Reducing the Impact of Environmental Emergencies through Early Warning and Preparedness: The Case of the 1997–98 El Niño

Lessons Learned from the 1997–98 El Niño: Once Burned, Twice Shy?

A UNEP/NCAR/UNU/WMO/ISDR Assessment
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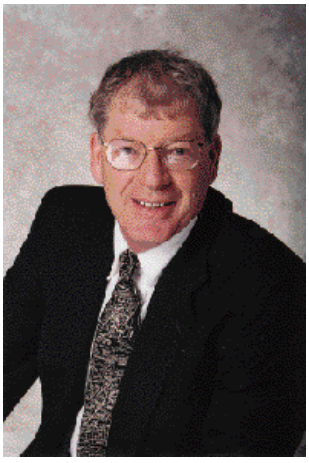
Contents

Foreword

ONCE BURNED, TWICE SHY?



The idea behind the adage “once burned, twice shy” is that when someone has had a bad experience he is likely to shy away from putting himself in that same position again. He has learned from experience what he might expect if he were to repeat the first experience in the same way.

This raises a question about whether societies that are forced to cope with recurring natural hazards learn from history. Not every natural hazard has to become a natural disaster. In fact, this adage ***should*** apply as well to societal (political, economic, social or cultural) responses to El Niño forecasts and to El Niño impacts. In the case of El Niño we will have to wait and see if societies are still “shy” once they have been “burned.” Most likely, we will not have to wait too long before this perspective is tested by reality.

I think that it is safe to assume that the most intense “El Niño of the 20th century,” the 1997–98 event, served as the most recent and most effective “wake up call” to governments, industries and publics around the globe that a shift from the west to the central and eastern part of the basin of a pool of warm water in the tropical Pacific Ocean can affect weather systems and human activities worldwide. Clearly, the countries around the Pacific Rim and those around the tropics are most directly and visibly affected by such a warm water shift.

The overriding purpose of this project has been to identify what worked and what didn’t work with regard to societal responses to the forecasts and impacts of the 1997–98 El Niño event. The approach taken was to look back to see what might have been done differently if an accurate (hypothetically perfect) forecast had been available several months in advance of the onset in March 1997 of El Niño. As a result of such an assessment in 15 countries and in the Panama Canal Zone, several lessons were identified in each country study, and many of the lessons proved to be similar among the countries as well.

Problems in coping with the impacts of an El Niño event, and possibly of other natural hazards as well, centered on jurisdictional disputes among government agencies, forecast reliability, lack of education and training about the El Niño phenomenon, political and economic conditions (or crises) existing during the event, lack of resources to cope in a preventive or mitigative way, lack of donor sensitivity to the local needs, poor

communication, lag time between forecast and impacts and between impacts and responses, responses and reconstruction, and so on.

The sad fact is that many of the lessons are those that have been identified for other countries facing a wide range of types of natural hazard. That means that "the word is out," so to speak, about what the problems are and how to address them, at least in theory. What seems to be lacking are the actions to remove the weaknesses and to reinforce the strengths of society's responses to these hazards. It is time for governments to confront the obstacles to needed changes in the way they respond to natural hazards. In this regard social, economic and political solutions must be sought. A blind faith in or dependence on new technologies such as high-tech early warning systems is not enough. The questions that should now be addressed in open forum are such questions as the following: What are the solutions needed for a more effective response to El Niño-related societal and environmental impacts? Why are many of those solutions known by governments, researchers and individuals, but not applied?

While one can find acceptable reasons to excuse any of the inappropriate responses taken by governments, industries or individuals to the 1997–98 El Niño, that should not be the case when it comes to the next El Niño events. The '97–98 event can be said to have served as a "dry run" or a test response to El Niño. And, there are good reasons that governments responded the way they did (a war going on, low credibility of the forecast, unclear teleconnected impacts of El Niño, etc). However, awareness of the El Niño phenomenon and what it can do to societies and economies is now high. As we are between El Niño events, the time is right for societies to improve their understanding of the phenomenon and to devise ways to better cope with its potential direct and indirect effects.

Resorting to an old adage to sum up, the time the farmer should fix his leaky roof is when it is NOT raining. The time to prepare for El Niño is when there is no El Niño under way.

Michael H. Glantz
Principal Investigator
October 2000

El Niño

Spawner of Hazards

In each country every year there are likely to be climatic anomalies that go beyond the range of what is considered to be normal. Because human activities are geared toward normal climate, it is these anomalies that concern societies. When what is considered to be normal does not occur, individuals, corporations and governments have to decide how best to respond. For example, farmers do not want climate conditions to be either too favorable for agricultural production (leading to over-production and low prices) or too unfavorable (leading to bankruptcy for some farmers). El Niño events are major disrupters of what most people view as their normal climate. In locations where El Niño is associated with regional or local climate variations such as droughts and floods, El Niño forecasts can provide decision makers with the earliest warning possible of an increased risk of such adverse climate conditions.

El Niño can briefly be defined as the anomalous appearance of warm sea surface temperatures in the central and eastern equatorial Pacific Ocean from time to time. The Southern Oscillation refers to a seesaw-like pressure pattern in the western part of the tropical Pacific. El Niño originally referred to the appearance of warm water off the coast of Peru and Ecuador, where the upwelling of deep cold ocean water normally occurs. By the 1970s, it was realized that these two Pacific Basin phenomena interact affecting climate processes around the globe.

ENSO:

The basin-wide phenomenon is referred to as ENSO (El Niño-Southern Oscillation). ENSO has both a warm and a cold phase. The cold phase is referred to as La Niña, and El Niño is the warm phase.

Many governments already know about the problems sparked by the impacts of climate anomalies but, for a variety of reasons, have not taken the steps necessary to cope effectively with those often devastating impacts.

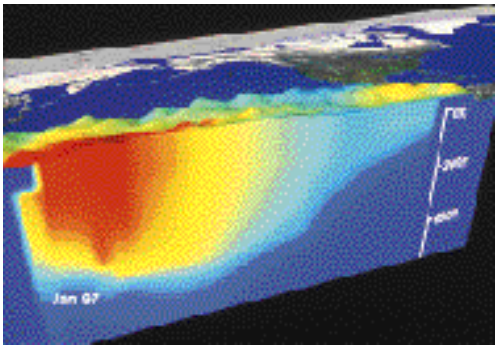
When responding to an El Niño event, one of the most important considerations for decision makers is to know the social, economic, and environmental conditions that existed at the time of the onset of the event. How a country responds to El Niño's impacts will be in large measure a function of how vulnerable it is at the time of the event. The same country plagued by the same natural hazard of the same level of intensity but at two different times will most likely be affected in different ways.

This document presents several of the lessons learned from the 1997–98 El Niño episode. The lessons are synthesized from an El Niño impacts assessment study performed in sixteen countries: Bangladesh, China, Costa Rica, Cuba, Ecuador, Ethiopia, Fiji, Indonesia, Kenya, Mozambique, Papua New Guinea, Panama, Paraguay, Peru, the Philippines and Viet Nam. Several of the study's findings proved to be similar to those that have appeared in other independent reports on societal responses to early warnings of climatic, oceanic, and geological and hydro hazards, among other life-threatening hazards. This points to another issue in need of attention: many governments already know about the societal problems sparked by the impacts of climate anomalies but, for a variety of reasons, have not taken the steps necessary to cope effectively with those often devastating impacts. Collectively, these reports provide governments and others with ***usable*** scientific information for climate impact reduction.

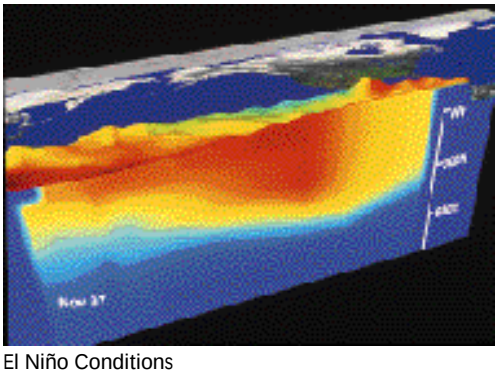
The 1997–98 "El Niño of the Century"[1]

El Niño reappears at intervals of 2 to 10 years with an average return of 4 ½ years. Once an El Niño event begins, it can last from 12 to 18 months, and sometimes as long as 24 months. The socio-economic and even political impacts on society of El Niño-related climate anomalies, such as droughts, floods, fires, frosts and infectious disease outbreaks, often last much longer.

1. Based on the WMO Retrospective (WMO, 1999)



Normal Conditions

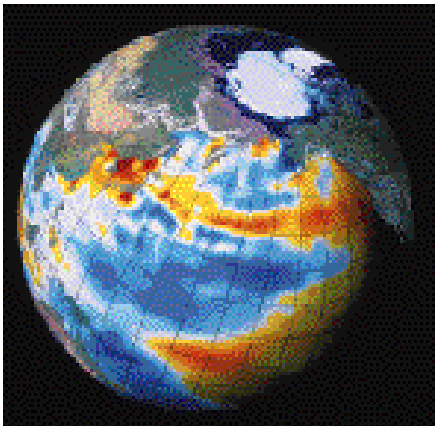


El Niño Conditions

El Niño events can have different levels of intensity from weak to very strong, depending on how warm the ocean surface water gets, how long it remains well above average, how much of the ocean's surface it covers, and how deep the warm water is. El Niño's impacts around the globe will vary. The severity of those impacts are also affected by the degree of vulnerability in a given society, and that degree of vulnerability can vary from one event to another.

During mid-1997, sea surface temperatures across the central and eastern equatorial Pacific Ocean became much warmer than normal, as a major El Niño event developed. In fact it was so intense that some scientists have labeled it the "El Niño of the Century," taking that title away from the 1982–83 El Niño.[2] Rain-producing cloud systems, i.e., deep tropical atmospheric convection, in the western Pacific Ocean shifted eastward. As a consequence, flood-producing heavy rainfall occurred in many parts of the usually dry western coastal regions of South America. Also, as the rain-producing cloud mechanisms shifted eastward, drought conditions prevailed over the western Pacific and Southeast Asian region. The El Niño event ended in June 1998, as unexpectedly and as rapidly as it had developed a year earlier. Sea surface temperatures in the tropical Pacific rapidly returned to normal and then months later a La Niña event developed, lasting well into the year 2000.

The destruction worldwide of the intense 1997–98 event made El Niño a household word just about everywhere on the globe, even in remote rural areas.



The event brought international attention to the risks posed by the climate-related extremes that El Niño can spawn, particularly in the developing world. Loss of life, destruction of infrastructure, depletion of food and water reserves, displacement of communities and outbreaks of disease all occurred as manifestations of climate-related natural disasters that were concurrent with the 1997–98 El Niño event. Estimates of global loss range from US$ 32 billion (source: Sponberg, 1999) to US$ 96 billion (source: Swiss Re, 1999).

The UN General Assembly took note of the intensity and global extent of natural disasters and requested the Secretary-General, as reflected in Resolutions 52/200 and 53/185, to develop a strategy within the framework of the International Decade for Natural Disaster Reduction (IDNDR) to prevent, mitigate and rehabilitate the damage caused by the El Niño phenomenon. As a response, the Inter-Agency Task Force on El Niño was created in December 1997. It provided a platform for combining efforts to improve the general understanding of the El Niño phenomenon, for disseminating early warnings and for channeling technical assistance and capacity-building resources to Member States threatened or affected by El Niño- and La Niña-related disaster impacts. The World Meteorological Organization (WMO), the UN Environment Programme (UNEP), the Intergovernmental Oceanographic Commission (IOC, UNESCO) and the International Council for Science (ICSU) working together with the IDNDR Secretariat organized the scientific program for the First Global Assessment of the 1997–98 El Niño event in Guayaquil, Ecuador, in November 1998. The report of the meeting, "The 1997–98 El Niño Event: A Scientific and Technical Retrospective" is available in several languages at the WMO.

2. Labeling El Niño events in such a way is very subjective, because El Niño events as such became a prominent focus of research during the 1970s. Relatively little detail has been gathered as yet on the impacts of earlier events.

Lessons
from the 16-Country UNEP Study

The UN Environment Programme (UNEP) was awarded a grant by the UN Foundation, and in cooperation with the National Center for Atmospheric Research (NCAR) (Boulder, Colorado, USA), carried out a study of the impacts of the 1997–98 El Niño event on sixteen countries in four major areas: Asia, Southeast Asia, Subsaharan Africa, and Latin America. The study was a partnership among United Nations agencies in addition to UNEP and NCAR's Environmental and Societal Impacts Group: the World Meteorological Organization's (WMO) World Climate Program, the International Decade for Natural Disaster Reduction (IDNDR, now the International Strategy for Disaster Reduction, ISDR) and the UN University's Environment and Sustainable Development Programme.

This assessment reviewed the forecasts and impacts of the 1997–98 El Niño, as well as the climate-related early warning and natural disaster preparedness systems in the selected countries in order to improve their ENSO coping mechanisms. Based on this assessment, the project identified research and policy needs and developed suggestions for regional and national disaster preparedness plans for ENSO warm and cold events and their impacts.

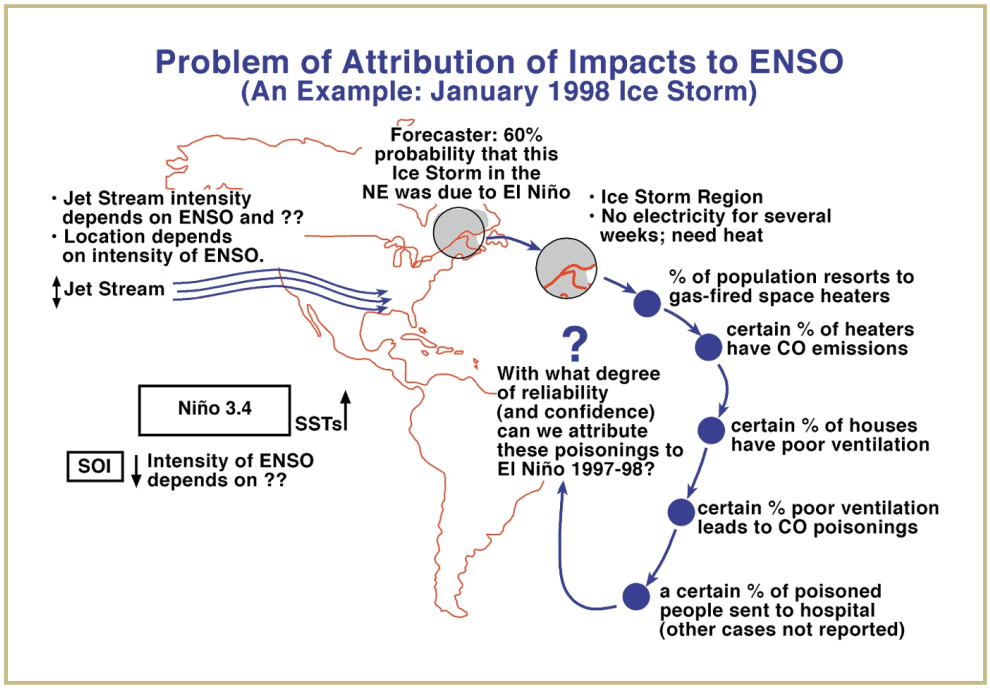
Teleconnections Drive the Severity of Impacts

Teleconnections:
Scientists refer to the process of associating a climate anomaly or its societal impact with the ENSO phenomenon, thousands of miles away from the central Pacific Ocean, as one of "attribution." The relationship is referred to as a "teleconnection." Teleconnections can be identified by observing physical processes or by statistical studies.

For some countries or regions within them, the teleconnections of climate-related anomalies with El Niño or La Niña events are very strong and are, therefore, considered reliable enough for use in decision making. For other countries such associations are likely to exist but may be less clear. Teleconnections can be further categorized by their timing of onset of the various phases that an El Niño goes through during its life cycle (onset, growth, peak, decay). ENSO's extreme warm (El Niño) and extreme cold (La Niña) events can disrupt regional and local climates around the globe to varying degrees and in a variety of ways, but especially in the tropics and, most directly, in countries that border the Pacific Ocean. Armed with details, individuals and groups as well as governments can develop appropriate seasonal response strategies that can mitigate the harmful impacts or enhance potential benefits. The fact is that any advanced warning of the onset of an ENSO extreme can provide usable information to those prepared to use it in decision making.

For some countries or regions within them, the association (called teleconnections) of climate-related anomalies with El Niño or La Niña events is very strong and is, therefore, considered reliable enough for use in decision making.

While the ENSO phenomenon and its extremes are not yet considered to be natural hazards, they clearly spawn hazards such as droughts, floods, fires, frosts, cyclones, and infectious disease outbreaks around the world. This means that ENSO-related forecasts can provide a society (or an individual or a corporation) with the ***earliest warning*** of potentially disruptive climate anomalies, even in locations where the teleconnections are not yet considered to be very robust.



Because several different kinds of hazards can occur in a country simultaneously, it can be difficult (but not impossible) to attribute with certainty a particular negative societal impact to a specific hazard. For example, the 1991–92 El Niño occurred at the same time as a major drought and the eruption of Mt. Pinatubo in the Philippines. To what extent was the drought influenced by El Niño, the eruption, or some combination of the two? Likewise, the 1982–83 El Niño and the eruption of El Chichon in Mexico occurred at the same time, making it difficult to determine El Niño's impacts worldwide from those of the volcano's emissions into the stratosphere. The volcanic events may have modified the effects of the El Niño events, but it is more likely, for example, that they simply masked our ability to observe from satellites the effect on such environmental conditions as sea surface temperature. The January 1998 ice storm in Canada is another example of the problem of attribution. It appears (from research) that the El Niño may have been a contributing factor to this damaging ice storm. However, it is not possible to draw a general conclusion about the influence of El Niño events on the formation of major ice storms over eastern Canada.

The 1997–98 "El Niño of the Century"

Governments must pay close attention to the subtle long-term influence of El Niño on sustainable development. The devastation caused by a drought lasting but a season can set in motion adverse ripples in the socio-economic system that can continue for several years. Agricultural losses during a drought can reduce export earnings that a developing country needs to meet its budgetary goals. Not only do the geographic impacts of El Niño need to be understood, but also its delayed impacts over time. Thus, a single El Niño-related drought (or any drought for that matter) could reduce a country's standard of living.

An appropriate analogy to a country's attempts at development that are periodically disrupted by El Niño (or La Niña) would be that of mythical Sisyphus pushing a boulder up a hill only to have it roll back to the ground before reaching the top. He must begin the process again and again.

Although many governments, corporations and individuals become alerted to El Niño once it has been forecast, their responses will depend on the level of confidence they have in the forecasts. While the climates of some countries have reliable teleconnections to El Niño, others do not. The same applies to El Niño's impacts on different economic sectors as well. For example, whereas teleconnections from the perspective of Chinese authorities may be perceived as weak, the authorities in Brazil or the Philippines consider their teleconnections to be strong. So, responses from different governments to the same El Niño forecast can vary by a wide margin. This underscores the need for regional and national studies.

El Niño-related teleconnection information can be used to create maps of "at risk" populations, regions and sectors of society. Such baseline information is useful for the development of El Niño-related responses by individuals, groups and governments. The preparation of at-risk maps requires international and national financial and moral support for national studies related to El Niño (and La Niña).

Need for attribution and understanding teleconnections

Scientists and the media often refer to El Niño's environmental impacts as if they had directly affected an entire country. Yet, seldom is a whole country, typically one with diverse topographical features, affected by the same El Niño-related anomaly. For example, during El Niño the Pacific coast of Costa Rica tends to suffer from drought. However, its Atlantic coast usually remains wet. As another example, northern Peru during El Niño suffers from floods, while the southern part usually suffers from El Niño-related drought. Northeast Brazil suffers from severe drought during El Niño, while southeastern Brazil is plagued by heavy rains and flooding.

Users of El Niño information need to know the degree of reliability of the teleconnections attributed to ENSO's extremes as well as the location and type of their sub-national impacts. In this regard and for the sake of the forecast users, forecasters need to include "error bars" with their forecasts – what they estimate to be the forecast's degree of reliability. Armed with such information, governments can plan to mitigate expected impacts in at-risk areas that have previously been identified. Under conditions of reliable attributions, governments can establish El Niño-specific forecast and disaster-response institutions.

Forecasting El Niño and Its Impacts

The more relevant the forecast to a potential user, the more likely it will be used. Also, the more reliable and the more detailed the forecast, the more widespread will be its use. Forecasts must be timely and provide lead time adequate for making plans to cope with the climate-related problems that El Niño spawns. Some people convincingly argue that forecasts about the potential societal impacts are needed more urgently than forecasts of El Niño's onset. Thus, ENSO-related forecasts should be of interest to all government ministries and not just those primarily concerned with disasters.

Forecasts about the potential societal impacts are needed more urgently than forecasts of El Niño's onset.

There are other troublesome concerns for the users of forecasts: for example, which forecaster(s) should they believe? With the advent of widespread interest in El Niño and with the growing access to the Internet and the World Wide Web, users are bombarded with scores of interpretations and predictions about the future state of sea surface temperatures in the tropical Pacific. How are they to distinguish between the reliable groups and the numerous ad hoc groups that emerge for the purpose of making forecasts of the onset of an El Niño? For example, only one forecast group made a reasonable forecast of the onset of the 1997–98 El Niño. But, was it based on good science or just a lucky guess? Even if it was a correct forecast, one must ask how well that group did with previous forecasts. Why did the dozen or so forecast groups around the globe miss making a correct forecast of the biggest El Niño of the century in 1997–98? El Niño research and forecast communities must determine how best to remedy this situation, so that users can identify bona fide sources and rely on their forecasts.

This problem is made more difficult by the fact that the forecasters of El Niño have had a mixed record of success and failure. In the world of forecasting, such a mixed record of success and failure leads to a popular belief that forecasts of ENSO's extremes are not very reliable, despite the fact that there may be an occasional success. The record of success for forecasting El Niño's (and La Niña's) impacts, however, is considerably better for some locations than it is for forecasting the onset of the event itself.

Despite the current scientific uncertainties surrounding the forecasting of ENSO's extremes, researchers must work to show policy makers at all levels of government the value in their use of basic ENSO information. This knowledge can be used to guide pro-active decisions involving El Niño-related disaster responses and to guide long-term sustainable development programs. It is also imperative that the scientific and forecast communities identify ways to reduce the level of public skepticism about the utility and reliability of climate and weather forecasts.

ENSO-related forecasts should be of interest to all government ministries and not just those primarily concerned with disasters.

One factor that leads to skepticism about forecasts (and, therefore, to inaction following the release of an El Niño forecast) is related to contradictory signals. For example, it is difficult for most decision makers to believe forecasters that a drought will be coming, if the country is in the midst of a rainy period, or vice versa. As another example, in the midst of a good commercial fishing season, it would be difficult, if not impossible, to convince fishermen and fishmeal processing plant owners that fish catches will drop drastically some months in the future because an El Niño episode might be emerging. Making such projections in the absence of visible signs of change is as risky for the forecasters as it is for users to take such projections seriously enough to act on them. In many countries forecasters fear that they will have to bear considerable personal responsibility for incorrect actions that decision makers might take if the forecasts are off the mark and disaster ensues. From the perspective of a forecaster, it may be safer in many instances to avoid making assertive forecasts that might prove to be controversial later. This brings to mind the adage, "take a position, take a risk," and most forecasters try to avoid taking such risks with their jobs.

The public, policy makers and educators must be introduced to the many ways that climate variability influences human activities and ecological processes. They also need to know about the various ways that climate forecasts can be used in the sustainable development of society and economy.

Importance of forecasts at sub-national level

The lessons learned by each of the sixteen country-study teams for their countries centered around the following: There is a lack of belief in the reliability of El Niño-related forecasts for many regions around the globe. To date most forecasts are presented in terms of whole countries, e.g., Ethiopia, Mozambique, Indonesia being affected by drought or Peru and the USA being affected by floods, but, as noted earlier, rarely is an entire country affected by the same climate hazard at the same time. Thus, such geographically generalized forecasts are at risk of being seen as failures by different regions within a country.

The public, policy makers and educators need to know about the various ways that climate forecasts can be used in the sustainable development of society and economy.

Reliable information about potential sub-national impacts is often absent. However, local users of these forecasts desperately need detailed information in the forecasts for effective planning. Such detail includes information about the probable onset of the event and its likely societal impacts, its magnitude, its duration, and so forth. Armed with such detailed forecasts, governments could identify the level of risk to its food-producing regions by determining if those regions might be at risk to drought or flood or some other climate-related hazard. If so, they could plan to adjust their exports and imports of food products accordingly. The Panama Canal provides another example: Canal operators need the earliest warning possible in order to be able to advise shipping companies about the increased likelihood for drought-related shipping restrictions in the Canal. This would

provide shippers with enough time to plan when and what to ship through the Canal or whether to ship around it.

Forecasts and the public

It is important to provide people in all parts of a country (rural as well as urban) with El Niño information, including forecasts and impacts. Urban populations are most frequently made aware of potential anomalies and impacts earlier than those in the rural areas. This disparity can be remedied by using the radio (as opposed to TV or the Internet) which people in the rural and poorer areas are more likely to have available. In the age of "high-tech," it is still very important to make full use of the radio as an important primary, as well as backup, channel of communication.

Often climate experts provide their forecasts in terms of probabilities, which many individuals do not readily understand. Therefore, the information provided to the public needs to be presented in plain language. To achieve this, different methods must be developed to convey timely climate information to the public and policy makers in a way that helps them to receive the intended climate message.

It is important for government agencies to identify the positive aspects of El Niño and not focus only on the negative.

Forecasting positive impacts

It is important for government agencies to identify the positive aspects of El Niño and not focus only on the negative. While some parts of their country or some sectors of their economy are negatively affected by an event, other parts might actually benefit. This does not mean that one balances out the other from the perspective of those directly affected – those who lose, lose; those who win, win. However, a system could be devised beforehand so that there is a sharing of the gains with those who are negatively affected. Identifying "winners and losers" of El Niño-related impacts deserves the attention of government leaders who are truly interested in identifying the real costs or benefits to their country of El Niño-related climate anomalies.

Forecast surprises

Each El Niño has some unique features that are not captured by the description of an average event and, as a result, there are likely to be surprises when a new El Niño event appears. For example, in response to the forecast in Costa Rica of the onset of the 1997–98 event, cattle were moved from the drought-prone northwestern part of the country along the Pacific coast to the country's wetter north central region. However, an unexpected drought occurred there as well, resulting in the death of thousands of the cattle that had been relocated there for protection.

Therefore, it must be remembered that other climatic processes continue to operate during an El Niño event. Often, these other processes may dominate locally and confound the normal or expected effects of El Niño. Ultimately, further research on the climate system will allow these other effects to be incorporated more effectively into forecast methodologies that are at present based predominantly on ENSO-related processes.

Information – Who Knows What and When

An old political adage suggests that "information is power." This adage is as relevant to El Niño forecasting as it is to politics. Whoever has a reliable El Niño forecast first is in a position to use it to his or her advantage, and sometimes to the detriment of others. Depending on how far in advance of an El Niño a forecast is received, the forecast can be used either for short-term (tactical) responses to climate anomalies or for responses that require longer (strategic) lead times. Furthermore, El Niño information (not just a forecast) can be valuable for long-range economic development planning for such sectors as agriculture, water, energy, manufacturing and public health.

Transparency of information to stakeholders

Transparency or openness, as it relates to El Niño, can increase trust among government agencies, scientists, forecasters and the public. At the very least, it can create awareness as well as educate, alert, and prepare people for the risks they may face from El Niño-related climate anomalies.

Transparency also requires forecasters and researchers to present an honest appraisal to governments and the media about the state of their capability for El Niño forecasting and an honest picture of their knowledge of the ENSO phenomenon. Transparency between governments and donors is also necessary, so that the needs and expectations of both about disaster assistance are well understood.

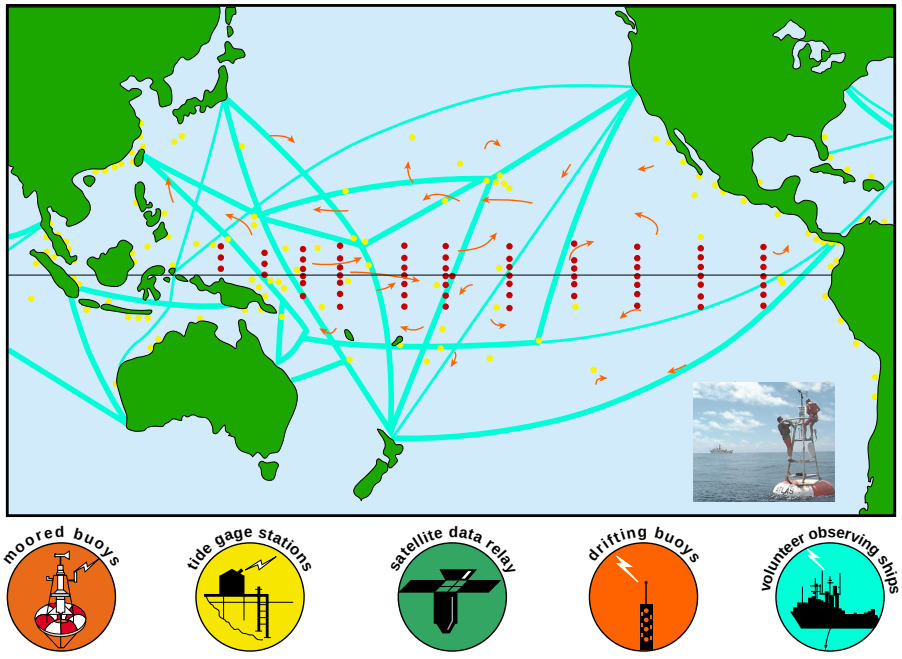
In many countries there are inter-ministerial rivalries and jurisdictional disputes. However, for the public good, such jurisdictional rivalries must be set aside, when it comes to dealing with El Niño-related hazards. Ministries need to establish close cooperative relationships to share their hazard-related information with other agencies in a timely way about potential impacts and about mitigative strategies and tactics that might be pursued.

Transparency between governments and donors is also necessary, so that the needs and expectations of both about disaster assistance are well understood.

Raising public awareness about El Niño

Governments should support the educational needs of their citizens about El Niño specifically, and more generally about climate-society-environment interactions. It is, therefore, important to organize multidisciplinary climate-related educational efforts that enable government personnel, the public and representatives of various economic sectors to become more aware of these issues. For their part,

ENSO Observing System



governments and corporations at all levels need to undertake post-disaster reviews following each major hazard and disaster, whether El Niño-related or not. The impacts of subsequent hazardous events will likely be mitigated, as a result of lessons learned.

Use of new technologies for information gathering and dissemination

Many governments do not have the human skills and financial resources to carry out national high-tech monitoring and forecasting activities focused on ENSO's extreme events. As a result, their meteorological services depend on the research outputs and forecasts from other countries. While the technology and expertise needed to make El Niño forecasts may be lacking in many countries, it is important for each country and the sub-regions within it to develop the expertise needed to assess the forecasts that have been produced by experts in other countries.

In addition, some countries do not have access to the latest research about climate's influence on society. As a result, trust must be developed between them and those that are climate-related "information donors." Information donors should assist the recipients of their climate-related information to undertake capacity building related to El Niño. As part of the capacity-building process, local officials should be encouraged to monitor as best they can El Niño and La Niña impacts.

Each of the sixteen country-study teams called for improving weather and climate monitoring in their regions. They recognized the value of a well-designed network of recording stations to collect meteorological information. Great value was seen in establishing a network of fixed ocean buoys in the Indian Ocean similar to the array of buoys completed in the equatorial Pacific in the mid-1990s. Scientists now realize that changes in the Indian Ocean can influence, if not overshadow, the expected impacts of an El Niño in some regions in Asia and Africa.

It is important for each country and the sub-regions within it to develop the expertise needed to assess the forecasts.

There is an urgent need to improve the efficiency and transmission (especially timeliness) of early warnings and forecasts of impacts associated with ENSO's extremes, at all levels of government from national to local. Although the Internet provides a useful tool for closely watching changes in the ENSO cycle of warm and cold events, it should serve only to complement national efforts and not replace them.

A Look at Societal Aspects of El Niño

Usefulness of forecasts to societies

It is easy to argue that El Niño forecasts are very useful to societies – to governments as well as to corporations and individuals. While people may understand to some extent the climate of the region in which they live, they are not necessarily aware of the many direct and indirect ways that its variations can influence their livelihoods. However, societies have to learn how best to use that forecast information for disaster preparedness and economic development planning. How to educate society about climate-society interactions is a major challenge to the meteorological community and to educators.

Public education about El Niño to improve societal response

Scientists and the media have helped to make El Niño a household word. As a result, people around the globe have a heightened awareness of what impacts they might expect in their regions. In a sense, scientists have successfully broadcast the notion of El Niño. The next stage is more difficult because El Niño forecasts must be tailored to the different needs of specific users. Such increased public awareness, training and education programs need to be carried out, especially in the at-risk areas.

Although there remains considerable uncertainty with El Niño forecasts, people must be educated about the El Niño phenomenon and how best to cope with it. As difficult as it may be to explain climate-related probabilities to the public, the scientific community must respond to the challenge. It is important, however, to make people realize that, even though they make preparations in response to an El Niño forecast, there will still be adverse impacts with which they will have to contend. Even the most industrialized societies have difficulties in protecting their countries (i.e., what they have called "climate-proofing") from climate variability and from extreme climate-related events.

A first step toward educating people about the ENSO cycle involves "educating the educators," who would in turn educate the public. Today, the public tends to blame many of society's ills on El Niño. Yet, many of those ills may have nothing to do with El Niño. Researchers can help the public and the media to determine which ills might legitimately be blamed on El Niño and which might be blamed on human activities. The need for climate-related education will vary from sector to sector and from user to user.

Although there remains considerable uncertainty with El Niño forecasts, people must be educated about the El Niño phenomenon and how best to cope with it.

While El Niño is a global phenomenon emanating from the equatorial Pacific Ocean, its impacts are local. Communities need a much-improved understanding of the ENSO cycle and its potential local societal and ecological impacts. Education, as an aspect of capacity building, must be carried out at all levels of society and not just at the highest political levels. Such education would go a long way toward improving societal interactions with the climate

system in general and, more specifically, with the ENSO process.

Governments must support programs that produce personnel who can understand and use information derived from the monitoring and predicting of El Niño and its impacts. They need to reinforce the training of disaster managers, impacts researchers, and those who require training to identify a country's at-risk populations and regions.

Funding to lessen societal impacts

Many of a government's problems that are related to difficulties in dealing with the forecasting of disasters center on inadequate funding. Several of the countries that are considered to be most vulnerable to El Niño's impacts are especially in need of financial assistance to carry out programs to cope with its occurrence. While the will of a government to take appropriate actions may exist once an El Niño event has been forecast, the financial mechanisms must also be in place at the time to enable the government to carry out those actions.

Countries most vulnerable to El Niño's impacts are especially in need of financial assistance to carry out programs to cope with El Niño's occurrence.

Along the same line, disaster-related funding from a national government to its regional and local governments needs to be made quickly to allow the funds to be used in an effective and timely way. This would enable those responsible at the local level to respond pro-actively, as they are truly on the frontlines

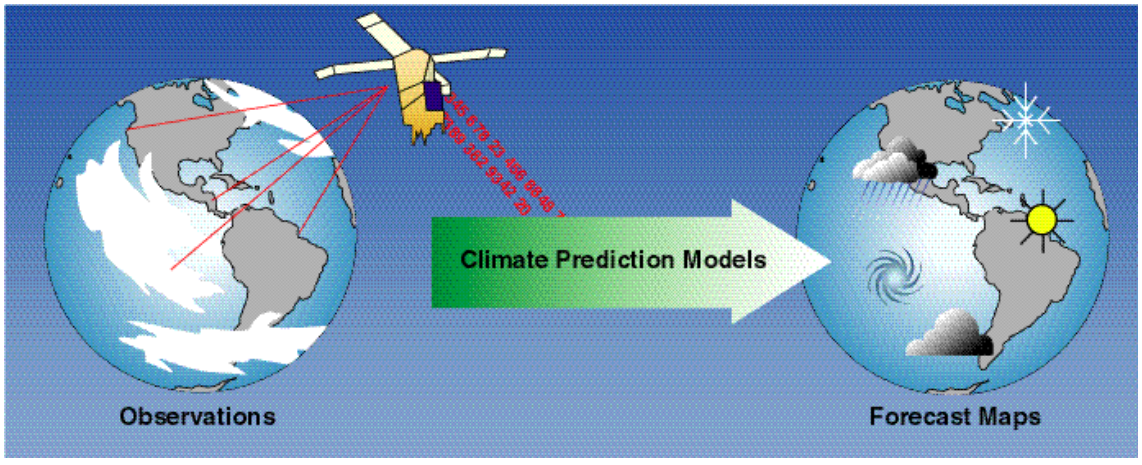
of disaster impact, response, reconstruction and recovery. International funding responses to a disaster must also occur quickly to be effectively used by the affected regions. More importantly, such funds must be made available between ENSO's extremes, not only during them. This would enable preventive measures to be developed and implemented under normal, as opposed to crisis, conditions.

Role of media in how society responds

A primary function of a country's media is to inform the public, fulfilling an educational role. Forecast of the onset of the ENSO cycle is apparently a major global news event. However, once the unusual weather patterns end, media interest wanes. Fostering media interest in El Niño between extreme events can build public understanding of the phenomena and of the steps required to mitigate their effects. Scientists, and not just the national meteorological services, must strive to convince the media of the importance of El Niño information to society and to encourage the media to run stories about the ENSO cycle between the onset of its extremes.

Understanding the Scientific Issues Underlying El Niño

The level of scientific development varies widely from country to country. Some governments place a high value on maintaining a strong research establishment, while others consider that to be a lower priority than dealing with chronic societal problems such as unemployment, poverty, and public health. Some governments see no reason to use their scarce resources in a competition with other countries to produce global climate assessments. Rather, they have chosen to receive such assessments from elsewhere and then to modify them to meet national and local needs.



Importance of focused and localized scientific research

At the least, it is important for governments to maintain a national scientific establishment that is capable of using research results from other countries for its societal benefit. More specifically, it is especially important for at-risk countries to improve the ability of their scientific communities to understand the ENSO cycle and its implications for decision-making by individuals, corporations, government agencies and national policy makers. This is prudent because preventive measures can then be identified and pursued, and prevention is often less costly than restoration.

National scientific establishments need the support of their governments, as well as international donor agencies, to undertake studies on regional and local teleconnections related to ENSO's extremes. The carrying out of such studies would also help to broaden national expertise in El Niño studies. This is an area of capacity building where donor assistance will be most beneficial. To reinforce such a scientific capacity-building effort, it is important for national governments to give significant weight to the assessments and views of their own national scientists. In the past, some governments have given greater credence to the assessments of foreign experts than to those their own national experts.

Communication within the scientific community

As the impacts of an El Niño ripple through society and economy, a cascade of uncertainty will accompany those impacts from first to second to third order (called "knock-on") effects. The increase in the level of uncertainty that surrounds these knock-on effects must be accurately conveyed by scientists to the users of El Niño information.

National scientific establishments need the support of their governments, as well as international donor agencies, to undertake studies on regional and local teleconnections related to ENSO's extremes.

It is very important to encourage research on the ***socio-economic setting*** of each country at the time of onset, in addition to scientific research on the physical and societal impacts of El Niño. The impacts of El Niño can clearly be mitigated or worsened by the existing conditions of the country's political system, infrastructures, environment and economy. Because these socio-economic and political conditions vary over time, an El Niño of the same magnitude in the same place but at a different time can, as noted earlier, generate totally different impacts. Thus, there is a strong need for multidisciplinary studies that involve the physical and social sciences and the humanities.

Role of National Institutions in Responding to El Niño

In many countries, political involvement at the highest level is required to marshal an appropriate level of government response to El Niño in an effective and timely way. Once the head of government or head of state publicly takes notice of El Niño, a government becomes quickly mobilized to deal with it. This was clearly the case at the onset of the 1997–98 event in Peru, Ecuador, China, Viet Nam, the Philippines, and Ethiopia.

Importance of interagency cooperation

Various government ministries need to be involved in El Niño-related activities, because no single ministry is capable of coping with the wide range of potential impacts. Different agencies have different experience and expertise that would likely be required at various times throughout the ENSO warm-cold event cycle. However, only one agency should be responsible for final actions, so that lines of authority and responsibility are clearly identified. Agencies to be imvolved should include those related to disaster management, climate-sensitive sectors such as agriculture, water, energy, public safety and health, as well as those concerned with economic development. Non-governmental organizations (NGOs) should also be included in El Niño-related activities from the outset.

The establishment of an inter-ministerial task force devoted to ENSO could help to reduce overlapping ministerial efforts and reduce competing jurisdictional disputes. Good cooperation and communication among a country's scientific institutions could go a long way toward producing a coherent message to the public about El Niño.

Institutions must review their operations during the 1997–98 El Niño event to identify strengths, weaknesses and jurisdictional constraints and conflicts in institutional responses to the forecasts and to the impacts of El Niño. Limited resources, such as time and people, make it difficult to review past events, their impacts, and a government's responses. Nevertheless, "hindcasting" must be undertaken to distinguish between those strategies and tactics that worked and those that did not.

Conflicting interests

Conflicting interests among citizens within a country, for example, between the "haves" and the "have nots," are worsened in times of a climate-related emergency. It is often the poorer populations who live in at-risk areas that tend to suffer an inordinate proportion of damage to life and property. During such times of emergency need, government actions could serve to close the gap between these two groups by providing, with donor support, appropriate and timely assistance.

Institutions must review their operations during the 1997–98 El Niño event to identify strengths, weaknesses and jurisdictional constraints and conflicts in institutional responses to the forecasts and to the impacts of El Niño.

It is important to recognize the fact that, no matter how well a society might prepare for the potential impacts of an El Niño event, it is likely to suffer significant damage. Making the public aware of this fact should help to minimize criticism of governmental responses to those impacts once the emergency has ended. Governments have to cope with many issues and problems simultaneously – climatic, hydrologic, geologic, political, demographic, economic and military – often with very limited resources. In a paired comparison between these problems and climate issues, problems related to climate might not be considered as important as other pressing social, economic, political or military issues.

In addition, there are varied impacts within a country and sometimes an expected El Niño-related climate anomaly (such as drought or flood) does not occur, but an unexpected one does. Governments

cannot prepare for all possible El Niño-related hazards, so they must weigh the risks, making difficult choices about which hazard(s) is (are) the one(s) to which they are most likely to have to respond.

Diverting limited available resources to deal with potential El Niño-related problems that might arise in future months is a difficult action for many governments to take, especially if there are no visible signs (as yet) of its negative impacts. Regardless of the recognized value of pro-action to deal with its impacts, considerations of El Niño's impacts are often delayed in favor of other pressing issues . . . until the next event has been forecast or, in some cases, until the impacts of the next event begin to appear.

Individual governments should create supra-national regional organizations devoted strictly to the ENSO phenomenon, as has been done by the countries along the Pacific coast of South America.

Integrated response is a must

Often, international donor agencies tend to treat the national recipients of aid as being in an inferior bargaining position. There are many examples of inappropriate donor actions that were either useless or counterproductive to the emergency. For effective and timely disaster reduction, therefore, international donors and recipients must interact as equal negotiating partners. Donors and recipients alike must rethink the validity of the budgetary distinctions and restrictions they make between emergency-disaster and long-term development assistance.

Individual governments should create supra-national regional organizations devoted strictly to the ENSO phenomenon, as has been done by the countries along the Pacific coast of South America. ENSO is a significant disrupter of national economies and national well-being. It does not respect international borders. Regional El Niño- and La Niña-related disaster plans can be developed less expensively than if each country in a region were to go its own way, as has often been the case. Even if neighboring countries are at odds over a variety of issues, the threat of adverse ENSO-related disasters can spark a modicum of ***"disaster diplomacy."*** This appears to have been the case in Central America, following the devastation caused by Hurricane Mitch in late October 1998.

Economic development and impact studies

Government policy makers must realize that climate affects their policies in both good and bad ways. They must realize that El Niño information can be used not only for disaster early warning but also for enhancing the prospects of sustainable development over the long term. Hence, government authorities need to encourage the study of climate-society-environment interactions.

Researchers need to undertake an inventory of climate resources in their countries. Broadly defined, such an inventory includes more than just meteorological data. It includes an identification of climate-related costs as well as benefits. It must also include domestic and foreign sources of climate information as well as climate-related development assistance. Doing so would require a focus on climate impacts on regions, institutions, disaster management, and economic sectors. Impact studies encompass climate's impacts on both managed and unmanaged ecosystems and on society.

Defining a management paradigm to cope with El Niño

There are several management issues raised by El Niño-related impacts. First, there should be transparency in those agencies dealing with those impacts. Transparency means that there will be openness and honesty in information about the El Niño phenomenon, the forecast, and its potential impacts. At-risk regions, populations and sectors should be identified and notified in a timely way.

Second, disaster plans and policies need to be backed up by adequate expertise and funding. National expertise should be maintained, if not strengthened, over time so that government agencies can call on it for ENSO-related experience whenever the need arises. Funding from donor agencies is an important

aspect of national disaster response for a variety of reasons: it helps to build national expertise (capacity building); it shows commitment of donors to disaster preparedness; it enhances the prospects for long-term planning instead of fostering a reliance on ad hoc reactions; it enhances logistical efficiency; it enables a government to maintain its infrastructures (transportation, health, communications).

Third, it is important for the donors and the recipient governments to improve their trust, dialog and relationship with each other in order to enhance the timeliness of response and appropriateness of assistance. Recipient governments have a responsibility to get the funds to the at-risk regions in time for decision makers in those regions to prepare to cope with the potential impacts. Local people must be involved in the planning at the national level for responses to El Niño forecasts and impacts. If expertise is lacking at that level, then a comprehensive education and training program needs to be put in place.

The ENSO cycle merits, where appropriate, its own autonomous government management structure. A well-defined El Niño emergency management structure encompassing national to local levels should be developed and maintained, even though El Niño (warm) events recur on an irregular time interval (at some time between 2 and 10 years). Administratively, a lead agency, among equals, should be identified. Agencies involved in this structure must take their responsibilities seriously. Part of its responsibility would be to periodically review national and local disaster management plans. This can be done at a relatively low cost by evaluating their country's responses to the 1997–98 event or an earlier event that had affected their country.

Understanding the Social, Economic, and Political Setting

In discussions about responses to El Niño's impacts on a country's socio-economic and political structure existing at the time of onset of either one of ENSO's extreme events, many comments appear to be no more than political rhetoric. Few could find good reasons to disagree with such platitudes as: "strengthen the economy," "reduce poverty," "saving lives is the highest priority," or "maintain the infrastructure." The reality is that when it comes to the potential impacts of natural hazards, including those sparked by El Niño, these statements are indeed highly relevant.

Reassessing the status quo

Many adjustments are likely to be required in the ways that societies operate to make El Niño earliest warnings more effective. Such societal changes might include, for example, a change of bank credit policies, a strengthening of infrastructure for transportation, communication and health, or identifying the currently at-risk populations, regions and socio-economic sectors. Also, environmental degradation must be taken into account in such assessments because existing degradation can magnify the adverse impacts of El Niño in different locations.

Many adjustments are likely to be required in the ways that societies operate to make El Niño earliest warnings more effective.

Not unlike other sectors of society, in the case of public health, many factors interplay to make an existing bad situation much worse in the event of an El Niño, e.g., existing poverty, an economic "meltdown" (as was the case in Asia in the late 1990s), inadequate public health facilities, and even the International Monetary Fund's restructuring policies (as was the case during the 1991–92 El Niño in Zimbabwe). Thus, a corps of national researchers, financed by their governments and international donors, is needed in order to distinguish between the physical impacts that can clearly be linked to El Niño from those that result from human activities.

Inter- and intra-national "brain drain"

Developing countries face a seemingly intractable "brain drain" problem, as trained personnel leave their countries to join UN and other international organizations and non-governmental organizations. The brain drain also occurs within countries, because trained personnel are forced to take additional jobs in order to support their families. They are forced to do so, because the pay for their work in science is insufficient to meet the needs of their families. The "brain drain" issue must be addressed in an international forum to identify how to minimize in an equitable way the outflow of expertise from the developing to the industrialized world.

Political change and challenges

A change in government is yet another obvious, but often overlooked, factor affecting a country's ability to respond to recurrent disasters such as those spawned by El Niño and La Niña. When a government is changed, whether by violent or non-violent means, the incoming government often discards many of the policies established by its predecessor. That's politics. However, when it comes to disaster preparedness, including El Niño responses, it is imperative that the incoming government administration not discard or neglect existing policy and plans only for political reasons.

Use of Forecasting by Analogy as a Predictive Tool

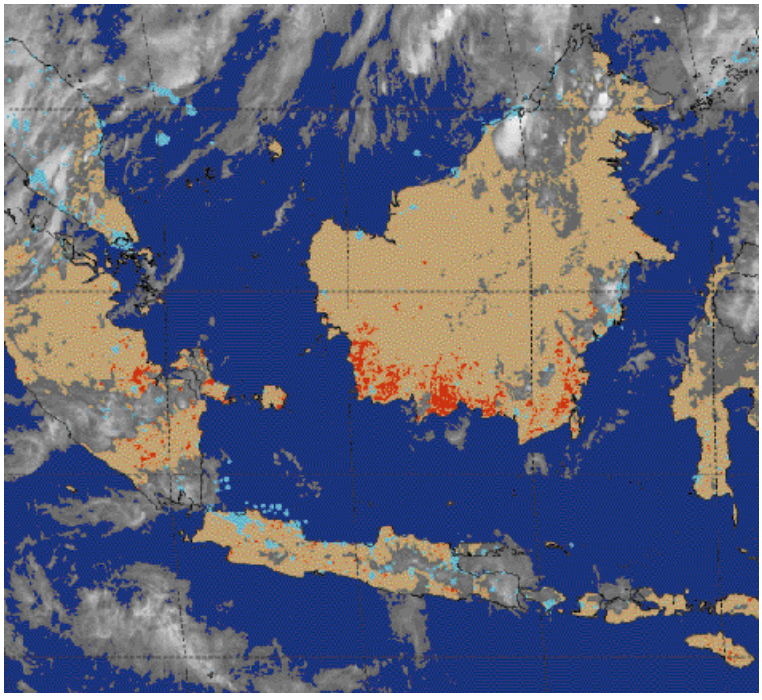
Forecasting by analogy (FBA) refers to the process of assessing the impacts on society of recent climate-related anomalies and assuming that, in the absence of any societal changes, similar anomalies in the near future are likely to have similar impacts. Such analogies can help to identify strengths and weaknesses in societal responses to recent droughts, floods, fires, frosts or cyclones. This would enable societies and their governments to reinforce those strengths and overcome the weaknesses in the face of future similar extreme climate and weather events spawned by the extremes of the ENSO cycle.

Forecasting by analogy can provide a government (and society in general) with quantitative and qualitative information on the impacts of previous El Niño events. While there is no certainty about the similarity of future impacts to those of the past, an historical retrospective does provide a glimpse of possibilities for which a society might prepare.

All governments must look back to the 1997–98 El Niño event, labeled by scientists as the "El Niño of the Century," and to the lengthy 1998–2000 La Niña event as well. A retrospective assessment would help them to gain insights into how such changes in sea surface temperatures in the tropical Pacific Ocean might affect their local climate regimes for good and for ill. FBA can provide disaster agencies with an opportunity to review how well their contingency plans worked in 1997–98 and, if necessary, make adjustments to them. This can be done agency by agency as well as at the inter-ministerial task force level.

Forecasting by analogy can provide disaster agencies with an opportunity to review how well their contingency plans worked in 1997–98 and, if necessary, make adjustments to them.

Such retrospectives can provide ideas in a preliminary way about the strengths and weaknesses of their institutions, when confronted by an ENSO extreme. For example, given the known linkages between an El Niño and the increase in forest fires in Indonesia (and the resultant haze throughout Southeast Asia), that government must maintain fire prevention programs and enforce compliance with them. By similar analogy, the United States must apply vigilance across the forests of the northwest and southern tier of the country during prolonged La Niña events. National researchers should be encouraged and supported financially, both domestically and



Fires in Borneo (shown in red), 21 September 1997

internationally, to undertake their own comprehensive national assessments. The studies described in this document offer a model for such assessments.

FBA assessments provide a government with insights into regions, sectors and populations that are likely to be at increased risk during an El Niño event. For example, since the early 1970s, many researchers have focused on the impacts of El Niño on Peruvian fisheries but few, if any, had given any thought to its devastating impacts on Peru's textile industry. As another example, the 1997–98 El Niño had a negative effect on the mining sector in Papua New Guinea, because the Fly River went dry as a result of severe drought. As a result, supplies could not be shipped by river transportation into or out of the mining region. Few, if any, studies have looked at El Niño's impacts on the mining sector. Thus, FBA can help government agencies to produce El Niño and La Niña vulnerability maps. It would be misleading, however, for decision makers to rely only on information about the last El Niño or La Niña, as impacts can vary from one event to the next.

Countries in the process of strengthening their scientific establishments can rely in the meantime on FBA techniques for an improved understanding of climate-sensitive physical processes, how these processes interact with human activities and ecological processes, and to identify potential El Niño-related problems before they occur. El Niño events come in different strengths, and various aspects of society are constantly changing. As a result, the impacts from one event to the next will not be exactly the same, even though there are sure to be some similarities.

The Need for Capacity Building

Many countries are in need of human capacity building in the area of climate impacts research and in ENSO-related sustainable development and disaster planning. Government agencies, policy makers, and the wide range of users of climate and weather information need to be made aware of the many not-so-obvious ways that climate variability affects their activities. The ENSO cycle is important to them, because it has predictive skill associated with it and because it lends itself to strategic decision-making.

Educators at all levels in a country's educational system should encourage their students to study climate-society-environment interactions. Building national capacity with regard to climate issues (climate change as well as ENSO and other climate-related extreme events) can reduce a country's dependence on outside expertise, if not for monitoring or forecasting, at least for analyzing the information they receive from abroad directly or by way of the Internet. This would help to improve the level of trust and respect between disaster-aid recipients and donors, when it comes to coping with disasters.

Educators at all levels in a country's educational system should encourage their students to study climate-society-environment interactions.

Local capacity building geared toward the interpretation of global forecasts and analyzing them for local use is an important aspect of disaster reduction. While the earliest of warnings can be made available to the public, people require education and training to interpret and use such warnings. For effective disaster mitigation, this expertise needs to be in place before the onset of a potentially disruptive El Niño event.

Capacity building at the national level can create and foster multidisciplinary expertise, while at the same time broaden existing disciplinary expertise. Both are needed for effective pro-active participation in national as well as international activities related to climate issues (e.g., research programs, education and training activities, workshops, conferences and scientific visits).

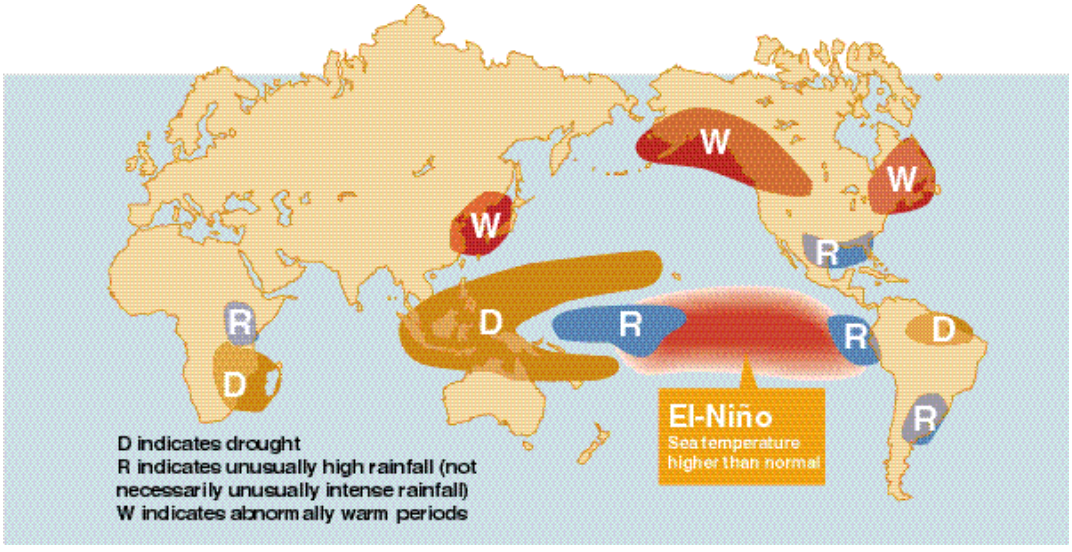
A Quick Summary of Lessons

In response to the UN General Assembly's resolution on El Niño, The WMO prepared a review of the science of the 1997–98 El Niño event. It was published in several languages by the WMO as The 1997–98 El Niño Event: A Scientific and Technical Retrospective. The IDNDR (now the International Strategy for Disaster Reduction, ISDR) was given the responsibility by the same UN General Assembly resolution to head an Interagency UN Task Force on El Niño. As part of its activities for this project, the ISDR identified lessons learned from coping with this event. A few of the highlights (suggested lessons) from the WMO, the ISDR, and from the country case studies are identified in the following paragraphs.

The 1997–98 El Niño event clearly demonstrated the useful and developing capabilities in the areas of climate monitoring and prediction, but the gaps in knowledge of the climate system, the gaps in monitoring coverage, and the early stage of development of climate forecasting models indicate the potential for significant improvement.

- El Niño is inseparable from broader issues of climate variability and change. This underscores the importance of a concerted effort on the part of governments and non-governmental organizations to continue research into climate variability, to improve forecast skill, and to develop appropriate policies for mitigating the impacts of climate extremes;
- Unless a concerted effort is made to prevent and mitigate the impacts, the extremes of climate variability will continue as a yoke of natural disasters burdening especially the developing world;
- The mitigation of the negative impacts of El Niño and other extremes of climate variability will require ongoing international support for the UN Climate Agenda;
- International commitment is critical to the development and operation of a Global Climate Observing System;
- To be fully effective, impact assessment studies at the national and regional levels should be multidisciplinary;
- Policies for the mitigation of the impacts of climate extremes should be integrated into sustainable development strategies;
- Governments must ensure that the appropriate scientific and technical infrastructures are adequately supported, and secondly, they must ensure that information and prediction services are accessible to policy and decision makers for planning, early warning and better management across a range of sectors, including natural disaster reduction;
- Effective climate information and prediction services require an appropriate framework where users recognize what is possible to predict, where the providers recognize what is essential to be predicted, and where the scientific information flow is in a form that can be readily assimilated in decision-making;
- Improved dialog and cooperation are needed between the scientific and technological areas of the UN system and between the UN's operational agencies with responsibilities for disaster management, humanitarian assistance, sustainable development, technical cooperation and capacity building;
- A crucial lesson of the IDNDR has been that effective disaster reduction strategies are possible and stand a better chance of being sustained if they are multidisciplinary in nature, and integrated within broader policy concepts pertaining to a society's economic growth and social development;
- A "Culture of Prevention" becomes even more important when applied to the consequences of recurrent phenomena, such as ENSO events, that can have both varied and severe social and economic consequences;
- It is necessary to appreciate that societal conditions of potential vulnerability are dynamic, affected as they are by changes in demography, land use, infrastructure development (or deterioration), etc. over time.

Specific Lessons from the Countries



Country responses to the forecast and impacts of the 1997–98 El Niño were evaluated for their strengths and weaknesses in order to identify ways to prepare for future events. Whether societies have learned from their recent experiences with El Niño will be tested during the next few El Niño episodes. The 1997–98 event served as a wake-up call to governments around the globe that El Niño can spawn adverse regional climate conditions that affect their society and economy in the short and long terms. Some of the key lessons learned in the 16 country case studies are presented here and are likely to apply to other countries as well.

Bangladesh

There was a low level of awareness about El Niño/La Niña impacts in Bangladesh before the present study. This study has made clear that El Niño/La Niña has a strong influence on monsoon weather patterns. However, there is an urgent need for further study to better understand and forecast El Niño teleconnections in such monsoon-affected regions as Bangladesh, India, Myanmar, Nepal, Sri Lanka and Thailand. As one of the most disaster-prone areas, Bangladesh must be integrated with existing international scientific and meteorological networks in order that it may better prepare itself with the benefit of forecasts, monitoring, and early warning.

China

It is necessary to improve communications between the meteorological community (weather services, research institutes, universities) and the public in order to close the gap that exists between scientific research and its application to society and economy.

Costa Rica

The level of detail of the El Niño forecast needs to be improved. During the most recent El Niño, the warnings were too generalized and therefore in some cases tended to mislead rather than inform. While correct in the forecast of a drought in Guancaste, cattle were moved to an area where no drought was forecast, but which later occurred, creating an intensified crisis.

Cuba

Because each El Niño or La Niña event has some unique aspects that are not captured in its average description, surprises are to be expected in terms of societal and environmental impacts. There is no typical El Niño, and a better job has to be done to prepare all levels of society – the public, the media, educators and policy makers – for a range of events.

Ecuador

Political, socio-economic and military problems will have to be dealt with by governments at the same time they are coping with an El Niño forecast or its impacts. In times of El Niño-related disasters, it is

imperative that rivaling agencies and ministries work together following the pre-established chain of command headed by the National Civil Defense, which is better prepared to cope with disasters than any governmental agency alone. The government must recognize the importance of weather and climate information, not only for disaster response but for development purposes as well.

Ethiopia

Involvement of the Prime Minister's office gave a level of credibility and importance to the 1997–98 El Niño forecasts.

There is a tendency to refer to whole countries when referencing El Niño's impacts. Yet, Ethiopia is known for its local small-scale climate regimes. It is important to better identify the regions and sectors that are vulnerable to the ENSO extremes. There should be an improved capacity of the regions, in terms of skill improvement, access to information and resources capability, to issue their own regional forecasts in order to make the forecast relevant to the local areas that have their own micro-climates. This could reduce the time spent in communication between the regions and the central government.

Fiji

A national drought plan of action would be beneficial for responding effectively to future El Niño-related droughts and other water shortages. An improved El Niño forecast capability would provide the earliest warning about drought. Because the drought tended to magnify chronic nutritional problems caused in part by low income, the lack of food and micro-nutrient deficiencies, there is a need for improved social and economic data collection to identify the at-risk regions and populations in order to improve disaster response.

Indonesia

Generalization of anticipated impacts of El Niño across large geographic areas of the country proved to be counterproductive. There are significant variations in impacts (and in climate-related as well as social and economic vulnerabilities) across different sectors and geographical locations in the country. Based on historical data and analyses, these variations could be studied and taken into account in dealing with the impacts of future El Niño events.

The role of intermediary organizations (such as agro-meteorological departments, forestry research organizations, crop production forecasting agencies) in translating forecasts into usable or actionable information should be adequately recognized. While the 1997–98 El Niño event brought into focus the role of meteorological agencies in providing timely and accurate forecasts, the intermediary institutions and their capacity for multidisciplinary response coordination have received relatively little attention.

Kenya

The national economic and political conditions at the time of the onset of an El Niño have been a major determining factor for its impacts on society. Roads and bridges in need of constant repair are highly vulnerable to a weather disaster, and the poor have few resources available for responding to disaster. The government needs to identify all of the country's climate-sensitive hazards and design plans to deal with them. Expertise should be channeled into a central coordinating unit to increase the effectiveness of monitoring and early warning.

Mozambique

Investments in weather forecasting are generally neglected because they are perceived to be high in cost and the results do not seem evident – until a disaster strikes. It is important to strengthen international and regional forecasting networks, and to include local participation. Forecasting cannot be considered something which belongs only to the industrialized Western countries.

Papua New Guinea

There is a need to involve a wider range of agencies, both government and non-government, in planning for, monitoring and responding to El Niño events and

not just those agencies focused on disaster-related activities. Also needed is a well-defined emergency management structure from the national to the local level, with clear responsibilities allocated to and accepted by all agencies involved.

Panama

New dams are under consideration as an answer to the need for better storage and provision of water within the Panama Canal's watershed. But for these measures to succeed, they must be accompanied by efficient water management and by early forecasts of warm events. Accelerated changes in land use in the Canal's watershed call for a permanent monitoring of the basin and an ongoing verification of models that simulate the response of the canal system to climate variability.

Paraguay

The reliability of El Niño-related forecasts needs to be improved for governments at all levels to take them more seriously, even though it appears that El Niño and La Niña events have significant impacts in the country. In this context, human and institutional capacity to undertake scientific research on El Niño needs to be developed and supported.

Peru

The ENSO cycle must be considered by policy makers as a recurrent event in national planning (civil defense, urban zoning, construction codes) rather than as an anomalous and temporary condition.

Philippines

Resources tended to flow for disaster preparedness and response, when the president took an interest in El Niño and set up an Interagency Task Force. However, local-level responses are increasingly seen as most effective in reducing the impacts of El Niño. The country is frequently affected by a wide range of natural disasters, but El Niño-induced drought has had the largest impact to its economy, which is largely dependent on agriculture. Early forecasts of El Niño's onset are critical in providing warning to a government with regard to both short-term emergency conditions and to long-term economic prospects.

Viet Nam

El Niño-related impact studies should be undertaken between El Niño events and not only during them when the focus is on disaster relief. There is a need for human and institutional capacity building in climate and climate-related impact assessment and disaster planning. There is a need not only for an improvement in the skill associated with El Niño forecasting but also with the forecasting of El Niño's likely impacts on society and the natural and built environments.

Acknowledgments:

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Graphic on page 20: Locations of fires detected the night of 21 September 1997 in Indonesia and Malaysia (Borneo) using data from the US Air Force Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). The OLS has a unique capability to perform low-light imaging of the Earth at night. Data processing by NOAA's National Geophysical Data Center, Boulder, Colorado. http://www.ngdc.noaa.gov/ngdc.html

Graphic on page 23: Climatic impact of warm El Niño event during October 1997 to March 1998. Adapted from Food and Agriculture Organization of the United Nations Fact File on El Niño.
http://www.fao.org/news/factfile/ff9716-e.htm

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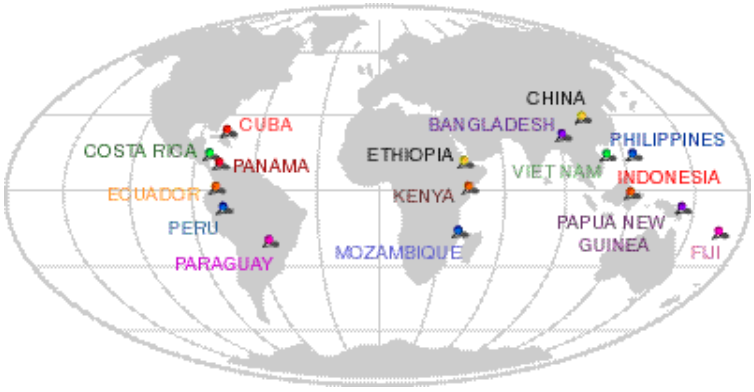

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