Usable Science 8:

Early Warning Systems: Do's and Don'ts

Report of Workshop

20–23 October 2003

Shanghai, China

www.esig.ucar.edu/warning/

Report prepared by

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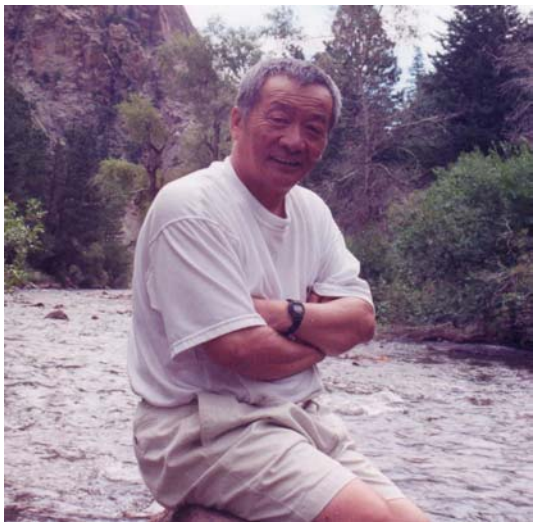
Dedication

This report is dedicated to the memory of **Ye, Dehui**, who was born in Beijing on December 30, 1932 and passed away in Shanghai on October 16, 2003. After serving in China's Air Force training school for twenty years, he was forced during the Cultural Revolution to leave the school and go back to his hometown – Shanghai – with his family in 1970. In Shanghai, he worked for Shanghai Automobile Cooperation until retiring in 1993. He is remembered by his friends and colleagues as a brilliant, straightforward and hardworking person with a great sense of humor.



Introduction

> *"Even if you're on the right track, you'll get run over if you just sit there"* (Will Rogers, American humorist).

A workshop was organized in Shanghai, China, from 20–23 October 2003 on the topic of "Early Warning Systems: Do's and Don'ts." It was sponsored by the National Center for Atmospheric Research (NCAR), the US National Science Foundation (NSF), the China Meteorological Administration's Academy of Meteorological Science (CAMS), and the US National Oceanic and Atmospheric Administration.

The focus of the workshop discussion was centered primarily around research activities and experiences with hydrological and meteorological hazards and warning systems designed to alert at-risk people, communities, and governments about the possible onset of those hazards and impacts of hazards. Participants represented a wide range of disciplines, countries, and professions in order to address the success and limitations of early warning systems in general. A representative of the second Early Warning System Conference (EWC II), held 16–18 October 2003 in Bonn presented the findings of that major international conference.

More than a score of questions about early warnings and early warning systems were presented for discussion (please refer to the Viewbook in Appendix 5). The workshop participants were in plenary sessions except for a breakout session in which they divided into three groups to undertake a preliminary review to identify strengths, weaknesses, opportunities and constraints of early warning systems. One group focused on "selecting and monitoring indicators." A second group focused on "communicating the warning," while a third group was asked to focus on issues relating to "receiving, believing, and acting on the warning." Some key observations of the groups are presented in charts.

This workshop was convened (by chance and not by design) ten years, almost to the day, from the first Usable Science workshop. That workshop focused on "The use of El Niño information in famine early warning in sub-Saharan Africa" (Glantz, 1994). Interest in early warning of all kinds of traditional, natural, and anthropogenic hazards has grown markedly over the years, as new hazards arise and as known hazards continue to plague societies worldwide. Newly identified hazards and known hazards appearing in new places include global warming, solar wind storms, SARS, West Nile virus, hantavirus, mad cow disease, wasting disease, global terrorism, and so on. Societies must remain on the alert and early warning systems provide them with one way to remain vigilant.

An objective of this Usable Science Workshop on Early Warning Systems has been to identify lessons – in short, do's and don'ts – from the experiences of those who have worked with or helped to develop early warning systems for a wide range of societal concerns. It was hoped that the lessons, experiences, and insights identified in the workshop discussions could be used to remind, if not inform, government officials as well as decision makers in various government agencies and nongovernmental organizations about how to prepare effective warnings. They would also be used to

educate the media and the general public about how to interpret and use such warnings. We will have succeeded if we help to find ways to make early warnings of potential "threats" to society and the environment more useful, credible, and reliable.

There are many early warning systems (EWSs) in operation today in every country, if not in every community. In this report, we focus primarily, but not exclusively, on those systems related to hydrometeorological anomalies. Governments maintain early warning systems to warn their citizens and themselves about, for example, impending climate- and weather-related hazards.

While there are early warnings and early warning systems for just about everything that a government, society, individual, or corporation might want to know about the future, many of those warnings are not as effective as they could (or should) be. There is no perfect EWS, except on paper, in governmental plans, or in a PowerPoint presentation. While warning systems look great on paper as organization charts or as input-output diagrams, they run into difficulties (bottlenecks) at various locations (nodes and arrows) in the flow of warning preparation to communication and to action. It is useful to start discussions about EWSs with the view that there is no perfect system, so that expectations about what an EWS can do for its users remain at a realistic, as opposed to hypothetical, level. Even with a highly effective EW, it is reasonable to expect that problems will still arise in the hazard-affected region, so past experience should be included in any EWS.

To be sure, there are conflicting views at just about every stage of an EW process that will tend to reduce the effectiveness of a warning. However, not all delays in response to a warning are the result of a conspiracy or a bureaucratic tendency toward inaction. Several honest scientific disagreements exist about, for example, what an EWS should do for a government or a society and, often, about what qualitative or quantitative data mean. In addition, one officially designated early warning cannot meet all societal needs. Often one EWS's output serves as input to another EWS downstream. A cascade of early warnings has been set into motion. At various downstream stages of the EW process, there will be room for delayed responses.

Attached to this report in the appendix are the findings and recommendations of three recent (1998, 2002, 2003) international conferences on early warning systems.

It is important to point out that at every stage in the early warning process, there will be ethical and equity issues that must be addressed. Several of these issues appear throughout the text.

The following selected highlights are noted in bulleted format. They are not presented in a specific order of importance but illustrate the kinds of points identified as worthy of attention by policy makers who want to assure that early warning systems are effective in achieving their goals.

Shanghai EWSs Highlights

- While warning systems look great on paper as organization charts or as input-output diagrams, they run into difficulties (bottlenecks) at various locations (nodes and arrows) in the flow of warning preparation to communication to action.
- Several honest scientific disagreements exist about what an EWS should do for a government or a society.
- One officially designated early warning system cannot meet all societal needs.
- At every stage in the early warning process, there will be ethical and equity issues that must be addressed.
- Hazards and threats can change over time not only in intensity, frequency, and in location and duration, but also in importance and interest.
- Those affected by hazards can be far removed from the disaster site and not just in the disaster zone.
- It is necessary to keep the definition of an EWS broad to allow for a wide range of interpretations and flexible to accommodate for the likely recognition of new hazards and development of new EWS technologies.
- Scenarios can help to uncover potential impacts of hazards that might otherwise have caught decision makers by surprise.
- Many early warnings knowingly and unknowingly activate other early warnings, as the time gap between a warning and the onset of a hazardous event shortens. This process can be referred to as a cascade of early warnings.
- However large or complex the formal early warning system, there exists an even larger ***early warning network*** which encompasses many more elements of society than one might realize.
- Creeping environmental changes are in need of early warning systems because the impacts of incremental but cumulative changes on society in the long run may be more costly and disruptive than the quick onset hazardous events.
- EWSs should also report on advances in hazards research, advances in the development of early warning systems, and in new technologies and techniques that can improve the effectiveness of existing EWSs.
- Each stage in the warning process from monitoring to responding must be interactive in such a way as to keep the warning timely, understood, and providing enough lead-time for responses.
- As new earlier warning technologies and techniques have been developed or new monitoring methods devised, EWSs have had the opportunity to become more effective in their spatial coverage and in the lead timing of the warning.
- Because of limited resources (human and financial) in many countries, it is important to distinguish between what is desirable for an effective EWS and what is essential.
- EWSs need to be treated as subsystems embedded and integrated into larger socioeconomic and political systems. Stakeholders need to be involved in the development of new EWSs or redesigning existing ones.
- Stakeholders can provide important insights into how warnings might best be prepared and delivered to the public, the media, and even to the governments at different levels.
- Transparency is important for building up credibility in the outputs of EWSs.
- Early warning systems for food security, for example, need to use all kinds of information as inputs, even rumors, to assure that the earliest warning possible can be made for potential food-related problems.

- The selection of indicators is very important, because monitoring will center on them. The wrong indicators can lead to wasted time, effort, and resources.
- There will be surprises with respect to hazards with regard to timing of onset, intensity, location and duration and even impact.
- Early warning system operators face a dilemma: they are often criticized for a missed or erroneous warning, but are infrequently praised for having been correct.
- The psychological aspects surrounding EWSs are more important than generally realized. The way that people view early warning systems will affect how effective the EWS might prove to be.
- Discounting the value of information has a negative effect on the many lessons identified from the impacts of previous hazards and disasters.
- While perceptions of reality may not accurately reflect reality, the actions taken based on those perceptions will have real consequences.
- The impacts of hazards need not be surprising, if the appropriate warning mechanisms are in place.
- It is essential to identify societal processes that can affect the impacts of hazards (quick onset and creeping), so that governments and individuals can better warn about and prepare for likely impacts.
- Each government has the responsibility to identify what it is that makes societies more or less vulnerable and more or less resilient.
- Early warning of hazards combined with the early warnings of underlying societal problems and processes can lead to a strengthening of resilience and a reduction in vulnerability.
- How well prepared a society is in order to be proactive in the face of early warning of a looming hazard determines how well people might respond to the hazard.
- Climate change will have impacts that add to the list of yet-unknown underlying processes that can affect hazards and societal vulnerability to them.
- It seems that EWSs are more likely to receive blame for missed or erroneous warnings than praise for successful ones. Memories of successes are short-lived and easily overshadowed by the next disaster.
- There should be multiple expressions of a warning. Foreseeability can be viewed as yet another way to express an early warning of potential harm, even if it is not used in an operational way.
- It would be useful to collect lessons of the past for evaluation by present and future EWSs. It is important to identify and then apply lessons so that the victims in previous disasters do not become victims without a legacy.
- Disasters get the lion's share of attention from the media when compared with "ordinary" adverse impacts resulting from seasonal climate variability. As far as early warnings are concerned, it is useful to talk about the "seasons of disaster."
- The seasonality of such hazards already provides policymakers with a clear warning for regions potentially at risk. However, a significant increase in global warming of the atmosphere is expected to alter the characteristics of the seasons in ways that are yet to be determined.
- Disaster priorities in a given location will likely vary over time as new hazards appear, as old forgotten hazards reappear, and as existing hazards known to inhabitants of one region appear in new unsuspecting areas.
- While the public might not understand quantitative probabilities, they do understand what it means to "take a chance" or to "take risks".
- Early warning systems have an important contribution to make by

"warning" that normal conditions are likely to prevail.

- An early warning system is an important tool in a government's program to achieve sustainable development. In fact sustainable development prospects are ***very*** dependent on the effectiveness of the many early warning systems.
- Early warning systems must partner with the media in a mutually beneficial way. A key problem is that disasters are media-friendly; creeping changes are not.
- There is a need for an intermediary to act as a translator of the warning's technical contents and background to the media.
- Not every warning is meant for public consumption and may be only for the eyes and ears of specific target audiences, such as relevant government agencies.
- The early warning system must take full responsibility for the warning when it presents its messages to the public, the media and the government.
- Human capacity exists in just about every country. What is needed is a desire and a mechanism to bring people together and to support them as they enhance their existing early warning capabilities.

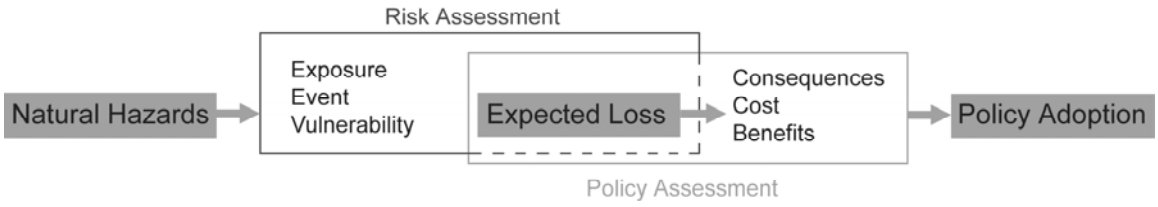
Note: These headlines were taken from various media

Oman, NCAR (2004)

Hazards

Hazards and disasters, as well as response mechanisms, cut across many space and time scales, as does vulnerability. In addition, hazards and threats can change over time not only in intensity, frequency, and in location and duration, but also in importance and interest, as does vulnerability. Societies have learned to cope with some hazards, while other hazards continue to cause problems whenever they occur. New hazards are occasionally recognized as new information becomes available. For example, we now know that droughts occur in distant parts of the globe during El Niño episodes. This new knowledge was not really uncovered until the late 1960s and was not really used in decision making until the late 1970s. Disparate regions that had been plagued by drought for unknown reasons learned that many of their droughts could be convincingly related to increases in sea surface temperature in the central and eastern equatorial Pacific (El Niño), or to changes in sea level pressure across the Pacific basin (Southern Oscillation). Other examples of newer hazards include the SARS virus outbreak and the appearance of mad cow disease.

Keep in mind that hazards can either be quick-onset or slow-onset (long-term, low-grade and cumulative). Those affected by hazards can also be far removed from the disaster site and not just in the disaster zone. Hazards are often blamed for damages that in fact may have resulted from other factors, such as technological or demographic changes, i.e., vulnerability. Some hazards are recurrent in a given area, some are occasional, and others are rare and unexpected. For some hazards there is skill for issuing warnings and for others there is little skill. Note that even the same hazard of the same intensity and seasonal timing in the same location can cause different consequences, depending on the changes in society that had occurred in the interim period, i.e., changes in societal vulnerability. Because hazard impacts are integrally linked to vulnerability, one could ask if there should be an EWS for vulnerability and vulnerability changes.



Schematic illustration of the science, technology, and fundamental knowledge needed for a risk assessment (Hays, 1999).

EWS Definitions

> *"I may not know how to define accurately an early warning system, but I'll know one when I see it"* (Anon.).
>
> *"What's in a name? That which we call a rose*
> *By any other name would smell as sweet"* (William Shakespeare, Romeo & Juliet)
>
> *"A rose by any other name is still a rose"* (M.H. Glantz).

A universally accepted definition of an early warning system does not yet exist. Probably one never will. There are many definitions of an EWS that are used to guide the actions of individuals, groups, and governments. The formal UN definition is as follows: "The provision of timely and effective information, through identifying institutions, that allow individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response" (ISDR, 2003). Interestingly, "early warning" did not appear in the UN Department of Humanitarian Affairs (DHA) report ten years earlier (DHA, 1992).

A participant proposed a broader definition: "An EWS is a social process for generating maximally accurate information about possible future harm and for ensuring that this information reaches the people threatened by this harm, as well as others disposed to protect them from the harm." Much discussion revolved around the necessity of an early warning to refer to harm. Many participants felt that an EWS could also be "a social process for generating maximally accurate information about possible future events."

Just as there are reasons for several definitions of drought, there are reasons for several definitions of EWSs. These include but are not limited to the following: different perspectives on what an early warning system is; disagreement on what it is supposed to do; changing societal demands and expectation of EWSs over time; hazard characteristics that can change over time; imprecise and often conflicting uses of terminology related to EWS. For example, while certain indicators observed by one person might suggest that a warning is warranted, another person using different indicators might not believe that a warning is warranted.

How early is early (this relates to the timing of the warning)? What constitutes a warning (monitoring, trend extrapolation, monitoring, prediction, forecast)? What is meant by a system (formal, informal; quantitative, qualitative or anecdotal)? What are to be its official functions? What else might it do, besides monitor the environment and warn society of a harm (educate, prepare societal responses)? What are the levels of warning (outlook, watch, warning, alert)?

With regard to terms used in English for warning, it was noted repeatedly that some concepts do not readily translate into other languages or cultures. For example, in Russian or Spanish the term "early warning" does not translate well. Other terms may also be difficult to translate such as creeping environmental changes or watch or outlook. Colors are sometimes used to identify the level of warning, as in the US terror warning

system of its Department of Homeland Security. However, the color red, for example, may mean danger in one culture but may mean the opposite in another. Culture matters.

Most people probably envision an early warning system as including a formal bureaucratic structure, including organizational charts showing who reports to whom. However, in many societies there are patterns of human interactions not taking place within a building or a ministry that qualify as EWSs, especially in traditional cultures and groups that have had to depend on themselves for their own well being or that have learned over time, through generations, how to cope with certain hazards.

The preceding paragraphs underscore the need to keep the definition of an EWS broad and flexible; broad enough as to allow for a wide range of interpretations and flexible enough to accommodate in time and space the societal recognition of new hazards and the development of new EWS technologies.

Need for Early Warning Systems

> *"Consideration of valuation methods, therefore, must always be put in the context of 'compared to what?' "* (Berk and Fovell, 1998).

The title of this section could have been put to the reader as a question, "Do we need early warning systems?" To do so would have been to set up the comment as a proverbial straw statement, the answer to which would already have been known. Of course, we need early warning systems. Full stop. But, one could then ask, to do what?

A Brazilian author, Joào Guimaraes Rosa (1963) wrote some decades ago the following "To live is very dangerous." This statement is valid in developed as well as in developing societies, in industrial and agrarian societies, and in capitalist and socialist economies. Danger can take on many forms, some of which are real and some of which are perceived to be real. Perception of danger, as well as perception of risk, is culturally constructed.

For example, while a drought (narrowly defined) might be seen as no more than a temporary setback in agricultural production, it can be much more than that as its impacts ripple throughout society. We now know that a severe drought (or any other natural hazard for that matter) has the potential to set back a country's development prospects for several years, and can cause funds to be diverted from development to reconstruction.

The fact is that EWSs exist in every society. They can be formal ones with readily visible structures that are part of the national government bureaucracy or they could be informal ones that are not necessarily sanctioned by the government and are local and cultural in nature. They could be operated by non-governmental organizations or corporations, each with its special interest. Just about everyone in society would like to have a glimpse of the future. It could be that it is part of human nature to seek insights into the future. They do this by looking at trends and by making projections, forecasts and scenarios. They do this by mystical and astrological means as well.

EWSs are needed for all kinds of changes in human activities and in ecological processes and for just about any change anywhere that is of interest to someone. Searching on the Internet for "early warning systems" brings up innumerable activities for which they are used. Early warning systems are part of a country's capacity to react to a perceived threat, in order to adapt to, mitigate or prevent harm.

Types of Early Warning Systems (EWSs)

> *"Warnings are based on indicators. Projections ten years or more out are based on assumptions"* (Anon.).

The category of the types of EWSs refers to natural and human-induced hazards about which societies are concerned enough to want to be warned. Every society has hazards with which it must cope. Every society has various activities that could be categorized as early warning of a harmful or of a beneficial occurrence. Forecasts, for example, of weather or climate anomalies or of technological risks, can be viewed as providing to decision makers and society at large a "heads up," that is, a warning, with regard to the outcome of the process or event being forecast. Trends and projections can also be viewed as types of early warning. But whether or not forecasts and projections are stand-alone early warning systems will depend on the forecasters' role in other components of an EWS.

Some consider "monitoring" as an EWS as well. However, it is only one part of an EWS. Those whose responsibility it is to monitor changes usually provide technical information to those whose responsibility it is to warn society or, as is often the case, to warn the government. As one researcher has suggested, "Predictions are not useful, however, unless they are translated into a warning and action plan the public can understand and unless the information reaches the public in a timely manner" (Hamilton, 1999).

Scenario development is yet another way to provide insights into potential hazard frequency, intensity, duration and location at various times in the future. Those who generate scenarios can also help to identify potential drivers of unwanted change. Scenarios can help to uncover hazards that might otherwise have caught decision makers by surprise. The further into the future one projects, the more speculative the scenario becomes. In scenario planning, anecdotal information is one important source of information, among many, for identifying principal drivers.

In most cases, forecasting is like monitoring and is one part of an early warning system. It provides input to an early warning process. If the forecast system is focused on a specific hazardous outbreak (weather or climate anomaly or vector-borne disease outbreak) ***and*** then raises an alarm, it, too, could be considered an early warning system in its own right. But these – forecasts, monitoring and scenarios – are not necessarily the overarching all-encompassing early warning system to which we are referring, although they are components of such a system. As one can see, it is easier to talk about EWSs than it is to describe or define them.

Many early warnings knowingly and unknowingly activate other early warnings, as the time gap between a warning and the onset of a hazardous event shortens. This can be referred to as a cascade of early warnings. For example, the technical forecast of a La Niña event (a cold episode) in the tropical Pacific Ocean should spark immediately a concern among those responsible for forecasting hurricanes in the tropical Atlantic and the Gulf of Mexico because there is an increase in the likelihood of an above average number of tropical storms, hurricanes and landfall events in the region. The warnings from the hurricane forecasters should, in turn, serve to activate warnings from various at-risk community disaster preparedness teams, and so forth. So, warning systems are subsystems of larger systems. Even the overarching EWS is an integral part (e.g., subsystem) of a larger social system. In this regard, however large or complex the formal early warning system, there exists an even larger ***early warning network*** which encompasses many more elements of society than one might realize.

Thus, when referring to EWSs, it is important to keep in mind that many of them are not isolated entities with well-defined boundaries. They can be portrayed graphically as cascades, pyramids, networks, and as subsystems.

As noted earlier, hazards can be divided into quick onset and slow onset hazards. They can also be divided into short, medium and long-term hazards and into geological, hydro-meteorological, anthropogenic (human-induced), technological, biological (e.g., viruses, mosquitoes, polar bears, and angry hippopotamuses) and space-related hazards (e.g., meteors, solar wind storms). Geological hazards generally include the quick onset kind: earthquakes, volcanic eruptions, mudslides, tsunamis, though there are ways to look at them as the end result of incremental processes that are being monitored rather than as the abrupt shocking events that they seem to be. It may be that the public can relate to terms such as quick onset and slow onset, though researchers seem to prefer to use the short-, medium- and long-term distinction.

Even the distinction between quick and slow is not so clear-cut. Tornado warnings provide minutes of lead-time for response. Hurricane warnings are on the order of weeks to hours. Drought warning is on the order of months to weeks; and so forth. These could be categorized as representative of the family of quick onset, though drought has also been referred to as a creeping phenomenon (Tannehill, 1947). The problem with drought is that one does not know if a dry spell of some days and weeks will become an intense prolonged drought and, as we have learned from the fable about the boy who cried wolf too often, one cannot cry “drought” during every dry spell within a growing season without adversely affecting the credibility of the warning mechanism.

Slow-onset (creeping environmental and societal) changes eventually cause serious problems to environment and for society, if left unaddressed. Most environmental problems in which people are implicated are of the creeping kind: soil erosion, land fill, deforestation, rangeland degradation, various aspects of desertification, air pollution, acid rain, ozone depletion, and global warming are examples of creeping environmental problems. Such environmental changes are in need of early warning systems because the

impacts of incremental cumulative changes on society and environment in the long run may be more costly and more disruptive than the quick onset hazardous events, though both kinds are devastating in their own ways.

At a recent NATO-sponsored meeting in Valencia, Spain (2-5 December 2003), "it was widely recognized that environmental degradation (i.e., slow onset) has a role to play in considerations of national security as well as international stability. Therefore, desertification has been seen as a threat to human security" (UNCCD, 2003).

There are alternative ways to categorize EWSs: formal and informal; national and indigenous; qualitative and quantitative; conflict conditions and non-conflict conditions; technical and anecdotal; objectively and subjectively based; political and apolitical. EWSs can be applied not only to societal well-being but also to the well-being of individuals and the environment. Biodiversity, coral, fishery, health early warning systems, among many many others, are in operation to monitor ecosystem health. There are so many societal and environmental changes of interest to groups or agencies in a given society that each one could justify having its own formal warning system. EWSs, however, are not without costs and benefits, although sometimes the costs are highlighted whereas the benefits – which can be substantially more than the costs – are not easily quantified. As a result, governments, NGOs, and individuals have to prioritize and choose carefully the EWS or EWSs that they want to focus on, maintain and support, morally and financially, over the long run.

As a cost-saving measure, and because some societal and environmental changes have at least some characteristics in common in a given region, hybrid warning systems are developed to handle more than one hazard at a time (e.g., heavy rains, mudslides, displaced settlements) or to handle hazards that occur in a sequence (e.g., El Niño and La Niña events; floods and droughts).

The discussion above makes it quite clear that one single early warning system cannot, but also need not, be expected to fulfill the needs of all of society's hazards or vulnerability concerns. Nevertheless, certain criteria and goals of EWSs must be explicitly noted, which can then be used to measure the success rate or, more correctly, effectiveness of the system.

A novel highly controversial suggestion for an EWS for terror was proposed by the US Department of Defense. It was an attempt to encourage people to bet on certain terror-oriented scenario outcomes: what are the odds that there will be another 9/11-type terrorist attack in some designated period of time. Considerable political and public opposition arose to such an approach to terror early warning, in part because it would be a game that the terrorists could play as well. For example, they could bet and make such forecasts either self-fulfilling or self-denying. Despite the public criticism of this approach, it does not mean that one government agency or another will not implement it.

Climate change, a warming of the global atmosphere by a few degrees Celsius by the end of the twenty-first century, is a creeping environmental problem of relatively long

duration. It has other problems for early warning as well: global warming scenarios are based on computer model output with incomplete understanding of the physical processes and feedbacks. The level of scientific uncertainty is relatively high when compared to other hazards and, as a result, the credibility level of the warning would be relatively low (even though signs of global warming are mounting, such as worldwide glacial melting). So, climate change – and ozone depletion for that matter – are creeping environmental problems with lead times on the order of years to decades and are quite different from most other creeping environmental problems.

Many hydrometeorological hazards are seasonal such as tropical storms, tornadoes, monsoons, floods, droughts, fires, and infectious disease outbreaks.

Regions around the globe, however defined, have their own particular sets of hazards with which they must contend. El Niño is a hazard to Peru and Ecuador, whereas La Niña is not yet perceived as a threat. The Philippines and Indonesia suffer from both of these events. In the United States it seems to be that El Niño is a problem primarily for the west coast of the country (coastal storm, flooding) and La Niña a problem for the east coast (more tropical storms). Knowing the seasonality of regional hazards of concern provides a useful input to EWSs.

Early Warning System: Structure and Function

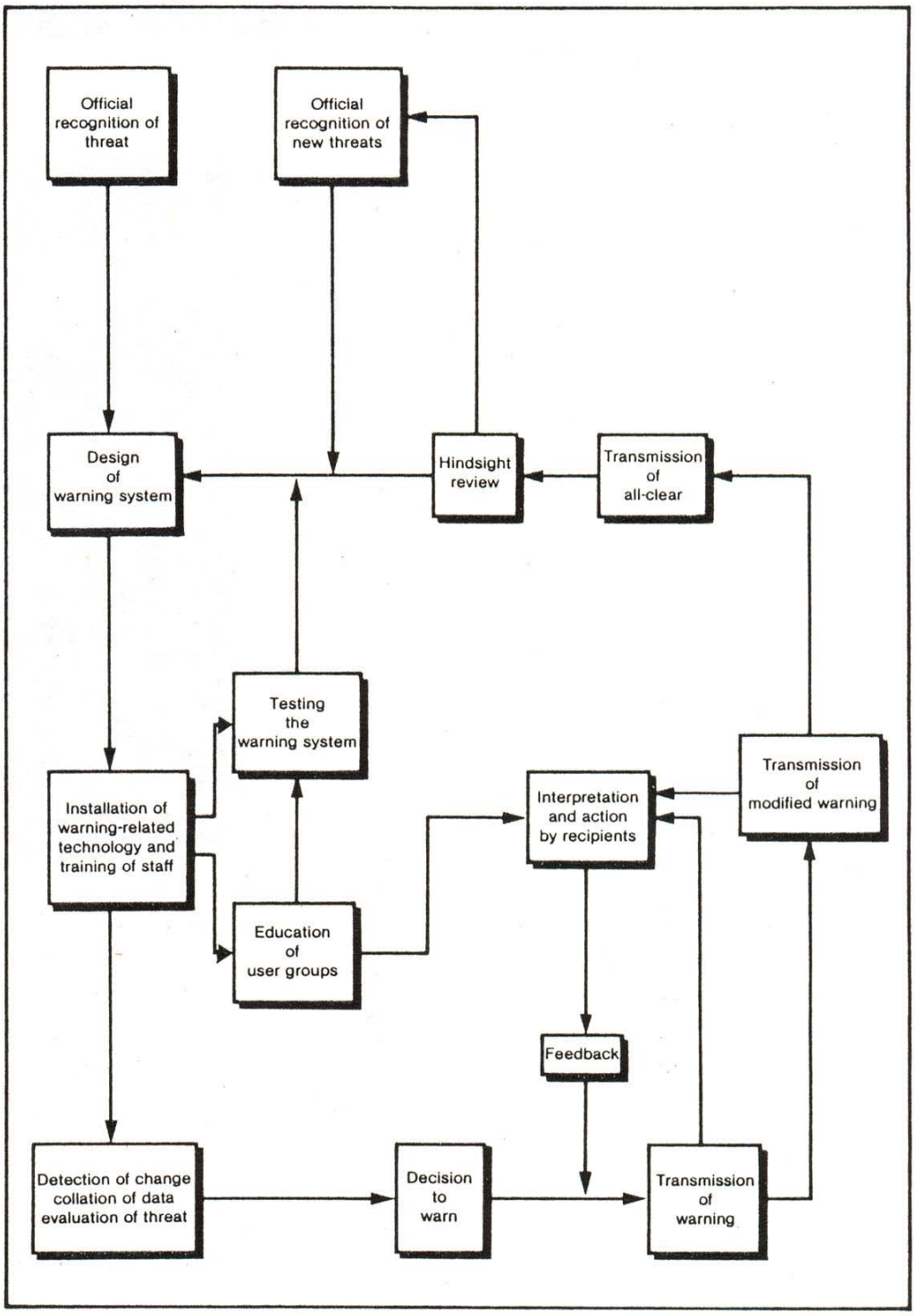
> *"The most effective warning systems integrate the subsystems of detection of extreme events, management of hazard information, and public response and also maintain relationships between them through preparedness"* (Mileti, 1999, pp. 174-75).

> *"Early warning systems are only as good as their weakest link. They can, and frequently do, fail for a number of reasons."* (Maskrey, 1997)

The functions of an EWS can be identified either by its operating rules and regulations or by "what gets done." The former is what it should do and the latter is what it actually does. The structure of an EWS can be identified by "how what gets done gets done." Using this distinction enables one to identify informal as well as formal early warning systems in a given region.

The structure and functions of an early warning system vary from one kind of hazard to another, and from one socioeconomic and political setting to another. They can range from a simple system to a very complex multi-hazard one. The point here is that the type of early warning system should fit the needs of the society and the groups or regions at risk to hazards of concern.

The following figure (Foster, 1980) presents an idealized warning system. To be sure, there are many variations in the structures of existing early warning systems.



EWSs can report to narrowly targeted at-risk populations, regions or socioeconomic sectors by providing timely warnings. They can report to the public by way of a press release to the media or directly in secret memos to key government officials. Governments want to be made aware of harms that might occur, while they are in office. However, they may not choose to pass that warning information on to the public for a

variety of reasons: they do not have the needed funds to assist the public to take preventive actions; the region of the country that is at risk is not in the favor of the government; the governments do not believe the warning; the warning system has not yet built up a credible or reliable track record.

Early warning systems for the most part are seen as providing information related only to harm or to an elevation of risks related to hazards. However, they should also report on early warning-related good happenings. For example, the system's outputs should provide information about advances in hazards research, advances in the development of early warning systems, and in new technologies and techniques that can improve the effectiveness of existing EWSs.

Differing views exist on how extensive an EWS should be. Should it only produce warnings, full stop? Or, should it have responsibility for issuing a warning to all at risk targets, for assuring that the warning is well communicated to the target audiences and understood by them, and that there are appropriate responses to various levels of warning? Most participants suggested that the EWS focus primarily on the warning component of early warning process. Although it should be involved in other aspects of the early process, other groups should have the responsibility for communicating, educating and preparing the public to take appropriate responses. In other words the group providing the warning was not viewed as the one that should have the primary responsibility to reduce societal vulnerability. Nevertheless, each of the stages in the warning process from monitoring to responding must be interactive in such a way as to keep the warning timely, understood, and providing enough lead-time for responses.

Early warning systems have evolved considerably during the past two decades. They gained much attention in the 1970s and 1980s during the extended droughts and famines in the West African Sahel and in the Horn of Africa. Famine early warning systems were created in at-risk countries and regions in sub-Saharan Africa and in various agencies in donor countries and international organizations. They were set up primarily for humanitarian purposes. Today, formal EWSs exist for just about every hazard – technological, hydrological, meteorological, and anthropogenic. They have also been created for conflict, ecological changes, health-related and complex humanitarian crises. Their functions have shifted (perhaps, more correctly, expanded) toward societal risk and vulnerability reduction and toward sustainable development.

New technologies have also affected the functions and structures of EWSs over the past few decades. As new earlier warning technologies and techniques have been developed or new monitoring methods devised, EWSs have had the opportunity to become more effective in their spatial coverage and in the lead timing of the warning. For example, cell phones may provide one way in the future for communicating outlooks and warning to remote areas that lack communications infrastructure. RANET, the use of satellite-based communications of hazard warning to remote areas, is another example. However, a particular problem faced by developing countries is that new technologies are not readily available to them, because of cost or because of the lack of infrastructure to support the new technologies. In addition, there is a need for trained personnel and, therefore, every

EWS must involve itself in capacity building through the training of new personnel in the activities of and technologies for EWSs. Because of limited resources (human and financial) in these countries, it is important to distinguish between what is desirable for an effective EWS and what is essential.

One problem that many EWSs face is related to the frequency of the hazards about which they are expected to warn society. Because of periods of "normal" between the hazards, there is a view that the EWSs have little to do during those apparent "down times." For example, the periods of down time can be productively used for education and training, as well as "normative" work, such as the preparation of risk maps. As another example, the EWSs can expand its focus to more than one hazard. They can work with other agencies and organizations to identify underlying causes of disasters. They can report about observations in the "normal" period (e.g., outlooks as opposed to warnings), as there are people who can benefit from such information as well. EWSs can interact with the media, groups in society, and other components of their early warning network about how to make the system more effective.

It is clear that the structure and functions of a formal government-sponsored EWS will be influenced to varying degrees and in different ways according to the particular political setting in which it has to operate. The example of Cuba is illustrative (see Appendix A). The Cuban government can not only warn people about potential hazards, but can move large numbers of people out of harm's way on relatively short notice. Given its authoritarian form of government, it has the responsibility for all components in an EWS, broadly defined, and it controls to a great extent the larger political and social systems of which the EWS is an integral part. Many governments, however, are not in a position to use its EWS in a similar authoritative way.

An EWS serves as an enabler in the sense that, by way of its warnings (outlooks, watches, warnings and alerts), it enables at-risk populations to take (or not take) appropriate mitigative or preventive actions. It enables various agencies and ministries in government and groups in the private sector to strategize on how best to respond to current as well as future impacts of a hazard. The response to the warnings (and the efficiency of this particular function) will depend in great measure on an EWS's track record, i.e., its warnings must closely match the actual occurrence of hazardous events.

Whether focused on one hazard or on complex humanitarian crises encompassing several hazards simultaneously, all early warning systems must address the ***five Ws***: what, when, where, who, and why. *What* is happening with respect to the hazard(s) of concern? *Why* is this a threat in the first place, i.e., what are the underlying causes for potential adverse impacts? *When* is it likely to impact (providing as much lead time as possible to at-risk populations). *Where* are the regions most at risk? *Who* are the people most at risk, i.e., who needs to be warned?

Various writers have identified what they considered should be the components of an EWS. For example, one suggestion was that an EWS should have five components: selection of indicators; communication of warnings; reception of warnings; early warning

education; generation and maintenance of awareness. A risk assessment expert suggested that an EWS should include the following activities: monitoring, risk analysis, dissemination of the warning, and societal preparedness. Yet another suggestion was that an EWS has responsibility for the following: forecasts, warnings, and responses. Other possible components include technical decision-making and responses to warnings and impacts. Obviously, there is no agreement on the ideal structure or function of an early warning system.

Perhaps the range of potential functions of an EWS remains one of its most inconclusive aspects. Should it focus solely on providing the best technical warning possible based on quantitative indicators? Should it be viewed as an integral aspect of a country's much broader sustainable development strategy? [This is discussed later in the report.]

> ***To the Reader:***
>
> As a question to the readers of this report (one not discussed at the workshop), can the IPCC be considered to be an EWS structure, the functions of which are to monitor scientific reports in order to provide warnings primarily to government leaders about the status of creeping environmental changes (e.g., the changing chemistry of the atmosphere)? If so, what are the various early warning systems that an IPCC warning (i.e., report) sets off in the cascade of early warnings?

EWS Users

> *"Formal EWSs in Africa are rarely run by the people whom they are supposed to serve – the potential victims of famine"* ((Buchanan-Smith, 1997).

At the very least, users of an early warning system must include the at-risk populations. Users must also include government officials that are responsible for responding to the warnings. There is, however, a broader community of users that could be viewed as EWS stakeholders. This would include organizations outside the affected country, such as the international donor community that is called on to assist the affected region with funds and expertise. In some countries such as Brazil (especially in the drought-plagued *Nordeste*) and Cuba, early warning systems are already incorporated into long-term development plans for droughts and hurricanes, respectively.

As noted earlier, EWSs need to be treated as subsystems embedded and integrated into larger socioeconomic, cultural, and political systems. Stakeholders need to be involved in the development of new EWSs or redesigning existing ones. They need to be actively involved in supplying input to the EWS process. In addition, efforts need to be made through capacity building to increase the number of stakeholders (those indirectly as well as directly concerned about the early warning of hazards regardless of cause) within the country affected by the hazard(s) of concern. To do so would help to grow a country's early warning network.

Early Warning Systems Characteristics

The characteristics of an early warning system are bounded by the characteristics of the hazard(s) of concern and by the political and cultural setting in which the EWS operates. However, there are generalizations that can be identified as a minimal requirement for an effective EWS regardless of the hazard or its political setting. These include but are not limited to the following:

> Continuity in operations: an EWS must operate continually, even though the hazard of concern may occur only intermittently.
>
> Timely warnings: for a warning to be considered useful, it must provide enough usable lead time for those at risk to decide whether and how to react. A warning should leave time for responses to the warning and to the event. This varies from hazard to hazard. For tornadoes, warning time may only be on the order of minutes. For hurricanes, it might be weeks to hours; for El Niño it could be months to weeks. For global warming it could be years to decades. A balancing act is required of those in an EWS because they must avoid issuing warnings that are too early as well as issuing warnings that are too late.
>
> Transparency: the process of early warning, whether the system only issues a warning or is involved in the total process from warning to societal response, needs to be open to the media and public. Transparency can help to minimize the potential for political influence on the various stages of early warning.
>
> Integration: an EWS must be integrated into other parts of the warning process, including monitoring and communication; it needs to be viewed as a subsystem within the larger socioeconomic, cultural, and political system.
>
> Human capacity: appropriate staffing is mandatory with the expertise of the personnel commensurate to the hazard(s) of concern.
>
> Flexibility: an EWS needs flexibility to expand its activities to other hazards and to other functions, if and when the occasions arise.
>
> Catalysts: there is a need for a defined "triggering" mechanism; the trigger can be anything from a quantitative indicator to an anecdotal comment.
>
> Apolitical: an EWS needs to be apolitical in performing its functions; it is important that the EWS be viewed as objective and uninfluenced by national or international politics.

Perhaps one of the most difficult tasks is to keep politics out of an EWS, even though most early warnings arise out of a political or societal need. An EWS will expose societal vulnerabilities and such an exposure can have political implications. Depending on the country, the hazard or the government, some EWSs are more influenced by political

pressures than others. For example, who to warn and when to warn them can be construed as a political (not neutral) issue. Even if an EWS were able to issue a warning deemed neutral (that is, apolitical and objective), the responses to that warning would likely have political implications. In this regard some have noted that an EWS should belong to the state and not to a particular government, so that it can survive changes in governments and in ruling political ideologies.

Multihazard Systems

If all hazards were the same, a generic warning system could be designed and used, but this obviously is not the case. There are six characteristics of hazards that affect one or more of the basic components of a warning system (detection, emergency management, and public response):

(1) *predictability* relates to the ability to predict or forecast the impact of a hazard with respect to magnitude, location, and timing;

(2) *detectability* refers to the ability to confirm the prediction that impacts are going to occur;

(3) *certainty* is the level of confidence that predictions and detections will be accurate and not result in false alarms;

(4) *lead time* is the amount of time between prediction/detection and the impact of the hazard;

(5) *duration of impact* is the time between the beginning and ending of impacts in which warning information can be disseminated; and

(6) *visibility* is the degree to which the hazard physically manifests itself so that it can be seen or otherwise sensed.

–Mileti, 1999, p.197

Transparency, Politics, and Early Warning Systems

"The bedrock for early warning is transparency" (US-EU Summit, Bonn, 21 June 1999)

There is a belief that better decisions can be made by an EWS, if the early warning process is transparent. Transparency is important for building up credibility in the outputs of EWSs. It is also possible that better responses to warnings can be expected as a result of transparency.

There are at least two ways to look at the politics of an EWS: political neutrality and political interference. Political neutrality vis-à-vis an EWS means that the government sets up and funds the EWS and then leaves it alone to fulfill its functions, letting the "political cards fall where they may." Political interference, however, is quite different. The government sets up an EWS and then shadows its decision making process in order to intervene if the process begins to work against its political interests.

Transparency in early warning deliberations is important, but is not as clear-cut an issue as one might think. The degree of transparency will vary from EWS to EWS and country to country. An EWS wants to warn governments and people about the status of hazards of concern. However, the EWS and the political leaders want to avoid causing public panic or false alarms. So, it is likely that in the early stages of monitoring environmental change and in warning, it may prove to be best not to expose the deliberations within the EWS as they are taking place. However, a record of those deliberations should be made available to the public once the hazard has materialized.

Goals of Early Warning Systems

The goals of EWSs refer to their objectives and functions and are usually reflected in EWS mission statements, which vary from EWS to EWS. These include but are not limited to the following: awareness raising, education, and risk and vulnerability mapping and reduction, in addition to the issuing of warnings (outlooks, watches, warnings, and alerts). They must work toward these goals in an objective manner by maintaining transparency and keeping political interference to a minimum.

Quick-onset hazards provide decision makers with a short time to respond. In some instances for some hazards decisions have to be made on the spot. However, hazards that are slow onset, like those of the creeping kind, allow some time for the warning agents to review their earlier pronouncements. Those at risk and those interested in the EWS pronouncements feel that they have the time to wait for future updates until the observations present a more certain picture of the hazard's probability of occurrence, intensity, and present more specific information on location and on the at-risk regions.

Operational goals would include creating and maintaining credibility in the EWS, identifying the appropriate warning level, minimizing political interference and, maintaining transparency. The EWS must assure that its outputs are integrated into other components of the EWS and that the warnings are understandable and relevant to the informational needs of the next tier of EWSs in the cascade that is likely to follow. Controversy remains over the extent to which an EWS should be involved in generating awareness among the general population.

Education

> *"Education is what survives when what has been learned has been forgotten."*
> (B.F. Skinner, *New Scientist*, 21 May 1964)

It is useful to refer to the five Ws noted earlier. "Five Ws" is shorthand for the following aspects of early warning about natural or anthropogenic hazards: what, why, who, where, and when. These are not the only EWS questions that need to be addressed, but they do provide some insight into core aspects.

What: The public must be educated about what early warning systems can and cannot provide. An EWS is not a guarantee of safety and should not be viewed as such by the government or the public. It is one way for society to hedge against being caught unaware. EWSs do not fare well in cost-benefit analyses, because it is difficult to calculate intangible benefits of an EWS in dollar terms. Setting up an EWS is the right thing for a government or organization to do, but it is not the only thing.

The several generations that exist within the general population at any given time have not shared the same hazard history and, as a result, various segments of society see hazards in a different light. For example, the younger elements of a population may not have witnessed the worst drought or flood in decades that the older elements of society had witnessed. Because of these different personal histories, there is a need to constantly remind the general population about its regional hazards and their potential impacts. Educating the public and its leaders on hazards and early warnings is not a one-time event but is a on-going process. One participant suggested that if it has happened once in a given place, it could happen again.

It is also very necessary to foster interest in hazard early warning between the occurrences of hazardous events. Although, for example, Australians and Peruvians in general are not concerned about the possible impacts (usually beneficial) of La Niña episodes in the Pacific, their governments should not relax their efforts to educate the public about the value of early warnings (in this case forecasts) of El Niño episodes or the forecasts of their potentially devastating impacts on life and property.

Political leaders must become more accepting of the fact that an EWS needs continuity so that it can build up in-country expertise and a track record of achievement. This will engender credibility as well as acceptance by the public of their hazard warnings. Minimizing the role (and influence) of politics in the early warning process is extremely important and would assure that the EWS belongs to the state and not to the particular government in office at a particular point in time.

Why: Governments have a responsibility (at least in theory) to educate their citizens about the value of and responses to early warnings. They also have an unrecognized need to do so for reason of self-interest. The reason is rather simple. The adverse impacts of an extreme hydrological or meteorological event such as a drought, flood, tropical storm or frost can set back a government's development goals by years if not decades. There are many adages in cultures worldwide that have recognized that it is better to prevent a harm than to bear the brunt of an unwanted occurrence and then clean up afterwards: "An ounce of prevention is worth a pound of cure" is one such adage. *"Un homme averti en vaut deux"* is another.

EWSs are valuable tools that can help a government to minimize the loss of life and property. They can also help to reduce if not avoid misery (population displacement, loss of personal items, the need for resettlement, etc). The public, politicians, media, scientists, and early warners must realize that no matter how effective an EWS is it will

not be able to reduce losses to zero, because there will always be risk-takers, that is, people who know the risks of a known hazard but choose to take the risk.

New or existing but increasingly severe technological as well as hydrometeorological hazards are appearing each year. It may be that scientific research has discovered physical processes that previously had not been well understood (e.g., El Niño, as a spawner of droughts, floods, fires and frosts worldwide was identified as such in the early 1970s). New technologies pose new benefits as well as hazards for which societies must be prepared.

In sum, one of the key educational aspects related to EWSs is to get ahead on the EWS learning curve in order to reduce the likelihood of hazard-related surprise.

Who: This refers to who is to be educated and who is to do the educating about early warnings. Those responsible for early warning have an obligation at the least to educate the public about the warning systems, its warnings, and the broader early warning network, even though they might not necessarily be responsible for educating the public on how to respond to those warnings. Educating the public could be the responsibility of different components of a much broader early warning network. They too must keep the government informed of progress and constraints with respect to their ability to make reliable early warnings.

One way to educate the public would be to educate those in society responsible for education. In Cuba, for example, schoolbooks teach the students about hurricanes. However, to date El Niño events have not been introduced to them in the same way. Yet, when El Niño is present in the tropical Pacific, there are likely to be fewer hurricanes in the tropical Atlantic. The opposite is true for La Niña events. Most likely this science-based information will eventually enter the Cuban schoolbooks. Information about EWSs and the hazards they focus on is too important to be left to a small group of early warning system technicians. Educating the educators means educating teachers as well as university professors and researchers in a wide range of disciplines. It will become a part of their lifelong understanding of the world around them.

People who live in regions at risk to various hazards need to be educated as well about what EWSs can and cannot provide them. Early warnings are often statements about the probability or likelihood of occurrence of a hazard from which one must then consider the probability of various possible adverse impacts on the environment and society.

There is a constant need to re-educate the public in general and especially the at-risk populations, because the return period of the hazard of concern may be relatively infrequent. Some hazards are known to be seasonal: hurricanes, tornados, floods, fires, etc. Others may have unknowable return periods. Nevertheless, societies must remain vigilant in order to have enough usable lead-time to prepare for, mitigate, or adapt to potential impacts.

Where: While the first thought is to educate those populations who are considered to be most at risk to the impacts of a particular hazard in a given region, a closer look suggests the need for a broader perspective. For example, while a flood event may directly affect a relatively small part of a watershed, it would be essential for early warning purposes to look for changes (probably of the slow onset kind) in the larger watershed and river basin. This is so because land-use activities, such as deforestation taking place in various parts of a river basin, could affect the likelihood of flooding as well as the intensity, seasonality and rapidity of the onset of flooding.

When: The time to educate the public and policy makers about an early warning system's strengths and weaknesses is between hazard episodes and not during them. The onset of a hazard itself heightens awareness and concern about preventive actions in the future. Yet, once a hazard has passed, there is usually a tendency to put that concern to the side as other, more urgent, matters arise. Complicating this is the fact that many people have difficulty in understanding probabilities. It is not uncommon to hear a flood victim erroneously state "well, we've had our one hundred year flood. We don't have to worry about floods for another hundred years." Educating the media is one key way to educate the public, though the media may not see their primary role as educational. The media, however, will tend to focus on the impacts of a hazard and on the warning and will focus less on the need to understand what those warning can and cannot do for society.

In sum, early warning systems in a given country can be looked at as part of a much broader early warning network that involves many components, some of which are closely related to the system itself, while others are only marginally connected.

Inputs to Early Warning Systems

> *"For example, non-codified information or knowledge systems of minority populations are often missed when assessments are undertaken at larger spatial scales or higher levels of aggregation"* (MEA, 2003, p. 19).

In order for an EWS to be timely and effective it must have credible information on which to base its levels of warning. Information can be quantitative or qualitative. Anecdotal information can also be useful. However, formal quantitatively based EWSs do not know how to plug such information into their system. So, what may prove to be the earliest warning of a potential increase in a hazard's impact might go unheeded. For example, a truck driver in Kenya might have notice along the route that women were selling their jewelry or families were selling their pots in the local market. Such sales would suggest that there are food shortages in the region. But who is the truck driver to tell? Early warning systems for food security, for example, have to figure out how to use all kinds of information as inputs, including rumors, to assure that the earliest warning possible can be made for potential food-related problems.

EWSs must have a core set of reliable indicators of change in the environment and in society in addition to other types of strategic and tactical information. The selection of

indicators is very important, because the monitoring that takes place will center around them. The wrong indicators or even interesting but lagging indicators can lead to wasted time, effort, and resources. In addition, the list of indicators for various hazards needs to be reviewed as new insights into the science and impacts are uncovered. It is important to identify triggers, catalysts and drivers of changes that can set the stage for the impacts of hazards to become much worse than would otherwise have been the case. The more objective and transparent the triggers for early warnings are, the more credible is the EWS likely to be viewed. Triggers exist at each stage in the broader EWS process from outlook to alert, and from communication to response. To be sure, there will be surprises with respect to hazards with regard to timing of onset, intensity, location and duration and even impact (e.g., a tropical depression can cause as much damage as a full blown hurricane). One may know some weeks in advance that a hurricane is likely but s/he will not know its exact characteristics for some time after an early warning has been issued. For those hazards that allow for warning updates, an increase in accuracy of the warning can reasonably be expected.

Maximum hurricane strike probabilities for forecast time frames

72 hours	10%
48 hours	13-18%
36 hours	20-25%
24 hours	35-50%
12 hours	60-80%

Source: National Hurricane Center and Emergency Management Institute, 1995. A strike probability forecast indicates the probability that the center of a hurricane will pass within 65 miles of a list of locations in certain time frames. As a hurricane approaches shore, forecasts become better. This table indicates the largest strike probability values any place will have at certain periods from landfall (Mileti, 1999, p. 178).

It is important to keep in mind that every early warning that makes its way to the public, no matter how strange it might seem, will have consequences. Someone is listening for and ready to act upon an early warning of a perceived or real hazard. As suggested earlier, early warning systems are too important to be left to technicians alone, because the hazards about which they are warning can derail development prospects for great lengths of time.

Constraints on EWS Effectiveness

> *"Whether a food crisis succeeds in its goal of eliciting an appropriate response is dependent on numerous factors, most of which are beyond the control of the EWS"* (Buchanan-Smith, 2000).

Effectiveness of an early warning system refers to the ability of the system to fulfill its designated functions. Early warning systems always work well (efficiently and effectively) in theory, in PowerPoint presentations, and on paper. In the real world,

however, constraints restrict the attainment of that efficiency and effectiveness. Constraints vary from one EWS to another. There are, however, some factors in common that tend to reduce the effectiveness of EWSs. For example, early warning system operators face a dilemma: they are often criticized for a missed or erroneous warning, but are infrequently praised for having been correct. People ask: If there were no devastating impacts of a hazard, was it because the warning was heeded and preventive actions were taken, or was it because the hazard was not as extreme as had been expected? In other words can one evaluate an early warning system's effectiveness, in the absence of damage?

The factors cited below are neither comprehensive nor mutually exclusive. They are meant to be suggestive. Many of those factors are affected by uncertainty.

Measuring EWS effectiveness --- what does it mean for an EWS to be effective? One could argue that it is effective if it leads to *appropriate* and timely societal responses to the advanced warnings (e.g., outlooks, watches, warnings, and alerts). Others might argue that an EWS has to issue a timely warning, one that is correct in that the hazard occurred at the suggested time, location and with the intensity. Still others suggest that EWSs must withstand traditional cost-benefit analyses, even though it is difficult to quantify all the benefits of an EWS.

One common attribute of effectiveness of a warning is to see if it changed behavior. Yet, it may be that behavior was reinforced by a warning and was not changed by it. The number of deaths provides another quantitative way to assess effectiveness. However, there are likely to be potential victims who turned a deaf ear to the warning and to the hazard. Risk-informed deaths can be expected to occur, even with a perfect, extremely reliable warning. The question of how to evaluate the effectiveness of an EWS continues to be addressed by the ISDR, which acknowledges this as a difficult ongoing task.

Quantitative and qualitative EWS information --- the information collected is uncertain with regard to the possible onset of a hazardous episode. Various groups use indicators to monitor for the early onset of a hazard, but they do not necessarily use the same indicators. Even with El Niño, for example, some scientists monitor changes in one part of the Pacific Ocean while others focus on measurements in other parts. Some rely on watching for changes in the atmosphere, while others rely on changes in the ocean or in the marine environment (i.e., living marine resources). Some countries consider information on environmental changes to fall under the umbrella of national security and this restricts the flow of information to those involved in early warning and in responses to early warning. It is important to keep in mind that, even with the best information possible, an EWS might not be able to generate optimal responses. Hence, we can expect that there will likely be "risk-informed deaths."

The timing of the warning --- an objective of an early warning is to have it issued at a time when it will capture attention and generate enough confidence to

provide usable lead time to spark a useful and appropriate reaction. Those responsible for warnings must make a subjective decision about the warning as well as about when to warn. Getting the timing of the warning 'right' is important for the credibility of the EWS because it will minimize the times that warnings could be viewed as "false alarms." A warning can be too early, when scientific uncertainty may be relatively low or when people will not deem it urgent enough to give it the concern that such a warning should merit. A warning can also be issued so late that it provides little if any usable lead-time for useful reaction.

Funding --- EWSs have a problem with maintaining their long-term sustainability, in part because they have difficulty maintaining a funding level that enables them to meet their objectives. A lack of a stream of adequate funding inhibits the necessary constant review of the EWS procedures and the indicators on which they rely. Governments face crises all the time. They must respond using their finite resources so they have to decide carefully where the funds are most urgently needed. For hazards and disasters that are expected to occur relatively infrequently, early warning systems wax and wane in importance. When a hazard is perceived to be a threat, the EWS receives support; when it has passed, interest in the EWS often dissipates…until the next time the hazard recurs. In addition, it is easier to get assistance from the international donor community for post-disaster recovery than for pre-disaster prevention. Sometimes cost-benefit analyses are proposed to evaluate in economic terms the utility of an EWS. However, factors other than destruction of property and the number of deaths are seldom included in the analyses. EWSs's warnings are constantly being scrutinized for correctness and for relevance. The funding of EWSs by governments can be influenced in this regard, because EWSs seem to be subjected to more criticism than praise.

Hazard characteristics --- there is uncertainty in the characteristics of a given hazard as to its timing of onset, its intensity, its location and its impacts on environment and on society. Quick, short-, medium- and long-term hazards (e.g., creeping environmental changes) are each surrounded by its own sets of uncertainties. So, it is basically a contest between those issuing early warnings and Mother Nature; the former are trying to reduce the uncertainties that surround a particular hazard of concern to the point where they can decide to issue a warning or not to do so. Even known and expected hazards can exhibit unexpected behavior. In addition, with a changing global climate regime, extreme hydrometeorological events may change their characteristics and they may start to appear in areas where they had not been witnessed in earlier times.

Vulnerability characteristics --- There is uncertainty in the characteristics of vulnerabilities as to timing of appearance and development, intensity, location, and impacts on environment, on society, and on hazards. Quick, short-, medium- and long-term vulnerabilities are each surrounded by its own sets of uncertainties. So, it is basically a contest between those issuing early warnings and societal inertia; the former are trying to reduce the uncertainties that surround a particular

vulnerability of concern to the point where they can decide to issue a warning or not. Even known and expected vulnerabilities can exhibit unexpected behavior.

Communications --- Warnings are made up of words (sometimes warnings use color coding) and words have different meanings to different people. Because of this, it is not always certain that the warning that is meant to be given will be the warning that is received by the government or the public. A technical group in the EWS will need to provide clear warnings. Avoiding technical jargon is important in this regard. Communication is also a problem between units in the EWS and between the EWS and other components of a broader EWS network, because when information is passed from one group, culture or country to another, it is at risk to imperfect interpretations. Each transmission of information or warning from one group to another introduces uncertainty into the EW process. Uncertainty in communications can be reduced in part by involving stakeholders, i.e., those at risk to and those interested in early warning of hazards in the early warning process.

Unclear bureaucratic jurisdictions --- EWSs require the involvement of many other governmental and non-governmental agencies. Some of them will act as if they were in competition with those responsible for issuing warnings. For example, agro-meteorologists usually work in a nation's meteorological services as well as in its ministry of agriculture. They will likely have different views about whether a drought is taking place. How an EWS is set up structurally and functionally can either increase problems encountered by the EWS or can reduce them. As noted earlier, is the responsibility of a small technical unit only to issue a warning or the responsibility of other groups to communicate and respond to it? Or, is it that the EWS encompasses all of these activities?

Bureaucracies have their own set of standard operating procedures (SOPs), guidelines, and paradigms by which they operate. If information comes to them but is not a neat fit with the SOP, then such information might be discarded, even though it may be very important for the early warning process (e.g., the monitoring and belated identification of stratospheric ozone depletion in the Antarctica). In some developing countries, institutions are often in need of strengthening through developing human capacity building of and developing expertise in early warning and in understanding hazards and their impacts.

Competition --- As noted earlier, several ministries of a government might consider information that they collect and analyze as strategic (such as the amount of national food reserves). They may not release it, even though it is important to the effective operations of an EWS. Another constraint on effectiveness is the fact that many organizations outside of a country are likely to be issuing hazard warnings for that country as part of their global monitoring and early warning activities. That can create problems for the EWS (and forecasters) in the affected country. For example, an El Niño forecast disseminated from a government agency in the United States can raise questions by political leaders in other

countries about why their own national EWS (or their own forecasters) failed to issue such an *early* warning. Why should a government fund an EWS if it can get warnings for free from reliable sources in other countries?

Political context at the time of the warning --- The type of political system in general and the domestic political situation at a given point in time affects the effectiveness of an EWS. Governments fund national EWSs, and those systems are subjected to guidance and funding from the government. There are examples where a government failed to act on an early warning given to it about a hazard or even a disaster (e.g., famine). The reasons for inaction were clearly political. Each warning requires responses, and each response generates costs in human and financial resources. Governments may be reluctant to act quickly on warnings that have some degree of uncertainty in them, so they tend to take a "wait and see" position. In many instances, governments want certainty when it comes to hazard warnings. Politics affect EWSs differently for quick onset hazards as opposed to creeping ones. With regard to the former, there is little time for indecision. With regard to creeping problems, government officials may believe that they have time enough to wait for the findings of the next assessment, or the ones that follow.

Psychological Aspects

"Reality: a weak match for perception" (M. Pinsdorf)

The psychological aspects surrounding EWSs are much more important than may generally be realized. The way that people view early warning systems will affect how effective the EWS might prove to be. For example, people will need to trust their EWS and the purveyors of warnings, if they are to be expected to act on its warnings. That is why it is important to keep politics to a minimum in an EWS's operations. It is also why there must be as much transparency as possible in the decision making process that leads to warnings.

Lack of warning helping market

By Joyce M. Rosenberg
Associated Press – 27 December 2003

NEW YORK – Sometimes one of the biggest factors in stock market trading is literally a non-event, something that isn't happening. In the past few weeks, companies have not been warning investors that fourth-quarter profits will be disappointing, and analysts say the dearth of bad earnings news has contributed to Wall Street's year-end advance.

Because perceptions do not always match reality, there is a need to pay attention to the reasons behind the gap. When an EWS is created, it also generates along with it high, often unrealistic, expectations and sometimes a false sense of security. This could lead a society to lower its guard against a hazard. Making this situation more difficult is an expectation that it is the government's job to protect its citizens from harms, especially harms linked to nature. This too could prompt a population to relax its self-protection mechanisms. It is important for the public as well as for the EWS to be aware of

the limits of an EWS so that expectations about what it can do more closely approximate reality.

Another aspect of perception is that people tend to discount the past; that is, they put less value on information about experiences of previous governments and previous generations than they place on the information that is collected in the present. Discounting the value of information has a negative effect on the many lessons identified from the impacts of previous hazards and disasters. This is in part the result of a belief that new technologies will change in a positive way the ability of society today to respond to an early warning of a potential hazard. It is in part the result of a belief that the current generation is more knowledgeable than previous ones.

In most societies, there are options available to the at-risk populations, once they have received a warning of the likely onset of a hazard. People then have the choice to believe the warning of the event and take appropriate evasive action or to believe that they are not really in harm's way and take no preventive measure. While perceptions of reality may not accurately reflect reality, the actions taken based on those perceptions will have real consequences.

Early Warning Targets

In addition to issuing general warnings to the public at large about the potential onset of a hazard, warnings designed for the special needs of specific users must be prepared, because different communities that are in need of early warning about potential hazards have different information needs. This includes those directly and indirectly affected by the hazard, which could occur sequentially or conjunctively, as well as those who are at risk to the second- and third-order impacts. There are also humanitarian and non-governmental organizations that must be informed as soon as possible, so that they can prepare their activities for the disaster and post-disaster reconstruction phases.

Although some people will respond immediately to a warning, others will choose not to take heed of the warning. They might, for example, see themselves as being outside the at-risk circle of people for whom that warning was meant. They may also be risk takers, or they may not have confidence in the system that produced the warning.

It is important to involve stakeholders in early warning early in the development and review of a warning system. Stakeholders can provide important insights into how warnings might best be prepared and delivered to the public, the media, and even to the governments at different levels. They will also feel a sense of ownership in the system that is supposed to warn them and, as a result, warnings will take on a higher level of credibility and reliability.

Stakeholders are not expected to be passively involved in the early warning process. As Mileti noted in a reassessment of natural hazards in the United States, "All stakeholders in a community need to be brought to the point of taking responsibility for recognizing

their locale's environmental resources and the environmental hazards to which it is prone" (Mileti, 1999, p. 268).

Underlying Causes of Vulnerability to Hazards

All societies are affected by natural and anthropogenic hazards of one kind or another. One of the goals of scientific and social research should be to understand more correctly the various ways that hazards can affect society, the ways that societies contribute to the impacts of those hazards on society and the environment, and the reasons that many but not all hazards become disasters.

With regard to geological hazards (earthquakes, volcanoes, tsunamis) and with hydro-meteorological hazards (droughts, floods, frosts), the physical processes are either well understood or are under close scrutiny by scientific researchers. With regard to socioeconomic and political processes, there is a heightened need to understand their roles in the conversion of a potential hazard into an actual disaster with loss of human life. Armed with physical, cultural, and socioeconomic information, it is increasingly possible for a society to convert its "culture of disaster" into a "culture of disaster prevention." According to one participant, a culture of prevention would be based on early warning and pro-action **where possible**, reaction and adaptation **when necessary**, and societal resilience **all the time**. Such knowledge can help societies and their government representatives to avoid backing their way into future disasters as opposed to using foresight to prepare for them. The impacts of hazards need not be surprising, if the appropriate warning mechanisms are in place.

There are processes under way in a society at the time of a hazard that can either mitigate or exacerbate the hazard's impacts on society and the environment. Is it the responsibility of a hazards-related early warning system to monitor a society's underlying social, cultural, economic and political conditions in order to better warn at-risk populations? If not, whose responsibility is it? Clearly, it is essential to identify societal processes that can affect the impacts of hazards (quick onset and creeping), so that governments and individuals can better warn about and prepare for likely impacts. It is most likely the responsibility of the various ministries and specialized governmental and non-governmental agencies to monitor these underlying processes and to report periodically to the early warning system on the status of the processes.

Each government has the responsibility to identify what it is that makes societies more or less vulnerable and more or less resilient. For example, rapid social, economic and political change can increase vulnerability. Societies not only have difficulty coping with many new issues but are continually having to cope with recurrent problems. Early warning of hazards combined with the early warnings of underlying societal problems and processes can lead to a strengthening of resilience and a reduction in vulnerability. The combination of social changes with the occurrence of natural hazards requires periodic objective review.

A common belief is that developing countries are more vulnerable and less resilient to hazards than are industrialized countries. However, this belief would benefit from closer scrutiny. Industrialized countries have the economic resources to respond to hazard warnings and to rebuild after a disaster, but they also have a lower level of tolerance for inconvenience than the developing countries, a lower threshold for collective pain. So, the concept of vulnerability should be broadened beyond a traditional view to include more than a consideration of death and destruction of property. How well prepared a society is in order to be proactive in the face of early warning of a looming hazard determines how well people might respond to the hazard. This could be considered an aspect of societal resilience. It could be used to measure the level of awareness and resilience of a society as well as the level of effectiveness of its early warning system.

It is important to note that a SWOC assessment can be undertaken (i.e., identifying strengths, weaknesses, opportunities, and constraints) for early warning systems in order to provide insights in general (see section on SWOC). However, the findings of such assessments will likely vary greatly from one specific EWS to another, and perhaps even for the same EWS at different times.

All the points in this section so far relate to climate variability and extremes. However, global and regional climate regimes are constantly changing on all time scales. Today, there is great concern from a large number of scientists from around the globe that the global climate regime is warming up to levels not seen in tens, if not hundreds, of thousands of years. Climate change will bring about changes in the frequency, intensity, duration and location of extreme events, adding to the list of yet-unknown underlying processes that can affect hazards and societal vulnerability to them.

Hurricane Mitch provides a relevant but unfortunate example of how underlying socioeconomic and political problems can make a bad hazard-related situation even worse. In late October 1998, Hurricane Mitch had been downgraded to a tropical depression when it did its worst damage to Honduras. The slow-moving tropical system dumped many inches of rainfall on hillsides, towns and cities and caused destructive mudslides and flooding. It was estimated that about 80 percent of the country's infrastructure had been damaged and more than 10,000 people perished. At the time of Mitch, Honduras was ranked as the fourth poorest country in Latin America. Out of the memory of most people at that time, and even today, is the fact that, 25 years earlier and almost to the month, Hurricane Fifi caused comparable levels of death and destruction**.** One can only wonder what the impacts might have been had lessons learned in Hurricane Fifi been applied in the decades before the impacts of Hurricane Mitch (Glantz and Jamieson, 2000).

Competition Among Early Warning Systems

> *"Bombarded by a barrage of conflicting information from a variety of sources, how were you to know when to believe?"* (Funk, 1986).

There are many EWSs in a given country at any point in time, several of which are likely to be focusing on the same or related issues. For example, a concern for food security generates climate forecasts, agricultural production assessments, water resources projections, household food security reviews and nutritional status reports. Even among food security EWSs, there are likely to be several NGO-operated EWSs for one or another aspect of food security. They do not necessarily measure the same indicators nor do they work closely together. Is the existence of a number of EWSs (formal and informal) a hindrance to effective warnings being issued and heeded? Or, is the opposite valid, that is, having numerous warning systems that can serve to check and balance each other so that only real emergencies are identified when several of the EWSs, using their chosen sets of indicators, yield similar warnings. This point remains controversial: are many EWSs operating at the same time better than having just one officially designated system operating at a given time?

Early Warning System Accountability

The issue of accountability of EWS personnel for the warnings that they issue (or fail to issue) always seems to arise in discussions. What if the warning is wrong? An erroneous warning about a hazard can cause serious socioeconomic problems, because governments need to respond by shifting some of their scarce resources away from economic development activities to disaster response. With a forecast of severe drought or a strong El Niño, financial institutions have been known to hold back on loans and investments to those at risk to the impacts of a hazard in given regions and sectors (e.g., farmers, fishermen). Not issuing a warning also prompts different types of responses. What if they warn about an event that does not occur or its intensity and damage is not as bad as suggested by the EWS; who, if anyone, should bear the blame? Like weather forecasting, it seems that EWSs are more likely to receive blame for missed or erroneous warnings than praise for successful ones. The following expression could apply: "Victory and success have many fathers. Failure is an orphan." However, when a formal EWS is in operation, failure can be attributed to an organization, a process, or even an individual.

There are several examples where political leaders and heads of forecasting units have been removed from office because of inappropriate warnings or poor responses to legitimate warnings. While there is a notion about pollution that the "polluter pays" for damages, there is no comparable notion for those who provide inadequate, untimely, or erroneous public warnings about hazards of concern.

Foreseeability

> *"Foreseeability encompasses not only that which the defendant foresaw, but that which the defendant ought to have foreseen."* (Gifis, 1991)

The notion of foreseeability was discussed about whether it has any value in early warnings. It is a notion taken from the law profession. Foreseeability is viewed here as a qualitative expression of probability. It has been used in law to determine accountability or fault in the case of an accident. If it is reasonable to expect that there are likely to be adverse consequences of a natural hazard's intersection with human activities in a given area and no steps are taken to minimize those impacts, should those with decision-making responsibilities be accountable for the damages that ensue? With respect to early warning systems accountability is not the primary purpose for using foreseeability; it provides an early qualitative expression of possible concern about a hazard's possible impacts.

One participant noted, "Most hazards are foreseeable. Everything that has happened in the past is foreseeable." The impacts of disasters, however, are different and in many instances are related as much to the level of societal vulnerability as to the intensity of the hazard. A recent example using foreseeability in early warning took place in mid-2002. Political changes in land use in Zimbabwe, coupled with electoral irregularities, suggested that, for the short term at least, food production would likely decline. Complicating this basic scenario was the forecast of the onset of an El Niño event later in the year, during the growing season, and continuing into the following year. There is a high probability of drought in southern Africa when an El Niño occurs. Putting the pieces of this puzzle together, one could foresee the possibility of severe food shortages not only in Zimbabwe but also in countries in the region dependent on Zimbabwe's food exports.

Foreseeability could be used as an educational tool for those operating early warning systems, even if it is not used in an operational way. In support of the view that there should be multiple expressions of a warning, foreseeability can be viewed as yet another way to express an early warning of potential harm. The vital question though is how to get decision makers to act on qualitative expressions of probability such as a statement of foreseeability. The same concerns can be raised for the "precautionary principle."

The precautionary principle is like a very conservative early warning. Its objective is to "do no harm" when making decisions for which scientific uncertainty remains a significant factor. Opposing groups focused on the same issue play upon scientific uncertainty (Martin, 1979). One group might conclude that there is too much scientific uncertainty to take a chance that actions will lead to irreversible damage to the environment and in turn to society. An opposing group might argue that there is no conclusive evidence (beyond a reasonable doubt) about potential irreversible damage that should merit the blocking of human activities in certain fragile environments. In a way, the confusion is the same that is created by two opposing adages: "look before you leap" and "he who hesitates is lost." Either adage is important in specific situations, and both are useful generalizations, but neither of them will work in all situations. Like the adages

and the metaphors that people live by, the precautionary principle has value if it makes decision makers pause to think before they decide.

It is difficult to apply the precautionary principle in specific situations but, when doing so, the pro and con of actions should be made explicit and weighed against each other. To developing countries, or developing regions within a country, the precautionary principle may be seen as a luxury because they have more urgent development priorities. For example, they point to industrialized countries noting that before they developed a great concern for environmental protection, they first exploited their environments and resources to the fullest. Once developed, the industrialized countries were able to turn their attention toward environmental restoration. Industrializing countries do better than the industrialized countries. No set development pathway is inevitable. We can learn from our mistakes, do better, and achieve development more quickly, more easily, and more efficiently than before, while reducing the detrimental impacts. The problem is, however, that history shows that environmental degradation can heighten the level of vulnerability to hydrometeorological and other hazards. So, is "an ounce of prevention really worth a pound of cure," as the saying goes?

Such issues may not be resolved nor resolvable; such questions may not be answered nor answerable. Discussing them and ensuring that people are aware of the issues and debates can, in many situations, be as important as reaching definitive conclusions, without such awareness.

Early Warning Systems and Government

> *"In politics, the quantitative input is secondary to the qualitative input"* (Schrodt and Gerner, 1998).

Much of what is written in this report about EWSs has to do with government type, structure, function, policy, and politics. A few points deserve additional attention. In theory at least, governments acknowledge that they have a responsibility to warn about natural hazard risks that affect their populations. Yet bureaucratic units within governments have their own constraints to contend with, and those constraints can influence the use, effectiveness, and value of an EWS. For example, often within a bureaucracy there is competition among various units for information ("information is power"), funding, or political influence. As a result, the timely sharing of information of interest to several other units might take place slowly, if it takes place at all.

Some bureaucratic units may play upon the warnings of a potential disaster in order to gain advantage over other units involved in early warnings. Keep in mind that a hidden objective is likely to be driven by the belief that "the first in time is the first to be served." If a warning is issued by one unit, it will likely set into motion other EWSs concerned with downstream impacts of a particular hazard (second- and third-order effects).

Those who are the first to warn (and are later proven to have been correct) are likely to receive increased political attention and funding from the government. As noted earlier, some governments may set up warning systems in order to keep themselves, and not necessarily the general public, informed of the potential onset of hazards. They, then, have the option to expose or not to expose a warning to the public (via the media). Governments support EWSs and can, if they so desire, influence for political as opposed to humanitarian reasons EWS outputs, unless measures are taken to avoid such a scenario.

Early Warning Lessons

> *For a variety of reasons, "institutions ignore evidence" which is "a major source of early warning failure"* (Schrodt and Gerner, 1998).

Lessons are learned with respect to early warning systems, their warnings, and the impacts of hazards. However, those lessons are not always applied when it comes to future hazards. Lessons learned as a result of disasters come with a high cost --- death, destruction and misery. The survivors of the impacts of hazards and disasters are the beneficiaries of those lessons, but only if those lessons are applied. It is important to identify and then apply lessons so that the victims in previous disasters do not become victims without a legacy.

There are many reasons that lessons identified as a result of one hazard are not used when seeking to cope with similar hazards in the future. Perhaps one key aspect about lessons that needs to be highlighted is that the value of many of the lessons that had been identified in the past are discounted because society believes that progress (technological, economic and social) have rendered them no longer relevant today. Lessons identified in the past may also have limited value because society's level of vulnerability may have changed over time, making the lessons appear to be less meaningful.

It is not clear at this time about the extent to which EWSs share their experiences in detail greater than making overviews of presentations at conferences. It is clear that EWS experiences in one culture, country or political system cannot be directly applied to other countries, even those countries that are facing similar types of hazards. Nevertheless, benefits can be derived from assessing the structures, functions, modus operandi, and impacts of EWSs in other places. It would be useful to collect lessons of the past for evaluation by present and future EWSs.

A political aspect related to lessons is that democratic as well as other kinds of changes in government can lead the new administration to neglect or to rescind the useful hazard-related activities that had been established by the preceding government. This can happen when a political party gains power and replaces another. In addition, a current government would be more willing to expose the weaknesses and failures of an EWS and the responses to a hazard of its predecessors than to expose the same problems in its own government.

Some governments might not want lessons to be identified and then exposed to the public. Such lessons can expose governmental weaknesses, as well as strengths. While the government itself might like to know about its hazard response weaknesses, it may not want to share that information with the public, the media, or its opponents.

Sometimes governments over-react to a disaster and set up a structure and warning system to cope with similar disasters in the future, even though the type of hazard of concern might be highly infrequent, even rare from a societal perspective. For example, in 1960 there was a red locust invasion and in response to its damage, a red locust-monitoring center was established. However, the red locust threat had not yet returned – in four decades, until its recent appearance in the late 1990s in southern Africa (Price and Brown, 2000).

As noted earlier, a hazard's frequency has an influence on the use of an EWS. For example, if a hazard's warning level remains the same over a long period of time, as with the US homeland terror security system (predominantly yellow) or with volcano warning in parts of Mexico, which has been at yellow for years, the public will over time likely disregard it.

There is a tendency for a government or a society to focus on and respond to the last disaster instead of taking a broader view of hazards in general. As a result, they tend to pursue policies that look back as opposed to those that might be forward looking and anticipatory of variations in impacts that might accompany future potential harms.

Choosing Disaster Priorities

Disasters get the lion's share of attention from the media when compared with "ordinary" adverse impacts that might result from climate variability from season to season and year to year. Clearly, disasters are newsworthy and the media do take notice. Governments, too, take notice of disasters, as do insurance companies, among others. Each of the aforementioned takes notice, but it does so for different reasons. Yet, with some notable exceptions, disasters do not impact the same location repeatedly. However, the impacts on human activities of variability are occurring all the time. Collectively, the low-frequency hazards (such as those related to hydrometeorological anomalies) are probably more costly cumulatively over the long run than a higher-visibility disaster.

Who, then, decides when a disaster has occurred? Sometimes it is the media, or the government, or an insurance (more correctly, reinsurance) company that labels disasters as such. Insurance companies report on their payouts to disasters and each year they publish lists of such events. However, using their own set of indicators, the reinsurance companies determine which disasters to put on their lists. Some of those disasters might not make it to the disaster lists that are compiled by others. As noted earlier, Hurricane Mitch devastated Honduras when it had already weakened to become a tropical depression, it was not at the time a hurricane.

Each country has to cope with its own set of hazards. Funds are scarce in most countries and diverting funds for the setting up of formal early warning systems can be a difficult political decision. How are they to prioritize which ones they are to focus on? El Niño is seen as a generator of hazards in Australia and Peru, but La Niña is not, even though both hazards can be associated with adverse impacts on these societies. In the US, the homeland security warning system uses 5 colors that correspond to levels of threat. The colors range from blue (no threat), green, yellow (elevated threat), orange and red (the highest threat). It is pretty obvious that blue will never be used. In mid-2003, the Department of Homeland Security elevated its warning from yellow to orange. It was most likely issued for such high-visibility locations such as major cities on the east and west coasts. People in various parts of the interior of the country, however, were not convinced that the threat in their location merited such an elevated warning level. For example, a sheriff in the southwestern state of Arizona referred to the warning as "orange lite," meaning that the threat was not real in his jurisdiction (*USA Today*, 2003). So there is clearly a spatial dimension to the risk of hazards and disasters.

Hazards can also be prioritized either from an individual/group perspective or a societal perspective. The criteria for prioritizing for individuals and for societies are likely not to be the same. Perceptions of hazard risk will vary by competing interests, level of knowledge, geographic location, cultural differences, and competing socioeconomic or political concerns over time.

As far as early warnings are concerned, it is useful where possible to talk about the "seasons of disaster." There are tornado seasons, flood seasons, hurricane seasons, hunger seasons, and so forth. Knowing that a seasonality of hazards exists should provide an increase in forecast skill, and therefore, a useful input to early warnings. Some hazards have already generated awareness of the seasonal need for an EWS, e.g., tropical storms.

State Post Bureau of China issues a special stamp on anti-SARS in Beijing May 19, 2003.

Disaster priorities in a given location will likely vary over time as new hazards appear, as old forgotten hazards reappear, and as existing hazards known to inhabitants of one region appear in new unsuspecting areas. SARS in China is one example. West Nile virus in the US is another example. A deadly heat wave in France is yet another example. Each of these unexpected health disasters took place in 2003.

A final note in this section refers to creeping environmental changes. Because they do not have readily identifiable step-like thresholds of change, it is more difficult to label them as disasters until they have reached a perceived crisis stage. Nevertheless, they are disasters in the offing and need to be recognized as such, so that timely and effective decisions can be made to arrest them.

Beijing on High Alert over SARS (Xinhua News Agency 12 September 2003)

Beijing issued regulations on Thursday for a three-level emergency alert to prevent the reappearance of severe acute respiratory syndrome (SARS).

When SARS cases are found in neighboring areas of Beijing and the capital city reports one case, the city will institute the third-level alert and Ditan Hospital, a hospital for epidemic diseases, would be put into use. Schools would be required to take students' temperatures every day and school access would be strictly controlled.

The alert will be raised to the second level when the capital reports six or more SARS cases and has three or more outbreak locations. Schools which report diagnosed or suspected cases might suspend class and You'an Hospital and the Chest Hospital might be put into use. Quarantine measures would also be taken.

When the city sees 30 or more diagnosed cases, the first level of alert will be sounded. Xiaotangshan Hospital, built during the SARS outbreak this spring, will be used and health checks will be strictly imposed at accesses to the capital. Also, a health condition report system will be put into use in hotels.

While a SARS prevention office has been set up in the municipal health bureau, the regulations stipulate that all district and county governments should be held liable in the prevention of SARS.

www.china.org.cn/english/China/74966.htm

Early Warning Systems and Uncertainty

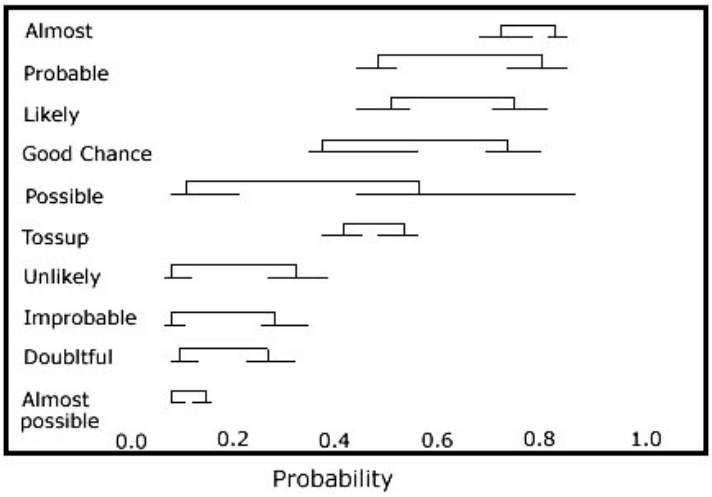
> *"A 100 percent reliable warning system does not exist for any hazard"* (Mileti, 1999, p. 125).
>
> *"Life is lived in the vast complexity of the gray"* (Thomas Merton, quoted in Funk, 1986).

Hazard warnings are accompanied by various scientific uncertainties about their timing of onset, magnitude and destructive potential (hazards usually expose societal weaknesses that remain hidden under 'normal' conditions). One might think that the earlier the warning the greater the uncertainty. That may be true for insight about the onset of the hazard, but may not be true for the other factors (intensity, damage, for example).

Uncertainty is often expressed by forecasters in terms of probabilities. However, it appears that the public as well as policy makers have a difficult time understanding probabilities. In fact, many scientists have such difficulties too. While the public might not understand probabilities when expressed quantitatively, they do understand what it means to "take a chance" or to "take risks." For example, farmers in many countries hedge against hydrometeorological problems by growing different kinds of crops in various locations or by using irrigation. As another example, people take chances every day, even though they do not know how to express those chances in probabilistic terms. For some reason, decision makers demand near certainty when it comes to early

warnings, even though they make decisions every day with much less than perfect information at hand. They, too, like farmers, know how to "hedge their bets." Nevertheless, even with highly certain information in hand, some people and governments will still fail to take the best actions for their own well-being. Thus, there will still be risk-informed death and destruction because of hazards.

There are varying interpretations of probability statements. Quantitative expressions of probability are influenced by perceptions and, therefore, do not necessarily match what people believe are equivalent to verbal expressions. This is generally true within a given country or culture, as suggested by the following chart (Fischhoff, 1994), and even more so when discussing probabilities across cultures.



Climate change (i.e., global warming) in the past several decades is a known fact. What is not known, however, is the degree of increase in global temperature in the 20th century that has been caused by human activities. So, it is difficult to make truly reliable quantitative expressions of probability of occurrence for the wide range of expected impacts of climate change. Warnings about the consequences of global warming will test the ability of climate change-related EWSs to maintain their credibility, because the uncertainties surrounding the consequences are quite large. The IPCC (2001) report provided charts showing the expected likelihood of occurrence of certain global warming impacts in general and for specific regions.

The global climate regime is constantly changing. This provides another reason why early warning systems, especially their indicators for the hazards of concern and for the hazards suggested in global warming studies, need to undergo constant scrutiny and updating.

Even though there is uncertainty in the science and impacts of global warming, there are many actions that societies can take to reduce their emissions of greenhouse gases to the atmosphere. There are also actions that can be taken to reduce societal vulnerability to the hypothesized changes in regional and local climates, changes such as more intense

storms, longer duration of droughts, increased intensity of precipitation, intense and frequent heat waves, and so forth.

Early Warning Systems Cascade

When the EWS's technical core group issues a warning, it often sets in motion other early warning systems related to anticipated downstream or second-order effects of the impacts. Those downstream warning systems identify risks to environmental processes and to human activities. In addition, there is a geographical aspect to an EWS cascade. For example, a disease outbreak in one country will likely spark a cascade of responses to the same disease in other countries, as was the case in the recent "bird flu" outbreak in Asia.

Because El Niño spawns droughts and floods around the globe, it may be the earliest warning possible about hydrometeorological hazards that a government might receive. The forecast of an El Niño will in essence set off a cascade of early warnings downstream. As a result, this information becomes input into other warning systems.

The Cascade of Early Warning Systems:
El Niño Forecasts as an Example

El Niño as a hazard spawner

***El Niño*: a change in sea level pressure across the tropical Pacific and a warming of the surface waters of the central and eastern equatorial Pacific, occurring on average every 4 ½ years.**

***Teleconnections*: meteorological anomalies around the globe that are associated in this case with El Niño: droughts, floods, fires, frost, tropical typhoons, disease outbreaks, haze, fish population shifts, etc.**

Warnings about impacts

–On ecosystems
- **Flora**
- **Fauna**

–On societies
- **Water**
- **Energy**
- **Food**
- **Health**
- **Public safety (disaster avoidance)**

In addition to this El Niño cascade, there are other examples: El Niño and the ice storm in Quebec in January 1998; The demise of the Aral Sea in the second half of the twentieth century; variations in the level of the Caspian Sea since 1930; and so forth.

The recent heat wave in Europe, and specifically in France, had apparently been forecast by various national meteorological services. Whether timely, effective warnings had been issued to the populace requires closer scrutiny. It does appear, though, that no apparent cascade of early warnings was set in motion following the reliable forecast of a protracted high heat period on the continent. Officially, about 15,000 people perished in France. The

disaster in France did serve to prompt other European governments (e.g., Spain) to take precautionary actions in order to avoid a repeat of the disastrous French experience. As one participant noted, "something obviously went wrong" with the cascade that should have taken place once the forecasts of excessive heat were issued. (See the following article for details.)

Early warning systems provide outlooks as well as higher levels of warning. They have an important contribution to make by "warning" that normal conditions are likely to prevail. Positive news would also set off a cascade of downstream warnings and outlooks for the second-order impacts of normal conditions, e.g., a low probability of an onset of a hazard.

August 2003 Heat Wave in France
(by Rene Gommes, Jacques du Guerny, and Michele Bernardi)[1]

During the first fortnight of August 2003, a severe heat wave affected most of Europe, with a number of consequences on water availability, energy supply (in Italy, for instance), a significant increase in forest fires (Portugal), and atmospheric pollution (Belgium) [10]. But nowhere was the impact as dramatic as in France where the mortality increased 55% nationwide, and as much as 221% in the area of Paris. More than 80% of the affected people were older than 75, and 64% were women [12]. About half the deaths occurred in homes for the elderly [11] in a country that spends 9.5% of its GNP on public health.

Excess deaths amounted to almost 15,000 [7,9]; early reactions saw the explanation of this "deadliest summer since liberation in 1945" [3] in a combination of exceptionally high temperatures coupled with the fact that most people were on vacation: hospitals were understaffed, with as much as 30% of staff missing in some hospitals [11].

On 11 August, first reports in the press indicated the "saturation of funeral parlors" and the fear that "several hundreds of deaths" may have occurred [5]. The editorial of the 13 August issue of *Le Monde* (the leading Paris-based newspaper) was entitled *Nonchalance*. It started by stating that "Siesta is a traditional way to conserve energy in warm climates" but then continued by asking, "but can it replace a method of government?" [8] Indeed, as early as 9–10 August, informed individuals such as physicians tried to raise the alarm by talking to the media. However, the reaction of official health and emergency structures was very slow; they mainly include the National Institute of Public Health Surveillance (Institute de Veille Sanitaire, IVS) and the General Bureau of Health (Direction Générale de la Santé, DGS) [9].

The National Assembly established the Commission d'Enquête on 7 October 2003 to inquire into the causes of the disaster caused by the heat wave. It appears that not only had warning systems failed, but on 8 August the Prefect of Police, Paris, instructed the Fire Brigades "not to be alarmist and not to disclose the number of deaths" in testimony by Jacques Kerdoncuff, Commander of the Paris Fire Brigade, before the Commission on 5 November [5].

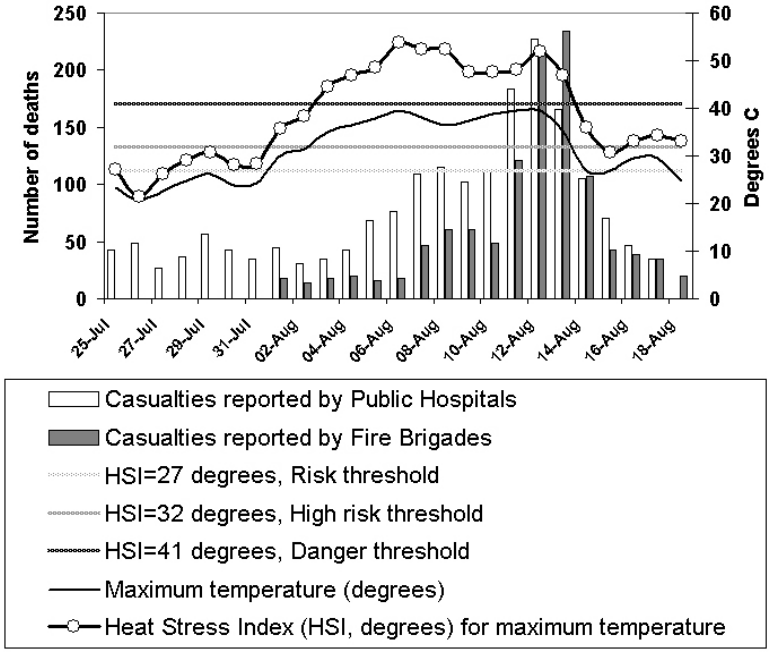
What went wrong? The early analyses blaming the problem on the vacations of medical staff are obviously simplistic. In fact, this simplistic analysis may have contributed to the disaster, as the first difficulties of emergency structures in handling the situation were interpreted as a deficiency of those structures, rather than a sign of a serious emergency. Standard administrative procedures were followed, because the epidemic nature of the problem was not first recognized [6].

[1] Gommes and Bernardi are with the Environment and Natural Resources Services of the UN Food and Agriculture Organization (FAO) in Rome, Italy. Dr du Guerny is the former Chief of the Population Programme Service, FAO.

Lessons from the heat wave include the need to improve the coordination of data analysis. In France, epidemiological and health data collection systems are partitioned between police authorities, army, fire brigades, health institutions, and National Security, among others [1]. This was admitted by Mr Jean-Paul Proust, the Prefect of Police, on 29 October before the Commission d'Enquête: "there has been insufficient cross-checking of information" [2].

Another lesson is that institutional links between health (and food safety) and environmental monitoring need strengthening; conflicts of competence systematically arise whenever environmentally triggered health or food safety problems appear, as when oysters were recently contaminated by oil slicks from the *Erika* [6]. This particular point was duly taken into consideration by the €9 billion plan announced on 6 November by the Prime Minister, Mr Jean-Pierre Raffarin, in favor of old and disabled people [6], as there is currently no formal link between the National Meteorological Service (MeteoFrance) and the mostly disease-oriented health system.

The absence of adequate analysis of meteorological data is patent in the report published by IVS in late August 2003 [12]. Many illustrations show profiles of raw weather data (minimum and maximum temperatures), but no attention is given to moisture and other variables (e.g., ozone concentrations), which very much aggravate stress and the physiological effects of temperatures. It is also worth noting that the dossier prepared by MeteoFrance on the heat wave describes only the behavior of different variables *in isolation*, mainly temperatures [14].



A number of monitoring tools (indices) has been derived by bioclimatologists. The one developed by Steadman [13] is often referred to as the Heat Stress Index (HSI). The HSI takes into account other relevant parameters in addition to temperature; it is expressed in the same units as temperatures, and each of the HSI thresholds is associated with typical stress symptoms.[2] An average HSI profile based on 5 meteorological stations[3] around Paris is shown in the figure. It is clear that heat stress started rising significantly faster than maximum temperatures at the very beginning of August. HSI passed several critical thresholds before temperatures alone could motivate serious concern. The HSI "danger threshold" was exceeded on 4 August, before mortality started increasing, and the mortality peaks occurred after the HSI had remained for 9 consecutive days above the "danger threshold."

[2] HSI=27 ("risk threshold") is associated mainly with fatigue; HSI=32 ("high risk threshold") is possible sunstrokes and heat cramps in the case of prolonged exposure; HSI=41 ("danger threshold"), the likelihood of sunstrokes and heat cramps is further incremented, as well as heat exhaustion. At HSI=54 ("high danger threshold") the probability of the listed symptoms sharply increases during prolonged exposure or physical activity.

[3] The stations are: Orly Airport (2.4°E longitude, 48.74°N latitude, and 96 meters ASL); Le Bourget Airport (2.45, 48.96, 65); Villaroche (2.68, 48.61, 92); Montsouris (2.33, 48.81, 77); and Charles de Gaulle Airport (2.53, 49.01, 109).

The resulting four-year plan specifically allocated €4.26 billion to help the elderly: 200 new homes for the elderly will be built, and more specialized medical personnel will be hired. The plan stresses the development of "personal autonomy," strengthening medical care at home, and the monitoring of the elderly. The government has also taken a series of measures aimed at improving early warning systems, covering the "chain" from meteorological to health authorities [6].

In addition to institutional and technical shortcomings, the impact of the 2003 heat wave also illustrates some serious weaknesses of the welfare state and, in general, the low status assigned to the elderly by western European society. Even if half the victims were living in specialized institutions, it remains that large numbers were insufficiently cared for by their families, in spite of warnings issued daily by the weather service and transmitted by all TV stations. Maybe an effective way to reduce the vulnerability of seniors is to improve solidarity within the family.

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[8] Editorial, *Nonchalance*, Le Monde, 13 Aug 03.
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Early Warning Systems and Sustainable Development

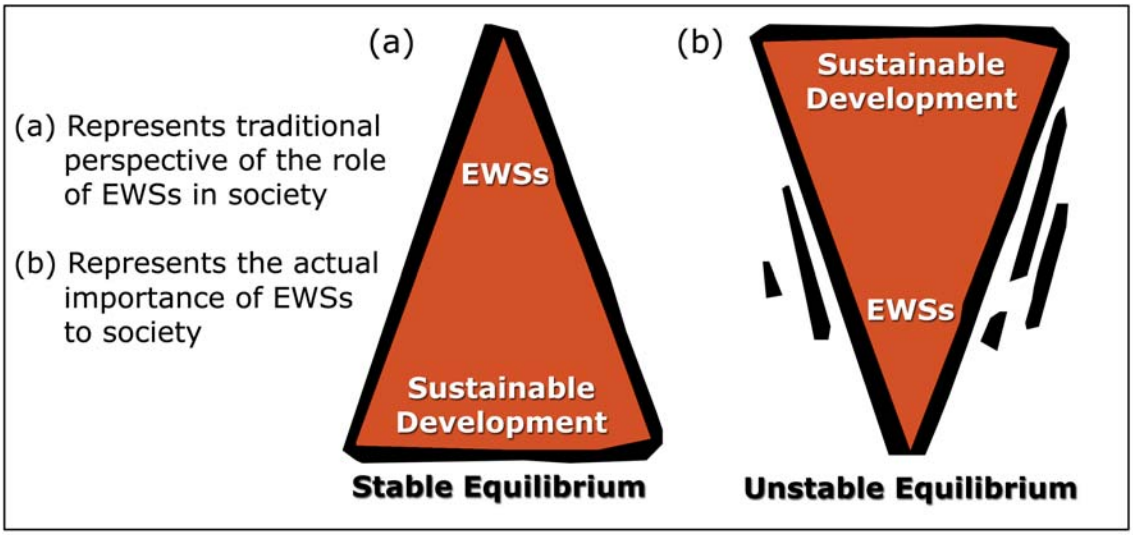
> *"If an early warning system does not contribute to sustainable development, it should not exist."* [a participant]

The concepts of early warning and of sustainable development grew out of different settings and different societal needs. Aside from EWSs related to the military, EWSs were based on humanitarian concerns to forewarn governments and their citizens of potential hazards that might occur in the near term. It is a call for preparedness to local hazards. In addition, a usual tactical response to early warnings is to get things "back to normal," without regard to what that "normal" condition was. Sustainable development was based on environmental concerns and the need to protect the resource base in a country for use by future generations. It is a response to poverty reduction and

environmental protection. The period of evaluation of an early warning begins immediately following the onset of a hazard. The period of evaluation for sustainable development could be years if not decades. One goal of sustainable development should be to improve upon "normal" and not just to preserve it.

An early warning system is an important tool in a government's toolbox for achieving sustainable development. It can be used to encourage settlements to develop in relatively secure areas, while discouraging them from developing in less secure areas. It is in fact an integral part of the sustainable development process. It is in a way analogous to a flashlight for use along the path of development, illuminating obstacles to development, which then have to be dealt with. A hydrometeorological hazard may take but a few hours, days or weeks to occur, but its adverse consequences can derail development efforts for years if not decades. An early warning system can help to identify and remove hazard-related obstacles to sustainable development. It is a necessary part of government operations and of sustainable development plans but it is not sufficient to assure that those plans will be successful. It is a cost-effective way to deal with potential disasters and to aid the process of, and prospects for, sustainable development.

For purposes of illustration, society can be graphically represented by a pyramid, the base of which represents sustainable development. The apex of the pyramid represents an early warning sentinel. Its function is to protect society from harm due to natural hazards and those hazards that are anthropogenic. This suggests that early warning systems have the role of seeking to identify (like a spotlight) potential problems for a government, as it seeks to pursue environmentally and economically sound development strategies. However, one might view this graphic in an opposite way: the apex of the societal pyramid represents the various early warning systems in a given society. This pyramid rests on its apex and not on its base.



The point is that sustainable development prospects are ***very*** dependent on the effectiveness of the many early warning systems. Hazards are acknowledged to have the potential to set back economic development activities for long periods of time, because of

the need to divert funds away from development to emergency, disaster and reconstruction activities. The society must rebuild the affected regions and socioeconomic sectors just to get back to "normal," and as noted earlier, normal may have been poor. This was the case of Honduras and the impacts of Hurricane Mitch, among the poorest countries in the Western Hemisphere. Thus, sustainable development prospects are much more dependent on successful early warnings than most observers and governments realize.

One participant raised the idea that early warning systems must be kept independent of sustainable development planning activities. He noted that the responsibility of an early warning system was to be kept at a minimum, by only serving as a technical group to provide warnings upon which other groups must (in theory) act. The remaining participants, however, supported the belief that early warning systems must be an integral part of any government's sustainable development strategies.

In fact, an EWS should actively contribute to sustainable development. An EWS is a necessary component within the sustainable development process. As noted in the Yokohama Message of 1994, "Disaster prevention, mitigation, preparedness, and relief are four elements which contribute to and gain from the implementation of sustainable development policies" (OCHA Online, 2000). EWSs should not be viewed as an essential component of development projects, which saves money. They are a component that specifically contributes toward, and is needed for, sustainable development. This sentiment appeared in a recent publication on disasters (Ingleton, 1999), when the former president of Brazil wrote the following: "Success in the prevention and reduction of natural disasters is closely related to the pursuit of sustainable development policies. Therefore, nations should incorporate preparedness against these phenomena into their social and economic agendas" (Cardoso, 1999).

Media

> *"The international news media are more likely to cover catastrophic failures of humanitarian relief efforts than they are to cover modest success"* (Schrodt and Gerner, 1998).

The media can be used to educate the public, but this is really not their primary function. They are in business. They sell newspapers or advertising spots on TV and radio. It is important for an early warning system to partner with the media in a way that is mutually beneficial and for the public good. One way to do this is to "embed" an aspect of the media (i.e., a channel of communication) in the early warning system. There is a need to convince the media of the importance of an EWS, an organization that issues early warning. Such systems are not of great or urgent interest to the media; that is, unless they have identified a "trigger" to a hazard, or are responding to dire warnings of an imminent threat.

Creeping environmental problems are generally not on the radar screen of the media. They lack the triggers of change that quick-onset hazards have. They do not easily capture the attention of journalists because the changes from day to day are imperceptible. There is no easily identifiable "warning bell" for a creeping environmental change that clearly degrades a society's vulnerability. Disasters are media-friendly. Creeping changes are not.

Participants also mentioned the role that celebrities might play in bringing attention of the general public worldwide to creeping environmental changes. There are examples where movie stars or singers have spearheaded a *cause célèbre*, such as the singer Sting has done for the protection of the Amazon rainforest, or actress Bridget Bardot has done for the cause of protecting baby seals and other fur-bearing animals. Celebrities could include politicians, rock stars, and other personalities who are in the news.

The media, like politicians, are always being pulled in several directions to cover a wide range of emerging issues. Realizing that some news days are slower than others, the best time to educate the media about hazards and early warnings and responses to them is during those relatively slow news periods. It is much more difficult for media representatives to take the time to learn about these issues at the moment of the onset of a hazard and potential disaster or when they have to deal with other newsworthy events. During the rush time of crises, the media may rely on people who they know will provide interesting sound bites about disasters or governmental involvement in them, even though the people interviewed may not be the most knowledgeable. Because the media reporters feel that they know them, they tend to rely on people who will provide information that reinforces or supports the views that they want to expose to the public. This has been the case with regard to the climate change debate between the IPCC scientists and the climate change skeptics.

There is a need for an intermediary to act as a translator of the warning's technical contents and background to the media. The intermediary would convert technical language into text that the general public could understand and relate to. An intermediary could also help to convince the media to focus more on the facts than on rumors or bad news, which happens to be news that usually sells papers.

One particular problem is that the media seek "news scoops." They want to be first with newsworthy information. In this regard, they may be in conflict with a warning system that issues warnings only when it feels it has the appropriate amount of credible indicators of the onset of a hazard. As one writer recently noted, "The compelling need to be first, but not necessarily right, seriously undermines veracity, particularly in medical, scientific, and environmental coverage" (Pinsdorf, 1999).

The EWS wants to avoid creating a panic but also wants to issue a timely warning. Its credibility is constantly at stake. Not every warning is meant for public consumption and may be only for the eyes and ears of specific target audiences, such as relevant government agencies. Reporters will be reporters, however, and they, and especially their

editors, tend to focus on scoops. As a result, their test for credibility of information may be lower than that of those responsible for early hazard warnings.

In theory, the media can be a powerful ally to an early warning system from hazard warning to disaster reconstruction. The media include photojournalism as well. Often, photos and satellite images capture the influence of the attention of readers and viewers. The text accompanying them only reinforces the images. Photos of "environmental refugees" fleeing from the impacts of a hazard along with regional environmental changes captured by satellites (the Aral Sea desiccation; deforestation in the Amazon) can generate a level of awareness and urgency that words alone cannot.

Thai PM in Bird Flu "cover-up": Thailand admits bird flu secrecy

www.cnn.com, **25 Jan 2004**: The Thai government only confirmed an outbreak of bird flu – a strain of H5N1 avian influenza – on Friday after days of denying accusations from farmers and opposition legislators that the nation had been hit by the dangerous disease. The Thai Prime Minister conceded on the weekend that his government suspected for "a couple of weeks" the country was facing an outbreak of bird flu but decided not to reveal the outbreak until Friday in order to avoid mass panic. His admission comes as his government faces increasing criticism over its handling of the outbreak amid claims of a cover-up.

www.cnn.com/2004/WORLD/asiapcf/01/25/bird.flu

Communications

> *"Decision makers are often reluctant to act and the problem is one of publicity, not probability."*

The globalization of communications has greatly affected early warnings. They are now coming in real time from all media (including the Internet) and from most countries. This is good on the one hand, because appeals for assistance can be broadcast instantaneously to every government and humanitarian organization around the globe. On the other hand, it might not be so good because some warnings may be based on rumor and not on reliable information. Every warning, as suggested earlier, has consequences; someone is listening to each warning. Even in the era of globalization the industrialized countries still have the advantage over the developing countries, because they are high-tech societies with instant, sometimes exclusive, access to satellite imagery that the developing countries do not have.

The Internet presents a particular problem for early warning. A website can appear to be authoritative when it may not be. It can make ordinary rumors look authoritative and attractive. Thus, warnings issued via the worldwide web should carry with it a special "buyer beware" label. Perhaps one of a government's biggest concerns related to hazards is to avoid panic among the population. That is why good communications and a credible early warning system are very important.

As noted earlier, there are problems when it comes to translating warning information across cultural lines. Some notions do not easily translate into other languages: for example, warnings, creeping change, and even specific color-coding.

The early warning system must take full responsibility when it presents its messages to the public, the media and the government. It can use others to spread its messages, but it is the one responsible for getting that message understood. It can work with the media. It can hire intermediaries, but it is its responsibility to get the correct message out.

There is a core need to get the warnings to remote areas that are likely to be in harm's way of specific regional hazards. Technologies exist to do that, but the will to carry it out does not seem very strong. As a result, remote populations are often the last to receive a warning, if they receive it at all. The truth of the matter is that there is no social equity when it comes to early warnings about potential disasters.

Warnings come from many places, and this confuses the public. If the warnings reinforce each other, then that would amplify the message from the official warning system. If, however, warnings are of opposite sign, the public will choose the one it likes and will become divided, minimizing the value of the early warning.

Capacity Building

> *"The UNDP recognizes that capacity building is a long-term, continuing process in which all stakeholders participate"* (GDRC, no date).

Capacity building, some say capability building, is called for in a variety of development activities in developing countries. It is also called for in early warning systems. The fact is that human capacity already exists in just about every country. What is needed is a desire and a mechanism to bring people together and then to support them as they enhance their existing capabilities.

It is also necessary to build additional early warning capacity among the general populations through education and training programs. There is a need as well to build institutional and public capacity for early warning. At the same time it is necessary to raise awareness of the milieu in which they operate. An early warning system cannot be effective if its milieu is not receptive to its functions and its messages. Support for capacity building cannot come from external agencies alone, but must come from domestic sources as well.

In sum, capacity building related to early warning activities must be undertaken continuously, using incentives, and must be constantly upgraded, if capacity building is to be more than a political palliative devoid of real intentions.

Concluding Comments

Just about everything we do in life, every decision, involves some form of an early warning. Sometimes those warnings come as personal hunches. Other times they come from external sources such as a government agency. Many of the warning signals that exist around us are accepted without giving them a second thought, e.g., streetlights, speed limits and road signs. Many of the early warnings we receive relate directly or indirectly to life and death. Others relate to gains and losses of goods and services. As humans coming from a wide variety of backgrounds, we are free to interpret those warnings in different ways. As a result, what one person may see as a warning, another person may not.

In any discussion of EWSs, disagreements can be expected on just about every definition of what constitutes early, a warning or a system. A wide range of views also exists on the meaning of sustainable development. Even within the hazards community, there are similar discussions about what constitutes a hazard and a disaster as well as about when a hazard turns into a disaster. A common distinction is that there are natural hazards that take place regardless of human activities: tornadoes, meteorological droughts, freezes, tropical storms, etc. Disasters are viewed by many as a natural hazard that has been influenced by human activities. For example, if people did not build homes in areas with a high risk to hurricane landfall, there would be no disaster, just a hurricane. If people did not live in trailer parks in tornado alley, there would be less damage to humans when tornadoes take place. The same can also be said of people who live in floodplains, near volcanoes, and so forth.

More recently (late December 2003), the city of Bam, Iran was hit by a major (6.5 intensity) earthquake, probably one of the worst in that specific location in at least of a millennium. We can suggest this, because several buildings in the area have apparently survived tremors in past centuries, until now. Some people might argue that this was not a natural disaster because people had settled in an earthquake prone area. However, one needs to distinguish between people who build a known earthquake prone area in 2000 and those who did so in the year 1000. The point is that today we allegedly know better.

In earlier times, depending on the hazard risk, people did not have the scientific information to back up claims that certain areas were high risk to hazards. Another distinction that might be made with hazards and disasters is that the at-risk populations, potential hazard victims, have no choice but to live where they do in order to eke out a living to feed their families. Others at risk may have a choice in the matter, such as whether to build a home on the hurricane prone outer banks of North Carolina or to build a home on an unstable cliff-side in El Nino-affected coastal California.

Early warning systems, formal and informal, are a way of life in industrialized societies and agrarian ones. As important as they are today and as imperfect as they may continue to be in the future as societies struggle to gain a meaningful glimpse of the future, they will become even more important to societies in the future. As noted earlier, EWSs can be viewed as a component of the broader sustainable development process. The idea of

sustainable development is to generate economic and social development results that are durable in a dynamic way. In a sustainable development situation society is constantly seeking protection against natural and anthropogenic crises. Society will develop mechanisms to help reduce its vulnerability (through development) by reducing the possible impacts of various types of hazards. An EWS is a tool that helps a society to cope better with natural or anthropogenic hazards. It is an important instrument for sustainable development.

Postscript

SWOC Charts from the Breakout Session

As suggested earlier, it seems that all EWSs function well on paper. When one attends a conference in which EWSs are described, they usually present the structures, functions and successes of their specific systems. Some references are made to weaknesses, such as the lack of continual funding, the need for more government moral and financial support, the need for better communication with those at risk, and capacity building. While EWSs can be discussed in general terms (as we are doing in this report), there is a need for documenting the activities of early warning systems and objectively identifying their SWOCs, keeping in mind that all of the identified weaknesses and constraints provide potential opportunities for improvement. While the details of specific cases of early warning activities may not be transferable from one country to another, case studies can be used in illustrative ways for future as well as present generations who have to deal with similar kinds of hazards.

Sample Early Warning SWOC Chart:

STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
• Early warning provides lead time to act • Shows a government cares about its people (symbolic) • EWS – could mesh with sustainable development goals • Building resilience into a society • Reducing vulnerability in sectors, regions or socio-economic groups • Warning governments in time to shift resources to prevent or mitigate impacts	• Not timely: human problems, nature problems (earthquake) • Nature + value of EWS not well understood • Bureaucratic process • When to warn • Who to warn first • Confirmation (certainty) • False alarms – loss of credibility • Societies are constantly changing • Need constant review of system • Infrequency of things being warned about • Shelf life of an EWS (as society changes) • Probabilities of occurrence not really understood; too many EWS • Cascading EWS and cascading uncertainties • "Father (not homeland security) knows best" • Demand for quantitative indicators and verification	• Educate people about local hazards; response possibilities • To work toward impact proofing society to certain aspects of hazards • Contingency planning • Pro-action over Re-action • The use of the Internet to improve, compare similar EWS • To identify uses of EWS between events (to avoid loss of interest if no threat occurs)	• Communication: telecommunication, human perception (people don't listen) • Fear of causing panic • Fear of looting (leaving one's possessions to theft as opposed to Nature) • Inter-ministerial rivalries • Poor communication techniques where people are most at risk • Who pays? • Not all hazards lend themselves to EWS • One EWS does not meet all needs (mixed messages to disparate groups. E.g., car dealer in Boulder and wind storm) • There are winners and losers with EWS: the warnings create winners and losers even if the impacts do not

Group 1: Selecting and Monitoring Indicators	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Process of Selecting Indicators	• Know what you need to collect • Eliminates extraneous information • Identifies important information • Identifies qualitative and quantitative data • Data resolution and complexity • Fine-grain-ness • Local "soft" indicators are important • Can use anecdotal information as a meta indicator to calibrate other data • Hindcast and review to identify better indicators for future EWSs	• Constrain what you need • However, you could eliminate important information about things we do not yet understand • Process selection is neutral selection (what, who, how, are not neutral) • Data resolution and complexity • Fine-grain-ness • Technology could bias the selection of indicators and could cause people to look in the wrong direction • There is limited data (100 years or so) for models • The use of spurious indicators • A chosen model is a weakness if it leaves out variables that might be important	• Increased data flow • Increased precision of data • Ongoing process/system of selection • Accuracy • Communicate process at different levels to different audiences • Access to everyone for raw data • Appropriate language choice • Multiplicity of uses and people using information; opportunity to educate, etc.; costs will increase • Learn how to use anecdotal information as a meta-indicator • Disasters also drive technological development as new ways are sought at each stage of the EW process	• Increased data flow • Increased precision of data • Time and space consistent • Timeliness • Inadequate funding for research needs • Cost/resources • Reaction of people to information • Total understanding of the process is not known • Communication • Disasters are rare, so statistical models do not work • Cost to maintain data • Not enough data for the atmosphere • Multiplicity of uses and people using information; opportunity to educate, etc.; costs will increase • Paucity of data, especially social, acts as a constrain on effect EW
Process of Monitoring Indicators Data include all kinds of information (qualitative, quantitative and even anecdotal; physical, biological and social)	• Keeping track of ability to indicate • Long time series • Should one use the last 30 years or use the whole available time series? • Improve the indicators	• Sampling error • Policy and funding attention to the process • Need for meta-indicators to determine indicator quality and cascade from that • Data resolution and complexity • Fine-grain-ness	• People use data in different ways • Improvement of technology and use of technology • Diffusion and decrease in cost • Empowerment of people through data availability • Can empower people • National food stock estimates are often secret. This is a major problem for food supply monitoring	• Different people understand information at different levels and in different ways • Resources for a system • Sampling error

Group 2: Communicating the Warning	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Technology is neutral but can be a two-edged sword	• technology allows us to reach many people • often, the information is already available (e.g., in met. Services) • media can communicate widely to many countries • early warning as a concept has a rich, long history • population expect governments will warn them of disaster This list is suggestive, not comprehensive. There are many other things we can do to improve communications of early warning	lack of technology means many people are not reachable not everyone will have their technology switched on Investments in new technology can undermine communication (e.g., UF radio vs. cellphone) Technology accessibility is different between countries (e.g., developing countries) means lack of equity in receiving warnings. Investment in services that might/should issue warnings has declined in many countries (e.g., met services) Information is often ambiguous, uncertain Media often garble warnings – message is complex and uncertain Probabilities are difficult to communicate, but usually essential Media can confuse the warning Probabilities are difficult to communicate Media forgets from disaster to disaster. They have to be re-educated constantly Information is not easily shared across political jurisdictions Not always clear who has the responsibility to issue warnings Even among government departments a willingness to share data, may not be possible because data is not compatible Lack of commitment to a sustained EWS Lack of authority give to EWS	Technology may allow more people to get access to warnings faster Improve interactions between the media and EWS Even "older" technology (pagers) can be used to improve communication of warnings Need "single voice" warning (sovereign); use local language For some phenomena, uncertainty is being reduced (and better ways to communicate uncertainty) Work with media to reduce confusion in communicating warnings Education is important: education about warnings is useful to improve general education, and governments like this – so opportunities to improve education Can learn from experiences in communicating other warnings There is money to be made from warnings (e.g., construction, industry) Regional cooperation can improve warnings Governments can be interested in funding EWSs because they may reduce the cost of damage Educate the media Engage private organizations to participate in EWSs Need to better target the early warning (government, at-risk population) Undertake risk and vulnerability	• Lack of technology - not accessible to many of the most affected (e.g., Internet, fax) • There will always be uncertainty • Rural areas less likely to set investment to improve access to warnings • Political and invasion of privacy constraints may restrict the use of technology (e.g., fax, Internet, cell phones) to disseminate warnings • There is always going to be uncertainty – most phenomena are probabilistic • The ability to communicate warnings may be reduced by political and other constraints. • There will always be some confusion/garbling by using media to disseminate warnings • Time consuming to educate the media • Warning is "content sensitive" – everyone will interpret it differently • Intercultural complexity (e.g., language) can make message delivery complex • Who has responsibility for warnings – governments or others? And how is this changing? • Probabilities are usually essential • The media is not the best way to educate the public • Too many early warnings and

Group 2: Communicating the Warning	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
			assessments Support monitoring on a continuous basis Learn from other warning systems Warnings can improve the general education of the public	forecasts • Legal constraint is that the central government is expected to be the only or first warned • Problem sharing data between countries • Media in several countries are not prepared to translate scientific warnings to the public • The bottom line is that disaster risk is less important than feedings one's family • Constraints on EWSs and response capabilities are dynamic aspects of vulnerability. In other words, vulnerability is not static

Group 3: Receiving, Believing and Acting on the Warning	**STRENGTHS**	**WEAKNESSES**	**OPPORTUNITIES**	**CONSTRAINTS**
A. Receiving Website, electronic and printed and broadcast media, GPS	• Strong credibility of issuing authority • Lead time to act • Technology allows the warning to reach many areas • Remote areas may depend on folklore and rumors	• Broad spectrum of stakeholders – can one EWS help all stakeholders? • Issuing body doesn't have enough credibility • Too bureaucratic, doesn't work at the local level • Multiplication of EWSs and information can cause confusion	• Use mass media as a means of distributing information • Establish disaster preparedness center (e.g., Russia) • Targeted and specific information to stakeholders in local/laymen terms (but Indonesia has 200 languages) • Improve science-policy-public- and public-media interfaces	• Poor interpretation by stakeholders • Access of information in remote areas • Panic heightens risk • In some countries, EW agencies are not allowed to go to the media without government permission. • The type of political system can be an effective constraint • The increase in the number an geographic extent of informal settlements in high-risk areas
B. Believing	• If culture, local customs, etc., are incorporated then people will believe • If information is credible, them people will act • Allows for informed decisions for people to protect themselves	• Different stakeholders believe in different EWS • Local myths and superstitions (volcano)	• Develop capabilities • Improve transparent reporting systems that see failures • Accommodate beliefs (cultural sensitivity in training) • Develop credibility criteria for EWS • Develop one or an ensemble of EWSs?	• Without good information, stakeholders cannot make good decisions • People don't listen • Develop one or various EWS?
C. Acting Who are the stakeholders? - farmers - water users - etc…	• If system is knows to work, they will act • EWS provides lead time to act • Warning governments in time to shift resources to prevent or mitigate impacts	• Bureaucracy • Delay in disseminating the warning • Poor observation skills • Lack of commitments from stakeholders due in part to lack of reliability of forecasts or warnings or lack of confidence in the government	• Incorporate local knowledge into hazard management/response • Rethink the flow of decisions and resources	• Not enough time • Lack of resources • Poor management • Quality of information received no confidence • Poor observation skills of stakeholders • Different people react differently to the same stimulus (doing nothing is an active decision)

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Appendix 1: Hurricane Early Warning in Cuba: An Uncommon Experience

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Introduction

Hurricanes are one of the more deadly natural disasters and are likely in the area of the Tropical Atlantic and the Caribbean, they are the deadliest. In the USA, for instance, their damages exceed those due to other hazards. In other countries in the area, damages are simply enormous, remember Hurricane Mitch that in 1998 killed thousands of people in Central America.

In a hurricane, we find almost all kinds of weather disasters: very strong winds, heavy rains, floods, high sea, tornadoes. But strong winds are considered their main and most dangerous characteristic and them they are classified by the maximum wind speed in 5 categories called the Saffir-Simpson Scale. Most dangerous hurricanes are those in categories 3, 4 and 5.

One of the more recent examples was Hurricane Isabel, which last September battered the Atlantic coast of the United States. Only a few days before, Isabel was a category 5 hurricane; however when it reached the coastline, it was only a category 2. Despite the weakening, Isabel killed 23 people and left millions without power. It is interesting to note that only 24 hours previous, the impact the National Hurricane Center showed much hesitation in their official advisories.

Hurricane Isabel

In November 2001, a category 4 hurricane named Michelle pounded Cuba. Losses were so big that its historical enemy (United States) took a break in the economic embargo which last more than 40 years and helped to sell food to Cuba. However, Cuban authorities faced the hurricane, taking important protective measures and evacuating more than 700, 000 people. As a result only 5 casualties were reported.

A very small number of casualties in Cuba during hurricanes has become usual in the last decades. Comparison with other poor countries in the area is simply dramatic and only human losses in the USA could be considered to compare. As a result, the Cuban experience has created strong controversies among politics and researchers; some of them have called for a careful look at risk reduction policy in socialist countries.

In the Cuban case there are a variety of multifactorial causes behind these results. They can be resumed by considering three main components from IDNDR: (1) the public's awareness of hazard risk; (2) public policy commitment; and (3) applied scientific knowledge.

Public Awareness of Hazard Risk.

Hurricane Michelle damage in Cuba

This component has been very important in Cuba to stimulate self-preparation of the population. In fact, Cuba traditionally has maintained a relative low record of casualties in relation to its neighbors. Statistically, one tropical cyclone hits Cuba every two years. From 1888 to 1998, Cuba was affected by 11% of the hurricanes generated in the Atlantic and consequently, society has developed adequate perceptions about hurricane threats.

The four deadliest hurricanes of the last century in Cuba and the USA serve to illustrate the former. As is shown in the following tables, casualties in Cuba remain in all cases lower than in the US, although the hurricanes of 1926 and 1944 hit Havana City, the most populated city in the Caribbean.

CUBA		U.S.A.	
year	deaths	year	deaths
1932	3 500	1900 (Galveston)	8 000
1963	2 000	1928	1 836
1926 (Havana)	600	1938	680
1944 (Havana)	300	1919	600

Of course, this is may not be the only reason but when people have an adequate idea about risk and how to proceed, they have more chance to stay alive.

Public Policy Commitment

The second component has a very special behavior, maybe unique. Cuba is a socialist country, a survivor from the socialism crash of the 1980s and 1990s. Its political structure is based on a centralized and long-lasting one-party communist government with no significant internal political struggles, which are very common in other countries. Such institutional stability highly favors the development of long-term plans, which can be applied and monitored in society in a practical undisturbed way for many years.

The hurricane coping capacity is considered, as well as education and health, as a piece of the ideological struggle between capitalism and socialism. Government caring about its people is not

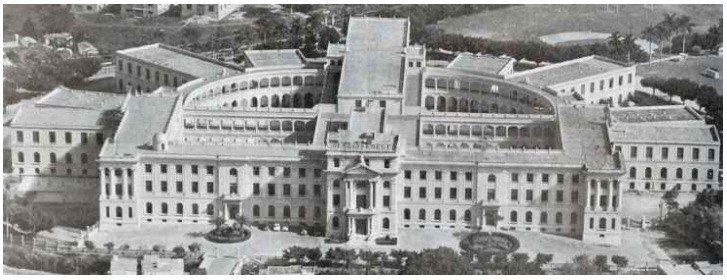
only symbolic or altruistic, but is also a practical action that proves the superiority of the Cuban system vs. neighboring countries.

Since the onset of the socialist government in the 1960s, Cuba has been immersed in a historical conflict with the US government which maintains a severe economic embargo against Cuba (Cubans claim it as a blockage). As a consequence of this conflict, Cuban society is highly organized under the umbrella of a military doctrine in order to face eventual US aggression. Response plans are included into this doctrine to take advantage from the system.

Applied Scientific Knowledge

The third component is maybe the least known of all. Cuba has a traditionally high level of scientific knowledge about hurricanes.

Over the nineteenth century, the Spanish government and the Catholic Church developed in Havana the first meteorological service in the Caribbean region. During the early twentieth century, the technical capability of Cuban meteorology led the US in hurricane monitoring.



Belen Collegue in Havana. Jesuit's institution
Where the first meteorological observatory born in the XIX century

This development brought some conflict with the American Weather Service, mainly because the Cubans were extremely good at predicting cyclones – way better than the US could hope to be. As early as 1870 they had set up a network of hundreds of observers and runners that were well trained and dedicated to the job. Their director, Father Benito Vines, dedicated his life to cyclone prediction and enjoyed great success.

After the disaster of Hurricane Flora in 1963 (more than 2,000 deaths) the Cuban government, supported by the former Soviet Union, undertook a serious effort to improve the national meteorological service. Soon, Cuba became self-sufficient in warning capability, and in the wake of the US-Cuba conflict , during the 1970s and the 1980s, the relationship between the NHC and the Cuban meteorological service reached its historical lowest point.

How the Early Warning Chain Works

The Institute of Meteorology of Cuba possesses the leadership in hurricane predictions and monitoring as a function of the Cuban State. Its monitoring facilities are based on a network of

more than 120 stations, 5 radars and operational access to satellite pictures. Operational forecasts are supported by their own hurricane prediction methods. In fact, Cuba is one of the few Western Hemisphere countries with major scientific research about hurricanes.

Over these bases, the meteorological service has developed its own advisory system with some resemblance to the NHC, releasing one advisory every 12, 6, or 3 hours, depending on the level of threat. Cuba has a warning system that is activated by a national defense council. Functional and structural organization is built into the law for the national defense of 1997. The highest levels of that system are the president of the government and the Minister of Defense.

The system is structured in "defense zones" spread throughout the country. It allows the system to send information to the governments of provinces and municipalities. The main economic and social concerns under risk maintain direct phone lines to the centers of the Civil Defense. Broadcast radio and TV networks and newspapers are public services fully controlled by the government. There are not private networks. Under a hurricane warning, all media are fully subordinated to the national defense council to play a role in disseminating warning and instructions for the public.

Cuban disaster management organization is not only focused on emergency response but also in risk reduction activities. Preparedness plans are designed to build capacities in local and rural areas under risk, to take measures. Although preparedness plans are established under military decision-making practices, military and civilian structures in the Cuban society practically overlap, ensuring a strong coordination between them. The internal Cuban economy remains highly centralized and government dependent; individual owners are practically reduced only to small business. Under these conditions resources, infrastructures and transportation for evacuation and other protective measures come from only one source.

Civil defense meeting. Training for hurricane

Conclusions

Cuba's experience is hard to be fully applied in a western-type society because it is supported by very different societal and economic bases. Undoubtedly, ideological basis, societal and economic structures performed under a communist government tends to favour its capability to take actions directly on any social or economical activity. However, in the Cuban case, the conflict with the United States and the embargo establish important singularities. A society severely stressed by an economic embargo, among others factors, has to be very concerned about natural disaster impacts. Besides, under a strong ideological struggle against capitalism, the Cuban government considers itself under a permanent military aggression risk, developing a military doctrine which involves every stage of society creating quick reaction capacities for emergency response. In fact, Cubans have been forced to be more efficient in facing natural disasters in a scenario of political conflict with the US government. This is maybe an opposite

view of the disaster diplomacy approach. Protective measures under a conflict are developed in such a way that the enemy would not be able to take advantages from the disaster. In the Cuban experience, not everything is politics. There is a solid historical background of social awareness about hurricane risk and technical capabilities in hurricane warning that it may be unique in the Americas.

Despite singularities, some lessons could be established from the Cuban experience in EWS. A strong societal awareness could be constructed over public perceptions of risk This is a long term educational task in many countries under hurricane risk. Poverty, isolation, lack of education, and inclusive traditional feelings about fate are majors obstacles to reach this goal.

The development of capabilities in hurricane monitoring and prediction are a crucial matter to reach an effective EWS. Almost all countries in the Caribbean and Central America area are highly dependent on the NHC products in the framework of the WMO region IV coordination. This ensures access to basic information. However, under the direct impact of a hurricane, national monitoring capability plays the main role, and many countries are not able to assume this responsibility.

Regarding this last topic, the National Hurricane Center plays a very important role in the Early Warning System strategies in the Caribbean, including Cuba. However, this role cannot be a substitute for those of the national weather services. Unfortunately, many governments in the area do not have a strategy to build capacities and leave almost all warning responsibilities to the NHC.

The achievement of adequate EWS is only possible when national authorities (political, public and private, all together) have the will to make a sustained commitment in establishing measures to educate and protect people. And this is the most difficult task.. It may be unreachable for many countries in the current century...

Appendix 2: Outcomes of Recent Early Warning Systems Meetings

The Second International Conference On Early Warning: 16–18 October 2003

Published by the International Institute for Sustainable Development (IISD), www.iisd.org/
Vol. 26, No. 1, Monday, 20 October 2003

Presentation of Conference Outcome and Follow-Up:

Sálvano Briceño, ISDR, introduced the draft document "Effective Early Warning to Reduce Disasters: The Need for More Coherent Action at All Levels," which contains the recommendations of EWC-II. He said that the document responds to: an increasing disaster burden; a growing recognition of the role of early warning; slow progress in effective use of warnings; specific proposals generated by EWC-II; and the need for an organized international approach. The document identifies five focus areas for an international early warning programme:

- better integration of early warning and related disaster risk reduction and management into development processes and public policies;
- improved data collection and availability for forecasting on different time scales and investigating long-term risk factors;
- improved capacities and strengthened early warning systems, particularly in developing countries;
- development of people-centered warning systems; and
- mechanisms for sustaining the early warning dialogue and supporting the development of the programme.

In conclusion, Briceño emphasized that there is a new and urgent opportunity to develop early warning as a contributor to disaster impact reduction. He noted the commitment of partner institutions to collaborate in building a structured programme for the future. He said that this begins of a new phase in the continuing process of dialogue and productive collaboration.

Presentation of Conference Statement:

Briceño then introduced the draft EWC-II Statement. In the Statement, the Conference considers that natural disasters are increasingly becoming an impediment to achieving sustainable development goals, and recognizes that:

- disasters are a result of natural hazards and of human, social, economic and environmental vulnerability;
- disaster reduction is an essential component of relevant global agendas;
- progress has been achieved in understanding early warning since EWC'98; and
- ISDR provides a suitable framework for advancing early warning as an essential tool for reducing risk and vulnerability.

The Statement calls for:

- integration of early warning systems into government policies;
- support by governments and relevant organizations to implement early warning systems, as recommended by EWC-II, and to integrate the future programme into disaster reduction strategies at all levels;
- the programme to focus on integration of early warning into development action, improvement of data collection, capacity enhancement, people-centered warning systems, and mechanisms to sustain the early warning dialogue; and
- ISDR action to facilitate the implementation of the early warning programme, sustain the dialogue and mobilize resources to strengthen capacity at regional, national and local levels.

The Statement welcomes Germany's offer of additional support to ISDR, invites other governments to contribute, and expresses appreciation to the German authorities for hosting EWC-II. In the ensuing discussion on the two EWC-II outcomes, one participant suggested including a definition of early warning, and several proposed using the terms "natural phenomena," or "natural and human-induced environmental disasters" instead of "natural disasters." Briceño said the term "natural hazards" had been used wherever possible. Participants noted insufficient consideration of risk management, vulnerability, gender, local wisdom and traditional knowledge in the Statement. A proposal was made to expand the invitation to support the early warning programme to development agencies and private institutions, and to add a provision on promoting transboundary cooperation and technical data exchange. Germany confirmed its commitment to additional contributions to ISDR. Japan announced that it will submit a draft resolution to the UN General Assembly on its intention to host a world conference on disaster reduction in Kobe, in January 2005.

Closing Remarks:

In his closing remarks, Hans-Joachim Daerr, Federal Foreign Office, Germany, called for implementation of the recommendations of EWC-II, and for continued research and exchange of views on early warning. Sálvano Briceño thanked participants, the German Government and the City of Bonn for support and hospitality provided for EWC-II, as well as all individuals, agencies and organizations that contributed to its success.

Overview of Early Warning Systems for Hydrometeorological Hazards in Selected Countries in Southeast Asia (Bangkok, Thailand).

ADPC (Asian Disaster Preparedness Center), 2002

Recommendations:

- Mitigation should be viewed as one part of an integrated disaster management system that includes sustained attention to risk management and mapping of vulnerable communities.
- There is an urgent need to promote community-based early warning systems based on maps of the vulnerable areas of villages, districts and provinces.
- Effective disaster management also requires coordination and cooperation between responsible agencies, institutions, officials, the media, political leaders and other players at local, national and international levels.
- Move towards a proactive approach and development of effective national and regional frameworks to facilitate prompt action. This can be realized through improved communications, mobilizing government support, raising awareness (impacts, safety measures, mitigation options and EWS) and building on existing knowledge and institutional structures and programs.
- Sustained political will is the most essential ingredient to establishing effective early warning capacity. Substantial progress may be achieved by capitalizing on momentum generated by international, regional and national level projects.
- With respect to seasonal and long-range forecasts, there is a need to enhance the technical infrastructure and capacity to produce, interpret and communicate seasonal and long-range forecasts. This need is most urgent in Cambodia, Lao PDR and Vietnam but the Philippines and Indonesia can benefit greatly from additional technical support as well.
- One way to strengthen existing EWSs is through ensuring the availability of trustworthy El Niño forecasts. Better forecasts will require application of new advances in modeling (statistical and dynamical) that enhance skill in downscaling, improve lead time, establish a community of trained technical personnel capable of forecasting, understanding the impacts of disasters and communicating this critical information to decision makers.
- In most countries the dissemination systems exist but are not maintained, in part because the sporadic incidence of hazards can lull decision makers into a false sense of security. Though in most countries the dissemination structure extends to the local level, the communication infrastructure is not effectively used. The reasons for the breakdown in communications need to be examined more closely and specific gaps need to be identified and bridged.
- As warning for hydrometeorological hazards is limited to the capacity of the existing infrastructure to forecast potential disasters, the mutual exchange and cooperation between the five countries would serve as an important tool for efficient early warning.
- Finally, effective communication channels between local meteorology and climatological agencies, other relevant agencies and stakeholders in potentially affected sectors need to be set up with some urgency in order to facilitate appropriate means of dissemination of warnings and other information.

Declaration of the Potsdam Early Warning Conference
(11 September 1998)
http://www.gfz-potsdam.de/ewc98/

The International IDNDR Conference on Early Warning Systems for the Reduction of Natural Disasters was held at the GeoForschungsZentrum in Potsdam, Germany from 7-11 September 1998. The meeting brought together 370 scientists, public officials, and representatives of the United Nations system, non-governmental and international organizations and diverse professional, commercial, and civic individuals from 86 countries. Together they comprised a wide and multidisciplinary range of experience, both as providers and users, of early warning and preparedness responsibilities related to natural disasters. The Potsdam Early Warning Conference represents the first major thematic component of IDNDR's concluding evaluation and provides recommendations to ensure disaster reduction into the 21st Century.

The conference was organized, with the support of the Government of the Federal Republic of Germany, within the framework of the International Decade for Natural Disaster Reduction (IDNDR 1990-1999), established by the United Nations General Assembly in December 1989. The subject of the conference dealt with an essential goal of the decade, expressed as a major priority of the Decade's Scientific and Technical Committee. It was included in the Plan of Action adopted at the 1994 World Conference on Natural Disaster Reduction in Yokohama, Japan, and was the subject of three subsequent UN General Assembly resolutions (between 1994 and 1997) on the improved effectiveness of early warning.

The conference was opened by the German Minister for Foreign Affairs, Mr. Klaus Kinkel, as an expression of Germany's support for disaster reduction in line with his initiative delivered at the UN General Assembly session in 1993 calling for improved early warning capacities for disasters that have an adverse effect on the environment. The subsequent discussions and presentations at the conference confirmed early warning as a core component of national and international prevention strategies for the 21st Century. The conference was closed with the issuance of this declaration.

The frequency and severity of natural disasters have increased in recent years, and these trends are expected to continue well into the next century. There is therefore a strong need to strengthen disaster reduction policies around the world to ensure that natural hazards do not result in economic and social disasters. Natural disasters have significant impacts on the economic development, physical sustainability and social well-being of all countries, particularly developing countries. They cause the loss of lives and human resources and threaten individual livelihoods. Disasters interrupt economic activity and destroy economic assets and financial investment. They also reduce private and corporate income, diminish job opportunities, cause declines in trade and commerce, and disrupt markets and business continuity. Disasters can result in the reorientation of public investment from economic development to the needs of urgent rehabilitations of infrastructure and other immediate emergency requirements. Consequently, disaster reduction measures, including effective early warning, contribute to the creation of a low

risk environment, thereby becoming a positive factor in international economic competitiveness and the maintenance of productive partnerships. Economic losses can be reduced considerably if a culture of prevention is introduced within a society at all levels - and particularly when local communities understand that response is not the only strategy when disaster strikes.

Participants shared their experience and identified opportunities provided by modern technology and scientific knowledge in conjunction with demonstrated commitments of public policy and local community endeavor. This has contributed to a concerted international framework for improved early warning capacities. They also made recommendations about information exchange, research priorities, technological applications, and institutional relationships that could result in the development of improved local capabilities. Many tragic events in recent years have demonstrated the cost of inadequate warning systems. By contrast, the successful application of local preparedness initiatives, such as those made possible by the effective communication of scientific analysis prior to the eruption of Mt. Pinatubo in the Philippines in 1991, among others, emphasizes both the feasibility and the value of early warning.

The successful application of early warning is among the most practical and effective measures for disaster prevention. It is a process that provides timely information so that communities are not only informed, but sufficiently impressed, that they take preparedness actions before and during the anticipated hazardous event. It depends on practical relationships between science and technology, and the understanding of social and economic implications of disasters in the context of sustainable development. Building on this foundation there is now a need to ensure that early warning of natural disasters becomes an integral part of government policy in every disaster-prone country, and that it forms an effective instrument for their preventive strategies. Ultimately, it must be comprehended by and motivate communities at greatest risk, including those disenfranchised and particularly disadvantaged people, who must take appropriate protective actions. In all of these cases, established organizational structures and already existing technical capacities should be considered first, rather than the assumption being made that new and possibly unproven systems may be best suited.

The Potsdam Early Warning Conference has identified major strengths and weaknesses in early warning capacities around the world. Participants repeatedly emphasized the multidisciplinary and multi-sectoral character of the early warning process. Although based on scientific and technology, early warning must be tailored to serve people's needs, their environments, and their resources. Successful early warning requires unrestricted access to data that is freely available for exchange. Ultimately, all resulting information must be credible, and emanate from a single officially designated authority.

Participants emphasized that early warning is effective only to the extent that policy makers at national levels of authority have the will, and make a sustained commitment of resources that will establish protective measures. It is crucial that these measures support the development of early warning capabilities at the community level and that they be based on local vulnerability and risk assessments. In all of these respects, the importance of training was stressed, as was the

requirement to provide resources for ongoing training activities, public education and the development of both technical and operational capabilities essential for early warning. Public authorities and private organizations concerned with early warning and related practices should realize the benefits of partnership in the development of technological innovation and related commercial opportunities. This may include the expanded use of technologies related to earth observation, telecommunications, and other information technologies, including geographical information systems. Equally important partnerships are those that match the needs of people exposed to natural hazards, with the information and technical capabilities provided through the cooperative efforts of public authorities and the private sector. It is particularly important to include disadvantaged groups of society as well as individuals having special needs. In order to extend the benefits of current applied research on early warning there is a need to promote continued development and practical use of commonly accepted standards for data acquisition, management, and exchange. Additionally, research is required to improve prediction capabilities and other methods which can reduce the consequences of natural hazards. Finally, it important that data and other scientific information which is available is adequately translated into early warning systems and forecasts of potential natural disasters, so that protective action can be taken by concerned authorities.

Presentations at the Potsdam Early Warning Conference demonstrated significant improvements in long-term forecasting of climate anomalies, such as El Niño episodes, which enables more rapid and extensive warnings pertaining to climate variability. Through its International Framework, the IDNDR can bring early warning activities, such as this, to the forefront of global and national disaster reduction policies. An immediate example where this may be valuable is to bring the results of the Potsdam Early Warning Conference to the attention to the first intergovernmental meeting of experts on the El Niño (ENSO) phenomenon. This meeting has been called for by the fifty-second United Nations General Assembly and is being organized in Guayaquil, Equador, from 9-13 November 1998 specifically to enable the conclusion of early warning issues in the review of the 1997-1998 El Niño event.

Conclusions

Considering the preceding discussion of the deliberations that took place at the Potsdam Early Warning Conference, the participants have drawn the following conclusions which must be seen in a larger context than this meeting. They can only achieve their true value by being translated into concrete actions.

1. Early warning represents a cornerstone of disaster reduction. It should, therefore, become a key element of future disaster reduction strategies for the 21st Century that are to be formalized in the conclusion of the IDNDR.
2. Effective early warning depends upon a multi-sectoral and interdisciplinary collaboration among all concerned actors, as demonstrated during the Potsdam Early Warning Conference.
3. While early warning capabilities must continue to be strengthened at the global level, it is important that greater emphasis be given to developing capacities that are relevant, and responsive to, the needs of local communities.

4. The issues of early warning for natural disasters (and similar disasters which have an adverse effect on the environment) should be brought to the highest levels of deliberation within the United Nations system and intergovernmental fora at regional and international levels.
5. Before the conclusion of the decade specific successor arrangements for the continued promotion of disaster reduction should be made in order to ensure, inter alia, the continuing integration and evolution of early warning at the local, national, regional, and global levels of responsibility.
6. Prepare an action plan resulting from the conclusions and recommendations of the Potsdam Early Warning Conference, within the IDNDR International Framework of Action, that will serve as the basis for the final IDNDR recommendations on improved early warning into the 21st Century. This should be presented to the IDNDR Programme Forum in Geneva in July 1999.

Appendix 3: Participants

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Appendix 4: Agenda for EWS Workshop in Shanghai, China

Sunday night, 19 October

7:00 pm to 9:00 pm	Informal get-together at the LaoFanDien Hotel,

Monday, 20 October

8:30 am to 9:30 am	Introductions by CAMS, CMA, NCAR, NSF
9:30 am to 10:15 am	Why this meeting? Roundtable introductions
10:15 am to 10:30	ISDR overview of Bonn EWS Conference held 16-18 October 2003
10:30 am to 11:00 am	Break
11:00 am to 11:45 am	Brief discussion of types of EWS
11:45 a.m. to 12:30 pm	Aspects of EWSs: The Basics
12:30 pm to 2:00 pm	Lunch
2:00 pm to 2:45 pm	Early warnings in a changing world
2:45 pm to 3:30 pm	EWS in theory and in practice: foreseeability, transparency, and accountability
3:30 pm to 4:00 pm	Break
4:00 pm to 4:45 pm	Expectation for early warning systems
4:45 pm to 5:30 pm	Sustainable development, EWSs, and politics

Tuesday, 21 October

8:30 am to 9:15 am	Reviewing the notion of ‘lessons learned’
9:15 am to 10:00 am	The Politics of Early Warning
10:00 pm to 10:30 am	Break
10:30 am to 11:15 am	The Cascade of EWSs

11:15 am to 12:45 pm	What is SWOC?
12:45 to 1:45 pm	Lunch
Free afternoon	
8:00 pm to 10:00 pm	Hollow Square at the Hotel ---- TOPIC related to China and its use of EWSs

Wednesday, 22 October

8:45 am to 10:00 am	SWOC revisited (continued discussion)
10:00 am to 10:30 am	Break
10:30 am to 11:15 am	Reliability and credibility of an EW
11:15 am to 12:00 pm	Communicating what to whom?
12:00 to 1:30 pm	Lunch
1:30 am to 2:15 pm	Institutional factors: Bureaucratic responses to EWSs
2:15 pm to 3:00 pm	"The role of the media and NGOs in EWS"
3:00 pm to 3:30 pm	Break
3:30 pm to 4:15 pm	An EW for new EWS-related developments?

Thursday, 23 October

9:00 am to 9:45 am	"Late lessons, early warnings": An open discussion
9:45 am to 10:30 am	Early Warning Capacity Building
10:30 am to 11:00 am	Break
11:00 am to 12:15 pm	Future Activities

ADJOURN

Appendix 5: Viewbook