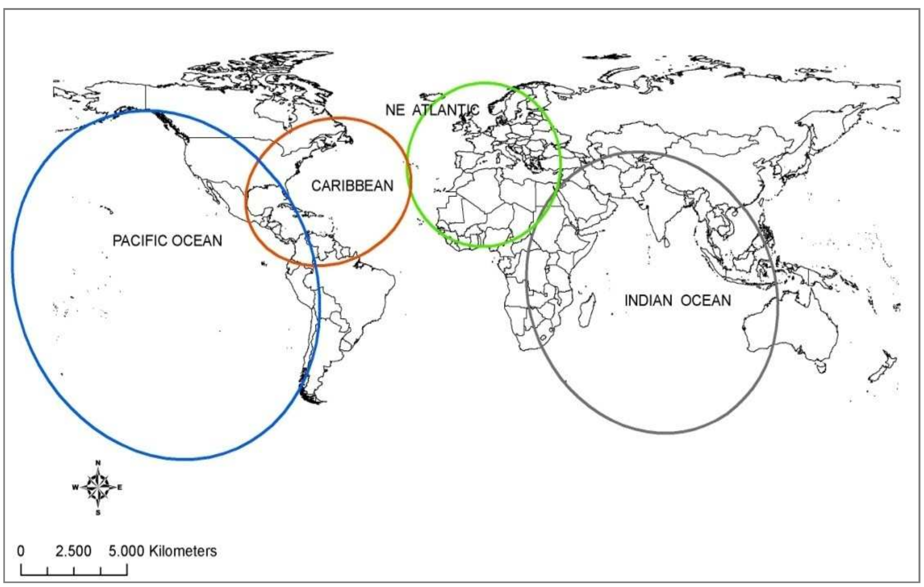

Figure 3: Global-regional governance of tsunami
Source: Chang Seng after IOC-UNESCO 2010

Pacific Tsunami EWS

The Pacific Tsunami Warning System (PTWS) operates in the Pacific basin from Hawaii, carrying out seismic monitoring operated by PTWC, USGS and ATWC to detect potentially tsunamigenic earthquakes. It serves as the regional centre for Hawaii and as a national and international tsunami information centre, issuing

[1] In addition to the TEWS in the Pacific Ocean

tsunami warnings to Member States. On the other hand, the National Oceanic and Atmospheric Administration (NOAA) national weather service operates the Pacific Tsunami Warning Centre (PTWC) and the Alaska Tsunami Warning Centre (ATWC) in Palmer, Alaska, which serves as the regional tsunami warning centre for Alaska, British Columbia, Washington, Oregon, and California. Official tsunami bulletins are disseminated by PTWC, ATWC, and the Japan Meteorological Agency (JMA).

Emerging Indian Ocean Tsunami EWS

Currently, interim advisories are provided by the Pacific Tsunami Warning Centre (PTWC) and the Japan Meteorological Agency (JMA) for the Indian Ocean. The ICG for the Indian Ocean Tsunami Warning System ICG/IOTWS is a primary subsidiary body of the IOC, which was created and governed by a governing body comprising 28 Member States from countries bordering the Indian Ocean. Thus, the IOC provides secretariat support to the ICG/IOTWS. Membership of the ICG/IOTWS is open to Member States bordering the Indian Ocean, other IOC Member States interested as observers, and invited NGOs and other organizations. The system is fully owned by Indian Ocean countries and is based on international and multilateral cooperation. It facilitates open and free data exchange and is transparent and accountable to all the countries. The IOTWS function is based on joint operation of international networks of observation connected with the national tsunami warning centres. In addition, ICG/IOTWS also expects countries to build on the current progress and expects one or more regional tsunami watch providers to play a similar function to PTWC. It is expected that Australia, India, Indonesia, Malaysia and a regional centre in Bangkok will take over this function. This means that the Indian Ocean region will no longer rely solely on official tsunami notifications from PTWC or JMA.

Indonesian Tsunami EWS

Since 2005, steps have been taken to develop an Indian Ocean tsunami warning system. These steps have included establishing 26 tsunami information centres and deploying 23 real time sea level stations and three deep ocean buoys in countries bordering the Indian Ocean. The Indonesian Tsunami EWS, supported mainly by Germany and partners was inaugurated in November 2008. The system has made much progress, particularly in terms of improving effectiveness in seismic observation and tsunami forecasting, especially with the introduction of a new processing and forecasting procedure that works in an automatic fashion, using a novel expert Decision Support System (DSS), which is particularly useful for application in a crisis situation. However, despite this success, considerable work needs to be done across all other EWS elements for it to become a reliable and effective TEWS, especially in terms of improving dissemination and communication, ensuring there is a functional legitimate warning chain from the national level to the local level, and improving the preparedness in all tsunami risk communities (Chang Seng 2010).

In addition, inter-institutional arrangements and coordination for tsunami warnings have improved in certain high risk communities such as in West Sumatra, Padang and Bali in Indonesia. Key mechanisms that have helped to improve coordination include the establishment of multi-level DM architectures and SOPs backed by regulations and the new Disaster Management law enacted in 2007. A final consensus on a tsunami warning chain is gradually emerging, especially in the tsunami high risk areas (See Figure 1). Actors have agreed through the Governors Decree that once tsunami information is received from a tsunami warning Centre or interface response institution, the provincial and district governments through their respective Emergency Operations Centres (EOCs) have the legitimate authority to make decisions as per SOPs.

International and National Tsunami Information Centre

International and national tsunami information centres exist worldwide. The International Tsunami Information Centre (ITIC) based in Honolulu was established in November 1965 by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). ITIC maintains and develops relationships with scientific research and academic organizations, civil defence agencies, and the general public in order to carry out its mission to mitigate the hazards associated with tsunamis by improving tsunami preparedness for all Pacific Ocean nations. ITIC is also assisting in the development and implementation of tsunami warning and mitigation systems globally. Its key responsibilities include monitoring the international tsunami warning activities in the Pacific and other oceans, and recommending improvements in communications, data networks, acquisition and processing, tsunami forecasting methods, and information dissemination. It also assists Member States in the establishment of national and regional warning systems, and the reduction of tsunami risk through comprehensive mitigation programmes.

2.1.3 Floods

Floods caused by storms or cyclones often lead to fatalities, injuries, and losses of many kinds. The International Strategy for Disaster Reduction reports that most fatalities associated with floods occur in the less developed regions, while economic losses associated with floods are concentrated in developed regions (ISDR, 2007b). In the context of early warning, the same report by ISDR indicates that through disaster preparedness and early warning, the impacts of floods can be reduced dramatically.

Grasso (2010) reports that floods are monitored worldwide from the Dartmouth flood observatory, which provides public access to major flood information, satellite images and estimated water discharge. Satellite microwave sensors can monitor, on a global scale and on a daily basis, increases in floodplain water surface, and are not affected by cloud interference. The Dartmouth flood observatory provides estimated discharge and satellite images of major floods worldwide but does not provide forecasts of flood conditions or precipitation amounts that could allow flood warnings to be issued days in advance of events. On the other hand, NOAA provides observed hydrologic conditions of US major river basins and predicted values of precipitation for rivers in the United States. NOAA also provides information on excessive rainfall that could lead to flash-flooding, and if necessary, warnings are issued within six hours, in advance. IFnet Global Flood Alert System (GFAS) uses global satellite precipitation estimates for flood forecasting and warning. The GFAS website publishes useful public information for flood forecasting and warning, such as precipitation probability estimates, but the system is currently running on a trial basis.

On a local scale there are several stand-alone warning systems, for example, in Guatemala, Honduras, El Salvador, Nicaragua, Zimbabwe, South Africa, Belize, Czech Republic and Germany. However, they do not provide public access to information. The European Flood Alert System (EFAS), which is under development by EC- JRC, will provide early flood warnings to National Hydrological Services in order to mitigate flood impact on population. The EFAS testing is being performed for the Danube river basin, focusing on the system's calibration and validation. EFAS is intended to monitor floods in Europe and to issue early warnings for floods up to 10 days in advance. This information will be sent to civil and water management agencies to help them efficiently implement their plans in downstream areas. It could also help the European Commission and international aid organizations to better prepare and coordinate their actions.

In this context, an interesting example of a people-centred flood EWS in the rural areas in developing countries is the Togolese flood EWS supported by the Togolese Government and the German Red Cross. The rural populations most vulnerable to floods live alongside the main river systems (Mono, Zio, Haho, Oti, Anié), which, during the rainy season regularly burst their banks in their lower reaches (Figure 4). Thus, a timely and effective local flood EWS is desirable.

Figure 4: Flooding in Togo.
Source: Dak Martin Doleagbenou 2011

The local flood EWS consists of 45 flood warning poles placed on the main river system. The flood warning pole indicates three levels of alert: green, yellow and red. A network of 495 community volunteers are involved in the 140 villages. The system uses phone networks to alert the communities at risk. People at the upper level of a river inform the communities downstream through mobile phones if the river rises or a local indicator is noticed. Interestingly, there is no hierarchy in the flood EWS system. The information is shared directly between the villages, and any decision about an eventual evacuation is taken by the chief of the village in cooperation with the trained volunteers. To improve the effectiveness, sustainability and relevance of the local EWS approach, local warning and preparedness strategies need to link in with national and global systems of Early Warning. This also means that local systems can make use of scientific data, and address potential communication failures and other issues.

Grasso (2010) finds that although floods are the deadliest natural hazards that are currently increasing in frequency, there is inadequate coverage of flood warning and monitoring systems, especially in developing or the least developed countries such as China, India, Bangladesh, Nepal, West Africa, and Brazil. In addition, on a global scale, flood monitoring systems are more developed than flood early warning systems, which have received less attention. For this reason, existing technologies for flood monitoring must be improved with a view to increasing prediction capabilities and flood warning lead times.

2.1.4 Epidemics

The World Health Organisation (WHO) is a key institution that provides information related to health risks and other public health emergencies.

Epidemics pose a significant threat worldwide, particularly in those areas that are already affected by other serious hazards, poverty, or underdevelopment. Globalization increases the potential for a catastrophic disease outbreak. A global disease outbreak EWS is urgently needed. WHO has launched a new integrated disease surveillance programme known as the Global Alert and Response System (GAR). This envisages all surveillance activities in a country as a common public service that carries out many functions, using similar structures, processes and personnel. The purpose of the programme is an integrated global alert and response system for epidemics and other public health emergencies. GAR tracks the evolving infectious disease situation, raises an alarm when needed, facilitates the sharing of expertise, and mounts the response needed to protect populations from the consequences of epidemics. Surveillance is based on collecting only the information that is required to achieve the objective of controlling diseases. Data requested may differ from disease to disease, and some diseases may have specific information needs, requiring specialized systems. WHO's integrated disease surveillance strategy has been endorsed by all Member States and is being adapted in the African region. In April and May 2004, WHO, in collaboration with other United Nations agencies, non-governmental organizations, Federal Ministries of Health and State Ministries of Health developed an EWS to detect, respond to and control outbreaks in camps and host communities for displaced people in North, South and West Darfur states. Countries where an EWS was implemented in 2002 are Egypt, Iraq, Jordan and Serbia. Activities using an integrated approach are under way in the Eastern Mediterranean, Europe and South-East Asia. The surveillance activities that are well developed in one area may act as driving forces for strengthening other surveillance activities, offering possible synergies and common resources.

Malaria is the most well known of the climate-sensitive diseases. Epidemics of malaria are often triggered by climate anomalies, and climate-informed EWS have been advocated in recognition of this. Africa bears the greatest burden of malaria worldwide and it is estimated that almost 125 million people live in areas prone to malaria epidemics. According to Grasso (2010), malaria EWS are not yet available and the need for system development is pressing, especially in Sub-Saharan Africa where malaria causes more than one million deaths every year. However, risk maps based on rainfall anomalies and distribution are provided by the IRI institute of Columbia University, but no warnings are disseminated to the potentially affected population. There are increasing collaborative efforts to develop an Epidemic Early Warning & Response system. For example, Ethiopia is the country with the highest proportion of the population (more than two thirds) living at risk of malaria epidemics. The Ministry of Health has commissioned the National Meteorological Agency to provide routine meteorological information to inform on changing conditions in epidemic-prone districts (Connor, Dinku, Wolde-Georgis et al 2006).

Figure 5: Vaccination campaign in Darfur
Source: UN Photo/Olivier Chassot

2.2 EWS for Slow-onset and Creeping Hazards

2.2.1 Desertification

Land degradation affects many countries worldwide and has its greatest impact in Africa. In 1994, 110 governments signed the United Nations Convention to Combat Desertification (UNCCD). The Convention aims to promote local action programmes and international activities. National action programmes at the regional or sub-regional levels are key instruments for implementing the convention. Regional and local action plans and strategies are detailed in the programmes on how to combat desertification. Desertification maps, documentation, reports and briefing notes are provided on the UNCCD website. According to Grasso (2011), there are currently no complete desertification EWS, despite their potential benefits for desertification mitigation.

2.2.2 Droughts

Likewise, drought EWS are less developed systems due their complex processes and environmental and social impacts (see e.g. Grasso 2010). It is reported that only three institutions (FAO's Global Information and Early Warning System on Food and Agriculture (GIEWS), the Humanitarian Early Warning Service (HEWS) by the World Food Programme (WFP), and Benfield Hazard Research Centre of the University College London) provide some information on major droughts occurring worldwide.

FAO-GIEWS is the institution that provides information on countries facing food insecurity through monthly briefing reports on crop prospects and the food situation, including drought information, together with an interactive map of countries in crisis, all available through the FAO website. However, the FAO-GIEWS, HEWS provide little information about food entitlements, access opportunities and access rights to different types of food, which are essential questions in times of drought. On the other hand, the HEWS prepares monthly packaged information on drought conditions from various sources, including FAO-GIEWS, WFP, and Famine Early Warning System (FEWS Net). It takes the form of short notes and a map, and is available from their website. In slight contrast, the Benfield Hazard Research Centre prepares monthly country-specific maps and short descriptions of current drought conditions. Grasso also highlighted that on a regional scale, there are various institutions and actors providing drought information, and these include the FEWS Net for Eastern Africa, Afghanistan, and Central America, and the United States Drought Monitor (Svoboda et al., 2002). The U.S. Drought Monitor is a joint effort between the US Department of Agriculture (USDA), NOAA, the Climate Prediction Centre, and the University of Nebraska Lincoln. It offers a unique approach that integrates multiple drought indicators with field information and expert input, and provides information through a single easy-to-read map of current drought conditions, and short notes on drought forecast conditions. It has become the best available product for droughts (Svoboda et al., 2002). Other institutions include the Beijing Climate Centre (BCC) of the China Meteorological Administration (CMA), the European Commission Joint Research Centre (EC-JRC), and also the WMO.

Figure 6: Somalia Suffers from the Worst Drought of the Century
Source: UN Photo/Stuart Price 2011

3.0 EWS in the Context of the Last Mile and Preparedness

Up to now, the approaches used to deal with the so-called Last Mile have varied from system to system. Compared to approaches that view the Last Mile solely as the final part of a top-down information and communication chain (Hollister 2008) or that put emphasis on the differences between the Last and the First Mile (see e.g. Thomalla and Larsen 2010; Richardson and Paisley 1998, Twigg 2003, Kelman 2009 etc.), we view the last mile as a frame to summarize and deal with issues of risk knowledge and potential response of the people. Furthermore, the Last Mile for us is also the place where the linking between national and local levels takes place and materializes. In this regard we also recognize the importance of community-based approaches, as well as multi-stakeholder and multi-disciplinary approaches, as good governance principles throughout the process.

3.1 Risk Knowledge and Response

The improvement of the EWS framework to a four-phase system (UNISDR 2006) specifically addresses the issue of the Last Mile (fourth phase). Earlier concepts and EWS frameworks did not pay sufficient attention to risk knowledge and response capabilities, although all EWS will fail if they cannot stimulate appropriate responses from people in harm's way.

The fourth element of the EWS *(International Early Warning Programme 2006)* is the response capability. It is essential that communities understand their risks; they must respect the warning service and should know how to react. The response system should include a designated agency for receiving and acting upon warnings, and critical infrastructures or lifelines should be identified to support evacuation. There should be drills, simulations and exercises to support the response phase.

Risk information generated by experts needs to be effectively communicated to the affected communities so that they are aware of the risks they face. Risk information (i.e. risk maps) needs to be developed in the context of a participatory approach with the local actors and the community. There should be a shift to preparing information "with" rather than "for" the community. Risk knowledge allows decision makers and the community to understand their exposure to various hazards and their social, economic, environmental and physical vulnerabilities. Risk information provides the basis for formulating policies and plans that allow effective preparedness (spatial planning and development) and response (evacuation).

3.2 Linking National and Local Level Institutions

3.2.1 Multi-Level Authority and Structures

An effective EWS requires multi-level and decentralized authority to address local problems. In this context, there is an increasing demand and requirement that national technical institutions and actors have the responsibility and mandate to issue advisories, alerts, and warning information to the respective stakeholders while the local government should be the legitimate authority for issuing guidelines and must decide what to do. This implies there is a need to have multi-level and scaled architecture/structures such as information hubs and emergency response centres to improve coordination and risk communication from the national level to the local level and vice versa (See also Figure 5 in the case of the Indonesia Disaster Risk Management System). Consequently, national agencies also have to better account for local needs and local risk communication procedures – including risk perceptions.

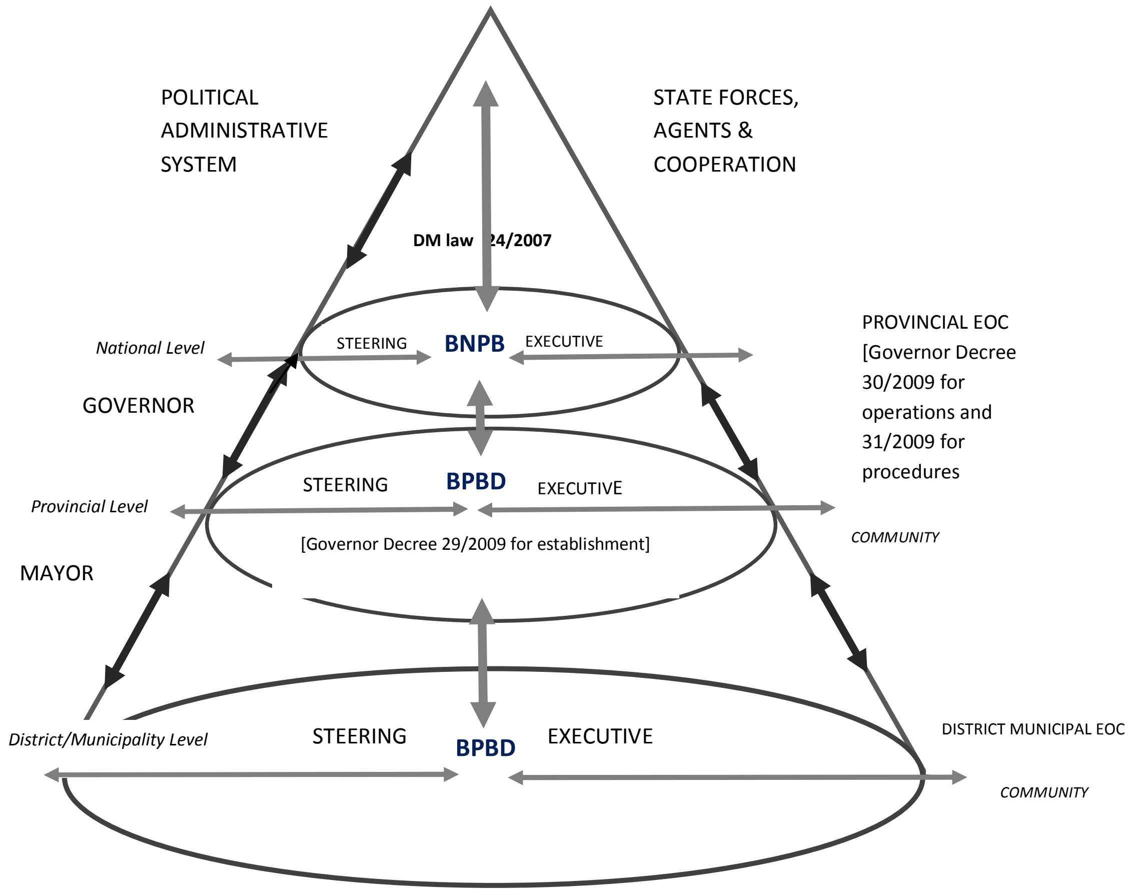

Figure 5: The multi-level architectures, structures and links to the community.
Source: Chang Seng 2010

3.2.2 Community-Based Approaches

Linking the national technical approach with local community-based approaches is becoming an important prerequisite for a legitimate and effective EWS. The relevance and strength of a local EWS depends on the cultural, technological and local governance setting, and the capabilities of the community. The participatory approach (PRA) is an important and effective method of implementing and sustaining an EWS, given limited technological conditions and socio-cultural context (Sagala and Okada 2007). In addition, traditional methods, community volunteers, and traditional leaders are particularly important assets for social networking and dissemination in a low-technology environment that does not have an end–to-end automated alert system. Equally important are the interest and priorities attached to community-based EWS. Chang Seng (2010) shows that the main contrast between the development of tsunami resilience in West Sumatra-Padang and Bali could be seen in the levels of interest, political commitment and participation between these two areas in Indonesia. Interest and political commitment were perceived to be higher in Padang compared to Bali, particularly soon after the December 2004 tsunami. For instance, Padang in West Sumatra has made more progress in institutional disaster preparedness at the local level compared to Bali. The key challenge is that multi-stakeholder partnership and institutional arrangements with the tourism sector, and the traditional and cultural structures are far more complex in Bali. On the other hand, Thomalla and Larsen (2010) found from post-tsunami EWS development in Thailand, Sri Lanka and Indonesia that recent calls to develop participatory and people-centred EWS as promoted by the Hyogo Framework for Action 2005 – 2015 have not been sufficiently translated into action in the implementation of national policies and strategies for early warning.

3.2.3 Multi-Stakeholder and Multi-Disciplinary Approach

Various studies have reported the importance and benefits of multi-stakeholder participation and the multidisciplinary approach. An effective EWS requires a multidisciplinary approach that recognizes all the stakeholders and the community and strives to create partnership (i.e. Keating 2006, Rodrıguez et al., 2004, Seibold 2003, Michaelis 1984, Quarantelli and Taylor 1977, Weller 1970, Chang Seng 2010). In the case of the Tsunami Early Warning System (TEWS) development in Indonesia, Chang Seng (2010) found a high degree of multi-stakeholder participation differentiated by various domains of knowledge and backgrounds operating vertically and horizontally at different levels and scales throughout the process. Highly scientific and technical actors (i.e. national meteorological institutions) tend to situate themselves at the national level, giving priority to the technical aspect of EWS (modelling and forecasting), while other actors such as civil societies with various domains of knowledge and expertise tend to operate at multiple levels, with interest and focus in the community-related activities (education, awareness, community-based risk mapping, drills etc). The multi-stakeholder participation tends to create a dynamic action arena, shaping the actions and outcomes at all levels. The establishment of the DRR platform in Indonesia began in 2006 and was declared official in November of 2008. It operates as a national mechanism for multiple stakeholders, acting as an advocate of DRR at different levels.

On the other hand, Thomalla and Larsen (2010), based on their research in Thailand, Sri Lanka and Indonesia, emphasize that very few platforms exist that enable stakeholders to coordinate and reconcile agendas, negotiate joint targets, share knowledge and critically reflect on lessons learnt, or to improve the integration of early warning with other priorities such as livelihood improvement, natural resource management and community development. In the case of Indonesia, the challenge associated with multi-stakeholder participation includes effective coordination between diverse actors operating at various levels and scales, duplication of structures and tasks, the existence of a certain level of conflict, and lack of transparency and accountability between the diverse actors on different issues, especially in regard to funding and resource allocation.

3.3 Enhancing the Focus from Saving Lives to Saving Lives and Livelihoods

3.3.1 Risk Perception, EWS and Livelihoods

People respond to hazards and risk in different ways. Some people respond by undertaking mitigatory measures, while others ignore the risks. Some studies support the assumption that human response options at the time of an earthquake (staying in place, seeking protection, grouping together with others, and so forth) varies with a person's physical situation and proximity to the earthquake's epicentre (Quarantelli 1996; Goltz et al. 1992). A person's selection of a response may also be influenced by others who are present at the time (Dynes 1993). Although recent studies have addressed human behaviour towards natural hazards in developed countries, human response to environmental risk in less-developed countries is still largely unknown, and the regulation of environmental risk to ensure efficient and equitable outcomes merits further research (Alexander 1993). Results of existing studies reveal that despite knowledge, high levels of concern, and perceptions about hazards and vulnerability, people's responses to environmental hazards may be biased or sub-optimal. A person may be aware of a hazard and know about mitigation measures, but still be constrained from appropriate action because of behavioural weakness and indecision, lack of money, community or social values, legal or bureaucratic impediments, or a host of other factors (Palm & Hodgson 1993). Perceptions are important factors influencing human reactions and response to hazards (Asgary & Willis 1997). In the United States, for example, the geographic pattern of insurance subscription is unrelated to relative geographic risk: households in areas subject to a high degree of ground shaking were no more likely to purchase insurance than those in less risky areas (Palm 1995). The strongest and most consistent predictor of earthquake insurance was perceived as vulnerability: those who perceived that their homes were likely to experience earthquake damage were more likely to purchase earthquake insurance.

3.3.2 Enhancing the Focus of EWS on Livelihoods

Currently, there is no well documented EWS that directly addresses livelihood as a prerequisite for an improved EWS, particularly in the context of rapid onset hazards. On the other hand, the very few institutions and stakeholders that operate EWS for slow-onset (creeping) hazards, such as desertification and droughts, tend to focus on response and recovery rather than on addressing livelihood issues as part of the process of reducing underlying risk factors. In recognition of the interdependency between early warning and livelihood, the European Commission for Humanitarian Aid (ECHO) funded a series of Regional Drought Decision (RDD) Projects[2] in the region from 2006 to 2010 that focused on timely response, community-based drought preparedness, promoting local resilience, and strengthening community-based early warning systems.

Key methodological areas addressed for livelihood enhancement from a local indigenous approach included animal health, local capacity building for communities and development agents, information analysis and communication, infrastructure development, natural resource management, livestock feed development and policy advocacy. The Ethiopian projects were implemented by international and national NGOs in three major pastoral areas, i.e. Somali, Oromia and Afar regions. The project findings suggested that the interventions individually and collectively contributed to food and income security of vulnerable pastoral and agro-pastoral households, and improved the capacities of local communities, partners and government offices in regard to timely response and preparedness.

3.3.3 Climate Information-Seasonal Forecast in EWS and Decision-Making

Climate information can improve prevention and preparedness (Figure 7). The rapidly increasing demand for easily accessible and timely climate information that can help governments and non-governmental institutions, the private sector, and community actors make better-informed decisions in the light of climate variability and change has motivated global and national efforts to develop climate services (IRI 2011). There is increasing demand for new and improved climate information to help in decision-making and actions. Equally, recent advances in climate science, including the production of climate forecasts on different time scales, are promising in terms of addressing this information gap.

IRI (2011) highlights the progress in the use of climate information, and improved decision-making to manage risks and improve livelihoods, through e.g. new information platforms. It underlines the experiences of a various non-governmental actors in this endeavour. The integration of historical trends, seasonal forecasts, and real-time climate information add value to complex decisions and can encourage early and effective responses or establish and maintain the readiness to respond. There is an adjustment in preparedness as uncertainty decreases. Climate information such as seasonal forecasts should focus on immediate opportunities and quick wins, particularly in regions with relatively good seasonal forecast skills, and where decision making can be influenced to generate large and immediate returns and investment. The food security community has successfully integrated climate information into several

[2] http://www.disasterriskreduction.net/fileadmin/user_upload/drought/docs/RDD%20Ethiopia%20lessons%20learnt%20document.pdf

existing tools and platforms. Seasonal forecast represent an important tool and approach in this endeavour. A long- and medium-term forecast gives people at the household level time to prepare and make changes regarding their livelihood (DKKV 2010).

Disaster risk managers and decision makers should be aware of the real potential, opportunities and limitations of climate forecasts, because unrealistic expectations can also prove harmful. Key constraints and challenges include the establishment of thresholds for action, because climate information is linked to impacts, and because there is a need to weigh the costs and benefits of action or inaction given a certain probability of occurrence. In addition, seasonal forecasts often only provide information on accumulated rainfall over a certain period of time, rather than individual extreme rainfall events that are related to flooding.

The decision-making process needs to take account the differences in weather and climate patterns, as weather varies over short periods, and climate varies over longer time scales. There must be an understanding that variations on annual and decadal time scales will have a greater impact on climate variability over the next few decades than the long-term climate change. Failure to appreciate historical variations, cycles in the climate, and analysis may lead to inappropriate strategic decisions. An improved understanding of these differences (weather, climate) and dynamics can support adaptive EWS in the context of DRR.

Overall, there is increasing evidence that livelihood-based or people-centred early warning will increasingly become the focus of early warning, and might even be a precondition for successful early warning.

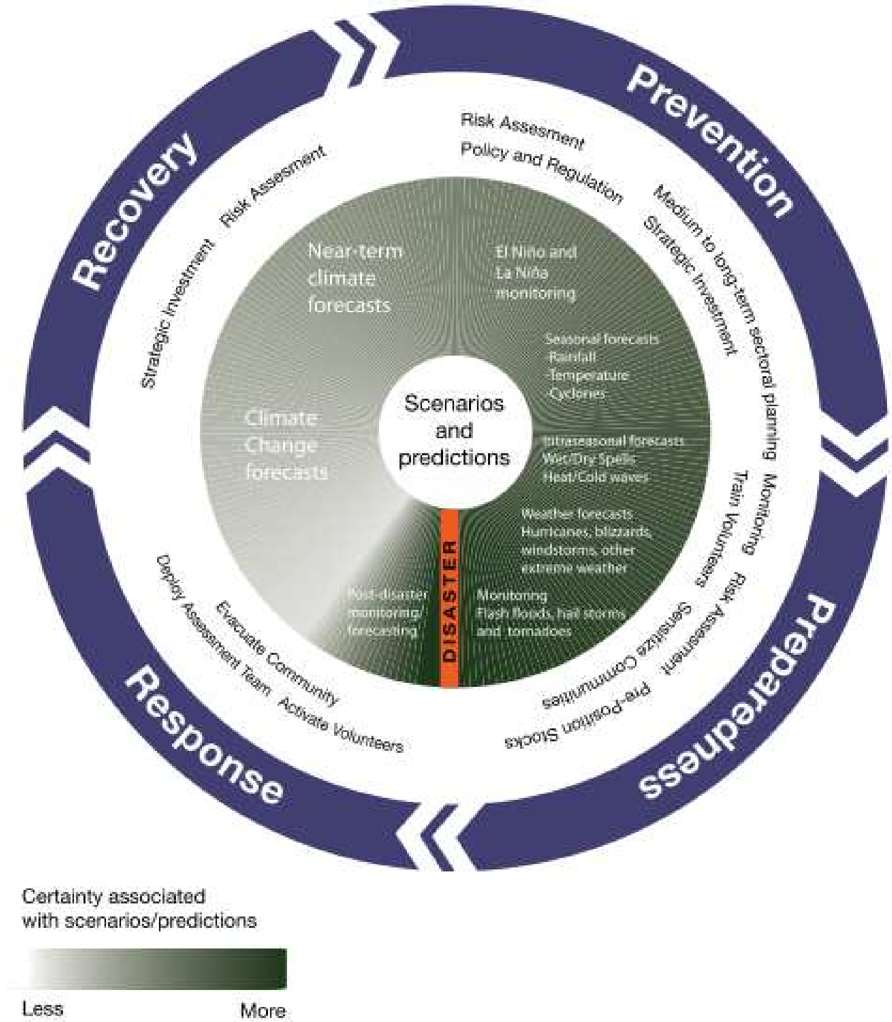

Figure 7**:** Incorporating climate information into the disaster risk management cycle illustrates the kind of information that can inform specific decisions
Source**:** IRI 2011

3.3.4 Access to Technology

The use of technology in DM at various levels is important. For example in the Philippines[3], the technology in disaster management, PSSHED and its modern command centre have been designed specifically to provide an interactive safety and hazard management system for every local government unit and private organization. The system features well-structured planning, information sharing and networking that will greatly improve rescue and relief operations, and reduce loss of life and damage to property.

Another example of the importance of technology in disaster risk preparedness is in Bangladesh. This is one of the world's most densely populated countries, and is highly vulnerable to natural disasters. The people at risk have low access to

[3] http://www.preventionweb.net/english/professional/news/v.php?id=18454&pid:50

basic technology. In this regard, Bangladesh has recently adopted early mobile phone and flag alerts to mitigate the negative impacts caused by natural disasters, primarily floods. This will enhance its capacity for forecasting floods through early mobile phone and flag alerts. Tens of thousands of mobile phone users in Bangladesh's flood and cyclone-prone areas will now receive advance warning of an impending natural disaster through an alert on their mobile phones[4].This will allow the people at risk to evacuate their homes and seek shelter in assigned locations, thus preventing the devastating effects of natural disasters. The mobile phone EWS have already helped in reducing disaster-related fatalities and loss of private and public assets in the five pilot areas. The 2008 post-flood survey in these flood affected areas showed that through early warnings, local people were able to save $1,499,893 in livestock, capital savings, agriculture, and fisheries per household compared to the losses experienced before. Similar developments are reported in other countries. On the other hand, Chang Seng (2010) highlighted that in West Sumatra, in Padang, Indonesia, the personal mobile phone SMS network was observed to be the least effective and reliable system for communication and dissemination during a crisis situation, particularly in the case of an earthquake. Evidence shows that often after an earthquake, power is cut and cellular networks including GSM are also down. This means that the public cannot send mobile text messages during the first hour in the event of a tsunami with an impact time of tens of minutes. In this context, a multi-mode telecommunication system is needed to support an effective end-to-end EWS.

4.0 Governance Context of EWS

4.1 Adaptive DRR

The governance context in which EWS are embedded is important. Particularly in the context of multi-hazard EWS it is essential that future EWS are linked both to stakeholders in the Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) community (see Birkmann et al. 2009, Birkmann and Teichman 2010). In this regard there is also a need to view an EWS as an important element of an adaptive DRR approach (Birkmann, Chang Seng, Suarez 2011). Additionally, there is a particular need to strengthen integrated risk assessments and effective communication strategies.

4.2 Integrated Vulnerability and Risk Assessments

The complex, ambiguous, as well as uncertain nature of risks and hazards requires the involvement and dialogue of stakeholders (Renn 2005, IRG 2009). While EWS for evident disaster risks only need to warn people at risk, climate change-related hazards – such as sea level rise – often imply uncertainty. The higher the level of uncertainty and complexity the higher the need to base

[4] http://www.trust.org/alertnet/news/disaster-prone-bangladesh-trials-early-warning-cell-phone-alerts/

decisions on how to respond to these on a broader and consensus-oriented approach. That means that for complex, uncertain, and ambiguous risks there is a need for an integrated approach rather than a top-down communication-oriented structure.

On the other hand, in many regions global trends such as urbanization and ecosystem degradation will greatly modify the vulnerability of today's population, and these trends should be considered when dealing with risk assessment as a component of the EWS process in the context of climate change. Climate change scenarios need to be further translated into risk and vulnerability profiles in order to provide a sufficient basis for decision-making. If climate scenarios alone are used to modify the hazard component, without taking into account societal and economic pathways, assessments will fail to provide a sound information base for decision makers and practitioners (Birkmann, Chang Seng, Suarez 2011). In addition, integrated risk assessment for climate change can only be successful if a combination of hazard and vulnerability scenarios is used on a longer timescale as part of the risk identification process.

In this context, national governments need to improve decision-making processes by using climate change-related vulnerability and risk assessments. These should be mainstreamed into ministries, sectoral plans, policies, and public investment, and integrated into existing programmatic tools and methods. Such measures, if well integrated, can lead to substantive benefits for improved EWS (Birkmann, Chang Seng, Suarez 2011).

4.3 Effective Risk Communication Strategies

The Integrated Risk Governance framework considers risk communication as a central element of risk governance (Renn 2005). It should enable both stakeholders and the society to understand the rationale behind the risk process and help people make informed choices about risk. Effective risk communication should encourage tolerance of conflicting viewpoints and provide the basis for their resolution. Likewise, communication between actors across all elements of the EWS is viewed as a central and important mechanism that should remain active at all times throughout the EWS process to improve learning, information exchange and coordination (Chang Seng 2010). In addition, clear and balanced information is critical, even when some level of uncertainty remains. For this reason, the uncertainty level of the information must be communicated to users, together with early warning information (Grasso et al., 2007). Likewise, early warning uncertainties need to be communicated to people at risk in a transparent way (Chang Seng 2010, DKKV/ISDR 2010).

Furthermore, the scientific community and policy-makers should outline the strategy for effective and timely decision-making by indicating what information is needed by decision makers, how predictions will be used, how reliable the prediction must be to produce an effective response, and how to communicate this information so that the information can be received and understood by the authorities and the public (Sarevitz et al., 2000). This requires bridging the gaps between science and decision-making, and there is also a need to strengthen coordination and communication links.

4.4 Multi-Hazard and Multi-Risk-Management-Approach

Practical experience shows that most institutional actors address natural hazards such as floods, tropical storms and weather-related hazards such as heavy precipitation and heat waves. However, although there are a number of studies on the subject, much less attention has been paid to slow; creeping hazard processes such as salinization and rises in sea level (Birkmann and von Teichman 2010). Even less attention is paid to accumulated shocks from non-extreme events (Birkmann, Chang Seng, Suarez 2011).

This implies that developing an approach that addresses all relevant hazards in an integrated fashion, and not as separate unconnected systems, is an important challenge for improving the capacity of societies to deal with environmental shocks and creeping environmental changes. According to Basher (2006) such a 'multi-hazard' or 'all-hazard' approach should provide synergies and cost-efficiencies, e.g. in data gathering and processing, and in public preparedness efforts, and should assist in improving and sustaining warning capabilities for the more infrequent hazards, such as tsunamis. Nevertheless, Basher warned that the multi-hazard approach should not be allowed to force generalities or centralized control upon warning systems, but must be tailored to the needs of each hazard, and should be built upon the specific technical capabilities required and the available institutional capacities. The need is for a coordinated 'system of systems'. Much remains to be elaborated in the practical implementation of these ideas. Chang Seng (2010) reports that the key obstacles and challenges of the multi-hazard approach in Indonesia to this end include the temporal and geographical scale characteristics of the different hazards throughout Indonesia, institutional and governance aspects, and most importantly, the availability of extra resources to address all hazards in an integrated manner. However, tsunami resilience building has provided a model experience to help in meeting the goal.

However, key ideas are emerging regarding multi-hazard EWS both at national and global level. For example, Shanghai[5] has become the first mega-urban city to showcase a multi-hazard EWS in an urban setting with the support of WMO and partners. Shanghai as an urban city meets the basic requirements of a demonstration project of the WMO multi-hazard early warning systems, namely, (1) frequent occurrence of natural hazards, (2) complete infrastructure of hazard

[5] http://smb.gov.cn/SBQXWebInEnglish/TemplateA/Default/ProjectInfoList.aspx?CategoryID=51bbabe7-4dd7-4e6c-aad8-978f4637630b

detection and early warning, (3) commitment from the local government and national-level meteorological departments. It is part of the process to initiate a worldwide, all natural hazard early warning system from its concept and design. The initiative can be traced back to a symposium on Multi-Hazard Early Warning Systems for Integrated Disaster Risk Management in May 2005 where the leading experts and officials (UNDP, ISDR, OCHA, IFRC, UNESCO, World Bank) came to recognize that a worldwide multi-hazard demonstration and pilot project should be established that would assist and encourage the development of multi-hazard early warning systems in all countries. However, the Shanghai Multi-Hazard EWS needs to be developed and tested in the context of multi-risk and crisis conditions so that lessons can be learnt in other countries.

4.5 Network of Multi-Level and Scale Architectures

An effective decentralized governance structure helps in improving coordination, dialogue, risk communication and decision-making, and responses at all levels. In this context, EWS need to be multilayered in their architectures at global, national, and local levels in the community. Moreover, the establishment of a worldwide early warning system for all natural hazards with regional nodes, building on existing national and regional systems and capacity has been proposed. The governance structure will not be a single, centralized architecture but will be based on a network of multi-level and scale governance systems that will take advantage of the already existing (Grasso 2010).

Dissemination of warnings often follows a cascading process that starts at international or national level and then moves outwards or downwards, reaching regional and community levels (Twigg 2003). Early warnings may trigger other early warnings at different authoritative levels (Grasso 2010). Existing or developing EWS that follow such governance architecture include the WMO worldwide tropical cyclone warning centres and the IOC-UNESCO global tsunami EWS that involve participation of member countries, as discussed earlier. In this context, Chang Seng (2010) found that polycentric and multi-layered institutions and structures synchronized according to the decentralized political-administrative system are ideal governance architectures for improved performance and for building national resilience to local and trans-boundary multi-hazard risks and disasters. However, such an approach is not quite sufficient for dealing with localearthquake-generated tsunami risks due to problems of fit, adaptability, institutional diversity and norms in Indonesia. In addition, embedding an EWS in larger structures needs to be treated with caution as this could often also encourage centralization behaviours, bureaucracy, ineffectiveness, poor coordination and lack of sufficient resources to address the risk.

4.6 Mixed–Institutional Approaches: People-Centred Approach

A people-centred EWS has not been explicitly defined; nevertheless central elements of a people-centred EWS identified[6] at the World Conference on Disaster Risk Reduction in January 2005 in Kobe, Hyogo, Japan included the incorporation of a combination of 'bottom-up' and 'top-down' elements, utilization of awareness techniques that populations can relate to, whatever their level of formal education, the involvement where possible of local communities in the process of data collection, monitoring and warning, embedding warning functions within systems that serve multiple purposes, and building awareness into the structure of communities.

In this context, EWS may need to be in initiated at the local level rather than the international and national levels. This implies that a mixed-institutional arrangement is needed, depending on the risk. The experiences in Indonesia in the context of both local and far field[7] tsunami EWS have pointed to the dangers of synchronizing the formal institutional linear warning chain with the polycentric-multilayered architectures of governance from the international to the local level (Chang Seng 2010). In this context, a local adaptive EWS approach, involving the people at risk starting some kind of anticipated response once a significant earthquake (i.e. a near field earthquake) is felt (Figure 8). The local TEWS approach consists of a combination of (1) social micro level reaction and response, (2) the legitimate response of the Emergency Operation Centres once a significant earthquake is felt, and (3) the use of religious-cultural based structures and norms. The concept is that the TEWS does not start only with observation and monitoring with instruments, but also from the correct reaction-response of the people. In this context, Chang Seng (2010) proposes a mix of formal and informal institutional approaches to improve the overall governance of Tsunami EWS. In a rural and low technological environment, informal institutions would be particularly important when designing and operating an EWS. Traditional knowledge should not be overlooked: it can provide added value to technical or scientific capacities. However, traditional knowledge should be assessed on the basis of its effectiveness, flexibility, equity, efficiency and sustainability. It will be necessary to improve the visibility and acknowledgement of bottom-up approaches in national policies, as policies and programmes are validated in terms of their effectiveness and relevance at the local level (Birkmann, Chang Seng and Surez 2011).

[6] http://www.unisdr.org/2005/wcdr/thematic-sessions/thematic-reports/report-session-2-7.pdf
[7] Distant tsunamis

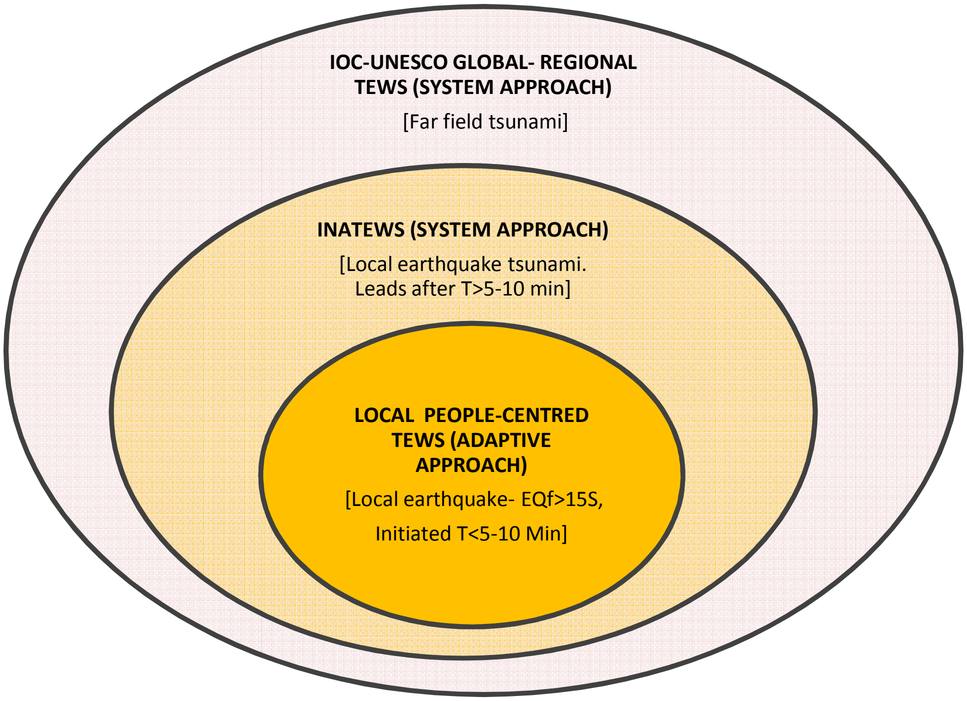

Figure 8: Mix model of TEWS

Source: Chang Seng 2010

4.7 Multi-Sector Approach

The EWS as a tool of DRR is not adequately linked and integrated into the different national sectors. Therefore, to improve the effectiveness of EWS there is a need to link and integrate EWS with a number of sectors, such as agriculture, health, water management, land use planning, and city planning, and thus involve relevant decision makers and structures.

WMO has also highlighted the need for sector-specific climate information and EWS to be developed. Examples of such activities are the WMO collaboration with the World Health Organization (WHO) to develop heat-health warning systems for coping with deadly heat waves and malaria; and work with the UN Food and Agriculture Organization (FAO) on monitoring and developing early warnings of locust swarms. Multi-sector approach would facilitate the integration of potentially changing risk patterns into EW (DKKV/ISDR 2010).

4.8 Stronger Links between Rural and Urban Areas

Currently, there is adequate attention to EWS in the context of rural areas. On the other hand, the mega-trend of urbanization and the increasing urbanization of coastal areas that are highly exposed to hazards caused by climate change calls for increased attention to urban EW strategies. There is an increasing demand for improved EWS in urban areas for example as illustrated by the case study of the city of Manizales, Columbia (Birkmann, Chang Seng, Suarez 2011) and the WMO multi-hazard EWS initiative in Shanghai. The specific challenges of early warning and preparedness strategies for the Last Mile will therefore need to be addressed more precisely in an urban context in future, especially if we take into account the likelihood of a rise in sea level and increasing urbanization processes in coastal zones globally (Birkmann, Chang Seng, Suarez 2011).

However, the overall approach is to improve the EWS links between rural and urban areas in terms of practices in agriculture, the water sector, etc., and in terms of reinforcement, building new infrastructure, land use and territorial and emergency planning. This requires EWS to be integrated in the overall governance of urban-rural areas in order to prepare for environmental shocks. Ensuring communities have good risk knowledge, and giving timely, accurate warnings will be inadequate if the authorities have failed to develop proper evacuation routes and infrastructure to allow effective evacuation or sheltering to take place.

4.9 Systems of Governance

Measures that will enable effective and sustainable EWS rest on the strong links to and backing from political-economic, socio-technological systems of governance. (Chang Seng 2010). For example, there is a relatively wide governance gap between Indonesia compared to the United States and Japan (Figure 9), which have had operational TEWS for decades. This underlines the challenge Indonesia has to face to support and sustain such an effective TEWS. It is clear that the economic dimension is the most promising system of governance; however for maximum positive impacts, all three governance systems need to be addressed collectively. For example, in the context of migration and human displacement, a weak and fragile system of governance will probably imply a frail and ineffective EWS. Such an EWS will fail firstly to address the exposures to multiple risk, due to various limitations, including lack of proper observation systems, human resources and proper institutional arrangements. Secondly, it will fail in securing not only lives but also livelihood issues.

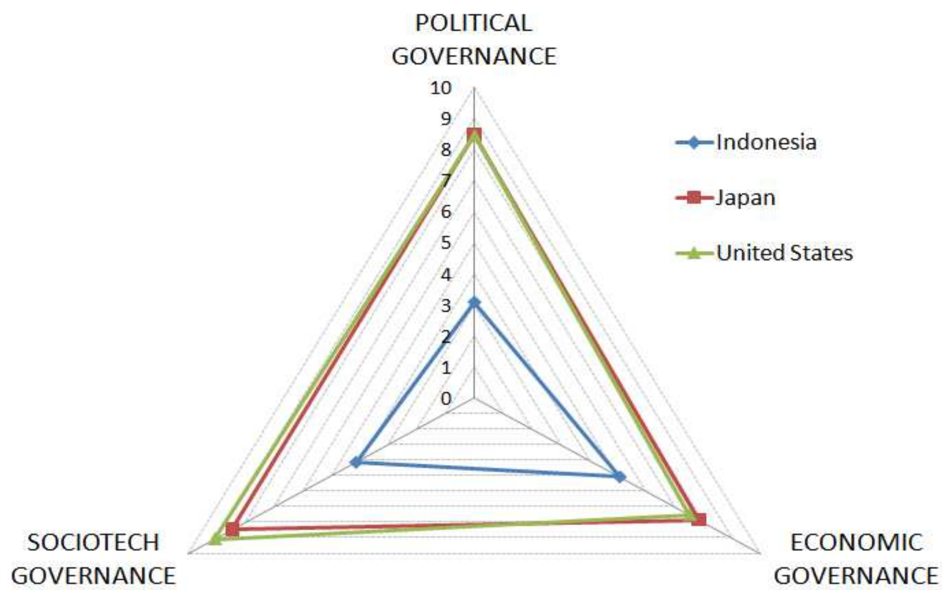

Figure 9: Systems of governance between Indonesia, the United States and Japan

Source: Chang Seng 2010

4.10 Agency: The Role of Non-Government Actors

ESG (2009) defines agency as the capacity to act in the face of earth system transformation or to produce effects that ultimately shape natural processes. Understanding effective earth system governance requires understanding of the agents that drive earth system governance and that need to be involved in order to enhance integrated and effective earth system governance. Agency here concerns especially the influence, roles and responsibilities of actors apart from national governments, such as business and non-profit organizations, NGOs, individuals. It also relates to the ways in which authority is granted to these agents and how it is exercised. The ability to exercise agency (ESG 2009) and good governance principles is an important issue in developing an effective EWS and disaster risk management system.

In this context, Behera (2002) highlights that over the last few decades, NGOs have become important players in the development process across the globe, engaged in wide-ranging activities, starting with community development to training, policy research, and advocacy. Today, NGOs play an important role in disaster response and mitigation in different regions. NGOs work at local level between the public and policymakers. They mobilize communities, and provide training, information and advocacy services. They are in a better position to bridge the link between researchers and the public in sending early warning information. Their organisational flexibility, informal work style, and close engagement with grassroots communities enable them to deliver services to people at lower cost. They supplement government initiatives by acting as a conduit between development programmes and beneficiaries, informing and sensitizing people about their rights and entitlements. Their ability to mobilize people and understand people's concerns enables them to better articulate problems these people encounter. Many international NGOs specifically focus on providing humanitarian aid to disaster victims. Local NGOs in South Asia have also played an active role in disaster management in recent years. For instance in India, NGOs played a significant role in emergency response and rehabilitation following recent disasters such as the 1993 earthquake at Latur, which killed 7601 people, the 1999 Orissa super cyclone which killed 8931 people, and the 2001 Gujarat earthquake which killed over 13,000 people.

In Indonesia two non-state actors have emerged as agents and have exercised agency beyond the state where and when the state government was unable to effectively respond to TEWS-related governance (Chang Seng 2010). In one case, one NGO, named the Indonesian Society for Disaster Management (MPBI), has emerged as an *agent* in driving and shaping governance and institutional change in DM on multiple levels and scales in Indonesia, while another NGO - Tsunami Alert Community Foundation (KOGAMI) - has emerged as an *agent* in exercising agency in community disaster preparedness in Padang city in Indonesia.

Additionally, non-governmental actors including the Red Cross and Red Crescent volunteers are often the first to provide relief to the victims when disasters strike. However, it is more effective to act before a disaster strikes. In this context, in collaboration with the International Research Institute for Climate and Society, the International Federation of the Red Cross and Red Crescent is investing more into people–centred EWS so that their early action can reduce the risks of extreme weather events from climate change. One element of that shift is a better use of climate information to anticipate disasters and act ahead of time to reduce their impacts. Most importantly, Red Cross and Red Crescent are building practical experience in the use of climate information for EW action at the community level. IFRC (2008) reports that a flood disaster in Mozambique's Zambezi valley was averted in December 2007 due to early action consisting of extensive evacuation in response to early warning. Similarly, in June 2008, the Caribbean Red Cross societies implemented their preparedness plans, including regional contingency plans, pre-positioned stocks (e.g. resources to pre-landfall coordinating meeting), and resources in the light of a predicted highly active hurricane season. This prediction regarding the hurricane season was supported by the US National Oceanic and Atmospheric Administration. The level of preparedness was worthwhile in this case.

In regard to the private sector, telecommunication companies funded siren networks in Indonesia. In addition, hotels in South Bali are now more involved in tsunami disaster risk preparedness activities. For example, they supported the funding of the RANET-Radio-Internet system in Indonesia. This has helped to bridge the information gap in receiving tsunami alert warnings. Another, concrete example of EWS is the initiative and partnership between the World Meteorological Organization (WMO) with Ericson and the Earth Institute at Columbia University to bridge the ground-level weather observation gap by installing automatic weather observations stations throughout Africa (Global Humanitarian Forum 2009).

Thus, non-state actors are playing a significant and important role in addressing key gaps, problems and challenges at various levels and scales. Nevertheless, despite the current effort, the UN Survey requested by Annan (2005) on a global EWS for all natural hazards confirmed that there is limited engagement of civil society, NGOs and the private sector. This implies there is a need to improve further the role of non-state actors in EWS and disaster risk governance.

5.0 Migration, Displacement and EWS

5.1 Demographic Change and Exposure to Hazards

In this section, we first examine and provide some empirical evidence on the role of demographic change in terms of culture, socio-economic capital, gender and age with respect to the exposure of these factors to natural hazards.

5.1.2 Gender, age and culture

The composition of households in the United States shows that women are more likely to take warnings seriously than men (Slovic 2000, O'Brien and Atchison 1998). However, age, race, ethnicity and socio-economic, educational achievements status may also shape perceptions of risk people exposed and their capacity to take protective action. Aging populations are among the most vulnerable people in society. In Katrina, of the 1330 deaths, nearly all of the victims were elderly people over 75 years of age (AARP 2006). The congressional Report to Congress estimates that 88,000 persons aged 65 and older were probably displaced by hurricane Katrina and 12.4% of the population were affected by flooding and storm surge damage (CRS 2005). Khunwishit (2007) finds four demographic changes that increase vulnerability in American societies. These demographic changes include changes in aging, foreign, female-headed household populations and population movement; hence the demographic changes affect the vulnerability and coping capacity of communities exposed to natural hazards.

Similarly, in another study, Birkmann and Fernando (2006) determined that the most vulnerable groups to the Indian Ocean tsunami in 2004 in Sri Lanka were women, young children, and the elderly. For example, the distribution of the dead and missing according to age and gender shows that in both cities (Galle and Batticaloa) the number of females reported as dead and missing was significantly higher than for males.

5.2 Demographic Change (Migration Flows and Displacements)

In this section, we focus on the movement or mobility of people and the drivers of migration and displacement. In all cases, the population vulnerability is dynamic because of mobility and displacement. Mobility is an important component of people's changing exposure and their adaptive capacity. Therefore, it is critical to factor people's mobility into the migration process. Movement of people will be internal, across borders, into neighbouring countries, and to some extent to distant countries. These movements will expose people to various risks. In addition, we consider why and when people start to move. We analyse if migration is monitored as an early signal of impending disaster or in case there is a need for intervention. Lastly, we examine if there are any particular warning systems where migration is a major outcome to be warned of or an outcome to be encouraged or avoided.

Figure 10: Displaced Sudanese face harsh environment
Source: UN Photo/Albert Gonzalez Farran

5.2.1 Migration Flows and Displacements

The most dynamic demographic process of the past 250 years has been the movement of people from rural areas to cities. For most of this period urbanisation has been concentrated in economically more developed parts of the world, but during the last 50 years the focus has shifted to economically less developed regions (Chester 2001). The migration process into areas that are highly exposed to natural hazards is particularly evident in many developing countries. There is a wide continuum of drivers and outcomes related to migration and human displacement. People migrate or flee mainly because of (1) unprecedented socio-ecological stressors such as an increase in urbanisation, (2) shock in terms of a disaster, and (3) immediate threats and future likely risks.

5.2.2 Urbanization

In the United States, since the 1950s, there has been an increase of approximately 10 percent in the number of people living in urban areas (U.S. Census 2007). On the other hand, the increasing movement of populations to the coastal mega-cities has skyrocketed (Nicholls 1995) and these people are at greater risk of a number of natural disasters (Klein, Nicholas and Thomalla 2003). The least developed countries have a higher share of their population living in the coastal zone than the developed countries, with even greater disparities in the urban areas (McGranahan, Balk and Anderson 2007). For example, in the former case, most notably China, urbanisation stress is driving a movement of population towards the coast (McGranahan, Balk and Anderson 2007). Zahran et al (2008) have shown that in the context of Texas, with every unit increase in population density, the odds of flood casualties rise by 2.99. However, it is important to understand people's exposure in mega-cities in developed and developed countries.

5.2.3 Mega-cities in Developed Countries

It is argued that in spite of the high hazard potential of mega-cities in general, and coastal mega-cities in particular, there is no compelling evidence that mega-cities are more vulnerable to hazards than smaller cities and towns. Handmer (1995) argues that major cities have inherent features that enable them to deal with hazards more effectively than smaller settlements.

The immense power and resources of large cities give them considerable capacity to respond (i.e., resilience). Most major cities are able to harness massive financial resources and expertise from within the city, the country, and the rest of the world, and this can be used to combat disaster and to aid recovery. Parker (1995) supports this view and argues that the in-built complexities and redundancies characteristic of very large urban systems and the modern global electronic trading systems of which they are part may also enhance resilience. Cross (2001) also emphasises the greater resilience of mega-cities compared to small towns. He argues that the different response capacities of smaller communities profoundly influence the long-term consequences of a disastrous event on the individual victims and whether they receive timely or adequate emergency assistance. Individuals in both small communities and mega-cities are vulnerable to hazard losses, but losses for residents of large cities are more easily reduced by the warning and protection systems that the cities' concentrated wealth can justify.

On the other hand, the changing population patterns shape the vulnerability and resiliency of social systems. Disasters can be amplified by demographic and socio-economic factors. Rodriguez (2008), for example, suggests that population dynamics (e.g. population growth, or migration from Latin America and Asia [Rodriguez, Diaz Santos and Aguirre 2006]) and urbanisation are perhaps two of the most important factors that have increased the United States' exposure to disasters and that have contributed to the devastating impacts of these events, as seen in the case of Hurricane Katrina. The changing size and structure of human populations across the United States may create new risks and worsen those already present. For example, new families that move to a new community can also increase the vulnerability of that community because they do not share the same disaster history as other residents of the area (Misomali and McEntire 2008). In this context, they are not familiar with hazards that often threaten the community and they do not know how to respond to them appropriately.

5.2.4 Mega-cities in Developing Countries

Urbanisation, particularly in developing countries, has led to increasing global exposure to a variety of natural hazards, for example, the risks posed to large cities by volcanoes (Chester et al 2001). It must be stressed that scientific literature discussing these issues is limited. New evidence, such as that obtained from the Indian Ocean tsunami, illustrates the consequences of living in coastal areas in mega-cities, particularly for poor communities (Rodriquez et al 2006). From the above discussions, we find no compelling evidence of the role of EWS in assisting people to move from one location as part of the urbanisation process.

5.2.5 **Daily Mobility (Excursus-Padang Indonesia)**

By Neysa J. Setiadi

Information on exposure provides knowledge about distribution of the population or elements at risk and serves as a basic consideration in EWS and disaster risk reduction in general. Exposure is qualified from spatial and temporal points of view, dealing both with the question of the spatial distribution of elements at risk in the potentially affected areas and the question of when and how long elements at risk might be exposed to natural hazards. The questions related to these spatial and temporal dimensions also deals with the dynamic aspect of population distribution which is shaped by mobility patterns. This can be observed especially clearly in urban areas, where migration flow and mobility is high. Population distribution at different times of day, e.g. the night and day population, varies significantly. This phenomenon is due to daily and economic activities, which take place in various locations corresponding to the existing land use. Accordingly, the exposure of the population will vary. This issue should be taken into account when planning measures in disaster risk reduction.

In the context of a people-centred EWS, more detailed information on the exposed population, such as which population groups are vulnerable to natural hazards, is also necessary. For instance, a decision on how to distribute an early warning or communication strategy can be made better if the decision makers are well informed on which population groups are currently in the exposed areas at the time of the possible occurrence of a natural event in any particular area (e.g. settlements or central business areas in a district). Padang is the capital city of West Sumatra Province, which is located on the west coast of Sumatra Island. Padang city covers an area of 694.96 km2 and consists of 11 sub-districts (Padang Dalam Angka, 2006). Although the majority of the city area (about 51%) is protected forest, only about 9% is built-up-area located mostly along the coast and in the lowland. The city is representative of coastal urban areas in developing countries, which were initially developed through historical intensive trading activities on the coast during colonial times. Presently, the central activities and densely populated areas remain in the coastal areas. The city of Padang is highly exposed to tsunamis (Borrero et al, 2006) and other coastal hazards such as storm surges and coastal erosion (Hidayati et al, 2006).

An exposure analysis in the context of tsunamis for different population groups in the coastal areas of the city was conducted using the methodology developed by Setiadi et al. (2010). In general, the exposure in the morning and afternoon is higher in the city centre and along the main roads close to the coast due to the concentrated economic activities in these areas. However, at night the exposure is quite evenly distributed in the settlement areas. Furthermore, the spatial distribution of the male and female population, especially during the day, reveals a differential exposure due to the variation in the main activities, and this variation is linked to the present urban land use. The main activities of the female population group are still household activities which are conducted at home or in the neighbourhood (settlement areas). Moreover, the female population work mainly in the service and trading sectors. About 30% of this work is conducted at home, i.e. in residential houses with mixed functions. This contrasts with the male population where employment involves quite a high proportion of outdoor sectors which are more concentrated in the city centre (Setiadi and Birkmann, 2010).

Consequently, a higher proportion of the female population is distributed in the settlement areas during the day than the male population, who, on the other hand are concentrated more in work or public places. Figure 3 shows an example of the areas exposed to tsunamis. According to the urban spatial structure, i.e. the location of settlement areas, public facilities and economic activities, the exposure of both gender groups varies.

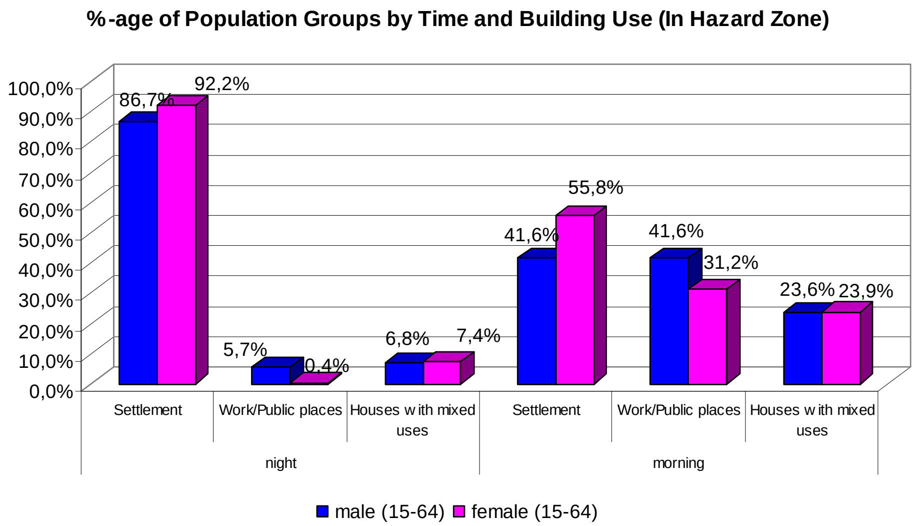

Figure 11: Distribution of female and male population for different daytime and building uses within the tsunami hazard zone (Source: Setiadi)

The spatial variation of the distribution of the female and male population is identified and visualized in Figure 11. During the night time, the differences are small (see Figure 12), due to relatively even distribution of both population groups. In contrast, the mornings and afternoons show a higher proportion of the female population in areas with more settlement buildings (the areas in blue and dark blue), while a higher proportion of the male population are clearly identified in areas with more work/public places (the areas in orange and brown).

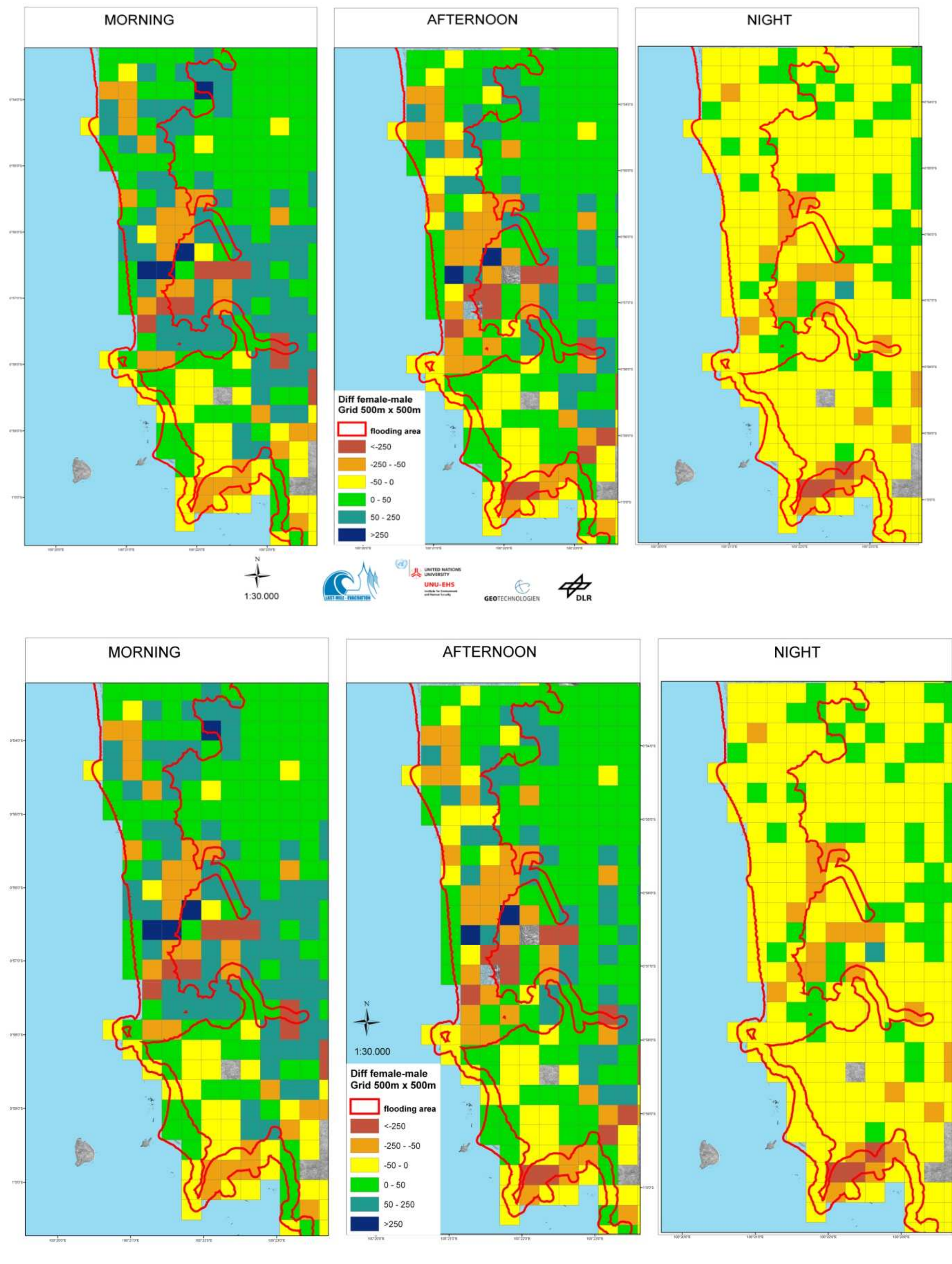

Figure 12: Spatial variation of female and male population distribution in the exposed area (Source: Setiadi)

This example shows dynamic exposure when taking into consideration the daily mobility pattern of different population groups in a large urbanised coastal city. The dynamic exposure indicates various points that need to be taken into account in early warning. They include identifying areas in which to position sirens for alerting the community as part of the EWS, as well as identifying areas which would need more assistance during response in terms of evacuation. It is also important to take into consideration the gender distribution at the local level in designing appropriate evacuation shelters and emergency response plans that ensure gender equality. Factoring in daily mobility and dynamic exposure of displaced people in EWS and disaster risk preparedness is an important requirement for reducing the people's vulnerablity to tsunamis.

5.2.6 Post Disaster- Voluntary Relocation

There is far too little documented evidence illustrating planned voluntary migration of households and communities with governments as an adaptation strategy to search for alternative livelihoods and sources of income. In one example of post-disaster voluntary relocation, in Manizales, Columbia voluntary relocation was undertaken since 1980. The last relocation which took place between 2005 and 2008 in the *La Playita* area of the city, relocated people exposed to floods and landslides. The relocation process also included a voluntary demolition program and the voluntary relocation of every family into a used property selected by the family themselves, in 'safe' areas (see in detail Birkmann, Chang Seng Surez 2011). However, emerging socio-ecological vulnerability and risk will need to be explored and analyzed in the new relocation.

5.2.7 Post Disaster- Involuntary Relocation

In contrast, the involuntary relocation processes after major disasters, such as after the Indian Ocean Tsunami in Sri Lanka revealed that many of the new relocation sites were safe from tsunami risk but were exposed to other natural and non-natural hazards and stressors. Research on the buffer zone and the relocation processes in Sri Lanka after the Indian Ocean Tsunami showed these phenomena (see e.g. Birkmann and Fernando 2008). In the aftermath of the Indian Ocean Tsunami, the Sri Lankan Government declared a strip extending inland 100 meters from the sea as a buffer zone of high tsunami risk where reconstruction of damaged houses was not allowed. Although the majority of people living within 100 meters of the sea were, in the direct aftermath of the tsunami, interested in a new house in a relocation site, the dependency of people on coastal resources and the difficulties in accessing market places and commercial areas near the city centre created many difficulties for those that were actually resettled after 4-8 months (Birkmann, Fernando and Hettige 2006; Birkmann and Fernando 2008). That meant the forced relocation into settlements far away from the city caused various severe shocks that have increased the social vulnerability and livelihood insecurity of the relocated households (Fernando 2010). Many of the relocated households, particularly in settlements far away from the city, were unable to successfully cope with the various issues and problems, including lack of water, and no proper bridge to cross the stream during the rainy season due to flooding. The displacement process is a post-disaster-driven process, hence the relocation process was mainly triggered by a government directive that established a no-construction zone along the coastal areas affected by the tsunami.

In both cases, most notably in the case of involuntary relocation in the light of post disasters, we argue that EWS did not play any significant role in the relocation process. In this regard, a disaster can also serve as a catalyst for change.

5.2.8 Imminent Short Term Threats & Future Risks

5.2.9.1 Imminent Short Term Threats

In the case of imminent threats, as we have seen even in Japan, the ability of EWS to provide sufficient time for evacuation and migration to safe places is rather limited, and this was apparent with the tsunami. Similarly, in Indonesia, a novel and rapid approach for monitoring and forecasting tsunamis has been developed, capable of issuing a warning in five to ten minutes, but there is simply not enough time to evacuate all the people at risk in the event of a tsunami, even if the dissemination and communication across the warning chain to the people is timely and effective (See Figure 13).

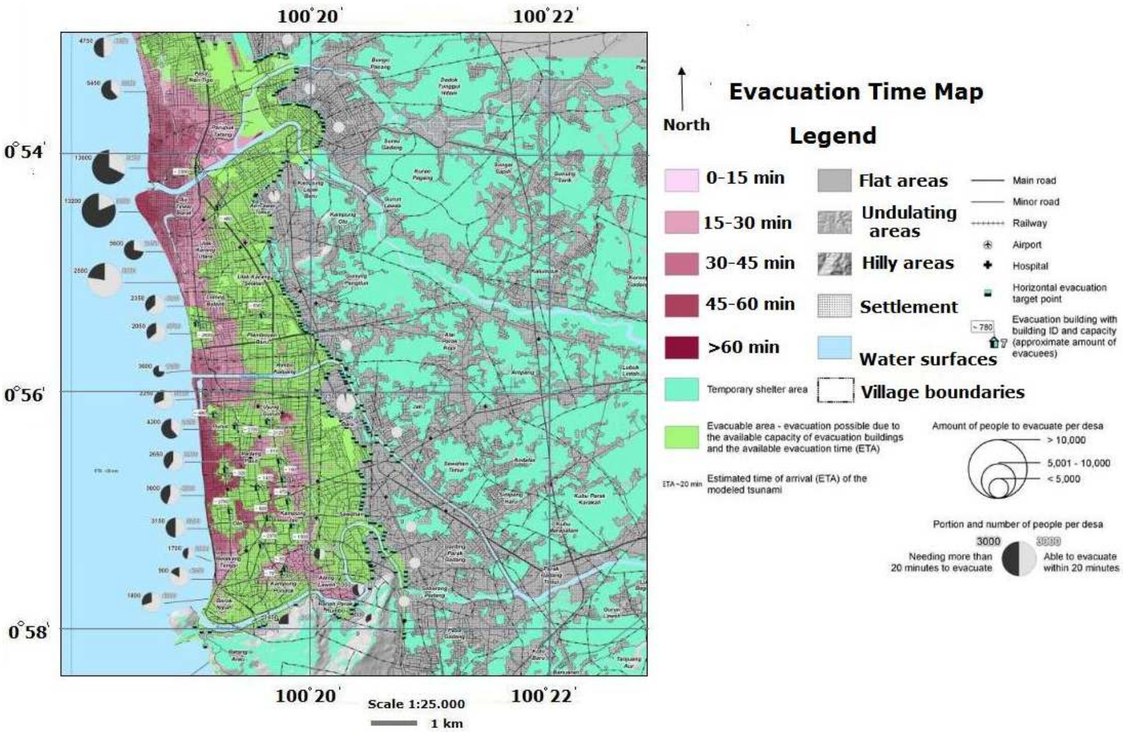

Figure 13: Tsunami evacuation time map in Padang

Source: DLR in the framework of the GITEWS project 2009

In addition, empirical evidence from Padang city, Indonesia, shows that people started self-evacuation after feeling the strong earthquake tremors and continued to do so even when the mayor later announced there was no tsunami risk. It must be stressed that 51% of the 200 respondents interviewed evacuated in the first hour (GTZ-IS 2010), and in the first five to ten minutes almost 70% of the respondents had evacuated before receiving an official warning.

In addition, considering the current nuclear problem we are seeing now, it would appear that there are important elements of the EWS process involved in supporting a multi-dimensional crisis, particularly in terms of observation, monitoring and risk communication. However, it is very difficult or at least a major challenge for EWS to operate in an environment of complex cascading effects, particularly in terms of satisfying the response (i.e. evacuation) component. For example, it is challenging to support voluntary and timely evacuation and migration if certain radiation thresholds are exceeded. Additionally, as an illustration of this, it would be nearly impossible to evacuate Tokyo (with over 12 million inhabitants) or to ensure that the effects of cascading crises (earthquake-tsunami -evacuation - nuclear power plant disruption etc.) were sufficiently captured by early warning systems.

5.2.9.2 Future Risks (Environmental Climate Change, Tipping Points and Migration)

Environmental change and tipping point threats in ecological systems have raised concern with the general public and many researchers. For example, Galaz, Moberg, Downing, Thomalla and Warne (2008) underline the unprecedented combination of climate change-associated disturbances (e.g. flooding, drought, wild fires etc) and other global-change drivers (such as land-use change and pollution) that is likely to increase the vulnerability of many ecosystems during the course of this century.

Tipping Points and Thresholds

Tipping points are moments or intervals of high sensitivity to abrupt and irreversible changes, and they are intended to aid in the identification of discrete thresholds for danger. Such catastrophic shifts occur when the cumulative effects of both creeping and fast environmental changes and disturbances reach thresholds that result in dramatic and often rapid negative changes in ecological systems (Galaz, Moberg, Downing, Thomalla and Warne 2008). For example, events such as droughts and floods might trigger much more significant ecological changes which are difficult or even impossible to reverse. On the other hand, accumulated stresses may lead to catastrophic shifts in many places, such as the observed loss of coral reefs and their ecosystem services.

On the other hand, thresholds are defined as non-linear transitions in the functioning of coupled human–environmental systems (Schellnhuber 2002, Lenton et al. 2008), such as the recent abrupt retreat of Arctic sea ice caused by anthropogenic global warming (Johannessen 2008). Thresholds are intrinsic features of these systems and are often defined by a position along one or more control variables, such as temperature and the ice-albedo feedback in the case of sea ice. Some Earth System processes, such as land-use change, are not associated with known thresholds at the continental to global scale, but may, through the continuous decline of key ecological functions (such as carbon sequestration), cause functional collapses, generating feedback that triggers or increases the likelihood of a global threshold in other processes (such as climate change) Such processes may, however, trigger non-linear dynamics at lower scales (e.g., crossing of thresholds in lakes, forests, and savannahs as a result of land-use change, water use, and nutrient loading). Such non-linear changes, from a desired to an undesired state, may combine to become a global concern for humanity, if they occur across the planet.

Currently, there is much focus on climate-related stressors combined with ecosystem change as concrete examples of tipping points that could drive population movements and human displacements. It must be stressed that more than 90% of the people exposed to disasters live in the developing world, and more than half of disaster deaths occur in countries with a low Human Development Index, and as we have seen earlier, certain individuals and social groups are considered to be more vulnerable than others.

Estimates of the number of people who will be environmentally displaced due to climate change in the coming decades range from 24 million to almost 700 million (cited in Galaz, Moberg, Downing, Thomalla and Warne 2008). It is estimated that drought, desertification, and other forms of water scarcity will affect as much as one third of the world's population and may play a part in forcing people to leave affected areas in order to secure their livelihoods. In addition, people may be forced to migrate because of sea-level rise, or because national governments plan to relocate communities due to increasing risks or to expand development infrastructure. The other issue of concern is that displaced people may lack the important local knowledge that is needed for adaptive management of resources. For example, distressed migrants can add further stresses to ecosystems, thus creating other environmental crises. The tipping point situation is not limited to the ecosystem dimension but will resonate and profoundly affect the global economy, international development resources, and national budgets. Also, indigenous knowledge should be examined; however, one needs also to account for the limits of such knowledge, particularly in the context of climate change, which is likely to expose people to hazards that they have not experienced before.

At present there is strong evidence that people's migration behaviour increases population density in coastal areas, thus they are generally moving towards coastal areas (McGranahan, Balk and Anderson 2007). However, in contrast to that, future climate change and particularly sea level rise might imply major threats for coastal communities and consequently might shift migration patterns again towards inland and higher ground, especially if the living conditions and livelihoods of coastal communities in delta regions heavily dependent on environmental services deteriorate further due to changing environmental conditions, such as salinization of water resources. At present, the factors driving coastward migration processes are still poorly understood, as Travis (2010) argues. In some ways we already have 'warnings' of climate change via reports of the Intergovernmental Panel on Climate Change (IPCC), and even more compelling sources (Travis 2010). This tends to suggest that we should consider the information from IPCC as a form of early warning. In this regard, early warning information seems out of place in this line-up of recurring phenomena. Hence, we argue that most EWS focus on discrete, short-term events to initiate and activate appropriate responses such as evacuation to avoid flooding, inundation from tsunamis, radiation leaks etc. However, EWS are not successful in moving people in the case of future risks that also involve a high degree of uncertainty; hence migration and displacement are not presently viewed as common outcomes of existing EWS.

Migration and population mobility	EWS integration	Case studies[8]	Additional explanation
Migration Factors: - Demographic change - Socio-economic change - Urbanization	No	None	EW information has not specifically targeted demographic change and dynamics of spatial exposure of people to hazards. However, this information is important as case studies on events such as Hurricane Katrina and the Indian Ocean tsunami disaster show
Daily Mobility Patterns	Yes, in some cases already considered; in many not	Little e.g. Padang, Indonesia	For example, in West Sumatra, Padang, Indonesia daily mobility-dynamic exposure to tsunami risk is factored into EWS and DRR
Short Term Mobility/ Evacuation Imminent Short Term Threats (Hydro-Meteorological, Epidemic and Technological Hazards)	Yes	Some-Many	Hydro meteorological EWS are well developed while epidemic-technological types of EWS are less developed or are now under development. However, it is very difficult or at least a major challenge for EWS to operate in an environment of rapid, complex and cascading effects, particularly securing an anticipated response to such complex crises. This was evident in terms of the Japan earthquake, tsunami and nuclear crisis.
Voluntary/Involuntary Relocation (Pre/Post-Disaster Shocks)	No	None	In certain cases, risk information may be employed in the decision-making process.

[8] Level of evidence here defined as None, Few, Some, Sufficient, Overwhelming

Potential Mass Displacement and Migration Drought Sea level rise, Major coastal storms impacting small island development states	Yes, but mainly the hazard focus; less on potential areas to evacuate to in case of sea level rise	Little	Climate change predictions or projections i.e. sea level rise and likely impacts can be viewed as a form of EW. However, EW information seems out of place because population movement is away from the coast. Risk perceptions and decision-making are influenced by actual experiences of serious personnel consequences, the proximity of threat, and pressing priorities of the people. In addition, these EW predictions are not systematically and methodologically integrated in EW.

Table 2: The role of EWS in different forms of migration and human mobility

Currently, EWS do not systematically or methodologically take into account tipping point conditions and migration. There is still a high focus primarily on the natural hazard and environmental change indicators, rather than on social thresholds or cascading effects. There is a gradual shift towards incorporating EWS in the context of demographic trends, migration flows and displacement. According to UNOCHA, population movement is 'sometimes included in the analysis of developing humanitarian situations' and the 'people concerned with EW monitor the socio-political and economic threats'.

Many forms of EWS are currently under development (e.g. the Global Earth Observation System, the Environmental Scanning Alert System and Humanitarian Dashboard etc) as indicated in the table in the Annex. The Inter–Agency Standing Committee has prepared an EW tool to anticipated changes in humanitarian response projections, with particular attention to new crises and changes in new emergencies (EWEA 2011). It identifies countries facing imminent crises and humanitarian needs using a colour coding alert system, and recommends increased preparedness. This tool is invaluable in the context of sharing and providing useful information to actors and institutions (FAO, OCHA, WHO, WFP, UNICEF etc) for crisis management. It is not possible to determine the full range of non UN-actors that use this information directly. It is viewed as an important step in the process of introducing EW in the context of migration and human displacement. However, the tool is not designed specifically to reach people in the Last Mile and empower them with essential information to assist in decision-making and responding appropriately.

5.3 Complex Population Movement and Epidemics

Population movement is a key determinant of vulnerability to climate–sensitive epidemics. For example, when unusual environmental conditions enabled vector breeding and population movement from Afghanistan to Pakistan, infected refugees brought disease to areas previously unaffected by malaria. This outbreak was circumscribed by the immune status of the affected population, e.g. particular problems were reported from non-immune migrants and their relative isolation within a camp (Leslie, Kaur, Mohammed et al, 2009). In this context, Afghan refugees in Pakistan have long been accused of bringing malaria to the country because of their high infection rates in the camps – the fact is that with their lower immunity they are more susceptible to malaria in Pakistan. Therefore, EWS targeting risky environments are important to give communities on the move choices on settlements and reduce their vulnerability to epidemics. This requires trust and effective collaboration between various actors in order to address the complex population movement and climate–sensitive epidemics.

6.0 Key Lessons Learnt and Challenges of EWS Pertaining to New Environmental Shocks

6.1 Lessons Learnt from Existing EWS and Vulnerable Groups

The policy lessons that can be learned from existing monitoring and EWS in the context of different hazards and vulnerable target groups are summarized as follows:

- In order to promote resilience building, the focus of EWS should not solely be on hazards but also on the notion of vulnerability. EWS need to be improved so that they not only warn people before a hazard event impacts a society, but also contribute to securing livelihoods at risk from the gradual changes due to climate change;

- Information about changes in hazard patterns needs to be combined with knowledge and predictions about the development of vulnerabilities. The combination of the two will provide the basis for high quality EWS;

- Isolated or individual hazard EWS are not sustainable, particularly in the context of addressing the challenges related to climate change. This implies the need to account for both rapid and slow-onset hazards at the same time (e.g. the potential impact of sea level rise and storm surges);

- Technocratic, linear, top-down and expert-driven EWS alone are ineffective at saving lives and reducing damage. A mixed-institutional approach including both formal and informal aspects is often necessary. In this, the people at risk are not controlled by the system but are an integral part of the system, thereby creating a people-centred approach. This involves integrating different types of knowledge in EWS, particularly in terms of linking scientific and traditional knowledge;

- The process of developing EWS requires a multidisciplinary approach which recognizes all the stakeholders along the chain and in the community, and strives to create partnership and dialogue rather than being based on a top-down alert process;

- The human assets and preparedness strategies linked to an EWS are particularly important in low-technology places;
- There should be a shift towards working, relating, and communicating "with" the community rather than "for" the community;
- The transfer of EWS technologies in different cultural and societal settings raises the question of fit and the societies' ability to uptake such sophisticated technologies without addressing the digital divide governance problem;
- Additionally, the new technologies and communication networks such as Twitter, Facebook, and the Internet in general have to be better understood in terms of their role in informing and warning people in crisis situations
- Systems of governance (i.e. political, economic, socio-technological) drive the effectiveness and sustainability of an EWS;
- The establishment of EWS should be an integral objective of both urban and rural planning and associated sectors;
-
- EWS have so far been very effective in detecting sudden-onset hazards, while creeping environmental changes and societal tipping points that are important factors in decisions to migrate and in terms of displacement have not been sufficiently considered, or at least have received much less attention compared to hazard detection;.
-
- Climate services are currently under development through the Global Framework for Climate Services (GFCS). In this context, the lack of effective climate services around the globe limits the current capacities and opportunities in the use of climate information for EWS.

6.2 Broader New Challenges

6.2.1 Integrated Vulnerability Risk Assessments

It is underlined that one of the key challenges for people centred EWS is related not only to more extreme and frequent shocks in certain places due to climate change, but also to the likely shifts of climate zones that will impose previously non-experienced risks, and both rapid and slow creeping environmental shocks on some regions and localities. In addition, the further increase in urbanisation and the population at risk will result in added stress in the Last Mile. This implies a strategy of integrated risk which includes dynamic vulnerability, and aspects of social development pathways will be a challenge to develop and implement at all levels and scales. This information is a prerequisite for people-centred EWS.

6.2.2 Effective Risk Communication and Governance

6.2.2.1 One Voice Principle

As risk becomes more complex and uncertain (Renn 2005), managing diverse views and information as part of the risk communication process becomes more challenging. For example, in the context of climate variability, even the evolution of ENSO and its associated environmental shocks are surrounded by a number of challenges. In this context, a unified global statement on the expected evolution of ENSO from the national meteorological and hydrological services and the world at large is needed.

6.2.2.2 Role of Media and Governance

On the one hand, countries with poor governance principles will be challenged to exercise transparency and accountability as risk and disaster shocks increase, particularly when EWS have failed to save lives and reduce property damage. The extent to which a country's citizens are able to participate in selecting their government, as well as enjoy freedom of expression, freedom of association, and free media as elements of good governance principles are important parameters that will shape the way risks are handled by the authorities and the community.

The role of media/press freedom is very important because it provides the opportunity to cover various points of view, and it is a tool for pressing for transparency and accountability. In addition, media coverage of natural disasters (and major events in general) defines and limits the discourse associated with these events (Miles and Morse (2006). However, all too often, media coverage gives priority to the recovery of various forms of capital – natural, human, social, and built (see Ekins, 2000 for definitions) – based on cultural, social, political, and technical biases present in all media. However, the sustainability and the preparedness level of societies depend on better knowledge of the risks associated with where and how we choose to live. The media's role in building social cohesion and constructing narratives has made it an important element of social change. Miles and Morse (2006) argue that these media priorities shape how the public perceives the risks posed by natural hazards, and that these perceptions will influence the strategies used for the mitigation of future vulnerabilities that the public deems to be reasonable and worthy of expenditure (e.g. taxes, opportunity costs, lifestyle changes, etc.). For instance, they illustrated how the media framed the events of Hurricane Katrina and Rita. The report shows that the forces of profit and politics impel the media to reproduce the status quo represented by market fundamentalism. Given these hegemonic forces, ecological economics must work within the constraints of the mass media to define the problems and present the policy solutions that will reveal the fundamental role that ecosystem services play in our economic system.

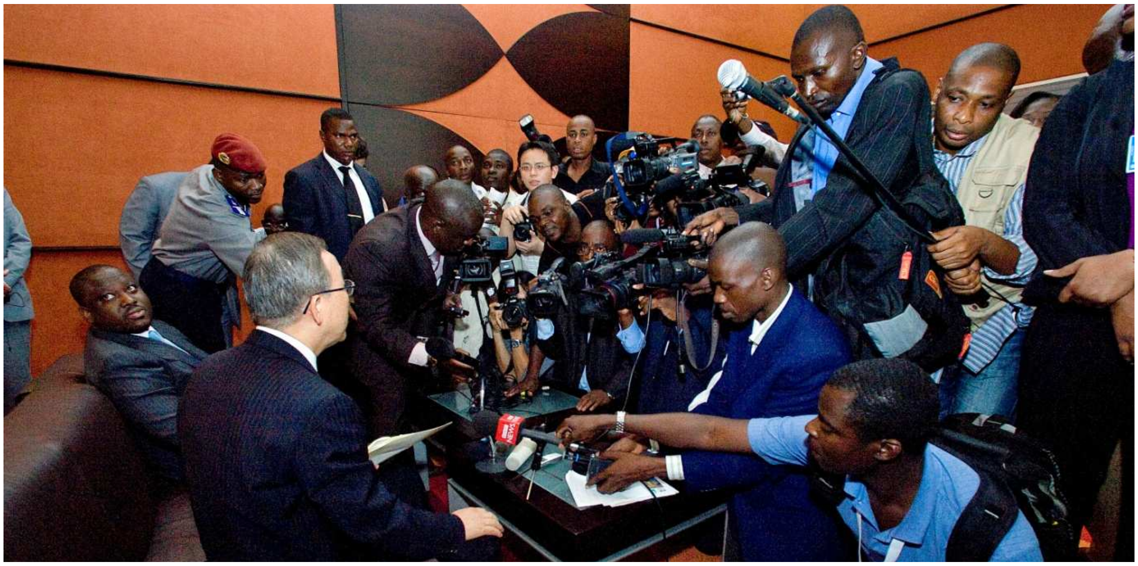

Figure 14: Secretary-General Briefs Media
Source UN photo

6.2.2.3 Operating in an Environment of Rapid, Complex and Cascading Impacts

On the other hand, risk communication as part of an EW process can be another level of challenge during complex and cascading impacts and crises even in countries that are considered to have established a well functioning governance and crisis management system, such as Japan. For example, the Japanese government in many ways has struggled to exercise effective risk communication related to the cascading and worsening effects of the nuclear disaster that was triggered by earthquakes and the following tsunami. In its interaction with the public it has failed to communicate the dangers of the highly exposed critical infrastructures that failed in the course of the event. Recent reports indicated that effective risk communication was absent or insufficient. For example, CNN on 20th March 2011 reported: '*Critics say it is often too little, too late. There's a worrying lack of detail'.* There is a general perception by many experts and institutions, at least from the media, that the communities at risk do not know whom to trust[9] due to conflicting views from various authorities and the lack of proactive information. Many problems were articulated after they were more or less evident in various ways. It is also reported that in Tokyo, long lines have formed at the immigration department. At the airport, people line up for flights, and consequently, some people do not sufficiently trust the official

[9] http://www.studentnews.cnn.com/TRANSCRIPTS/1103/16/ctw.01.html

risk communication that all issues are under control. This has also created a certain atmosphere in which some people do not trust what they are told. This is a particularly problematic process that has been experienced within the context of Early Warning Systems. Therefore, establishing effective Early Warning Systems also means developing trust through appropriate risk communication and good governance.

6.2.3 Trust

Trust is an important aspect of social capital and collective action. For example, in Indonesia, following the tsunami disaster, there was a perception of very strong cohesion and trust among the actors, and this contributed to the fast pace of the disaster management legal reform and the formation of the National Platform for DRR (UNDP 2009 and Chang Seng 2010). The collegial bond and high trust between actors attracted additional actors to the cause. The mechanisms described by actors as encouraging social cohesion and trust worked through regular contacts such as meetings at the national level, music, sports, and tsunami drills in the local community. The best time for trust building and creating social harmony was actually during and following tsunami drills in the local communities when new challenges and problems were discovered collectively. Additionally, it was found that social cohesion and trust were not strongly institutionally based. On the other hand, there is still a significant level of lack of trust in the EWS due to a number of false alarms, particularly in the case of local earthquakes (see Figure 15). False warnings rapidly degrade people's trust in the EWS. IFRC (2008) outlines that the development of trust between climate and humanitarian communities is crucial. Through collaboration, differences in the needs are often revealed and new products and research identified.

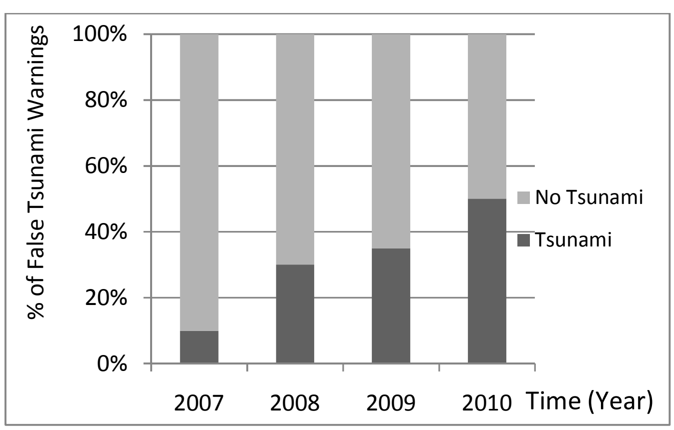

Figure 15: Percentage of false tsunami warnings from INATEWS 2007-2010

Source: BMKG 2010

6.2.4 Education and Awareness

Although at the local level, there is little differentiation between Disaster Risk Reduction and Climate Change Adaptation (Birkmann et al. 2009, Birkmann and Teichmann 2010, DKKV 2011) there are important differences between hazards and what actions the authorities and the local community need to take in order to address the respective risks. All the stakeholders will be challenged to become familiar with all the hazards (i.e. cyclones, flooding, earthquake, tsunamis, sea level rise etc) in a multi-hazard framework, and what course of action to take. There should be no generalisation in education and preparedness; instead these aspects should be tailor-made because each risk requires specific decisions and actions. In this context, empowering the authorities and the community with more information and education in a world of competing priorities could become a real challenge.

6.2.5 Proper Facilities and Infrastructures

Reducing the exposure and susceptibility to new hazards and environmental shocks is one of the most important measures for reducing the underlying risk factors. However, often there is a lack of proper facilities and infrastructure, particularly for less developed countries and in areas which have had no experience of new environmental shocks. Having proper facilities and infrastructure represents a central challenge when dealing with new environmental shocks. For example, in Padang and Bali, despite major project interventions, in the event of a near field tsunami with a travel time of tens of minutes, the community at risk have limited good infrastructure to quickly evacuate and shelter. Similarly, in the Seychelles, when an intense tropical cyclone made direct landfall for the first time on the outer islands, a group of inhabitants had no proper facilities or infrastructure for evacuation, and had to be evacuated by air at night while a group of six men had to take refuge in a drained concrete water tank.

6.2.6 Effective Decentralisation

Decentralisation is fundamentally a strategy of governance to facilitate the transfer of power closer to the people (Ribot el al., 2006) and is therefore closely linked with democratic mechanisms and processes (Smoke 1999). Decentralisation enhances the ability to solve regional and local problems, while central government will have more time and energy to deal with globalisation and promote the interests of the country. However, case studies reveal that most decentralisation reforms suggest that the institutional arrangements to meet such a desired outcome are rarely observed (Agrawal 2001, Agrawal & Ribot 1999, Larson & Ferroukhi 2003, Ribot 2002, 2003, 2004; Ribort & Larson 2005). Ribot et al., (2006) underline that most decentralisation is either flawed in the concept or faces strong resistance from diverse actors, mainly from state central actors and agencies which make policy and implementation choices that serve to preserve their own interests and power. In this context, establishing an effective polycentric and multi-layered EWS architecture to address risk on multiple levels and scales relies on the effectiveness of the political governance system (i.e. decentralisation backed with adequate financial and human resources). An effective decentralized architecture also provides favourable conditions for the local bottom-up approach.

6.2.7 Legitimacy of Local Approaches -Linking Across Levels

As indicated earlier, the technocratic, linear, top-down approach of the EWS is desirable, yet is vulnerable to sudden shocks. In this regard, there have been increasing efforts to develop community-based approaches to EWS to reduce vulnerability and improve EWS effectiveness. However, the links between the community-based approach and the national and global EWS are poor (Birkmann, Chang Seng, Suarez 2011). Improving the links and legitimacy of both approaches is a new challenge to address.

6.2.8 Sharing and Exchange of Local Experiences

Sharing and exchange of local experiences is an important mechanism for learning, reorganizing and adapting in order to build the resilience of communities to hazards and risks. The local traditional knowledge of the story of "Smong[10]" in the Simelue islands following in the context of the December 2004 Indian Ocean Tsunami taught us two main lessons. On the one hand, it demonstrated the paternalistically shared knowledge of tsunamis amongst the locals through generations, exclusively in the Simelue islands, and on the other hand it showed the fundamental weakness that such knowledge was available only to a very limited degree in neighbouring districts (Lassa 2008, Chang Seng 2010). In this context, the most important issue relates to sustaining the sharing and exchange of local experiences. Sharing and exchanging information, tools, methodologies, base line studies, experience, lessons learnt and best practices with new areas from pilot project interventions is very important. Very often, through project interventions, multi-stakeholder and community participation is very high. However, once the projects end, institutional actors re-prioritize their needs and mobilize to other areas, and in the process the community participation fades away, particularly if there is a lack of institutional backing to guarantee funds. In addition, another problem is identifying new, committed actors in new areas that would be capable of exercising effective agency in relation to the problem. In this context, developing incentive mechanisms and structures to secure sustainable community involvement (including volunteers)

[10] The possible reason for the low number of deaths is the Smong story was documented by UNISDR in the context of 'The Power of Knowledge'. The local leader of the Simelue district reports that '*In 1907 a smong (i.e. tsunami) happened here in Simuelue, and so our grandmothers always gave us the following advice: if an earthquake comes, we must go and look at the beach. If the sea is at low tide the smong or tsunami will be coming and we must look for higher ground*.'

and multi-stakeholder partnerships, particularly with private institutions, are key challenges to be addressed.

6.2.9 Effective, Robust Dissemination and Communication Systems

A major challenge in the context of the Last Mile and preparedness is the availability and functioning of proper effective and robust dissemination and communication systems that reach all the people at risk. For example, there is a need to ensure that all countries, particularly the least developed, have access to the global communication systems i.e. WMO Global Telecommunication System. On the other hand, at the sub-national and community level there is a lack of communication and dissemination application devices. For instance, in the context of the EWS in Indonesia, good telecommunication infrastructures are mainly concentrated in the big cities. There is a wide telecommunication and information gap between the cities and the rural areas.

The key challenge is to encourage institutional leadership and innovative business partnerships in order to improve the availability of user communication devices and fill the telecommunication and information gap at multiple levels and scales. The role of public private partnerships in making EWS more effective and sustainable is increasingly recognised, though much more needs to be done in practice. For instance, through a consultative and transparent participatory process, a concept paper on the National EWS in Sri Lanka for the design of an effective all-hazard public warning system has been prepared. The concept strongly encourages the importance of the private sector supporting complementary resources and necessary infrastructure (e.g. telecommunications and broadcasting networks**)** that are needed for disseminating warnings (Samarajiva, Knight-John, Aderson et al 2005).

6.2.10 Response Behaviour and Effective Coordination

As we have seen, a longer time forecast often does not convey the element of immediate threat and fear which is necessary to initiate the correct actions. Thus, the warning information needs to be repeated (Birkmann, Chang Seng, Suarez 2011) to trigger the expected response behaviour and actions. The level of risk accepted by people at risk, and the trust in the EWS and the institutions that run these systems are key factors influencing changes in livelihood and decisions to evacuate or migrate.

A specific challenge is related to the response behaviours of the people and the issue related to Negative Outcome Expectancy (NOE) (See Paton et al., 2008). Some people decide not to prepare, while others are predisposed to act, but need support and guidance (Paton, Smith & Johnston 2005). 'Preparing' and 'Not Preparing' are discrete processes. The challenge is that the stakeholders concerned need to develop and implement separate strategies (Paton & McClure 2007) to address the issue. For example, in Indonesia, a separate policy strategy for education and awareness is required for Negative Outcome Expectancy (NOE) (i.e. negative perceptions of religious and cultural constructs, limited use of the tsunami EWS particularly for locally generated tsunamis, and ongoing fears of potential negative impacts of hazard preparedness on economic activities (i.e. tourism)) (Chang Seng 2010).

On the other hand, the close link between effective risk communication and response coordination is very important. For example, in the case of the multiple crises in Japan following the earthquake, tsunami, and the widespread fear of nuclear radiation leaks and meltdown, the important question raised is how to handle evacuation of both locals and foreign nationals, and particularly how to handle evacuations from a large urbanized area. Differences in views about procedures for evacuations and technical support have affected some aspects of the response, despite the fact that Japan and the United States are among the closest of allies (Centre for a New American Security 2011). It is argued that if these challenges are daunting, coordination would be even more difficult during a crisis on the Korean peninsula in which major military forces from several countries are in far closer proximity, the nations involved have more divergent interests, and the risk of miscommunication is higher.

The link between risk perception, coordination and response can be emphasised in the example analysed by Thomalla F, Schmuck H. 2004. It was argued that although people knew that a cyclone was coming and would impact Orissa in India in October 1999, those living in the affected areas did little to protect themselves, and as a result more than 10,000 were killed. The key problem identified was poor collaboration at the state level

Alex De Waal revealed some important insights into the dynamics of famine and famine relief-response in the context of EWS. When news of the Darfur famine broke out in the 1980s, relief experts predicted that without massive international relief, millions of people would starve. Deaths during the famine were not due to starvation, but rather were caused by disease, which ravaged the place in the aftermath of social disruption caused by the famine. Political stability should be viewed as an important element here because it is a social practice where human needs and securities are constantly contested and fought over (Bohle 2007) and it has strong links to the other elements of good governance such as participation, mediation, negotiation etc. In this context, collaboration, effective coordination and response can be seriously negatively impacted by other factors such as political instability, social disruption and conflicts.

6.2.11 The Early Warning and Information Dilemma

As indicated above, another level of challenge includes the role of EWS in the context of livelihood issues such as animal diseases and food contamination which may in fact disadvantage specific groups. For instance, there was a boycott by Middle Eastern importers, and trade disruption caused by African livestock disease following an outbreak of Rift Valley fever in sheep. There is a certain level of conflict of interest and dilemma for farmers, for instance to inform and response to early warning because they suffer (Sheriff and Osgood 2007). New livestock forecasting and monitoring systems have been put in place but producers have demonstrated a resistance to revealing livestock safety information, undermining the EWS and leading to further boycotts and producers being blacklisted. Hence, through a system of equilibrium contracts, buyers may need to compensate for the information provided, as part of the EWS process to address the shepherds' dilemma about revealing livestock information.

Additionally, the deadly Enterohaemorrhagic E. coli (EHEC), which sparked food-health crises, particularly in Germany, is another case which shows the challenges for EWS in terms of providing early and accurate information, without harming specific groups (e.g. agricultural segments). Thirty-one people died, while 3,000 were infected by the bacteria after the first cases were reported on May 24[11]. Within the chain of events, the German authorities of Hamburg identified three cucumbers from Spain as the cause of the disease, along with a fourth whose origin was unknown. In this context, Spain was blamed for the outbreak of the E. Coli crisis. However, Spain's agriculture minister contested the accusation. Nevertheless, in response to the health risk, Russia banned the import of all vegetables from Germany and Spain. Later the ban was extended to include all 27 EU member states. As a consequence, Spain and the Netherlands demanded EU compensation after their vegetable sales collapsed. The European Union Commission has raised its offer of compensation to 210 million Euros for vegetable farmers, up from an earlier 150 million Euros. On the 10th June, Germany identified contaminated sprouts as the source of the bacteria and lifted its warnings on eating raw lettuce, tomatoes and cucumbers. This crisis at the European level illustrates the multidimensional impacts and challenges related to accurate and timely risk information as part of the EW process.

[11] http://www.physorg.com/news/2011-06-deadly-coli-germany-timeline.html

6.3 Key Challenges of EWS- Migration and Displacement

6.3.1 New Concepts

The key barriers and challenges related to the nexus between EWS and forced displacement and migration, include the fact that it was only recently, in December 2003, that migration and human displacement became internationally recognised, following the launching of the Global Commission on International Migration (GCIM) with the support of Secretary-General of the United Nations Kofi Annan and several countries. The recent publication of the IPCCC's Fourth Assessment report has shed further light on migration and human displacement in the context of climate change. Likewise, as indicated earlier, end to end, people-centred EWS are also relatively new concepts capturing global interest and gaining momentum following the third international conference on EWS in Bonn, Germany in 2006.

6.3.2 Focus on Advocacy, Community-Based Protection Strategies

The Inter-Agency Standing Committee (IASC) policy paper identifies fourteen strategic areas to focus on regarding migration and human displacement. These include advocacy, prevention, and preparedness, supporting community-based protection, and developing strategies to protect women, children and vulnerable groups (IASC 1999). However, little attention is paid to the use of the EWS as a tool to empower displaced societies and communities to prepare for and confront the power and the uncertainties of both natural and climate change-driven hazards.

6.3.3 Focus on Natural Hazards and Environmental Change Indicators

Existing EWS tend to focus on specific hazards such as floods, or creeping hazards such as droughts and environmental change indicators, rather than on access rights to food or potential triggers of migration. This focus on specific hazards might also be related to the specific institutional set-up of most EWS, which are linked to meteorological or environmental agencies or even the military. The current and unabated Japanese disaster highlights in the strongest way the issues involved in a multidimensional crisis and the cascading effects of an earthquake; a tsunami, radiation leaks and multiple level exposures and risk.

A major challenge for EWS in the context of migration and human displacement is the need to address not only natural hazards but also epidemics and impacts on health, as we have illustrated in the case of malaria-infected migrants from Afghanistan moving into Pakistan.

6.3.4 Uncertainty in Predicting Slow Onset Disasters and User Information

As we have seen earlier, slow onset hazards such as drought remain highly uncertain in terms of predictability as part of the climate prediction services. Even with substantive improvements in current scientific knowledge, the key challenges include information dissemination, communication, and interpretation at the local level, particularly in less developed countries. In this context, it is important to establish the skill in forecasting slow onset hazards such as drought, and enhance the understand how climate change variability and climate change projections can be better communicated to decision makers also linked to EW and extreme events.

6.3.5 Response Behaviours (Believability and Proximity of Risk)

It must be stressed that one of the key challenges in regard to the role of EWS in migration and human displacement is linked to the actual response behaviours. Response behaviours are not based on a simple stimulus-response. In reality, warning involves far more than just a linear transmission of the message. In a review of the warning process and evacuation behaviour, it was found that warning behaviour involves selective perception, collective multiple perceptions, and social interactions including other independent observations to socially confirm the warning message before accepting or rejecting a warning which may evoke an appropriate response (Quarantelli 1990, Chang Seng 2010). Hence, reaction behaviour is not simple stimulus-response behaviour. Believability depends on the confirmation process, the proximity of the threat, and the perception of the danger as real. On this note, it is well recognized that environmental problems may remain undiscovered until a certain threshold is reached beyond which they become a severe threat to the environmental security of the region. In this context it is important to monitor these threats at an early stage. These social behaviours tend to explain why EWS for future likely risks will face strong challenges in encouraging migration and human displacement.

7.0 Outlook and Recommendations for Improving EWS and Preparedness

7.1 Multi-Risk, Vulnerability and Social Development Scenario Assessment

Birkmann, Chang Seng, Suarez (2011) underline that the scientific progress which is needed in order to improve people-centred EWS and their preparedness includes the challenge to the scientific communities of preparing a set of climate change and social development scenarios in collaboration with the national government in order to translate general climate change scenarios into risk profiles that can serve as a basis for policy-making on different scales. The development of such risk profiles requires also enhancing the scientific knowledge on how climate change scenarios translate into hazards, modified exposure and risk distribution, and development of risk.

7.2Multi-Scaled Global Information Network and Common Alerting Protocols

It is recognized that great achievements in science and technology have occurred during the 20th century which have supposedly improved warning and forecasting systems (WMO 2005). On the other hand, the scientific progress which is needed in order to improve people-centred EWS and their preparedness function for local communities at risk is related to the global multi-hazard EWS. Concrete steps highlighted by Grasso (2010) include several measures and strategies to improve EWS. These specifically include establishing a Multi-Scaled Global Information Network towards a global EWS supported by standard protocols (Common Alerting Protocol (CAP). Interestingly, more than a decade ago Quarantelli (1998) proposed the establishment of global disaster information network (GDIN) while underlining the social challenges associated with this endeavour. More attention must be given to the social dimensions of a GDIN. Thus it is mostly a matter of involving those who are knowledgeable about such matters and having them make explicit what research has found or could find.

Nevertheless, in the coming years, it is anticipated that the multi-scaled global information network will greatly improve because of new, innovative technology that will make possible the global distribution of data and information at all levels. The impact of globalization and rapid communication provides an unparalleled opportunity to catalyze effective action at every level by rapidly providing the authorities and the general public with high-quality, scientifically credible information in a timely fashion. However, it has to be recognized that there are also competing demands. For example, Quarantelli (1998) underlined that the developers of GDIN recently discovered that there was an overlapping domestic effort in the US. This involves an attempt to create a National Emergency Resource Information Network (NERIN). This effort basically focuses on the development of a national Internet-based human services infrastructure for disaster recovery.

To improve risk communication and dissemination through such a multi-scaled global information network also means establishing standard protocols to allow effective coordination and data exchange among the institutions and actors. The benefits of standard format alerts are their compatibility with all information systems, warning systems, media, and most importantly, with new technologies such as web services. Standard protocols guarantee consistency of warning messages and are compatible with all types of information systems and public alerting systems, including broadcast radio and television as well as public and private data networks, with multi-lingual warning systems and emerging technologies.

7.3 New Multi-Purpose End-User Device Applications

The various types of EW information being prepared by key institutions are often not reaching the right people who represent the Last Mile of the pathway to effective preparedness (See table in Annex).The scientific challenge hinges on developing and making available various multi-purpose, end-user device applications for communicating and receiving information**.** There is already a global interest in developing an effective disaster warning network with new device applications. The technology model will integrate remote sensing, localization, geographic information systems, embedded intelligence, and networked wireless communications. The model will work with any or all point-to-multi-point wireless networks. However, as technological gadgets improve, new multi-purpose device applications will be required such that tailor-made EW information can reach various people at risk, for example on their mobiles. These devices should be simple to use. Grasso (2011) highlighted the benefits of enhancing the visualization of scientific information on environmental change and threats by employing satellite imagery.

7.4 Climate-Ecological and Socio- Economic Indices

In order to address environmental shocks, EWS need to include socio-ecosystem resilience attributes (see Label et al 2006, Ostrom 1999, Carpenter et al., 2001, Holling 2001, Scheffer and Carpenter 2003, Berkes 2002, Young 2002, Folke et al. 2003, Chang Seng 2010). This implies paying very close attention to attributes such as knowledge, uncertainty, thresholds, fit, and the element of surprise, diversity etc. The recent mega earthquake and tsunami disaster in Japan has taught us lessons about the importance of such elements. In this context, in a recent workshop, experts suggested that EWS frameworks for situations related to climate change particularly need to consider the climate, ecological and socio-economic indices (See Birkmann, Chang Seng and Suarez 2010). One emerging area of interest for managing climate-related risk disasters-particularly in the agricultural and food security environment, is incorporating index insurance into EWS. The potential of index insurance is being tested in a growing number of countries. Based on a wealth of practical experience and knowledge Hellmuth, Osgood, Hess et al., 2009 highlight that index insurance might provide new opportunities for some regions, including new approaches on how to address risk, new methods of risk pooling and transfer, and new roles for national insurance companies. However, there are also many open questions about the availability of data for index based micro-insurances which would normally require a large scale stationary network to monitor, e.g. precipitation of rainfall patterns. Additionally, it will be interesting to examine how people on the move or forced to migrate can claim such insurance benefits if they end up in a new location due to the migration process.

7.5 Understanding Short-Term Variations and Slow onset Events

It is very important to pay attention to variations at annual and decadal time scales because they will have a greater impact on climate variability over the next few decades than long-term climate change. On the other hand, as discussed earlier, there is a relatively well developed capacity for forecasting rapid onset hazards and impacts around the role with the national meteorological-hydrological services playing a central role under a WMO and UNESCO governance framework. However, more attention should be paid to slow onset events and impacts which are often more complex to predict, and there is a need to consider many other factors beside the identification of the hazard. Greene, Giannini and Zebiak (2009) estimate the recurrence times for extreme drought events in the African Sahel using a classical peaks-over-threshold model. Their results suggest that the distribution of dry extremes after about 1970 is statistically distinct from that of preceding years. Most importantly, in relation to slow hazards and impacts, it is crucial that we improve our understanding of both the critical role played by attribution of causes, and of the physical processes driving precipitation variability in the Sahel.

7.6 Potential, Limitations and Quality of Forecasting

It is important to integrate climate information such as seasonal forecasting in EWS and disaster risk management. Thus, disaster risk managers and decision makers should be aware of the real potential, opportunities and limitations of climate forecasting.

The limitations of a forecast depend on the quality of the forecast. Therefore, it is important to address this quality. Verification forecasts in Africa, particularly in the last decade, indicate evidence of positive skill to varying degrees, but also show evidence of systematic errors, and so it will not be immediately apparent to users, particularly in the greater horn of Africa whether any useful information can be gained from the forecast (Mason, Chidzambwa 2008). One of the main systematic errors is the tendency to hedge the forecast towards higher probabilities on the normal category which are subject to the forecaster's decision to communicate the forecast deterministically. An effect of hedging that has been found is that normal rainfall was forecast to occur much more frequently and extensively than was actually observed. Additionally, there are difficulties in setting reliable probabilities for the forecasts. Hence, there is a need to implement more objective methods for making the forecast than are currently used. Not only is there a strong need to reduce the subjective component of the process, but also a need to ensure that reliable objective schemes are introduced. Understanding the quality of the forecast allows the correct interpretation and effective use of the information. It serves administrative, scientific and economic purposes (Brier and Allen 1951). It is useful for evaluating performance at scientific and user levels, which should subsequently lead to improvements in the forecast methods. The challenges to address are therefore to clearly identify and establish thresholds for action, because climate information links to impacts, and because it is necessary to weigh the cost and benefits of action or inaction given a certain probability of occurrence.

7.7 Data

At the centre of all climate information and EWS is data. Thompson, Connor, and Zebiak (2011) highlights that Africa needs climate data to fight disease. In Africa for example, the limited access to daily observations of surface air temperature from meteorological stations, in quality–controlled, long time series has constrained studies. In this context, researchers have relied heavily on short time series, and have used data of poor quality in favour of spatially interpolated global data sets that could not provide meaningful results at local scale. To partly address this data gap, a new high quality database consisting of air temperature and rainfall of both meteorological and socio-economic data has been initiated in Ethiopia. This represents an opportunity to establish the value of climate information in improving health. Identifying the data set that might be relevant to EWS varies for each need. Therefore, it is crucial that communities work together in order to improve existing data for better climate information and EWS.

Overall, mobility is an important component of peoples' changing exposure, vulnerability and their adaptive capacity. EWS have focused on and are useful in targeting imminent short-term events and impacts, prompting temporary mobility of people in terms of evacuation. To a certain extent, the daily mobility and exposure of people are currently being addressed in EWS. However, to this end EWS have been formally recognised as important in decision-making when people are displaced, relocate or migrate as a result of urbanisation or from post-disaster experiences as an adaptation strategy. EW information about future climate change-related risk, for example sea level rise, is not stimulating the right decisions and actions, and is not yet systematically and methodologically integrated in EWS. States and the international community need to recognise the urgency of tackling migration flows and human displacements. As such, the scientific community, emergency managers and policymakers need to keep their fingers closely on the demographic pulse of their communities, especially as settlement increases in the coastal zones. Migration is one set of adaptation strategies, but it requires the right policies and support. In this context, concerned institutions such as UN-OCHA would like to see a situation where migration and other socio-economic aspects are more systematically included in EWS[12]. However, delivering these services to vulnerable populations can be difficult, if not impossible. One of the important steps is to institutionally recognise the role of the EWS when addressing the issue of migration and human displacement. In some ways, there are important steps being undertaken toward that goal. For instance, three approaches were proposed to address the issue as reported in the UN System Side Event[13] in Cancun in November 2010. It was outlined that there is a need to provide protection to those being displaced and to facilitate migration as an adaptation strategy. An integrated solution that links migration and CCA and other relevant domains of disaster DRR is required. Notably, a human rights-based approach has been proposed which includes ensuring access to essential information. In this context, EWS have an important institutional role to play in providing critical and essential information on migration and displacement in the face of environmental shocks.

In order to properly reach people that have migrated or have been displaced there is a need to develop EWS that focus on hotspot or risk environments, not only in terms of natural hazards but also epidemics that could potentially transform into environmental and social health-related insecurity. In this context, EWS should be flexible and adapt to complex environments with cascading effects and impacts. It is therefore important to have a system for collecting various data and identifying possible affected areas. In this regard, the EWS should be based on a multi-hazard approach, with polycentric governance systems that also recognize the local adaptive approaches. EWS approaches should be capable of reaching people in urban and rural areas and across sectors. The role of multi-stakeholder involvement, collaboration and trust as a form of agency is particularly important. Critical thresholds, potential tipping points in social-ecological systems, and appropriate response capabilities are critical elements to address as part of the EWS process. Moreover, effective and transparent risk communication strategies incorporating an effective role for the media, as well as measures that factor in quality-based climate information such as seasonal forecasts that address livelihood issues are particularly important. The challenge is to develop methods that account for the interactions between sudden-onset hazards (e.g. storm surges), environmental changes (e.g. sea-level rise) and socio-economic trends (e.g. urbanization, poverty etc.), potential socio-economic thresholds and tipping points (e.g. tipping points that lead to migration) and climate-related information that addresses livelihood in the broader context of people-centred EWS.

[12] Personal communication

[13] http://www.iom.int/jahia/webdav/shared/shared/mainsite/activities/env_degradation/Climate-Change-Displacement-and-Migration-Shared-Messages.pdf

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9.0 Annex

Name	Who	Purpose and audience	Type	Indicators	Output
UN Agencies					
Epidemic and pandemic Alert and Response (EPR)	WHO	Purpose: Integrated global alert and response system for epidemics and other public health emergencies; tracks evolving infectious disease situation, sounds alarm when needed, shares expertise, and mounts response needed to protect populations from consequences of epidemics; Audience: External (Member States, health professionals); Coverage: Global	Global alert and response system	Epidemics and pandemics.	Global Public Health Intelligence Network (GPHIN) is a secure Internet-based early warning tool that continuously searches global media sources such as news wires and websites to identify information about disease outbreaks and other events of potential international public health concern.
Food Security Monitoring Systems	WFP	Purpose: Monthly and quarterly food security monitoring systems to inform WFP and partner operations. Audience: Internal and external; Coverage: Focus on specific countries with WFP operations: Afghanistan, Burkina Faso, Burundi, CAR, Chad, Cote d'Ivoire, Haiti, Lesotho, Mali, Mauritania, Nepal, Niger, Rwanda, Sudan, Swaziland and Uganda	Monitoring system	Food commodity and cash crops/livestock prices, terms of trade, inflation, progression of agricultural season, food consumption score, and coping strategies.	Monthly or quarterly reports
EP Web: Early Warning and Response Web	WFP	Purpose: Early warning and response system to support existing as well as new humanitarian operations; Audience: External; Coverage: Global	Early Warning System		Latest reports and maps on current and emerging natural and man-made crises throughout the world.
Global Disaster Alert and Coordination	OCHA/ EC	Purpose: Web-based platform that combines existing web-based disaster information management systems; provides near real time alerts about	Alert and Coordination System	Earthquakes, cyclones, floods, volcanoes	Media monitoring, map catalogues and virtual on-site operations coordination

System (GDACS)		natural disasters around the world and tools to facilitate response coordination; Audience: External (humanitarian community)			centre; access alert-notification and interactive components are restricted to disaster managers in donor countries, response organizations and disaster-prone countries.
Humanitarian Dashboard - under development	OCHA	Purpose: To consolidate core and common humanitarian information on individual humanitarian crises on a real time basis in a single screen or page format. Audience: Internal (Senior UN management). Coverage: Global	Crisis monitoring	Humanitarian crisis indicators.	*In development.*
Global Focus Model	OCHA	Purpose: To analyse hazards, vulnerabilities and response capacity at the country level, using a range of quantitative indicators to make decisions on where OCHA should focus and put resources. Audience: Internal (OCHA staff); Coverage: Global	Model-based risk assessment	Four categories of indicator: hazards, vulnerability, capacity and OCHA role.	Global focus matrix.
Humanitarian Early Warning Service (HEWSweb)	WFP/IASC	Purpose: Global one-stop shop for early warning information for all natural hazards; main objective is to bring together and make accessible in a simple manner the most credible early warning information available at the global level from multiple specialized institutions; Audience: External (humanitarian community); Coverage: Global	One-stop shop for early warning info		Graphics, maps, and simple (non-technical) language and messages that are accessible to managers & decision makers.
IASC Early Warning/ Early Action Report	Inter-Agency Standing Committee (IASC)	Purpose: Report every four months on the status of the world's current and potential emergencies with prioritization rating; Audience: UN + Humanitarian NGOs	Global Early Warning and Preparedness to humanitarian response		Report produced every four months.

Early Warning / Early Action system	UNICEF	Purpose: Analysis of threats having the potential to lead to humanitarian implications in all countries where UNICEF has a field presence and triangulation timescale / country office capacity / level of risk to generate early-warnings if need be and to improve humanitarian preparedness; Audience: Internal, for UNICEF Country / Regional offices and Headquarters; Coverage: Global	Early Warning, Early Action, and preparedness for humanitarian response	Imminence of threat, capacity level of Country Office to respond, number of women and children potentially affected. Under development: quantitative indicators for UNICEF programmatic areas (Education, Nutrition, Water & Sanitation, Child Protection, Child health).	Maps, description of types of crisis and potential humanitarian implications on women & children, preparedness priorities and activities undertaken, assessment of level of preparedness in real time of UNICEF country offices, generation of alerts.
Global Risk Identification Programme (GRIP)	UNDP/ BCPR	Purpose: To improve information on disaster risks and losses and facilitate the incorporation of that information into risk management decision-making. GRIP is the thematic platform for the implementation of Priority Action 2 of the Hyogo Frame for Action: Identification, assessment and monitoring of disaster risks. The goal of GRIP is to reduce natural hazard-related losses in high risk areas to promote sustainable development; Audience: ?; Coverage: Global?	Risk assessment	?	Website, risk assessments, reports.
Desert Locust Information Service (DLIS)	FAO	Purpose: Global monitoring of desert locust situation and habitat conditions in Africa, Near East and Asia on a daily basis, and provision of early warning and forecasts on the timing, location and scale of potential locust breeding and migration in order to reduce the frequency of	Global monitoring and early warning	Field data collected by national survey/control teams and real time transmission by satellite; satellite-	Monthly bulletin that contains national level situation summary and 6-week forecasts (produced by FAO/DLIS since 1976) supplemented by

		locust plagues, and improve early response; Audience: Locust-affected countries, decision makers, general public, scientists, UN, NGOs, donors, governments		derived estimates of rainfall and green vegetation; meteorological data; seasonal (6-month) forecasts of precipitation and temperature; locust development and trajectory models; historical data (1930 to present); information exchange agreements (i.e. International Maritime Organization and UN Military Observers).	warnings (by direct email to concerned officials), alerts and updates during periods of increased locust activity; colour-coded alert levels; Locust Watch web site.
Global Information and Early Warning System on Food and Agriculture (GIEWS)	FAO	Purpose: Global monitoring of food demand and supply for all basic foods, and early warning alerts of imminent food crises; Audience: External (governments, etc.) and internal; Coverage: Global	Global monitoring and early warning	Country cereal balance sheets, agro-climatic indicators, international commodity prices and basic domestic food prices, rainfall estimates at the provincial level (Africa), Vegetation index.	Issue reports on the world food situation, a list of countries in crisis, early warnings and updates on specific countries, a list of global early warning indicators, a basic domestic food prices database, satellite imagery and rainfall estimates for sub-Saharan Africa, by country. Also includes reports from joint FAO/WFP Crop and Food Security Assessments.

Turnkey crop monitoring and forecasting tool (CM BX)	FAO/EC	Purpose: "CM Box" is a national turnkey crop monitoring and forecasting system; it is an automated software suite that analyses weather data to assess their impact on crop production; Audience: Interested countries	Monitoring and forecasting software		
Programme on Risk Evaluation, Information and Early Warning (PREVIEW)	UNEP	Purpose: To help identify natural hazard risks in a quantitative way; Audience: ?; Coverage: ?	Evaluation and early warning system	Drought, earthquakes, fires, floods, landslides, tropical cyclones, tsunamis and volcanoes.	?
Global Environment Alert Service (GEAS) - under development	UNEP	Purpose: Will be collecting and integrating data about environmental changes from various scientifically credible sources, making it accessible on the Internet; Audience: UNEP, UN, decision makers, general public, scientists, etc.; Coverage: Global	Alert system/early warning system	Climate change; disaster and conflicts; ecosystem management; environmental governance; hazardous substances; resource efficiency.	Website which will link all the components of the GEAS system, containing data, visualizations, analysis and reports; weekly alerts that users will be able to receive by email (near real time environmental alerts; environmental hotspots alerts; environmental science alerts). A prototype is currently being developed and is expected to be finalized by the end of 2009.
Data and Indicators Platform - under development	UNEP	Purpose: Will be applying UNEP's science assets in ecosystem services, environmental governance, hotspot identification and early warning, and socio-economics in combination with easy-to-use-	Data and indicator platform	?	Platform - prototype version expected to be ready mid- 2009

		and-understand visualization and analytical tools in order to guide sound policy development; Audience: Internal?; Coverage: ?			
Early Warning / Early Action, situational reports on "hot-spots"	UNHCR	Purpose: Real time up-to-date reporting and analysis of critical developments in key operations or emergency situations for the purpose of developing timely and appropriate protection responses; Audience: Internal (UNHCR generally and in particular, senior management; some data is placed on the UNHCR public website for public information and update generally); Coverage: Global?	Rapid, real time information, early action/warning system and preparedness for protection response	Categories of persons of concern (refugees, IDPs, stateless persons, returnees), protection needs; legal status; documentation; physical safety; non-refoulement; access to essential services; host government's receptivity; access to durable solutions.	Daily/Weekly/Monthly situation reports; UNHCR's Global Report and Global Appeal on an annual basis; State of the World Refugees.
Environmental Scanning Alert System - under development	UNFPA	Purpose: Currently based on email communication among UNFPA offices; alert messages represent ad-hoc analysis of crucial political developments and are being captured in regional political reports in three UNFPA regions. In the future, synthesis of these messages as well as development of a Web-based dashboard for receiving and responding to alerts are envisioned. Audience: Internal; Coverage: 3 UNFPA regions	Alert system/early warning/risk analysis	Political, socio-cultural, and economic developments.	In development.
Risk Mapping Exercise - Disaster Risk Reduction and	UN-HABITAT	Purpose: To improve capacities to predict and address future post-disaster shelter needs as well as to manage information about ongoing risks after a disaster, and their implications for planning;	Risk mapping for prevention and response strategies	?	Municipal information and database.

Response Planning		<u>Audience</u>: Local authorities, organized communities and relevant stakeholders; <u>Coverage</u>: Global?			
Disaster Assessment Portal	UN-HABITAT	<u>Purpose:</u> A collection of assessment tools and case studies (vulnerability, risk, capacity, needs, etc) and useful information for disaster risk assessment. <u>Audience</u>: Disaster management specialists and practitioners, local authorities; <u>Coverage</u>:	Tools and case studies for assessments		Links to sites with resources and useful information for disaster risk assessment .
Global Urban Observatory (GUO)	UN-HABITAT	<u>Purpose</u>: To monitor global urban conditions and trends, focusing on trends in the world's slum population, which is generally vulnerable to forced eviction, natural and human-made disasters, and water-borne diseases. <u>Audience</u>: Central governments, local authorities, development aid organizations and non-governmental development organizations involved in urban and shelter work; <u>Coverage</u>: Global	Global observatory	Number of urban slum dwellers; number of people/households without security of tenure; number of people living in non-durable housing; square metres of living space per person; percentage of people/households without access to safe drinking water; and percentage of people/households without access to safe/improved sanitation.	Global database (Urban Info); flagship reports (Global Report on Human Settlements and the State of the World's Cities report, published every two years).
Environmental and Security Initiative (ENVSEC)	UNEP, UNDP, OSCE, NATO, UNECE, REC	<u>Purpose</u>: To assess and address environmental problems that threaten or are perceived to threaten security, societal stability and peace, human health and/or sustainable livelihoods, within and across national borders in conflict-prone regions across South Eastern and	Analysis and assessments		Website, assessments and reports with maps illustrating the linkages between environment and security, and drawing attention to areas where

		Eastern Europe, Central Asia and the Caucasus. Audience: Decision makers as well as the general public; Coverage: Regional			risks are high.
Community-Based Monitoring System (CBMS) network	UNESCAP	Purpose: To collect data to assess the impact of the economic crisis on poverty among households and evaluate their coping mechanisms (in selected communities in 14 project countries) with the aim of being able to help countries and the international community in efforts to mitigate the impact of the current crisis and develop social protection measures to lessen the negative effects of the crisis on the poor: Audience: ?; Coverage: ?	Monitoring system		
Government					
Global Earth Observation System of System (GEOSS) - under development	Gvts/IOs	Purpose: GEOSS will be a global and flexible network of content providers allowing decision makers to access a range of information; Audience: External (decision makers, experts); Coverage: Global	Observatory	Focus on natural and human-induced disasters, environmental sources of health hazards, energy resources, climate change and its impacts, water resources, weather forecasts, ecosystems, sustainable agriculture and biodiversity.	GEOPortal will offer a single Internet access point for users seeking data, imagery and analytical software packages relevant to all parts of the globe; connects users to existing databases and portals and provides reliable, up-to-date and user-friendly information.
CEWARN	IGAD	Purpose: To receive and share information concerning potentially violent conflicts as well as their outbreak and escalation in the IGAD region; Audience: IGAD Member States; Coverage: Regional	Early warning (sub-regional)	Livestock rustling, conflict over grazing and water points, nomadic movements,	Baseline reports (every 5 yrs), country and cluster updates (updated every four months), real time alerts.

				smuggling and illegal trade, refugees, landmines and banditry.	
Famine Early Warning Systems Network (FEWS NET)	USAID	Purpose: To provide timely and rigorous early warning and vulnerability information on emerging and evolving food security issues; Audience: Internal and external; Coverage: ?	Early warning/alert	Harvests, internal factors (economic, social, demographic, health, environment), external hazards (conflict, natural disasters, price shifts) and coping capacity.	Monthly food security updates for 25 countries, regular food security outlooks, and alerts, as well as briefings and support for contingency and response planning efforts. More in-depth studies in areas such as livelihoods and markets.
Universities					
FUGI Global Early Warning System	Japan	Purpose: Global modelling; one of the first integrated global models; originally an amalgam of three different types of model: an input-output model, a macro-economic model, and a natural resources model; evolved into a primarily macro-economic model and then into a broader model used for refugee flow early warning.	Integrated Global Model (IGM)		Irregular publication.
Foundations/NGOs					
FAST Project - *operational until 2008*	Swiss Peace Foundation	Purpose: To enhance the ability of decision makers to identify critical developments in a timely manner (early warning) and identify windows of opportunity for peace building; Audience: External (governments, NGOs, etc.); Coverage: Regional	Early warning system; model- based risk assessment		Annual country risk profile.

Table 3: Selected institutions, organizations and actors running alert and monitoring systems, Source: modified after Grasso 2011